NEWBURYPORT HARBOR
PLUM ISLAND NORTH POINT
NEWBURYPORT, MASSACHUSETTS

§204 PROJECT
BENEFICIAL USE OF DREDGED MATERIALS

APPENDIX E
ECONOMIC ANALYSIS

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APPENDIX E
ECONOMIC ANALYSIS

1 Introduction

This report presents the economic analysis of using dredged material from the Federal Navigation Project for Newburyport Harbor to provide coastal storm risk reduction measures on North Point Beach, Plum Island in the City of Newburyport, Massachusetts. The analyses follows the U. S. Army Corps of Engineers (USACE) guidance for conducting economic evaluations as contained in EP 1105-2-58 dated 01 March 2019.

The economic benefits of providing coastal storm damage protection through beneficial use of dredged material are calculated in two steps. First, the projected without-project conditions are compared to the with-project condition. Then, the least-cost disposal plan associated with the Navigation maintenance dredging (base plan) is compared to the cost of providing the coastal storm damage protection. This analysis was conducted using the Fiscal Year 2020 Federal interest rate for water resources projects of 2.75%. A ten year period of analysis is used. An updated analysis using the FY 2021 rate of 2.5% is provided later in this appendix.

2 Description of Study Area

The study area is within the City of Newburyport portion of Plum Island at its northern end. Plum Island is a barrier island with the Atlantic Ocean to the east and extensive salt marsh to the west between the island and the mainland. Plum Island is located about 32 miles north of Boston. The northern end of the Island is primarily a residential area split between the Town of Newbury and the City of Newburyport. The southern areas of the Island are included in a State Park and the Parker River National Wildlife Refuge (PRNWR) located in the Towns of Newbury, Rowley and Ipswich. Plum Island is separated from Salisbury Beach to the North by the Merrimack River inlet including the Federal Navigation Channel for Newburyport Harbor. Newburyport Harbor has been maintained by the Federal government for navigation purposes since the early 1800s. Federal maintenance of the navigation channels is carried out periodically with the dredged sand placed by hopper dredge, nearshore of the beaches in Plum Island and Salisbury on either side of the inlet.

The proposed project will use the dredged material from the Federal Navigation Project for Newburyport Harbor as beach-fill on a 900-foot-long eroded section of North Point Beach on Plum Island.

While Plum Island is comprised of Newburyport, Newbury, Rowley, and Ipswich, the study area for the proposed placement of the dredged material on North Point Beach is solely in the City of Newburyport. The City of Newburyport, in Essex County, Massachusetts contains primarily suburban residential development, with clusters of commercial and retail development as well as areas of open space. The dredged material will be placed on a beach known as North Point Beach and would protect only residential homes from erosion in the near term. Selected economic characteristics from the American Community Survey 5-year estimates (2014-2018) show Newburyport has a population of 17,990, has a median household income of $103,200, and has a poverty rate of 5.2% (https://data.census.gov)

3 History of Major Storm Events

New England has a long history of severe winter storms. Most winter storms bring to coastal areas both storm surge and high winds, making the coastline particularly vulnerable to damage. Due to the high development of the coastline, properties and infrastructure are at significant risk of erosion impacts caused by storm surge and high winds. Table E-1 below presents a list of Disaster declarations made by the Federal Emergency Management Agency (FEMA) that affected coastal areas. Massachusetts has had sixteen (16) storm-related emergency declarations since 1954 involving coastal flooding and damages.

Table E-1: FEMA Major Disaster Declarations

Number	Date	Incident Description
4379	03/13/2018	Severe Winter Storm and Snowstorm
4372	03/02/2018	Severe Winter Storm and Flooding
4214	01/26/2015	Severe Winter Storm, Snowstorm, and Flooding
4110	04/19/2013	Severe Winter Storm, Snowstorm, and Flooding
4097	12/19/2012	Hurricane Sandy
4028	09/03/2011	Tropical Storm Irene
1895	03/29/2010	Severe Storm and Flooding
1614	11/10/2005	Severe Storms and Flooding
1364	04/10/2001	Severe Storms & Flooding
975	12/21/1992	Winter Coastal Storm
920	11/04/1991	Severe Coastal Storm
914	08/26/1991	Hurricane Bob
751	10/28/1985	Hurricane Gloria
546	02/10/1978	Coastal Storms, Flood, Ice, Snow
43	08/20/1955	Hurricane, floods
22	09/02/1954	Hurricanes

http://www.fema.gov/disasters/grid/state-tribal-government/2?field_disaster_type_term_tid_1=All

