LAKE MONTAUK HARBOR, EAST HAMPTON, NY

NAVIGATION IMPROVEMENTS FEASIBILITY STUDY

FINAL

APPENDIX C: ECONOMICS

New York Department of
Environmental Conservation

U.S. Army Corps of Engineers
New York District

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1 INTRODUCTION

This appendix accompanies the Lake Montauk Harbor, East Hampton, NY Navigation Improvements Feasibility Study Final Report. This appendix is prepared in accordance with the Water Resources Council's Economic and Environmental, Principles and Guidelines for Water Related Land Resource Implementation Studies, dated March 1983 (USWRC, 1983). Included in this appendix is an evaluation of the benefits that would result from the proposed plan of improvement for Lake Montauk Harbor. Also included is the relevant information used in determining the impact of channel modification. The analysis included demonstrates the identification of the recommended plan which consists of deepening the authorized channel from 12 feet mean lower low water (MLLW) to 17 feet MLLW. This economic appendix concludes with the results of cost refinement in optimization for the recommended plan, identifying a final estimate of net national economic development benefits and confirming economic justification.

1.1 CATEGORIES OF BENEFITS

There are two ways that the deepening of the channel will provide national economic development benefits. First, a deeper channel enables higher values of commerce from existing fishing resources by allowing depth-limited vessels to operate in an optimal way. Second, coastal storm risk management (CSRM) benefits are produced as a necessary incident of the least cost method of placement the dredged material from the channel deepening and subsequent maintenance on the adjacent shoreline.

The next several sections will set forth the analysis that describes the way that these benefits have been calculated. In the first section, the manner in which the depth-limited vessels are operated in the currently authorized channel is illustrated. The next section presents analysis of the manner in which those vessels would be operated given various alternative improved channels. The final section describes the evaluation of the damages in the without project condition and the damages and benefits in the with-project condition in terms of: (a) the increase in economic efficiency that the various alternative improved conditions would make possible in terms of production of marketable fish and costs avoided, and (b) the incidental benefits as measured by U.S. Army Corps of Engineers (USACE) risk analysis produced during the time that this study was pursued under Public Law Number 113-2[1].

[1]Public Law 113-2 is the disaster relief appropriations bill in response to Hurricane Sandy, under which potential

2 DATA COLLECTION

Data on the commercial fishing operations detailed in the following analysis was collected from a variety of sources. Existing condition information reflects the actual fleet currently in Lake Montauk Harbor. Commercial fishing operations and vessel activity are informed by survey evidence of 10 fishing vessel owners/captains using a survey approved by the Office of Management and Budget, Approval Number 0710-0001. The survey was conducted in 2011 and updated in 2019. USACE followed up with 10 of the 11 vessels that identified as being constrained by the depth of the channel in the original 2011 survey. The owners/captains were asked their best estimates of the effect of the various depths on several key commercial outcomes. The purpose of the survey is to help determine if the benefits derived from the project will outweigh the costs. The survey focused on the additional commerce or cost savings that may be derived from a channel maintained at various depths: -12, -13, -14, -15, -16, and -17 feet MLLW. Information on existing conditions in terms of vessel specifications and typical commercial activity was collected.

The data collected from 10 vessel owners and captains yielded reliable responses based on the following three survey questions[2]. All of Question 1 has been reproduced here for illustrative purposes; Questions 2 and 3 are constrained to the question content for brevity.

1. Reduction in vessel repair and maintenance

   Based on records from the US Coast Guard as of 6 June 2005, there have been three reported groundings at Lake Montauk Harbor: F/V Jason & Daniele, 1/14/2000; F/V Wonder Lust, 1/14/2000; and F/V First Lady 1999. After speaking with some F/V owners, there was a consensus amongst them that not all the vessel groundings are reflected in the US Coast Guard records. There have been incidences where the vessels have scraped the channel bottom causing hull and propeller damage. There may also be savings in stretching out the time period from general maintenance such as hull repainting if the channel was deepened.

CSRM benefits were quantified for the Lake Montauk Harbor study. Coordination with non-federal interest and key stakeholders led the study team to focus on navigation improvements rather than CSRM measures, however, the information developed under PL 113-2 can still be used to explain incidental benefits to the proposed navigation improvements.

[2]The reader may think of additional potential benefits that are not quantified here. The approved survey requests that the captains estimate the effect of channel depth on two additional attributes: (1) reduction in total loss of fishing vessel, and (2) additional commerce from additional landings of non-quota fish. In these two categories, there was insufficient information for a reliable quantitative assessment. For the first category, vessel operators have no experience with the other channel depths and could not therefore provide reliable evidence of the incremental benefits at various channel depths. Responses are not provided for the second category

We would like you to place a dollar value on the avoided vessel repair and maintenance costs if the channel was deepened and maintained at 13 feet, 14 feet, 15 feet, 16 feet, and 17 feet. If you feel there is no savings until the channel is at least 14 feet, you can so indicate. Perhaps the savings is the same for 14 feet and 15 feet and the next increase in savings is for 15 feet. Please see Example 1 in Table 1 for an illustration. This example shows that the savings will begin at 14 feet and 15 feet with an annual savings of $25,000. The example savings at 16 feet and beyond is $30,000 a year. The survey respondents were provided with the opportunity to fill in their estimated savings on an identical table.

Table 1: Reduction in Repairs and Maintenance

Current Depth at Mean Low Water	Estimated Annual Savings
12 feet (Current Depth)	$0
13 feet	$0
14 feet	$25,000
15 feet	$25,000
16 feet	$30,000
17 feet	$30,000

2. Reduction in fuel and supplies used per trip

   Because of weather conditions that may prevent a fishing vessel from entering or exiting the channel, a fishing trip will be extended and extra fuel and supplies such as ice and food will be used. If a deeper channel will eliminate this loss of fishing time and result in a shorter fishing trip, we would like you to place a dollar value on this savings. This savings in fuel and supplies will also apply if you off-load your catch at a harbor farther than Lake Montauk because your vessel could not enter the harbor due to lack of channel depth. This would also apply if you have a vessel that is currently based at another harbor (for example, New Bedford), and you would save money by fishing out of Lake Montauk if the channel depth was deeper. We would like you to place an estimated dollar value on this savings for different channel depths.

3. Increase in income by commanding a higher value per pound for ex-vessel landings due to timeliness to market, freshness of fish and other market factors

   If the channel at Lake Montauk Harbor is dredged and maintained at deeper depths, your vessel may be able to bring the catch in port in a timely fashion and not occasionally miss the market for that day. For example, due to weather conditions, your vessel is unable to transit the current channel, and you have to wait several hours before coming into port and

will therefore be unable to truck your finfish to the Fulton Fish market for that day. You would have to keep your catch on ice for an extra day and this may result in a lower price for your finfish. If this scenario does exist, we would like you to place a dollar value on your annual increase in revenue from this factor for different channel depths.

The responses to Question 1 and 2 are consistent with expected transportation cost savings which is the typical benefit category of a navigation study. The responses to Question 3 measure the expected increase in the net value of the output of the fishing industry at this location by, among other things, getting fresher fish to market faster thereby commanding a higher value. The aggregate of vessel captains' and owners' responses over these three questions will be used for the derivation of the national economic development benefits. The responses were consistent across vessel owners/captains in terms of the substantial gains that could be achieved if the channel were maintained -17 feet MLLW. The information collected from the survey was further verified by site visits and field observations of vessels utilizing the inlet. The results of the survey outcomes and further details on their use in the derivation of project benefits are provided in Section 4. Data on the commercial activity produced out of Lake Montauk Harbor has been obtained from Commercial Fisheries Statistics, published by the National Marine Fisheries Service. Table 2 contains data on volume by weight and value in millions of dollars of annual fish landings that come through the port.

The commercial fishing industry operating out of Lake Montauk Harbor has seen moderate variation in the volume and value of fish landings coming through the port over the last two decades. While the volume of commerce was at its lowest level in 2017 at 10.1 million pounds, there is recent historical precedent for reaching nearly 15 million pounds per year.

The quantity and size of fishing establishments operating out of Lake Montauk Harbor from 2012 through 2016 is organized in Table 3. The information is sourced from the Census Bureau's American Community Survey, 4-digit NAICS/ZIP code level establishment data. In 2016, there were 17 establishments tracked by the Census Bureau with 1 to 4 employees each.

