FINAL REPORT

New York State Office of General Services

Engineering Report for WA.37 Blind Sodus Bay

February 14, 2020

LAKE ONTARIO REDI

Resiliency & Economic Development Initiative

RAMBOLL

FINAL REPORT

2069 | 73070

Engineering Report for WA.37 Blind Sodus Bay

Prepared for:

New York State Office of General Services

TERRANCE P. MADDEN, PE | SR. VICE PRESIDENT
O'BRIEN & GERE ENGINEERS, INC.

RAMBOLL

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

1. EXECUTIVE SUMMARY

In 2017 and 2019, the Lake Ontario and the St. Lawrence River System experienced high-water levels that resulted in severe flooding and erosion throughout the region. These conditions have caused adverse effects on property, infrastructure, business, and public safety. The elevated water levels are from a combination of natural and anthropogenic processes, as well as the system's response to regional climatic trends. In response to the extended pattern of flooding along Lake Ontario – St. Lawrence River shorelines, Governor Andrew M. Cuomo created the Lake Ontario Resiliency and Economic Development Initiative (REDI). Given changes to the climate, New York recognizes that planning is required for mitigation of a 'new normal' set of environmental conditions. For the Lake Ontario Region, learning how to adapt to and plan for a warmer, wetter, and more dynamic regional climate is emerging as a reality. By focusing on proactive resiliency planning that is informed by useful climate information and local input, the Lake Ontario Region has an opportunity to promote shoreline resiliency that allows communities and stakeholders to adapt to climate-related challenges.

This report is in regard to Blind Sodus Bay, Wayne County, NY. Wayne County includes an approximate 53-mile stretch of Lake Ontario shoreline and open bay frontage spanning between Monroe County to the west and Cayuga County to the east. The Wayne County shoreline is primarily undeveloped land, recreational areas, coastal communities, orchards, farm fields, single-family homes, and a limited amount of industry.

As part of the REDI program, this report is prepared to evaluate shoreline resiliency alternatives and help guide the next steps of the project execution process. The information provided in this document is based on online sources, previous reports prepared for the REDI program, a site visit and an aerial drone survey performed by Ramboll. Furthermore, this report includes recommendations for next steps to investigate the site, perform the required field work and prepare a detailed assessment of the alternatives prior to making a final decision on the selected alternative.

Sections 2 and 3 provide project background, history and general permitting requirements. Section 4 includes a summary of the alternatives considered, including the no action alternative, with comparisons and cost estimates. Section 5 summarizes the alternatives, including consideration of resiliency and natural/nature-based solutions and presents next steps to advance this project. Section 6 concludes with recommendations, including identification of data gaps and other next steps. It is also important to note that this report only considered nature-based alternatives and a hybrid approach incorporating stronger features to increase resiliency of the system. The cost estimates provided in Section 4 Alternative Analysis are estimated and variable based on actual design. The grand scope of the area with limited construction access and location may increase the potential costs of the project.

2. PROJECT BACKGROUND AND HISTORY

2.1 LOCATION

Blind Sodus Bay (**Figure 2-1**), located in Wayne County, New York, abuts Lake Ontario to the north and is separated from the lake by a barrier bar. There are numerous residential properties along the shoreline of the bay. Additionally, the seasonal Holiday Harbor RV park is located to the west of the bay. Aside from Lake Ontario, the nearest water bodies to Blind Sodus Bay are Little Sodus Bay to the east and Meadow Cove to the southeast. The project focuses on two critical locations, i.e., the barrier bar which had extended across the lakeward edge of the bay, as well as a bluff immediately to the west of the bay. The bluff has public sewer infrastructure, residences and an associated road.