4 Benefit Methodology

For this analysis, the without project condition is defined as the Federal Base Plan, in which the least-cost ocean disposal method is used for most of the material. Under the Base Plan about 57,000 cy of material would be placed at the eastern end of North Point to prevent flanking of the South Jetty, and the remaining 163,000 cy of material would be placed at nearshore sites with a hopper dredge. The material placed at North Point will protect the South Jetty but will not be placed to protect the residential homes, associated lands, and utilities further west. The with-project condition is defined as the use of a beneficial placement option where the entire 220,000 cy of material would be placed at North Point Beach with a pipeline dredge. The benefits to beach placement are determined by estimating the value of the erosion losses and damages that would occur without beneficial placement, and comparing them to the erosion losses and damages that would occur with beneficial placement. The benefits equal the degree to which erosion losses and damages are reduced. For this analysis, the long-term erosion rate of 53 feet per year was used for both the with- and without-project conditions based on the hydraulic analysis. If protective measures are not implemented, it is anticipated that long-term erosion will continue at the current rate and eventually threaten shorefront structures along the beach. Figure E-1 shows the three disposal sites available: nearshore area off of Plum Island Beach, a nearshore area off Salisbury Beach, or the beach area on Plum Island, North Point. The teal locations indicate historic placement locations at nearshore sites. The areas in red off the coast are proposed nearshore placement locations. The red area on North Point indicates the proposed placement directly on the beach. This location on the beach provides storm damage protection to residential properties, improves recreation benefits, and delays land erosion.

Figure E-1: Placement Sites for Base Plan

Figure E-2 shows more detail for suggested disposal on the beach at North Point. The federal base plan is the darker shaded region protecting the jetty and the suggested 204 alternative is the larger shaded region which provides protection to residential properties.

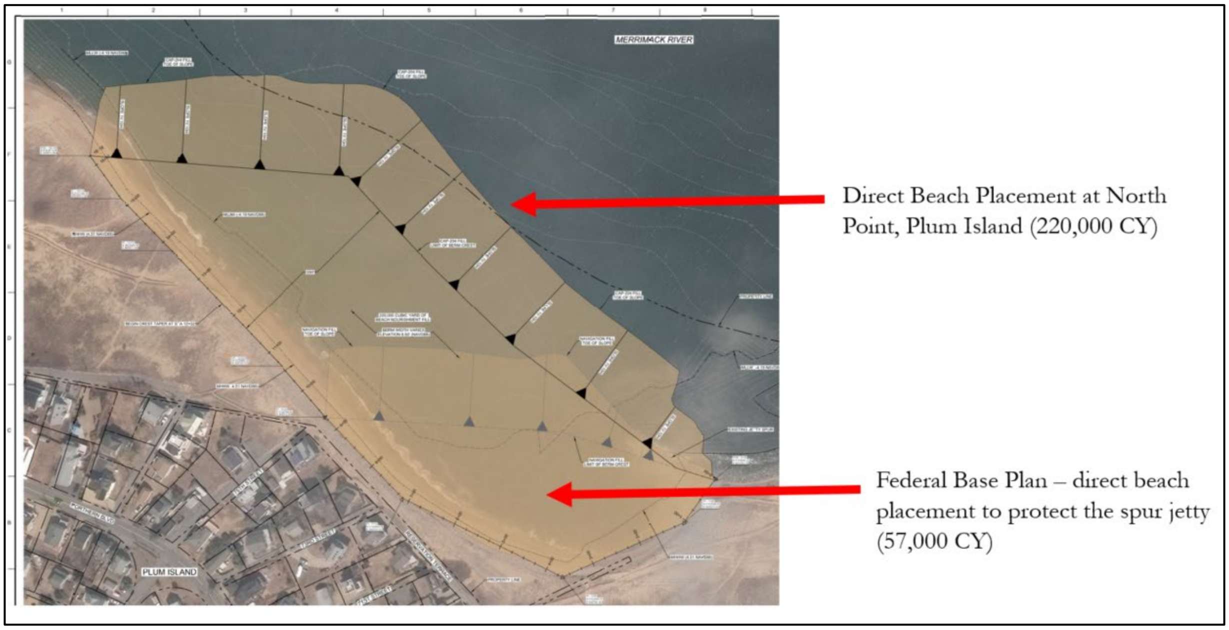

Figure E-2: Alternative Feasibility Level Design

4.1 Future Without-Project Condition

The study evaluated 68 residential structures at risk of being undermined due to coastal erosion from 2021 to 2030. The value of each structure was determined using *Square Foot Costs with RSMeans Data, 40th Annual Edition 2019* and inputs from tax assessment records available from the City of Newburyport to calculate depreciated replacement costs. The values were escalated to 2020 values using a price level update factor of 1.02. This factor was derived from the average of the Engineering Construction Cost Index (CCI) and the Implicit Price Deflator (IPD). Damages were analyzed for the Future Without-Project (FWOP) condition using ArcMap Geographic Information Systems (GIS) and LiDAR to mark the dune line on aerial photographs geo-referenced to parcel maps. The hydraulic analysis estimated that the structures closest to the dune line would be impacted as early as 2021. The dune line was then advanced landward in annual increments at the 53 feet per year erosion rate. A structure was considered damaged when the erosion line reached the seaward edge of the structure. The present value of the structure was determined for that same year using the current 2020 Fiscal Year Federal Discount Rate of 2.75%. The structure was considered a total loss and was not rebuilt once this occurred. Structure values totaling $12,352,800 for the FWOP condition are presented in Table E-2 below.

The local ability to respond to this erosion problem in the future is not known but likely limited. The state has declined to permit shoreline structural solutions opting for beach fill. As homes start to erode, political pressure may force regulatory change as has happened historically in other locations in Plum Island.