2.1 Existing Navigation

Lake Montauk Harbor can accommodate recreational craft and fishing boats. There are currently 18 marinas and five temporary docking and ramp facilities within Lake Montauk Harbor. The marinas have a total of approximately 1,235 dockside slips. Currently, the largest slip is 70 feet

Table 2: Lake Montauk Harbor Annual Fish Landings

Year	Millions of Pounds	Millions of Dollars
2018	11.3	17.3
2017	10.1	14.8
2016	11.8	16.3
2015	11.6	15.9
2014	11.8	16.9
2013	13.1	17.7
2012	14.8	21.2
2011	13	18.8
2010	12.9	17.7
2009	11.5	14.6
2008	11.2	14.3
2007	10.8	15.7
2006	10.9	16.8
2005	12.4	16.5
2004	12.3	13.1
2003	10.9	11
2002	11.3	11.1
2001	14.5	13.2
2000	12.6	13.1
1999	12.9	12.1
1998	12.7	12.1
1997	13.6	13.6

Source: `https://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/`

Table 3: Quantity and Employment Size of Fishing Establishments

Year	Establishments	Employment
2012	18	1 to 4 Employees Each Establishment
2013	21	1 to 4 Employees Each Establishment
2014	20	19 Establishments with 1 to 4 Employees and 1 Establishment with 5 to 9
2015	20	1 to 4 Employees Each Establishment
2016	17	1 to 4 Employees Each Establishment

Source: `https://data.census.gov/cedsci/`

long. A few of the marinas have slips designated for transient boats and fishing and charter boats. Lake Montauk Harbor has two town docks, one named Star Island with 23 slips and the other named Montauk Dock with 17 slips. Nearly all of these slips are occupied.

The heavy volume of vessel traffic using the federal channel consists primarily of pleasure and commercial fishing boats. The channel is used on average by 500 boats per day during the warmer months. The commercial fleet has consisted of up to 30 trawlers, 12 inshore and 7 offshore lobster boats and 53 long liners, including as many as 32 transient commercial fishing boats from other areas of the East Coast. Within the fleet, approximately 11 of the largest vessels are constrained by the current authorized channel depth of -12 feet MLLW.

The contract costs for recent U.S. Army Corps of Engineers maintenance dredging operations are shown in Table 4. These costs are used to develop the future without project conditions below. Approximately $350,000 for construction supervision and administration and 25% overall contingency were added to the contract cost to obtain the estimated overall maintenance cost in the last column of the table.

Table 4: Lake Montauk Harbor Maintenance Dredging Costs

Year	Volume (cy)	Contract Cost	Estimated Overall Maintenance Cost
2011	12,000	$400,000	$937,500
2014	19,000	$530,000	$1,100,000
2018	37,000	$780,000	$1,412,500

2.1.1 Problem Statement

There are two water resources problems in the study area.

1. Insufficient channel and harbor depth at various times, such as low tide, due to both the channel's currently authorized depth and it regularly being shoaled in above this depth.
2. In addition, erosion damages due to a combination of (a) navigation inlet jetties blocking some sediment flow and (b) coastal storm surge and wave attack, resulting in failure of bulkheads and damage to homes, businesses, and roads.

The existing federally-authorized 12-foot-channel and harbor depths cause some vessels to operate in a sub-optimal way through restricted channel use, longer-distance operations, and risk of dam-

age. Further, maintaining the channel depth and width has become more difficult with the accretion of sand on the eastern side of the east jetty. The sand migrates through and around the east jetty and continues westward into the federal navigation channel. Experience shows that maintenance dredging has been necessary every 4 to 5 years. As described in Section 2.1 above, maintenance dredging in the past several years has been necessary as often as every 3 to 4 years (2011, 2014, and 2018). In recognition of a need for maintenance dredging at least every 3 years, the U.S. Army Corps of Engineers determined that its maintenance work planned for the fall of 2018 should include advance maintenance of an additional 2 feet of depth to extend the estimated maintenance cycle from 4 years to 8 years.

Even with the advanced maintenance, some of the commercial vessels must still transit the channel during high tide periods, sail light-loaded (that is, at less than their full carrying capacity) or some combination of the two. This has the effect of reducing the productivity of the commercial fisherman in terms of the market value of the fish caught. Further, in the year leading up to the most recent maintenance operation, 9 vessels bumped the bottom of the channel even on departure when they were not loaded. For example, Jason & Danielle which has a fully loaded design draft of 16 feet must be operated with some combination of delays in commercial activity, intentional light-loading both in- and out-bound, and risk of hull damage. Vessel damages from these groundings have occurred. Finally, Lake Montauk Harbor is the easternmost harbor of refuge in New York and the only harbor of refuge on the south coast of Long Island for vessels westbound to New York Harbor and the New Jersey Coast, or eastbound to the open Atlantic.

In addition, beach erosion along the shoreline west of the western jetty of the federally-authorized navigation channel is an issue of concern to the local interests. The area of erosion extends for approximately 5,100 feet along this shoreline. The least cost disposal method of the dredged material is placement on the downdrift beach, and this disposal method produces incidental CSRM benefits. At the eastern end of this shore adjacent to the western jetty, there is 500 feet of stone revetment along West Lake Drive. The eroding shoreline is endangering West Lake Drive, the 35 residential properties behind the bulkheads, and the structures behind narrow dunes or bluffs in the unbulkheaded reach.

Experience from past maintenance cycles supports the proposition that this method of placement of the dredged material on the downdrift beach has favorable CSRM effects. Based on a comparison of historical shorelines, the average long-term erosion on the downdrift shoreline was approximately 2 feet per year up through jetty construction in 1926. Following jetty construction, the shoreline erosion rate increased to approximately 3.3 feet per year until 1980, but recent place-

ment of dredged material every 4 to 5 years since 1980 in combination with shoreline property owners hardening the shoreline in front of their development has, in effect, decreased this erosion rate to 2 feet per year again. Storm erosion and wave attack forces from recent nor'easters and Hurricane Sandy has caused additional rapid and extreme shoreline losses, bulkhead failures, and even damages to structures. Very little beach area remains even at low tide.

2.2 SOCIOECONOMIC CONDITIONS

A formal census update of post-Hurricane Sandy demographic information is not currently available, however information from the American Community Survey provides detailed socioeconomic information for the Town of East Hampton, Suffolk County, and New York State (U.S. Census Bureau, 2018). The population of the Town of East Hampton has grown quickly for the area and has experienced relatively strong economic conditions between 2010 and 2018. The population of the Town of East Hampton grew at 1.6% to 12,672 people. The population of Suffolk County grew at a slower pace of 0.4% from 2010 to 2018, while the population of New York State grew 2.0% over the same period. Employment trends from 2010 to 2017 follow a different pattern as growth in population; the Town of East Hampton experienced a 0.7% increase in employment, while Suffolk County employment grew at 2.1% and employment in New York State grew at 4.3%. Finally, real median household income is a third measure of the Town's socioeconomic status, and has grown by 15.5% to $97,943[3] over 2010 – 2018. While real median household income fell by 2.5% in Suffolk County, real income rose by 0.6% in New York State.

2.2.1 ENVIRONMENTAL JUSTICE

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" requires Federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its program, policies, and activities on minority and low-income populations in the U.S., including Native Americans. Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks," requires federal agencies to identify and assess environmental health risks and safety risks that may disproportionately affect children. The 2018 combined minority population is 21% in the Town of East Hampton and 31.49% in Suffolk County. Moreover, 9% of the population was living below

[3]Real median household income is measured at FY 2020 price level using the CPI: All Items Less Food and Energy.

the poverty line in the Town of East Hampton in 2018 (U.S. Census Bureau, 2018). This figure is of the same magnitude as the 7.1% of the population living below the poverty line in Suffolk County in the same year. Therefore, the study area that comprises Lake Montauk Harbor is not considered an Environmental Justice community.

2.3 Future Without-Project Conditions

The future without-project condition[4] serves as the basis of comparison in the analysis of all with-project alternatives. In the future without-project condition over the period of analysis of 2024-2073, the navigation channel operations and maintenance cycle is unchanged at 4 years. The depth of the channel is assumed to be maintained at -12 feet MLLW.

Currently and into the future without the project, fishing production is not fully realized. The 2011 survey evidence suggests that the sub-optimal production level occurs because the commercial fishing vessels are constrained by the depth of channel, and this is assumed to continue in the future without-project condition. The 2011 survey results were updated in 2019 with information from captains of 10 of the 11 depth-limited vessels that are most impacted by the current conditions of the channel. The survey evidence has shown that vessels demanding use of the harbor continue to grow in size, resulting in a growing level of inefficiencies over time. The growing number of depth-limited vessels in the future without-project condition would require extensive repair and maintenance from groundings and the like, would expend high levels of fuel and supplies used per trip (e.g. due to weather conditions preventing transit of the channel), would have low relative average value of commercial fish production as the timeliness to market depends on access to the channel, would obtain a low quantity of fish landings relative to potential (e.g. due to light-loading), and would experience a persistent risk of total loss of the fishing vessel. As a result of these inefficiencies, up to $2,325,000 of annualized commerce would not be not realized in

[4]The definition of the without-project condition, according to ER 1105-2-100, is "the most likely condition expected to exist in the future in the absence of a proposed water resources project. Proper definition and forecast of the future with-out project condition are critical to the success of the planning process. The future without-project condition constitutes the benchmark against which plans are evaluated. Forecasts of future with-out conditions shall consider all other actions, plans and programs that would be implemented in the future to address the problems and opportunities in the study area in the absence of a Corps project. Forecasts should extend from the base year (the year when the project is expected to be operational) to the end of the period of analysis" (USACE, 2017). From the same engineering regulation, the with-project condition is defined as "the most likely condition expected to exist in the future with implementation of a particular water resources project. Comparison of conditions with the project to conditions without the project will be performed to identify the beneficial and adverse effects of the proposed plans. These with and without-project comparisons provide the framework for the evaluation of alternative plans."

the future without-project condition. The survey evidence suggests that current and the future without-project operations occupy the nation's scarce resources in a sub-optimal way.