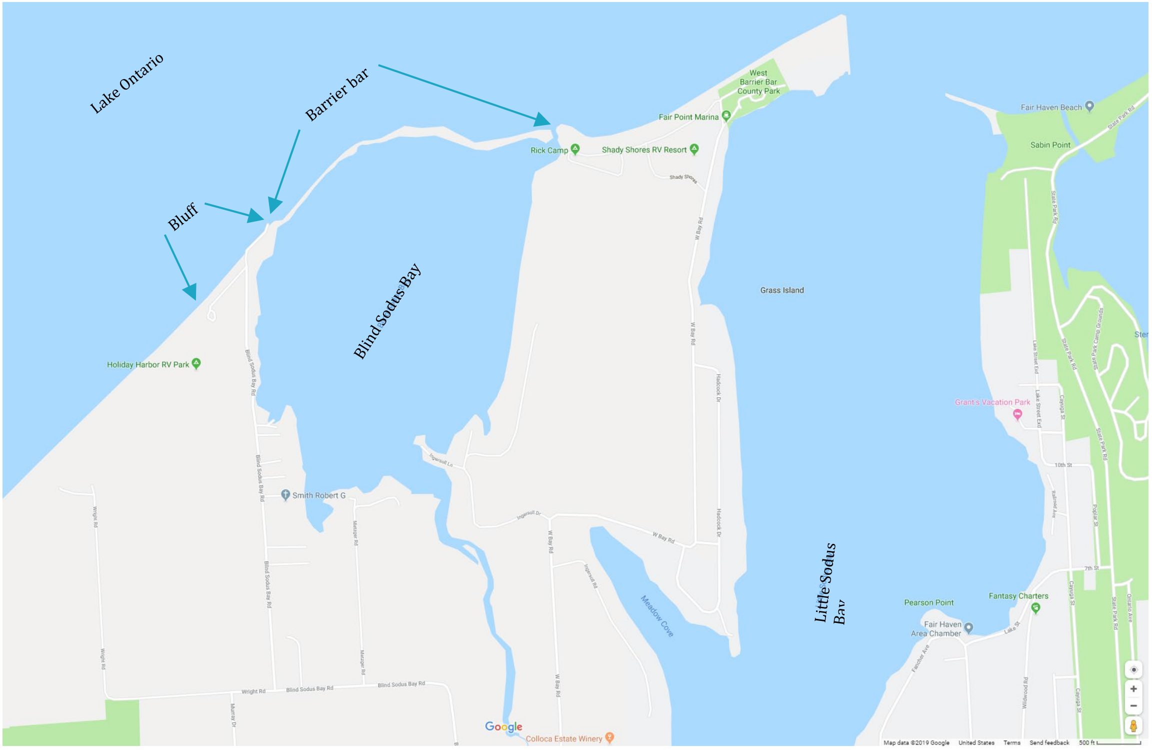


Figure 2-1 *Location Map for Blind Sodus Bay. Approximate extents of the bluff and barrier bar are shown.*

Blind Sodus Bay has approximately 3 miles of shoreline with the majority being either vegetated or residential housing, which is predominantly used on a seasonal basis. According to the online resource DataUSA.io, (https://datausa.io/profile/geo/wolcott-ny/) the average property value in 2017 in Wolcott, NY was $76,100 and the homeownership rate was 61.3%. In 2017, the median household income was $31,905 per year, a decline of 3.36% from the previous year. The largest industries in Wolcott, NY were Retail Trade, Manufacturing, and Accommodations and Food Services. The tourism industry is not listed as an industry on the website, but instead is split into other sectors that are likely influenced by the high amount of seasonal tourism in the area. Based on aerial imagery from 2015, there appear to be 8 homes and 7 docks located on the north shore of Blind Sodus Bay, adjacent to the barrier bar. These low-lying properties are the most vulnerable to impacts from the breach and damage from debris, ice and waves from Lake Ontario. There are approximately 65 permanent buildings within 100 feet of the Blind Sodus Bay shore, and several locations for mobile homes or RV parking.

The Bluff Area is located south of the barrier bar and extends for approximately 1,100 linear feet of shoreline. A private homeowner installed approximately 175 linear feet of shoreline protection at the northern terminus of the Bluff Area. Shoreline protection consists of a concrete cap, drilled steel pipe piles filled with concrete extending up 8 to 10 feet above the concrete cap, timber cribbing behind the steel pipe piles, and gabion baskets behind the cribbing. Wave and freeze action have continually eroded the toe of the bluff causing sloughing and encroachment onto properties and structures; several properties have structures that are undermined from erosion. **Figure 2-2** shows an overview of the Bluff Area. The sloughed material is at the base of the bluff and is referred to herein as the slope. The bluff has a near vertical face at the top of the bluff in most areas and at the toe in several areas.