4.2 With-Project Condition

The with-project condition assumes the placement of dredged material on the beaches within the study area. Maintenance dredging of Newburyport Harbor will result in approximately 220,000 cubic yards of sand available for beneficial use. Coastal engineering analysis determined that this amount of material will provide a beach fill with a berm length of approximately 900 linear feet that will last approximately 4 years. In the with-project condition, it was assumed that the erosion rate would remain at 53 feet per year, but the structures would be damaged 4 years later than in the without-project condition. This is a onetime placement with no plans for renourishment. Therefore, while the project life is 4 years, the impact of the placement will last beyond those years. For example, a home lost in year 5 will now be lost in year 9 in the with-project condition.

Properties at imminent risk of destruction were located in Google Earth Pro. A measurement of 900 feet, as shown in Figure E-3, was used to define the shoreline area where sand disposal would have the greatest beneficial effect and reduce the greatest number of potential damages.

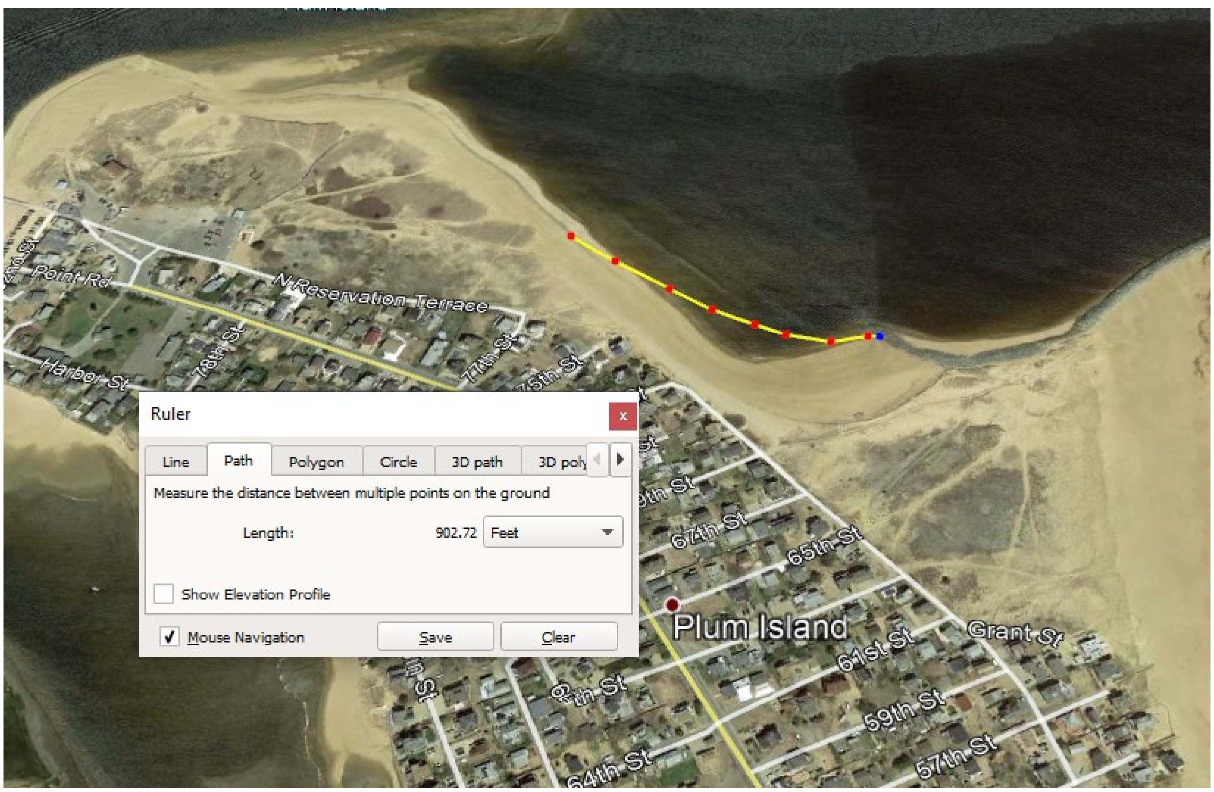

Figure E-3: Shoreline Impact Distance

The present value was determined for structures in the with-project condition based on the additional length of time before erosion undermined the structure. Structure values for the with-project condition are also presented in Table E-2.