Littoral material estimated to be 10,000 to 12,000 cubic yards per year on average that is transported westward along the beaches east of the jetties will continue to supply the inlet system in the future without-project condition. The littoral material would sediment at a rate of 7,000 to 8,000 cubic yards per year and would have to be dredged and bypassed. Following the maintenance cycle that started in the fall of 2018 and will be complete in 2026, the U.S. Army Corps of Engineers estimated in 2018 that maintenance dredging will be required more often to maintain the authorized channel depth, producing 32,000 cubic yards every 4 years. This estimate is based on dredging history including the past several years, engineering analysis, and sediment budget. There will also be increased disturbance caused by more frequent channel maintenance. Further, the annualized maintenance costs (100% federal) would rise significantly beginning in approximately 2026 because maintenance dredging would be required every 4 years in the future without-project condition.

West of the inlet, the shoreline will continue to recede at approximately 2 feet per year. The existing erosion of the shores downdrift of the west jetty will continue to worsen due to storm waves and surges, the natural condition in which less sediment arrives on the western shoreline than is being transported away past Culloden Point, and the littoral sediment depravation of the western shores from the blocking effects of the jetties at the stabilized inlet channel, as described in 2.1.4 above. There will be an increased threat of undermining of West Lake Drive immediately adjacent to the inlet, and engineering models predict that after 20 years this road will be undermined along any reach that is not hardened. Therefore, it is anticipated that the remaining 700 feet of road would receive riprap protection as the shoreline narrows. Eventually, the entire 1,200-foot-long stretch of road would end up being bulkheaded. In the future without project condition, the continuing erosion, along with future storm damage, would require repairs to the bulkheads and even the road itself.

3 Navigation Improvement Measures

Plans are composed of measures. A measure is an activity or a feature that can be implemented at a specific geographic site to address one or more planning objectives. They can be used individually or combined with other management measures to form alternative plans. The following measures

were developed to address problems and to capitalize upon opportunities. They were derived from a variety of sources including prior Lake Montauk Harbor studies, the public scoping process, and the project delivery team. The following measures were considered in the Lake Montauk Harbor Navigation Improvement Feasibility Study. Table 6 shows the results of screening the identified measures.

1. Unconventional drafts

   Use of larger vessels with shallower drafts was considered, but this is not the present trend. It is not projected that the commercial fishing fleet at Lake Montauk Harbor will deviate from the general trend of using larger, deeper draft vessels. This measure was removed from further consideration because it does not meet study objective 1. Specifically, Measure 1 does not provide adequate channel depths for the existing fleet. Rather, the measure would call for the replacement of the existing fleet and meets no other study objective.

2. High water transit

   Waiting for high tide to traverse the inlet for deeper draft vessels was considered. Astronomical tides in the study area are semi-diurnal, flooding and ebbing twice a day. The mean and spring tides range from 2.0 to 2.4 feet. Waiting for the tide leads to costly delays for commercial fishing vessels as estimated by local fishing captains. The U.S. Coast Guard reports that potentially unsafe navigation practices result from the limited channel depth. This measure was removed from further consideration because it does not meet study objective 1; the measure does not provide reliability nor is it cost effective, based on, for example, at least a portion of the without project commerce not realized.

3. Relocation of the Existing Fleet

   Relocation of the existing fleet would be to the nearest major commercial fishing fleet, which is at Shinnecock Inlet. This measure was removed from further consideration because it is not cost effective. Indeed, boats still calling at Lake Montauk Harbor would relocate to another harbor if it were cost effective.

4. Channel Extension East and West of Star Island

   Extending the channel into the former yacht basin area, east of Star Island, was also given consideration. The use of the area which is maintained by the Town of East Hampton was investigated for the purposes of including a turning basin for transient vessels and for access to southern portions of the lake. The presence of sea grass beds and productive shellfish

areas in the shallow portions of Lake Montauk, south of Star Island, would require a detailed evaluation of potential environmental impacts associated with such extension. The option would likely be less cost effective than other viable plans as there is no advantage for the large fishing boats to transit further into the harbor. Generally, only recreational vessels would benefit from a channel extension and Corps projects cannot be formulated with recreation as a purpose. The federal government is restricted from participating in maintenance of private marinas, berthing areas, and access points. In addition, extending the federal channel into the Coonsfoot Cove area, west of Star Island, was given consideration. However, the large percentage of silts and clays in the sediment would make this material unsuitable as beach fill and would require further environmental testing. This measure was removed from further consideration because it does not meet study objective 1 in that it does not provide adequate channel depths. The requirement for detailed environmental evaluation also makes this measure likely technically not feasible.

5. Channel Widening

   The present authorized channel width of 150 feet was determined to be sufficient for two-way vessel traffic clearances. Since channel deepening would inevitably lead to a wider channel also, this option was not given further consideration. It also meets no other study objective.

6. Channel Realignment

   Any major shift in the authorized channel due to its large initial costs would likely not be feasible. Shifting the outer channel west of its present position would temporarily improve the present shoaling condition resulting from east jetty leakage, but this plan would not solve the deeper draft requirements of the larger vessels per Objective 1. It also would not provide a long-term safeguard against shoaling because, without jetty rehabilitation, sand bars would begin to form again. This option was not considered as an effective use of resources. It also meets no other study objective, and it was not considered further.

7. Deepening of Boat Basin

   Sediment sample analyses indicated the presence of many silts and clays in this area, which is currently authorized at -10 feet MLLW. This may be a disposal hindrance, pending further testing. The area is currently used primarily by shallow draft recreational craft. Based on boating survey conducted in 2005, there are not enough transient vessels or turning basin needs to deepen the existing depth. Further, this measure does not address the channel. It also meets no other study objective. As a result, this option was not considered further.

8. Sand Bypassing

   Based on the results of sediment budget analysis, there is an approximately 12,800 cubic yard per year sediment supply from the updrift (east) shoreline. Of the total supply, approximately 7,000 cubic yards per year is bypassed to the downdrift beach via channel dredging and approximately 800 cubic yards per year is lost to deep water offshore. The remaining 5,000 cubic yards per year continues to accumulate to the east of the inlet. The east sediment fillet is close to saturation and the accumulated sediment is shoaling the entrance channel both around the east jetty and by migration into the inner channel through gaps in east jetty. The accumulated updrift sediment fillet could be bypassed to the downdrift beach via trucking or hydraulic pumping across the channel to reduce future channel shoaling and maintenance dredging costs. Due to the small bypassing rate, temporary hydraulic pumping equipment or trucking would be more cost effective than using a fixed bypassing plant which requires a high investment cost (close to $1,000,000) and annual operation, maintenance, and equipment depreciation, which may double the unit trucking cost of $15 to $20 per cubic yard to $30 to $40 per cubic yard. Further, mechanical dredging has been determined to not be engineeringly feasible based on previous experience in a similar study area at Mattituck, New York. This measure has been carried forward for further consideration.

9. Jetty Rehabilitation

   Rehabilitation of the eastern jetty could play an essential role in improving navigation through the channel for the vessel fleet. A large portion of the shoaling material that enters the channel results from leakage through the eastern jetty. Accordingly, this plan component could reduce the future operation and maintenance costs for the navigation channel. The without-project future condition would mean continued deterioration of the eastern jetty and a mandate for more frequent dredging (shorter dredging cycles). Since the shoal that results from leakage tends to be localized but quite intrusive at certain channel points, this component could help enhance navigation maneuverability. The U.S. Army Corps of Engineers New York District, under a separate operations and maintenance authority, rehabilitated a section of the eastern jetty from Station 5+55 to 9+55 together with a tie-in at the inshore end in 1999. Despite this, it is projected that seepage of sand into channel through the voids of the east jetty would continue without further rehabilitation. The jetty rehabilitation component is included for further consideration despite previous analyses showing that it would not be cost effective in reducing the need for navigation maintenance.

10. Deepening of the Federal Navigation Channel

There is a trend toward larger, deeper draft commercial fishing vessels. In 1993, there were 24 vessels overall with a loaded draft of 12 to 13 feet that listed Lake Montauk Harbor as a homeport. According to local fishing captains who were recently interviewed, there are approximately 15 large fishing vessels that operate out of the harbor. The vessels range from 50 to 100 feet in length with loaded drafts of 10 to 16 feet. When considering squat requirements, wave allowance requirements, and safety clearances, deepening would be necessary under present guidance and would meet concerns of local interests. Deepening would improve navigation through the channel for the existing and future fleet and would enhance navigation maneuverability. This measure is considered further.

11. Removal of shoal at the inshore end of the East Jetty

    A large sand shoal has been developing near the inshore end of the eastern jetty, just northeast of Star Island. It has been infringing upon the authorized channel width. In 1995, 2000, 2004, 2009, 2011, and 2014 the U.S. Army Corps of Engineers New York District removed part of this shoal during maintenance dredging. Local interests have indicated however that it has already begun to shoal in again because the jetty has not been rehabilitated enough to prevent further leakage into this area. However, due to the construction of a bulkhead, complete removal of the shoal will result in flanking of the structure; therefore this measure is no longer technically feasible and does not meet technical constraints.

12. Advance maintenance dredging outside the channel limits as a deposition basin

    Over the past several dredging cycles (1991, 1995, 2000, 2009, 2011, and 2014), advanced maintenance dredging measures have been employed. Essentially, for a length of channel approximately equal to the existing east jetty length, an additional 50 feet (outside and to the east of the existing channel) is dredged. This additional cut serves as a deposition basin to protect the authorized channel. This is also done for economic reasons because removing larger quantities is more efficient, given the high dredging mobilization and demobilization costs. This practice could be permanent and extended around the bend and into the inner channel, approximately an additional 1,800 feet length. The width of the deposition basin could be extended from 50 feet to 100 feet to increase the capacity. This measure is carried forward for further consideration.

Table 5: Measure Screening Summary

Measure	Provides adequate Depths for Reliable Navigation	Provides for Efficient Navigation Maintenance	Efficiently Utilizes all Dredged Material	Carried Forward
1. Unconventional Drafts	No	No	No	No
2. High Water Transit	No	No	No	No
3. Relocation of Existing Fleet	No	No	No	No
4. Channel Extension	No	No	No	No
5. Channel Widening	No	No	No	No
6. Channel Realignment	No	No	Yes	No
7. Deepen Boat Basin	No	No	No	No
8. Sand By-passing	No	No	Yes	Yes
9. Jetty Rehabilitation	No	Yes	N/A	Yes
10. Deepen Channel	Yes	Yes	Yes	Yes
11. Remove Shoal	Yes	Yes	Yes	No
12. Advance Maintenance	Yes	Yes	Yes	Yes

3.1 INITIAL SET OF ALTERNATIVES

Measures that remained after the initial screening were considered for the initial set of alternatives. In the final set of alternatives, navigation improvement measures were combined to arrive at two alternatives for further evaluation and consideration. Alternative 1, for these evaluations, is the future without project condition.

Alternative 1: The future without-project condition

Alternative 1 estimates that the current channel at -12 ft. MLLW and the regular practice of having the 50-foot deposition basin will be maintained approximately every 3 years at a volume of 24,000 cubic yards per operation beginning in 2026, which is the date estimated in the formulation of the maintenance conducted in 2018. Measure 2 (high water transit) is an inherent component of this alternative. The annualized cost of this alternative during the period of analysis, 2024-2073 at the FY 2020 discount rate of 2.75% and FY 2020 price level is $203,000.

Alternative 2: Uniform dredging of the 150-foot-wide channel and 50-foot-wide deposition basin

This alternative includes Measures 10 and 12. For this alternative, for both the channel and the deposition basin, the depths for a new congressional authorization that have been considered range from -14 to -18 feet MLLW. Both the channel and the deposition basin would be dredged to a uniform depth (both to -14, -15, -16, -17, or -18 feet MLLW). All dredged material would be placed on the downdrift beach but with no design (or disposed of offshore using the methods discussed in the next section). The annualized cost of the maintenance of this alternative during the period of analysis at the FY 2020 discount rate of 2.75% and FY 2020 price level is $197,000. The difference in the maintenance between this alternative and Alternative 1, the future without-project condition, is a cost savings of $6,000 on an annualized basis and is counted as an added benefit of this alternative.

Alternative 3: Uniform dredging of the 150-foot-wide channel and 100-foot-wide deposition basin

This alternative includes Measures 10 and 12 with the option in 12 to widen the deposition basin to 100 feet. For this alternative, for both the channel itself and the deposition basin, the depths for a new congressional authorization that have been considered range from -14 to -18 feet MLLW. Both the channel and deposition basin would be dredged to a uniform depth (both to -14, -15, -16, -17, or -18 feet MLLW). All dredged material would be placed on the downdrift beach but with no design (or disposed of offshore using the methods discussed in the next section). The

expected maintenance cycle would be approximately 7 years at a volume of 56,000 cubic yards per operation beginning in 2030. The annualized cost of the maintenance of this alternative during the period of analysis at the FY 2020 discount rate of 2.75% and FY 2020 price level is $143,000. The difference in the maintenance between this alternative and Alternative 1, the future without-project condition, is a cost savings of $60,000 on an annualized basis and is counted as an added benefit of this alternative.

Alternative 4: Uniform dredging of both the 150-foot-wide channel and 100-foot-wide deposition basin with East Fillet Mining

This alternative includes Measures 8, 10, and 12 with the option in 12 to widen the deposition basin to 100 feet. The east jetty impoundment offers an additional source of sand for the channel, and mining it reduces that source. The potential borrow region extends east from the inlet approximately 1000 feet and out to a depth of approximately -10 feet NAVD88. It was assumed that the fillet would be mined back to the baseline with a final slope of 1 on 12 down to a depth of -10 feet NAVD88. Originally it was thought a cutter head dredged would be used to mine the fillet out from a depth of -17 ft NAVD88 up to the baseline, creating a construction slope of 1 on 3 that would gradually evolve to a final slope of 1 on 12. Field work (Mattituck Inlet) in 2014 indicated this is not a viable option for mining any appreciable volume of material. An alternative mining method of beach scraping and trucking of the subaerial portion of the fillet is considered, and it would yield a significantly smaller volume of material (approximately 7,000 to 10,000 cy of sand). The rate at which this sand would be replenished to the fillet was estimated to range between 8 and 11 years. This was constructed using the most recent sediment budget for the region, assuming equal distribution of sand within the transport cell and along the profile, and constraining the mineable area to the subaerial portion of the fillet. The gradual impoundment on the beach face and berm east of the jetty will reduce shoaling rates within the channel and deposition basin by roughly 3 to 5 percent, increasing the maintenance cycle by 1 year, to approximately 8 years. Maintenance would be at a rate of 64,000 cubic yards per operation beginning in 2031. The annualized cost of the maintenance of this alternative during the period of analysis at the FY 2020 discount rate of 2.75% and FY 2020 price level is $148,000. The difference in the maintenance between this alternative and Alternative 1, the future without-project condition, is a cost savings of $55,000 on an annualized basis and is counted as an added benefit of this alternative.

Alternative 5: Uniform dredging of both the 150-foot-wide channel and 100-foot-wide deposition basin with Jetty Rehabilitation

This alternative includes Measures 9, 10, and 12 with the option in 12 to widen the deposition basin to 100 feet. Some of the sand depositing in the main channel and deposition basin enters from leakage through the eastern jetty. It is estimated that decreasing the porosity of the structure may reduce overall shoaling by 5 to 7 percent, increasing the maintenance cycle by 1 year, approximately to 8 years (or 9 years if Measure 8, sand bypassing from scraping and trucking, is included). The rehabilitation of the east jetty is estimated to cost approximately $10 million. This is based on recently completed stone work at Long Beach, NY. The remoteness of the site, length of structure, and water depth at the jetty head significantly impact construction costs. Even if the rehabilitation efforts defer two maintenance dredging cycles (approximately $1.6 million), the cost savings would not be justifiable. This alternative was removed from further consideration as the analysis shows that it would not be cost effective.

Figure 1 shows the channel and deposition and the stationing to be used. The 150-foot navigation channel and 50-foot deposition basin are shown in red. The eastern 50-foot deposition basin extension proposed in Alternative 3 is shown in blue.

Figure 1: Lake Montauk Harbor Layout

Figures 2–5 show typical cross sections of some of the alternatives at select depths. The angle of elevation of the sides of the channels are defined by their side slopes and are the standard 1 vertical on 3 horizontal.