Table E-2: Structure Valuation for Without- and With-Project Conditions

		WITHOUT PROJECT CONDITIONS				**WITH PROJECT CONDITIONS**			
Structure ID	2020 Depreciated Replacement Values	*Year Damaged*	*Study Year*	*Present Value Factor*	*Present Value*	*Year Damaged*	*Study Year*	*Present Value Factor*	*Present Value*
12	$ 181,200	2024	4	0.897	$ 162,600	2028	8	0.805	$ 145,800
41	$ 389,000	2024	4	0.897	$ 349,000	2028	8	0.805	$ 313,100
43	$ 222,300	2025	5	0.873	$ 194,100	2029	9	0.783	$ 174,100
58	$ 138,800	2026	6	0.850	$ 117,900	2030	10	0.762	$ 105,800
64	$ 194,000	2025	5	0.873	$ 169,400	2029	9	0.783	$ 152,000
66	$ 388,200	2024	4	0.897	$ 348,300	2028	8	0.805	$ 312,500
67	$ 200,600	2027	7	0.827	$ 165,900	2031	11	0.742	$ 148,800
76	$ 101,300	2028	8	0.805	$ 81,500	2032	12	0.722	$ 73,100
77	$ 200,300	2029	9	0.783	$ 156,900	2033	13	0.703	$ 140,800
103	$ 112,900	2024	4	0.897	$ 101,200	2028	8	0.805	$ 90,800
108	$ 102,900	2027	7	0.827	$ 85,100	2031	11	0.742	$ 76,400
110	$ 161,700	2024	4	0.897	$ 145,000	2028	8	0.805	$ 130,100
130	$ 205,500	2029	9	0.783	$ 161,000	2033	13	0.703	$ 144,400
136	$ 218,400	2025	5	0.873	$ 190,700	2029	9	0.783	$ 171,100
137	$ 160,500	2026	6	0.850	$ 136,400	2030	10	0.762	$ 122,400
141	$ 212,400	2022	2	0.947	$ 201,200	2026	6	0.850	$ 180,500
176	$ 175,100	2027	7	0.827	$ 144,800	2031	11	0.742	$ 129,900
182	$ 113,200	2026	6	0.850	$ 96,200	2030	10	0.762	$ 86,300
197	$ 177,600	2024	4	0.897	$ 159,300	2028	8	0.805	$ 143,000
233	$ 210,100	2024	4	0.897	$ 188,500	2028	8	0.805	$ 169,100
235	$ 164,500	2025	5	0.873	$ 143,600	2029	9	0.783	$ 128,900
236	$ 151,600	2026	6	0.850	$ 128,900	2030	10	0.762	$ 115,600
246	$ 92,700	2025	5	0.873	$ 81,000	2029	9	0.783	$ 72,600

Table E-2 (Continued): Structure Valuation for Without- and With-Project Conditions									
		WITHOUT PROJECT CONDITIONS				**WITH PROJECT CONDITIONS**			
Structure ID	2020 Depreciated Replacement Values	*Year Damaged*	*Study Year*	*Present Value Factor*	*Present Value*	*Year Damaged*	*Study Year*	*Present Value Factor*	*Present Value*
253	$ 158,800	2026	6	0.850	$ 135,000	2030	10	0.762	$ 121,100
254	$ 152,800	2022	2	0.947	$ 144,700	2026	6	0.850	$ 129,800
257	$ 164,200	2029	9	0.783	$ 128,600	2033	13	0.703	$ 115,400
259	$ 221,200	2023	3	0.922	$ 203,900	2027	7	0.827	$ 182,900
264	$ 240,200	2022	2	0.947	$ 227,500	2026	6	0.850	$ 204,100
266	$ 121,600	2024	4	0.897	$ 109,100	2028	8	0.805	$ 97,900
270	$ 8,600	2027	7	0.827	$ 7,100	2031	11	0.742	$ 6,400
272	$ 153,900	2027	7	0.827	$ 127,200	2031	11	0.742	$ 114,200
273	$ 185,000	2022	2	0.947	$ 175,200	2026	6	0.850	$ 157,200
281	$ 326,500	2028	8	0.805	$ 262,800	2032	12	0.722	$ 235,800
282	$ 168,900	2023	3	0.922	$ 155,700	2027	7	0.827	$ 139,700
284	$ 162,000	2026	6	0.850	$ 137,600	2030	10	0.762	$ 123,500
288	$ 374,700	2021	1	0.973	$ 364,700	2025	5	0.873	$ 327,200
293	$ 192,100	2025	5	0.873	$ 167,700	2029	9	0.783	$ 150,400
365	$ 139,600	2026	6	0.850	$ 118,600	2030	10	0.762	$ 106,400
380	$ 171,300	2030	10	0.762	$ 130,600	2034	14	0.684	$ 117,100
385	$ 147,700	2029	9	0.783	$ 115,700	2033	13	0.703	$ 103,800
389	$ 306,700	2030	10	0.762	$ 233,800	2034	14	0.684	$ 209,800
406	$ 201,700	2028	8	0.805	$ 162,300	2032	12	0.722	$ 145,600
408	$ 135,100	2029	9	0.783	$ 105,900	2033	13	0.703	$ 95,000
414	$ 270,200	2028	8	0.805	$ 217,500	2032	12	0.722	$ 195,100
420	$ 187,200	2023	3	0.922	$ 172,600	2027	7	0.827	$ 154,900
423	$ 118,500	2026	6	0.850	$ 100,700	2030	10	0.762	$ 90,300
426	$ 291,000	2029	9	0.783	$ 228,000	2033	13	0.703	$ 204,500