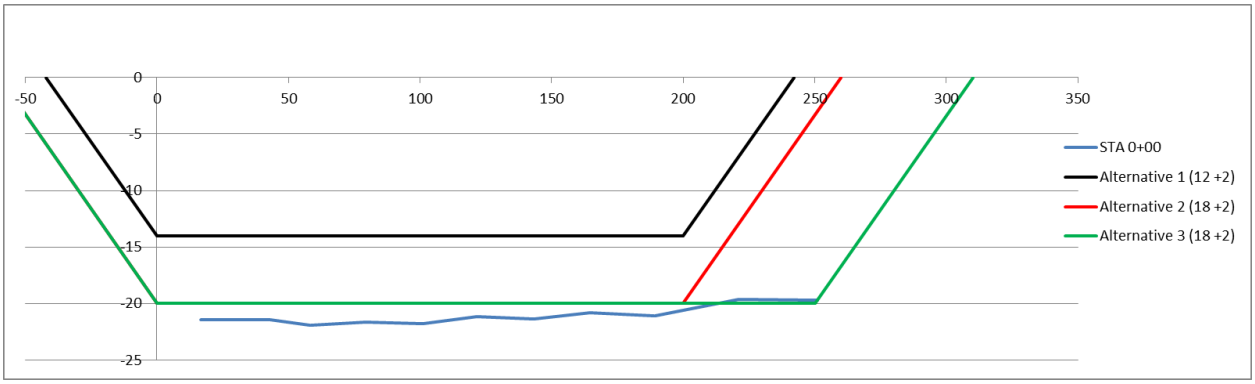

Figure 2: Select Channel Alternatives at Station 0+00

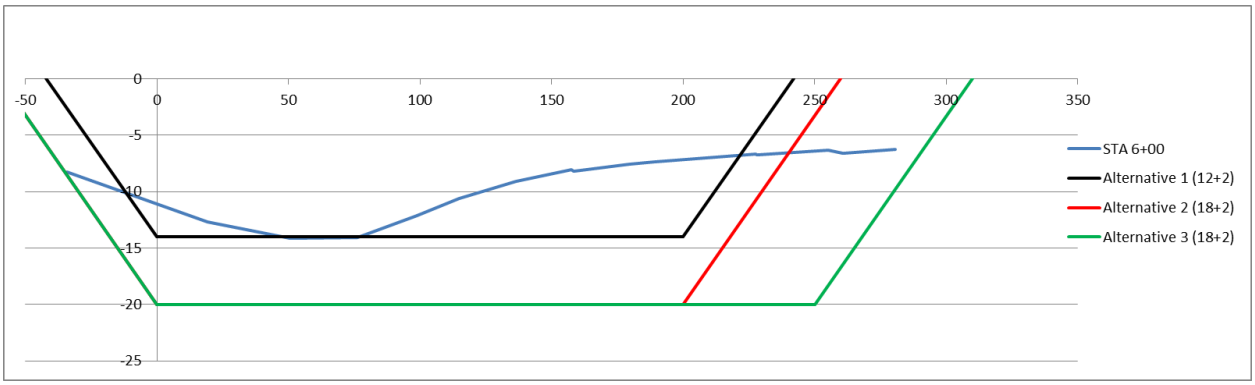

Figure 3: Select Channel Alternatives at Station 6+00

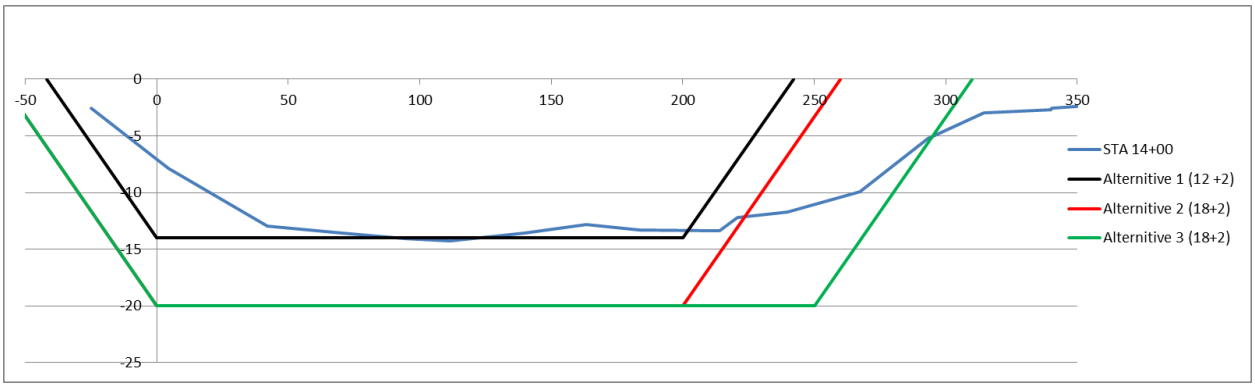

Figure 4: Select Channel Alternatives at Station 14+00

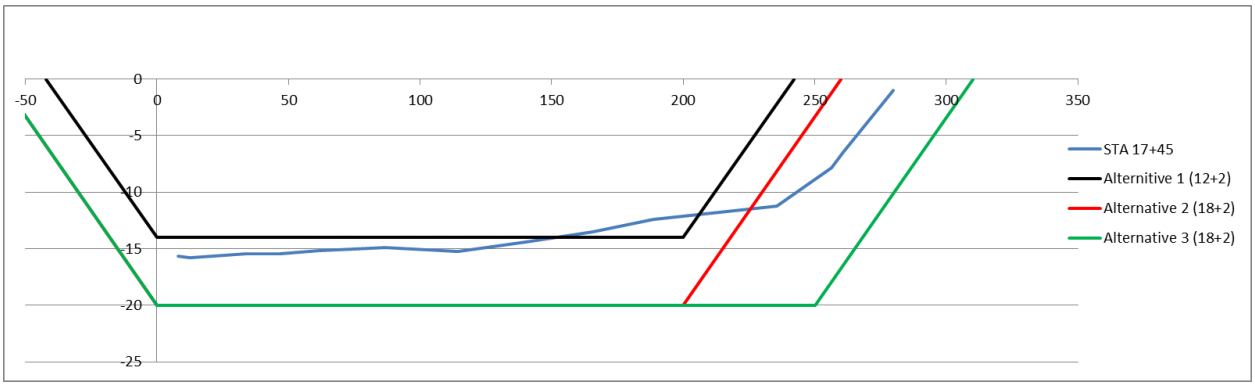

Figure 5: Select Channel Alternatives at Station 17+45

3.2 The Federal Objective

The 1983 Principles and Guidelines state that the federal objective of water and related land resources project planning is to "contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other federal planning requirements".

Principles and Guidelines Criteria, 1983

The 1983 Principles and Guidelines require that plans are formulated in consideration of four criteria: completeness, effectiveness, efficiency, and acceptability (USWRC, 1983).

Completeness is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other federal and non-federal entities. For the Lake Montauk Harbor navigation improvement fea-

sibility study, an alternative had to provide benefits to all similarly-situated commercial fishermen to be considered complete.

Effectiveness is the extent to which the alternative plans contribute to achieve the planning objectives. Effectiveness of the alternatives was measured by the benefits that the alternative would provide to the commercial fishermen. Alternatives that have a benefit-to-cost ratio (BCR) lower than one will be eliminated from consideration.

Efficiency is the extent to which an alternative plan is the most cost effective means of achieving the objectives. Efficiency will be measured through a comparison of BCRs and benefits. Plans that provide the same benefits, but at higher cost, will be eliminated from consideration.

Acceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies. The alternatives were formulated to be in accord with applicable laws and regulations.

4 Estimation of Damages and Benefits

4.1 Without-Project Damages

The without-project damages follow from the future without-project condition as described in Subsection 2.3. USACE risk analysis based on Monte Carlo simulation using @Risk Software of the continuing erosion, future storm damage, and required maintenance and repairs results in the without-project estimate of equivalent annual damages at the FY 2020 price level and plan formulation and evaluation rate (discount rate) of 2.75% in accordance with EGM 20-01 of approximately $1,896,000[5].

[5]The @Risk modeling was a product of the Lake Montauk Harbor CSRM feasibility study, when the project was being formulated for both CSRM and navigation. The @Risk model was certified 1 April 2016 for use with the feasibility study. The model is currently being used as the basis for the incidental CSRM benefits of the TSP. See Section 4.1.4 for more information.

4.1.1 Additional Fish Production and Costs Avoided

It is necessary to know the preliminary benefits and costs of the alternatives in order to assess their effectiveness and efficiency. Benefits of each alternative come directly from the increase in the value of commerce that commercial fishermen can realize at the incremental channel depths as they reported on the study survey approved by the Office of Management and Budget. Survey results updated in 2019 reliably report benefits in three categories: (1) the increase in the net value of output from getting fish to market fresher, (2) savings in fuel and supplies used per trip, and (3) reduction in vessel maintenance and repair. Annualized benefits and costs are reported at FY 2020 price level and the plan formulation and evaluation rate (discount rate) of 2.75% in accordance with EGM 20-01 (USACE, 2019).

Table 6 contains the increase in the net value of output that captains and vessel owners have forecasted that they would obtain from getting fresher fish to market at various channel depths. The estimated benefits are aggregated over the quantity of vessels within each of the three ranges of vessel drafts for the depth-limited vessels surveyed. The largest increase in benefits attributable to this variable occurs at 16' with $472,000 higher value output. At -17 feet MLLW, no further benefits are realized in terms of getting fresher fish to market.

Table 6: Increase in Commerce from Fresher Fish to Market at Various Channel Depths

		Increase in Commerce at Increasing Channel Depths (ft)					
Maximum Draft	Vessel Quantity	12	13	14	15	16	17
12	4	$0	$88,000	$143,000	$143,000	$154,000	$154,000
14	4	$0	$26,000	$108,000	$359,000	$462,000	$462,000
16	2	$0	$0	$154,000	$308,000	$667,000	$667,000
Total	10	$0	$114,000	$405,000	$810,000	$1,283,000	$1,283,000

Source: Lake Montauk Harbor Shallow Draft Navigation Feasibility Study Survey, OMB Approval Number 0710-0001.
FY 2020 Price Level.

Table 7 contains the estimated savings in fuel and supplies at various channel depths. Savings in fuel and supplies may occur at various channel depths by: (1) allowing vessels to transit the channel at optimal timing as opposed to high tide, and (2) availing depth-limited vessels the lesser-cost option of operating out of Lake Montauk Harbor. The estimated savings are aggregated over the quantity of vessels within each of the three ranges of vessel drafts for the depth-limited vessels surveyed. Benefits are realized at each channel depth greater than -12 feet MLLW, and are the result of the use of the nation's scarce resources in an optimal way. If the channel is deepened to -17 feet MLLW, $724,000 will be saved in terms of fuel and supplies among the 10 vessels

surveyed.

Table 7: Estimated Savings in Fuel and Supplies at Various Channel Depths

		Estimated Savings at Increasing Channel Depths (ft)					
Maximum Draft	Vessel Quantity	12	13	14	15	16	17
12	4	$0	$11,000	$24,000	$29,000	$32,000	$32,000
14	4	$0	$0	$107,000	$199,000	$261,000	$261,000
16	2	$0	$0	$46,000	$154,000	$349,000	$431,000
Total	10	$0	$11,000	$177,000	$382,000	$642,000	$724,000

Source: Lake Montauk Harbor Shallow Draft Navigation Feasibility Study Survey, OMB Approval Number 0710-0001. FY 2020 Price Level.

Captains' and vessel owners' estimates of the reduction in vessel repair and maintenance required at various channel depths are organized in Table 8. The estimates are based in the captains' and vessel owners' experience with vessel repair and maintenance that has been required after the documented channel groundings. Survey evidence indicates that the captains and vessel owners would realize $26,000 in reduced repairs and maintenance if the channel were dredged and maintained at -12 feet MLLW. This reflects that shoaling is sufficiently problematic at the current nominal depth to cause scraping of the channel bottom, propeller damage, and groundings. As the authorized depth of the channel becomes greater, captains and vessel owners anticipate larger savings in vessel repair and maintenance, up to $318,000 at -17 feet MLLW.

Table 8: Reduction in Vessel Repair and Maintenance at Various Channel Depths

		Estimated Savings at Increasing Channel Depths (ft)					
Maximum Draft	Vessel Quantity	12	13	14	15	16	17
12	4	$25,000	$36,000	$46,000	$46,000	$77,000	$77,000
14	4	$0	$0	$113,000	$164,000	$164,000	$164,000
16	2	$0	$0	$21,000	$21,000	$51,000	$77,000
Total	10	$25,000	$36,000	$180,000	$231,000	$292,000	$318,000

Source: Lake Montauk Harbor Shallow Draft Navigation Feasibility Study Survey, OMB Approval Number 0710-0001. FY 2020 Price Level.

The two captains that operate the vessels that draft between 14 and 16 feet were the only two captains to report incremental benefits in any of these three categories from a potentially congressionally-authorized depth from -16 to -17 feet MLLW. Thus, 20% of the survey respondents realize further benefits from the marginal increase in depth to -17 feet MLLW. The benefits are realized in savings in fuel and supplies and reduction vessel repair and maintenance. Further, both reported in follow-up telephone interviews conducted by New York District staff that they would not have additional

benefits quantifiable if the channel were to be potentially congressionally authorized at -18 feet MLLW or any greater depth.

It may be observed that among the most depth-limited vessels currently using the federal channel into Lake Montauk Harbor, four vessels have a maximum draft of the authorized depth. Of these four vessels, there are three vessels that have a draft of less than 11 feet. Further, the owners or captains of these vessels have indicated that they would experience benefits of deepening up to and including 17 feet. These vessels' ability to generate benefits reflects the information that even with advanced maintenance, vessel owners and captains have reported rapid rates of shoaling. The shoaling quickly cuts into the underkeel clearance requirements. This shoaling explains some experts' expectations of the ability to generate higher annual levels of commerce on average over the life of a maintenance cycle where the design draft is just shallower than the authorized depth. In Section 4.2.3, it is shown that removing these three vessels from the analysis has no effect on plan selection nor on the economic justification of the recommended plan.

The formulation-level cost structure of the four alternatives and the future without-project condition is organized in Table 9 according to the various channel depths at the FY 2020 price level[6]. Construction duration is listed in the second column. First cost in Column 8 is sum of Columns 3 through 7: dredging, trucking, real estate, pre-construction engineering and design (PED), and supervision and administration through construction (S&A). Interest during construction (IDC) and discounting are based on the plan formulation and evaluation rate (discount rate) of 2.75% in accordance with EGM 20-01. The final columns contain annual first cost, annual IDC, marginal annual operations and maintenance (O&M) and annual total cost. Total annual cost is the sum of annual first cost, marginal annual operations and maintenance costs, and annual interest costs. The marginal operations and maintenance costs are those operations and maintenance costs above the future without-project operations and maintenance costs, which are $0 for all alternatives. Alternative 2 has annual operations and maintenance costs that are $6,000 lower than in the future without-project condition. Alternative 3 has annual operations and maintenance costs that are $60,000 lower than the future without-project condition. Alternative 4 has annual maintenance costs that are $55,000 lower than in the future without-project condition. As a result, this line item is zero and the margin is recorded as costs avoided. Observe that annual costs are increasing with greater channel depths generally. Alternative 3 has a slightly higher total cost due to construction of the 100- foot deposition basin. Alternative 4 has a futher higher cost reflecting the sand bypassing.

[6]Please note that these costs are used for formulation; costs of the recommended plan have been refined and can be found in Section 5.

Table 9: Cost Breakdown by Alternative

Alternative	Depth	Months	Dredging	Trucking	Real Estate	PED	S&A	First Cost	Total IDC	Annual First Cost	Annual IDC	Marginal Annual O&M	Annual Total Cost
1: FWOPC	12	0	$0	$0	$0	$0	$0	$0	$0	$0	$203,000	$203,000	
2	14	0.8	$1,300,000	$0	$248,000	$455,000	$110,000	$2,113,000	$5,000	$78,300	$200	$0	$78,000
2	15	1.2	$1,728,000	$0	$248,000	$533,000	$146,000	$2,655,000	$6,000	$98,400	$200	$0	$99,000
2	16	1.5	$2,048,000	$0	$248,000	$592,000	$173,000	$3,061,000	$7,000	$113,400	$300	$0	$114,000
2	17	1.9	$2,369,000	$0	$248,000	$650,000	$200,000	$3,467,000	$8,000	$128,500	$300	$0	$129,000
2	18	2.2	$2,704,000	$0	$248,000	$712,000	$229,000	$3,893,000	$9,000	$144,200	$300	$0	$145,000
3	14	1.2	$1,785,000	$0	$248,000	$543,000	$151,000	$2,727,000	$6,000	$101,000	$200	$0	$101,000
3	15	1.7	$2,231,000	$0	$248,000	$625,000	$189,000	$3,293,000	$7,000	$122,000	$300	$0	$122,000
3	16	2	$2,572,000	$0	$248,000	$687,000	$217,000	$3,724,000	$8,000	$138,000	$300	$0	$138,000
3	17	2.4	$2,919,000	$0	$248,000	$751,000	$247,000	$4,165,000	$9,000	$154,300	$300	$0	$155,000
3	18	2.8	$3,273,000	$0	$248,000	$815,000	$277,000	$4,613,000	$11,000	$170,900	$400	$0	$171,000
4	14	1.2	$1,785,000	$168,000	$248,000	$547,000	$169,000	$2,917,000	$7,000	$108,000	$200	$0	$108,000
4	15	1.7	$2,231,000	$168,000	$248,000	$629,000	$206,000	$3,482,000	$8,000	$129,000	$300	$0	$129,000
4	16	2	$2,572,000	$168,000	$248,000	$691,000	$235,000	$3,914,000	$9,000	$145,000	$300	$0	$145,000
4	17	2.4	$2,919,000	$168,000	$248,000	$754,000	$265,000	$4,354,000	$10,000	$161,300	$400	$0	$162,000
4	18	2.8	$3,273,000	$168,000	$248,000	$819,000	$294,000	$4,802,000	$11,000	$177,900	$400	$0	$178,000

Plan formulation and evaluation rate (discount rate) of 2.75% in accordance with EGM 20-01.

FY 2020 Price Level. Contingency included in costs. Dredging includes Mob/Demob

Annual first cost and annual IDC rounded to hundreds unit for illustrative purposes.