Table E-2 (Continued): Structure Valuation for Without- and With-Project Conditions									
		WITHOUT PROJECT CONDITIONS				**WITH PROJECT CONDITIONS**			
Structure ID	2020 Depreciated Replacement Values	*Year Damaged*	*Study Year*	*Present Value Factor*	*Present Value*	*Year Damaged*	*Study Year*	*Present Value Factor*	*Present Value*
433	$ 128,600	2025	5	0.873	$ 112,300	2029	9	0.783	$ 100,700
435	$ 222,000	2025	5	0.873	$ 193,800	2029	9	0.783	$ 173,900
436	$ 125,700	2025	5	0.873	$ 109,800	2029	9	0.783	$ 98,500
437	$ 271,200	2029	9	0.783	$ 212,400	2033	13	0.703	$ 190,600
441	$ 219,600	2022	2	0.947	$ 208,000	2026	6	0.850	$ 186,600
442	$ 219,600	2023	3	0.922	$ 202,400	2027	7	0.827	$ 181,600
443	$ 137,100	2024	4	0.897	$ 123,000	2028	8	0.805	$ 110,300
722	$ 343,500	2027	7	0.827	$ 284,100	2031	11	0.742	$ 254,900
42	$ 176,700	2030	10	0.762	$ 134,700	2034	14	0.684	$ 120,900
47	$ 121,200	2027	7	0.827	$ 100,200	2031	11	0.742	$ 89,900
143	$ 113,500	2030	10	0.762	$ 86,500	2034	14	0.684	$ 77,600
147	$ 120,300	2030	10	0.762	$ 91,700	2034	14	0.684	$ 82,300
180	$ 88,400	2030	10	0.762	$ 67,400	2034	14	0.684	$ 60,500
191	$ 126,500	2029	9	0.783	$ 99,100	2033	13	0.703	$ 88,900
232	$ 79,800	2030	10	0.762	$ 60,800	2034	14	0.684	$ 54,600
250	$ 92,700	2029	9	0.783	$ 72,600	2033	13	0.703	$ 65,200
287	$ 152,500	2028	8	0.805	$ 122,700	2032	12	0.722	$ 110,100
292	$ 270,100	2026	6	0.850	$ 229,500	2030	10	0.762	$ 205,900
299	$ 113,000	2027	7	0.827	$ 93,500	2031	11	0.742	$ 83,800
301	$ 209,700	2028	8	0.805	$ 168,800	2032	12	0.722	$ 151,400
304	$ 147,300	2030	10	0.762	$ 112,300	2034	14	0.684	$ 100,800

5 Project Benefits

5.1 Coastal Storm Damage Reduction

The benefit of providing measures to manage the risk of coastal storm damage in the study area is equal to the reduction in annual damages between the without- and with-project conditions.

The value of structures damaged in the without-project condition is approximately $10.5 million compared to $9.4 million in the with-project condition. Annual damages, presented in Table E-3, were calculated using the current 2020 Fiscal Year Federal Discount Rate of 2.75 percent for the 10-year life of the project. A total of 68 residential structures are expected to be damaged due to coastal erosion from 2020 to 2030 if risk reduction measures are not implemented. That number would decrease to 37 structures in the with-project condition, yielding annual benefits of $125,300.

Table E-3: Annual Structure Damage Calculation

	Without-Project	With-Project
Total Damages over 10 years	$10,526,600	$9,444,100
Capital Recovery Factor	0.1157	0.1157
Annual Damages to Structures	$1,218,400	$1,093,100
# Structures Damaged in 10 years	68	37
With-Project Annual Benefit		**$125,300**

6 Land Loss Avoided

The value of land lost to erosion was estimated using average land values obtained from the City of Newburyport assessment office. A sample of ten backshore properties were used to determine land value. The backshore land value was used for a more conservative estimate as compared to more expensive shore front properties. The price per acre is $2.6 million, or $59 per square foot. Table E-4 below presents the land valuation and calculation for Land Lost Due to Erosion. The toe of the dune was established by the New England District Hydrology team. The calculation is based on the projected distance eroded landward during the 10-year period of analysis. An erosion rate of 53 feet per year and a project length of 900 feet was used. The following equation was used:

(900 Linear Feet) x (53 Feet per Year of Erosion) = 47,700 Square Feet per Year
(47,700 Square Feet per Year) x ($59 per Square Foot) = $2,814,300 per year

In the without project condition, land will erode at a rate of 53 feet per year. In the with-project condition, land loss will be delayed 4 years. Therefore land loss avoided will be four years total. The second half of the table below shows the annual land loss calculations used in the benefit-cost analysis.

Table E-4: Land Loss Due to Erosion

Address	Acres	Land Value
6 77TH ST	0.08	$261,500
6 75TH ST	0.05	$246,000
9 71ST ST	0.11	$271,000
5 73RD ST	0.12	$272,200
12 69TH ST	0.06	$248,200
5 77TH ST	0.14	$288,500
224 NORTHERN BLVD	0.15	$282,100
234 NORTHERN BLVD	0.14	$291,000
5 67TH ST	0.11	$271,100
218 NORTHERN BLVD	0.08	$263,400
TOTAL	1.04	$2,695,000
Average Price per Acre		$2,591,300
Average Price per Square Foot		$59
Shoreline Impact Distance (Linear Feet)		900
Landward Erosion per Year (Feet)		53
Area Eroded each year (Square Foot)		47,700
Value of Land Loss Per Year		$2,814,300
Total Land Loss Without Project (10-years)		$28,143,000
Total Land Loss with Project (delays 4 years of land loss)		$16,885,800
Total with project benefit		$11,257,200
Annual Benefit Over 10-Years		**$1,302,900**