4.1.2 Operations and Maintenance Cost Avoided

Advance maintenance dredging outside the channel limits is a key component of all alternative plans. The advance maintenance dredging features a deposition basin which is a dredged area outside the channel where sediment accrues and allows the channel to maintain its authorized depth longer. Alternative 2 proposes a 50-foot-wide deposition basin which is the current deposition basin used for advanced maintenance of the federal channel. This plan would push back the operations and maintenance cycle by one year, leading to $6,000 fewer annual operations and maintenance cost as compared to the future without-project condition.

The use of a 100-foot deposition basin with Alternative 3 stretches out the required maintenance dredging schedule from every 4 years to every 7 years. The same effective level of operations and maintenance of the channel can therefore be provided at a lower cost, accruing benefits to Alternative 3. The operations and maintenance costs avoided with Alternative 3 are $60,000 per year. That is to say, the channel would be maintained at its authorized depth for $60,000 less than what the annualized costs would have been in the future without-project condition. This benefit is recorded in Column 4 of Table 11.

Alternative 4 includes a 100-foot deposition basin. However, this alternative also proposes east jetty impoundment which offers an additional source of sand for the channel and mining the jetty reduces that source. Thus, the maintenance cycle is stretched out to every 8 years, leading to a $55,000 annual operations and maintenance cost savings. The annualized operations and maintenance costs that coincide with the different plans are organized in the second column of Table 10.

Table 10: Operations and Maintenance Cost Analysis

Alternative	O&M Annualized	Marginal O&M Annualized
1: FWOPC	$203,000	$0
2	$197,000	-$6,000
3	$143,000	-$60,000
4	$148,000	-$55,000

Plan formulation and evaluation rate (discount rate) of 2.75% in accordance with EGM 20-01. FY 2020 Price Level.

4.1.3 Recommended Plan

Table 11 contains a summary of the estimated benefits together with the estimated total annual cost for Alternatives 2, 3, and 4 at channel depths of -14 feet through -18 feet . Total annual costs are the sum of marginal annualized operations and maintenance, annual interest during construction, and annualized project first costs[7]. Annual benefits are presented as the sum of the higher values of commerce as identified in Tables 6–8 together with the operations and maintenance costs avoided in Table 10. The eighth column presents the net benefits as calculated by the difference of total annual benefits and total annual costs. The ninth column contains the ratio of benefits to costs. Based on having the greatest net navigation improvement benefits of $2,230,000, Alternative 3 with a 100-foot-wide deposition basin authorized to a depth of -17 feet MLLW is identified as the recommended plan[8]. This plan best alleviates the problem of a group of commercially important vessels having to change their operations in a sub-optimal way. The benefits of more than $2 million come from the savings of the nation's scarce resources that result from operating these vessels in an optimal way.

Table 11: Annual Costs and Benefits for Final Set of Alternatives

Alternative	Depth	Annual Cost	O&M Avoided	Marginal Commerce	Annual Benefits	Net Benefits	BCR
2	14	$78,000	$6,000	$762,000	$768,000	$690,000	9.8
2	15	$99,000	$6,000	$1,423,000	$1,429,000	$1,330,000	14.4
2	16	$114,000	$6,000	$2,217,000	$2,223,000	$2,109,000	19.5
2	17	$129,000	$6,000	$2,325,000	$2,331,000	$2,202,000	18.1
2	18	$145,000	$6,000	$2,325,000	$2,331,000	$2,186,000	16.1
3	14	$101,000	$60,000	$762,000	$822,000	$721,000	8.1
3	15	$122,000	$60,000	$1,423,000	$1,483,000	$1,361,000	12.2
3	16	$138,000	$60,000	$2,217,000	$2,277,000	$2,139,000	16.5
3	17	$155,000	$60,000	$2,325,000	$2,385,000	$2,230,000	15.4
3	18	$171,000	$60,000	$2,325,000	$2,385,000	$2,214,000	13.9
4	14	$108,000	$55,000	$762,000	$817,000	$709,000	7.6
4	15	$129,000	$55,000	$1,423,000	$1,478,000	$1,349,000	11.5
4	16	$145,000	$55,000	$2,217,000	$2,272,000	$2,127,000	15.7
4	17	$162,000	$55,000	$2,325,000	$2,380,000	$2,218,000	14.7
4	18	$178,000	$55,000	$2,325,000	$2,380,000	$2,202,000	13.4

Plan formulation and evaluation rate (discount rate) of 2.75%
in accordance with EGM 20-01. FY 2020 Price Level.

[7]The costs are formulation-level costs; the net national economic deveopment benefits with refined costs following optimization are presented in Section 5.

[8]The authorized depth of -17 feet MLLW has been identified on the basis of reasonably maximizing net national economic development benefits. This depth is roughly consistent with the required depth as identified in the Engineering Appendix. The required depth is a function of the design vessel, which is a vessel with characteristics that are representative of the draft-limited vessels currently using Lake Montauk Harbor.

4.1.4 INCIDENTAL CSRM BENEFITS

USACE performs risk analysis of the expected future damages using Monte Carlo simulation in the same way that the without-project damages are estimated. The Monte Carlo simulation is performed using @Risk software based on the cost of rip rap and backfill, RSLC, and characteristics of erosion and structures at the coast. The model is based on data from three reaches.

- Reach 1 consists of approximately 1,200 feet of shoreline with an approximately 20-foot wide beach on the Long Island Sound side, an armored dune/revetment with elevation +12.5 feet NAVD88, and a paved road along the shore line immediately landward of the dune.
- Reach 2 consists of approximately 1,800 feet of shoreline with an approximately 20-40-foot wide beach on the Long Island Sound side backed by bulkheads with an average crest elevation of +10 feet NAVD88. Behind the bulkhead line exist 19 residential structures with an average depreciated structure replacement value of $457,000 and an average offset from the bulkhead line of 70 feet.
- Reach 3 consists of approximately 1,800 feet of shoreline, a narrow beach on the Long Island Sound side that is backed by bulkheads, and an elevation of +12.5 feet NAVD88. Landward of the bulkhead line are 21 residential structures with an average depreciated structure replacement value of $362,000 and an average offset from the bulkhead line of 60 feet.

The analysis is performed on a spreadsheet basis. Damages are based on emergency services and clean-up that result from a major overtopping, bulkhead failure, or minor overtopping or still water. This method was an effective modeling tool for analyzing alternatives when this study was being formulated for both coastal storm risk management (CSRM) and navigation. Currently, this study is being formulated for navigation only. However, the result of the modeling demonstrates that there are coastal storm risk management benefits that would result from the least cost placement method of the dredged material. As this study is being formulated for navigation, these CSRM benefits are incidental to the study economics.

Annual without-project equivalent annual damages at the FY 2020 price level and plan formulation and evaluation rate (discount rate) of 2.75% in accordance with EGM 20-01 are approximately $1,896,000. With the deeper dredging project at -17 feet MLLW, additional dredged material beyond that which would arise from the current maintenance schedule would be available. The

dredged material would be placed within 3,000 feet of the western jetty, creating a berm 44 feet wide. The benefits would be greatest in the first year of placement and decay linearly through the tenth year. The @Risk simulation of the with-project scenario projects that the continuing erosion, future storm damage, and required maintenance and repairs lead to $1,720,000 in with-project equivalent annual damages over the 50-year period of analysis. This means that the recommended plan provides $176,000 in annualized incidental coastal storm risk management national economic development benefits. The annual net national economic development benefits of the recommended plan taking into account the incidental coastal storm risk management benefits are $2,406,000.

4.2 Sensitivity Analysis

The sensitivity of the formulation and conclusion of the recommended plan can be assessed across three factors. First, as identified in Section 3.3 in the main report, RSLC is a key uncertainty. Second, the magnitude of the benefits derived from the survey evidence are projections and inherently subject to error. Third, an analysis of the results of the survey as they relate to design draft is presented.

4.2.1 Relative Sea Level Change

Relative sea level change will impact the operations and maintenance cycle for dredging the channel and the incidental CSRM benefits realized as the result of the least-cost placement of dredged material on the adjacent downdrift beach. The intermediate (high) scenario for RSLC for this area is projected to be 3 (7) feet over 100 years. Higher relative sea levels have the effect of extending the required maintenance cycle. This effect would translate into a monotonic shift of the cost curves because the rate of littoral build-up is 8,000 cubic yards for each alternative, and one RSLC scenario would be applied to each set of alternatives at a time. All else equal, this would not change the net benefits ranking of the alternatives for the various channel depths.

The incidental CSRM benefits depend in a small way on the RSLC scenario. It is reasonable to assume with faster rising sea level, erosion happens quicker. However, the benefits are realized during the first 10 years of the analysis period during which time the sea levels across all three scenarios are similar, even while the rates of sea level change are not. Despite the small reduction expected for the incidental CSRM benefits with higher rates of sea level change, this effect would

not change the formulation of the recommended plan. The plan was formulated for navigation improvements. The CSRM benefits derived from the least cost placement of the dredged material are incidental to the evaluated benefits and are therefore evaluated ex post facto.