7 Avoided Utility Loss

There is a sewage line that runs under Northern Boulevard and is vulnerable to erosion. In the without project condition, damage to the sewage line will start in year 8 and be more extensive than in the with-project condition. Damage to Northern Boulevard will start in year 9 and be less extensive in the with-project condition. Figures E-4 and E-5 below show the total damage area in the without and with-project conditions respectfully. A cost of $1,125 per square feet was determined by the New England Cost Engineer using an estimate from a recent district project. Using Google Earth to measure the length of the erosion on Northern Boulevard for both alternatives, the annual avoided utility lost cost was calculated. Table E-5 below shows that calculation.

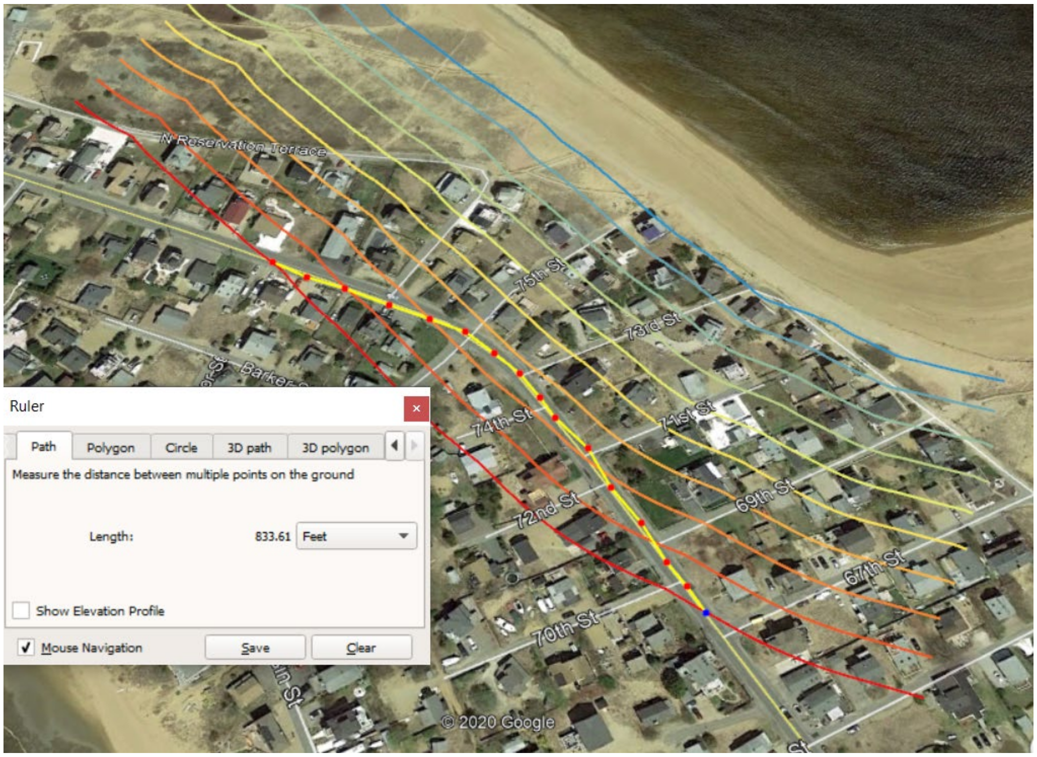

Figure E-4: Utility Damage in Without-Project Condition

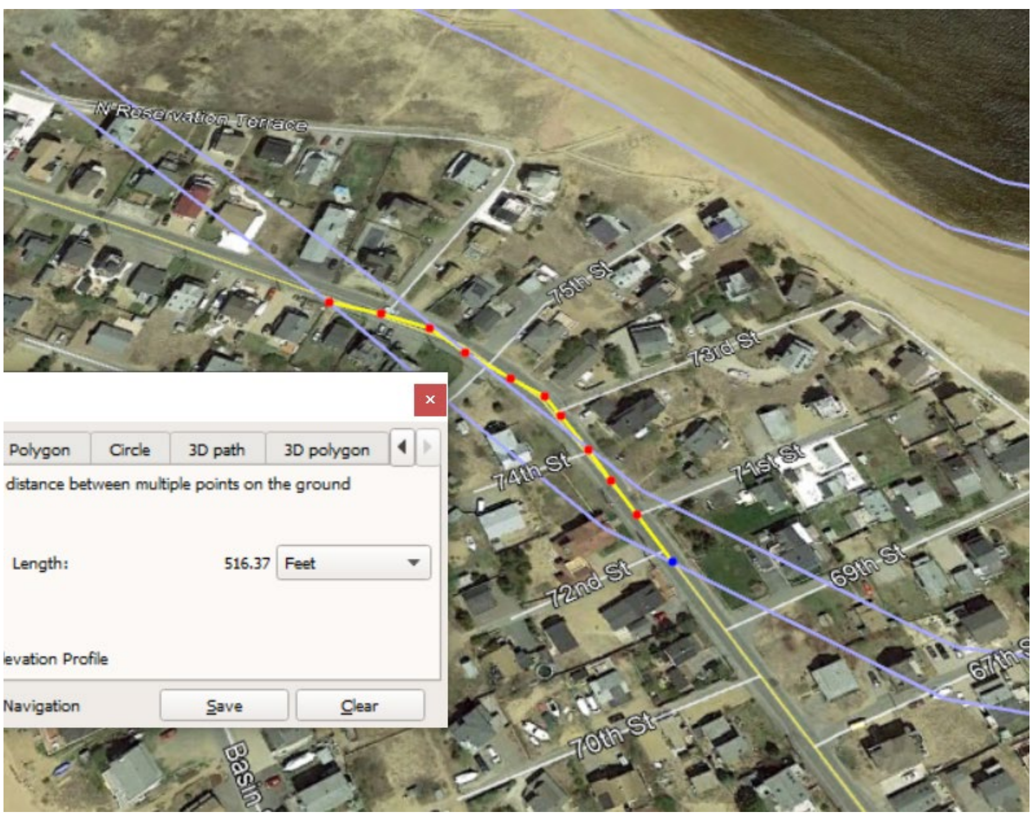

Figure E-5: Utility Damage in With-Project Condition

Table E-5: Avoided Utility Damage					
Year	**Total Damage (ft)**	**Incremental Damage (ft)**	**Incremental Damage x $1,125**	**Present Value Factor**	**Total Damage**
Without Project					
Year 8	320	320	$360,000	0.8049	$289,800
Year 9	600	280	$315,000	0.7833	$246,800
Year 10	835	235	$264,300	0.7624	$201,500
TOTAL					**$738,100**
With Project					
Year 9	150	150	$168,700	0.7833	$132,200
Year 10	520	370	$416,200	0.7624	$317,300
TOTAL					**$449,500**
Total Avoided Utility Repair Cost					**$288,600**
Capital Recover Factor					**0.1157**
Annual Avoided Utility Damage					**$33,400**

8 Recreation

Beach nourishment provides enhanced recreational benefits based on overall enhanced beach experience. Recreational benefits for Federal Water Resource Projects are calculated using the Unit Day Value Method (UDV) as detailed in Corps Economic Guidance Memorandum #20-03, "Unit Day Values for Recreational, Fiscal Year 2020." The recreation experience is evaluated through a point system which rates the beach using the five criteria listed in Table E-6 below.