4.2.2 BENEFITS MAGNITUDE

The magnitude of the benefits derived from the survey evidence are projections based on a sample of captains' and vessel owners' projections for benefits at various channel depths. Due to the nature of the estimate and the small sample, error is inherent to the magnitude identified. An assessment of the sensitivity of the conclusions to this error can be made by varying the size of the benefits by a margin of 10%. Table 12 contains the benefits and costs of the two alternatives at various channel depths, where a margin of 10% has been added to the magnitude of the survey outcomes.

Table 12: Benefits Magnitude Sensitivity Analysis

			Benefits 10% Lower			Benefits 10% Higher		
Alternative	Depth	Annual Cost	Annual Benefits	Net Benefits	BCR	Annual Benefits	Net Benefits	BCR
2	14	$78,000	$692,000	$614,000	8.9	$844,000	$766,000	10.8
2	15	$99,000	$1,287,000	$1,188,000	13.0	$1,571,000	$1,472,000	15.9
2	16	$114,000	$2,001,000	$1,887,000	17.6	$2,445,000	$2,331,000	21.4
2	17	$129,000	$2,099,000	$1,970,000	16.3	$2,564,000	$2,435,000	19.9
2	18	$145,000	$2,099,000	$1,954,000	14.5	$2,564,000	$2,419,000	17.7
3	14	$101,000	$746,000	$645,000	7.4	$898,000	$797,000	8.9
3	15	$122,000	$1,341,000	$1,219,000	11.0	$1,625,000	$1,503,000	13.3
3	16	$138,000	$2,055,000	$1,917,000	14.9	$2,499,000	$2,361,000	18.1
3	17	$155,000	$2,153,000	$1,998,000	13.9	$2,618,000	$2,463,000	16.9
3	18	$171,000	$2,153,000	$1,982,000	12.6	$2,618,000	$2,447,000	15.3
4	14	$108,000	$741,000	$633,000	6.9	$893,000	$785,000	8.3
4	15	$129,000	$1,336,000	$1,207,000	10.4	$1,620,000	$1,491,000	12.6
4	16	$145,000	$2,050,000	$1,905,000	14.1	$2,494,000	$2,349,000	17.2
4	17	$162,000	$2,148,000	$1,986,000	13.3	$2,613,000	$2,451,000	16.1
4	18	$178,000	$2,148,000	$1,970,000	12.1	$2,613,000	$2,435,000	14.7

Plan formulation and evaluation rate (discount rate) of 2.75%
in accordance with EGM 20-01. FY 2020 Price Level.

The benefits, net benefits, and benefit-to-cost ratio are organized in Columns 2—5 for 10% lower benefits, and the same attributes are organized in Columns 6—9 for 10% higher benefits. The margin of error is applied only to the survey evidence outcomes; each alternative retains the O&M cost avoided as presented in Table 11. Alternative 3 at -17 feet MLLW remains the plan with the highest net navigation benefits within the range of +/- 10% of the surveyed outcomes. The net navigation benefits range between $1,998,000 and $2,463,000 with benefit cost ratios ranging between 13.9 and 16.9 for the recommended plan.

4.2.3 DESIGN DRAFTS

In Section 4.1, the results of the survey of the most depth-limited vessels is presented. Among the most depth-limited vessels currently using the federal channel into Lake Montauk Harbor, Vessels B, C, and G have design drafts that are lesser than the authorized depth. The owners or captains of these vessels have indicated that they would experience benefits of deepening up to and including 17 feet. It has been explained in Section 4.1 that these vessels' ability to generate benefits reflects the information that even with advanced maintenance, vessel owners and captains have reported rapid rates of shoaling which cuts into underkeel clearance requirements. Table 13 presents the results having removed the benefits that are derived from the three vessels with drafts less than 11 feet. Alternative 3 at -17 feet MLLW is still the plan with the highest net benefits at $1,982,000 and has a benefit-to-cost ratio of 13.8.

Table 13: Design Drafts Sensitivity Analysis

Alternative	Depth	Annual Cost	O&M Avoided	Maginal Commerce	Annual Benefits	Net Benefits	BCR
2	14	$78,000	$6,000	$396,000	$402,000	$324,000	5.2
2	15	$99,000	$6,000	$1,001,000	$1,007,000	$908,000	10.2
2	16	$114,000	$6,000	$1,762,000	$1,768,000	$1,654,000	15.5
2	17	$129,000	$6,000	$1,870,000	$1,876,000	$1,747,000	14.5
2	18	$145,000	$6,000	$1,870,000	$1,876,000	$1,731,000	12.9
3	14	$101,000	$60,000	$564,000	$624,000	$523,000	6.2
3	15	$122,000	$60,000	$1,220,000	$1,280,000	$1,158,000	10.5
3	16	$138,000	$60,000	$1,969,000	$2,029,000	$1,891,000	14.7
3	17	$155,000	$60,000	$2,077,000	$2,137,000	$1,982,000	13.8
3	18	$171,000	$60,000	$2,077,000	$2,137,000	$1,966,000	12.5
4	14	$108,000	$55,000	$564,000	$619,000	$511,000	5.7
4	15	$129,000	$55,000	$1,220,000	$1,275,000	$1,146,000	9.9
4	16	$145,000	$55,000	$1,969,000	$2,024,000	$1,879,000	14.0
4	17	$162,000	$55,000	$2,077,000	$2,132,000	$1,970,000	13.2
4	18	$178,000	$55,000	$2,077,000	$2,132,000	$1,954,000	12.0

Plan formulation and evaluation rate (discount rate) of 2.75%
in accordance with EGM 20-01. FY 2020 Price Level.

5 COST OPTIMIZATION - RECOMMENDED PLAN

This section documents the net national economic development benefits for the recommended plan following optimization of costs, as described in the cost appendix. The national economic development benefits are unchanged following optimization. The values are presented at FY 2020

price level, annualization reflects the plan formulation and evaluation rate of 2.75% in accordance with Economic Guidance Memorandum 20-01.

Table 14: Refined Cost Breakdown - Recommended Plan

Account	Description	Subtotal	Contingency %	Contingency	Total Cost
01	Lands and Damages	$ 748,097	20%	$ 149,619	$ 897,716
12	Navigation Ports & Harbors	$ 3,176,827	25%	$ 793,119	$ 3,969,945
30	PED	$ 954,001	7%	$ 67,181	$ 1,021,182
31	Construction Management	$ 313,524	7%	$ 22,031	$ 335,555
Total	-	$ 5,192,448	-	$ 1,031,950	$ 6,224,399

FY 2020 Price Level.

Table 15: Annual Costs Refined - Recommended Plan

First Cost	$ 6,224,399
Sunk Cost	$ -
Interest During Construction	$ 76,000
Total Investment Cost	$ 6,300,399
Annualized Investment Cost	$ 233,373
Marginal Annualized OMRR&R	$ -
Total Annual Cost	$ 233,373

Plan formulation and evaluation rate (discount rate) of 2.75% in accordance with EGM 20-01. FY 2020 Price Level.

The breakdown of first costs of the recommended plan as refined during optimization is presented in Table 14. Total first cost is approximately $6,224,000. Annual costs as refined during optimization for the recommended plan are presented in Table 15. With approximately $2,800 in annual interest during construction costs and $0 in marginal annual operations and maintenance costs, the total annual cost amounts to approximately $233,000.

Table 16: Economics Refined - Recommended Plan

Annual Cost	$ 233,000
O&M Avoided	$ 60,000
Marginal Commerce	$ 2,325,000
Annual NED Benefits	$ 2,385,000
Annual Net NED Benefits	$ 2,152,000
Benefit-to-Cost Ratio	10.2

Plan formulation and evaluation rate (discount rate) of 2.75% in accordance with EGM 20-01. FY 2020 Price Level.

The resulting refinement of the economics following optimization of costs are presented in Table 16. Annual national economic development benefits are unchanged in optimization at $2,385,000.

Annual net national economic development benefits as refined are $2,152,000. The recommended plan is economically feasible with a benefit-to-cost ratio of 10.2.

6 CONCLUSION

This appendix contains an evaluation of the economic justification of an array of alternatives for improving the general navigation features of Lake Montauk Harbor in accordance with the Water Resources Council's Economic and Environmental Principles and Guidelines for Water Related Land Resource Implementation Studies (P&G, 1983). A recommended has been identified as Alternative 3 featuring a depth of -17 feet at mean lower low water and a 100-foot deposition basin. The recommended plan has a project first cost of approximately $3,981,000 and an annualized total cost of approximately $233,000. Annualized benefits are expected to be $2,385,000 resulting in annualized net benefits of $2,152,000 and a benefit-to-cost ratio of 10.2. The recommended plan avails higher values of commercial output, savings in fuel and supplies, and reductions in the cost of maintenance and repairs. The recommended plan also accrues incidental coastal storm risk management benefits that result from the least cost placement method of the dredged material. The $176,000 of annualized coastal storm risk management benefits bring total annualized net national economic development benefits to $2,328,000. In conclusion, the economic analysis has identified an economically justified recommended plan that allows commercially-important depth-limited vessels to operate in an economically optimal way.

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