The number of points attributed to the overall visitor experience is cross-referenced to dollar values provided in the economic guidance memorandum to determine the average dollar value per day per user, or UDV. The beneficial use of dredged material will add substantial area for beachgoers and fisherman to access the beach without trespassing on private lots. The beach fill alternative at North Point Beach will generate a total of 46 points and a UDV of $7.90 compared to the without-project value of 28 points at a UDV of $6.60. The UDV is multiplied by the number of visitors to determine the value of recreational benefits. The number of annual visitors was provided by the Chief Administrative Officer for the City of Newburyport and is based on the number of parking spots (121 spots) and seasonal traffic to the parking lot located on North Point. Table E-6 shows the annual recreation benefit calculation.

Table E-6: Recreation Benefits Based on Unit Day Value

UDV Criteria	Point Range	Without Project Points	With Project Points
Recreation Experience	0-30	4	10
Availability of Opportunity	0-18	0	0
Carrying Capacity	0-14	2	4
Accessibility	0-18	14	16
Environmental Aesthetic	0-20	8	16
TOTAL POINTS		28	46
$ Value/User/Day		$6.60	$7.90
Annual visitors		6,000	6,000
Recreation Value		$39,600	$47,400
Annual Recreation Benefits			**$7,800**

9 Benefit and Cost Comparison

The benefit of providing protection through beneficial use of dredged material is equal to the reduction in annual damages between the without- and with-project conditions, plus additional recreation benefits obtained from the nourished beach. Table E-7 below summarized the benefits.

Table E-7: Total Benefits

Benefits	
Annual Structure Damage Avoided	$ 125,300
Annual Land Loss Avoided	$ 1,302,900
Annual Recreation Benefit	$ 7,800
Annual Avoided Utility Cost	$ 33,400
TOTAL ANNUAL PROJECT BENEFITS	**$ 1,469,400**

Benefits are analyzed further by comparing the least-cost disposal plan associated with the Navigation maintenance dredging (base plan) to the cost of providing the coastal storm damage protection. Open water disposal is the least-cost Federal base plan that is compared to beach fill, using a pipeline dredge to place disposal material on the beach in North Point, Plum Island. The cost difference between these plans is then used to determine the overall benefit of the project. Table E-8 below presents the cost comparison between the two plans.

Table E-8: Benefit-Cost Comparison

Beneficial Use of Dredge Material - §204	Base Plan: Place Material at North Point and Nearshore Sites with Hopper Dredge	Alternative: Place Material at North Point Beach with Pipeline Dredge
2020 Total First Cost	$5,946,000	$6,415,000
IDC - @ 2.75%	$6,700	$21,800
2020 Total Investment	**$5,952,700**	**$6,436,800**
Incremental Cost of Beach Placement		$524,400
Capital Recovery Factor-10 years		0.1157
2020 Annual Costs for 10-Year Period of Analysis		$60,700
Annual Benefits for 10-Year Period of Analysis		$1,469,400
Net Annual Benefits		$1,408,700
Benefit-Cost Ratio		**24.2**

* Note: 1 month construction period for base plan hopper dredge and 4 month construction period for the pipeline dredge

10 Price Level Update for Fiscal Year 2021

Costs were escalated to 2021 price levels to better reflect the release date of this report. Construction costs were updated using a factor of 1.03 following guidance in EM 1110-2-1304 Civil Works Construction Cost Index System (CWCCIS). To stay consistent for comparison, benefits were similarly escalated using a factor of 1.03. Table E-9 below summarizes the updated benefits and Table E-10 summarizes the revised cost and cost-benefit analysis.

Table E-9: Total Benefits in FY21 Dollars

Benefits	
Annual Structure Damage Avoided	$ 129,100
Annual Land Loss Avoided	$ 1,342,000
Annual Recreation Benefit	$ 8,000
Annual Avoided Utility Cost	$ 34,400
TOTAL ANNUAL PROJECT BENEFITS	**$ 1,513,500**

Table E-10: Benefit-Cost Comparison in FY21 Dollars

Beneficial Use of Dredge Material - §204	Base Plan: Place Material at North Point and Nearshore Sites with Hopper Dredge	Alternative: Place All Material at North Point Beach with Pipeline Dredge
2021 Total First Cost	$6,137,000	$6,619,000
IDC - @ 2.75%	$6,900	$22,500
2020 Total Investment	**$6,143,900**	**$6,641,500**
Incremental Cost of Beach Placement		$497,600
Capital Recovery Factor-10 years		0.1157
2021 Annual Costs for 10-Year Period of Analysis		$57,600
Annual Benefits for 10-Year Period of Analysis		$1,513,500
Net Annual Benefits		$1,455,900
Benefit-Cost Ratio		**26.3**

* Note: 1-month construction period for base plan hopper dredge and 4-month construction period for the pipeline dredge

11 Regional Economic Development

The impacts of project spending on the employment, income, and output of the regional economy are considered part of the Regional Economic Development (RED) account. These regional impacts associated with construction spending for the NED Plan are calculated using the USACE Regional Economic System (RECONS) certified regional economic model. The RECONS model uses IMPLAN® modeling system software developed by Minnesota IMPLAN Group, Inc. to trace the economic ripple, or *multiplier*, effects of project spending in the study area. The model is based on data collected by the U. S. Department of Commerce, the U.S. Bureau of Labor Statistics, and other federal and state government agencies. RECONS uses categories defined by the U.S. Office of Management and Budget's North American Industry Classification System (NAICS). Nationally developed input-output tables represent the relationships between the many different sectors of the economy to allow an estimate of changes in economic activity on the larger economy as a whole, brought about by spending in the project area.

There are two types of effects estimated by the RECONS model—direct and secondary effects. These effects, or impacts, are described as follows:

- Direct effects are the change in dollars or number of jobs that are created because of the direct construction spending made through payroll and direct purchases from businesses for goods and services.

- Secondary impacts measure the change in dollars or employment caused by the next round of spending as businesses make further purchases and pay their employees—these are often called the multiplier effect.

Estimates are provided for local, state, and national levels of geographic impact areas based on Flood Risk Management construction spending of $6.6 million in Essex County for the proposed Section 204 project. Of the total expenditure, $5 million will be captured within the local impact area. The remainder of the expenditures will be captured within the state and national impact area. The direct and secondary impacts are measured in output, jobs, labor income, and gross regional product (value added) as summarized in the Table E-11 below.

Table E-11: Regional Economic Development

Area	Local Capture ($000)	Output ($000)	Jobs*	Labor Income ($000)	Value Added ($000)
Local					
Direct Impact		$5,021	23.3	$1,836	$2,400
Secondary Impact		$2,302	15.9	$884	$1,361
Total Impact	**$5,021**	**$7,323**	**39.2**	**$2,721**	**$3,761**
State					
Direct Impact		$5,697	26.1	$2,214	$2,939
Secondary Impact		$3,628	21.3	$1,455	$2,214
Total Impact	**$5,697**	**$9,325**	**47.4**	**$3,669**	**$5,153**
US					
Direct Impact		$6,387	30.1	$2,593	$3,277
Secondary Impact		$8,752	45.3	$2,765	$4,659
Total Impact	**$6,387**	**$15,139**	**75.4**	**$5,358**	**$7,936**

* Jobs are presented in full-time equivalence (FTE)

12 Conclusion

The incremental construction cost of beach nourishment is $497,600 or $57,600 when annualized over the 10-year period of analysis. Net annual benefits amount to $1,455,900 yielding a positive Benefit to Cost Ratio of 26.3 to one.

These benefits indicate a positive National Economic Development plan for beneficial use of dredged material to provide coastal storm damage reduction measure in the City of Newburyport, Massachusetts.