Figure 2-2 *Bluff Area*

Existing structures from STA 2+25 to 3+10 are currently undermined and unsafe. The structures include a single-story residential home, shed, and manhole (see **Figure 2-3** below).

Figure 2-3 *Undermined Structures*

The bluff is encroaching on an unpaved road which provides access to several properties to the north and has public wastewater infrastructure that serves those properties. Approximate stationing from STA 5+50 to STA 8+10 (see **Figure 2-4** below). A slope stabilization design was completed for this portion of the bluff by MRB Group (**Appendix A**).

Figure 2-4 *Bluff STA 5+50 to STA 8+10*

2.2 OWNERSHIP AND SERVICE AREA

Blind Sodus Bay is owned by NYS as land under water. The bluff portion of the project area is owned by a combination of the Blind Sodus Bay Sewer District and private landowners.

2.2.1 Stakeholders and Community Support

Several public meetings with regional stakeholders and planning committee members were held to discuss this project and others involved in the NYS REDI program. Those meetings include five stakeholder meetings held on July 10, July 31, Aug 26, and Sept 9, 2019 as well as three planning committee meetings held on Aug 13, Aug 21, and Sept 5, 2019. Throughout these meetings, strong community support was expressed for the initiatives evaluated herein this report.

The Blind Sodus Bay Improvement Association is a not-for-profit comprising residents and seasonal users of the Bay. Funds raised by the Association are used to maintain the channel to Lake Ontario through the eastern end of the barrier bar. The Association also participates in other important water quality and conservation programs as well as maintaining contact with elected officials to represent Bay interests.

2.2.2 Population Trends and Growth

According to the United States Census estimate, the Town of Wolcott has a current population of 4,212. Between 2000 and 2017, the Town of Wolcott experienced a population decrease of approximately 10%.

2.3 GEOLOGICAL CONDITIONS

2.3.1 Soil Type

The Blind Sodus Bay Barrier and Bluff are mapped as proglacial lacustrine silt and clay, generally calcareous, and prone to land instability (Muller, E., Cadwell, D., Finger Lakes Sheet - Surficial Geologic Map of New York, 1986). Drumlins mapped along the southern shore of Lake Ontario are generally oriented North-South with tapering shallow southern edges. At the eastern and western shore of Blind Sodus Bay it appears drumlins at the shoreline were eroded and only the southern tapered edge remains, which may suggest diminishing sediment supplies over time in addition to diminishing sediment due to shoreline stabilization efforts.

The bluffs of Lake Ontario are cut only sparingly in Ordovician red sandstone and shale and expose three major lithostratigraphic units. A lower red or pink sandy-till sheet is overlain by widespread gray and red glaciolacustrine silt and clay. These fines provide major input to a younger, siltier, purplish-gray or gray till marked by both massive basal facies and upper subaqueous-flow or basal melt-out diamicton. A blanketing glaciolacustrine sequence occurring in the lower, nondrumlin areas is largely related to glacial Lake Iroquois. Locally, proglacial sands, lenses of flow till, or stone concentrations indicate a short re-advance during lake formation (Fletcher, C., Wehmiller, J., Quaternary Coasts of the United States: Marine and Lacustrine Systems, SEPM Society for Sedimentary Geology, 1992).

Around the perimeter of the lake floor, the high energy of water circulation has prevented the deposition of postglacial muds, except in sheltered areas (Thomas et al, 1972). Strongly linear bathymetric features displaying the imprint of glaciation, or of exhumation of bedrock topography and structure, occur at intervals along almost the entire lakeshore. In most areas around the lake perimeter, quaternary sediments are relatively thin or absent, and bedrock exposures are common, possibly reflecting the effects of subglacial erosion and subsequent abrasion by lacustrine waves and currents.

2.3.2 Bluff Area Boring Summary

A slope stabilization design was prepared by MRB Group, D.P.C. for the Bluff Area located south of Blind Sodus Bay and submitted in a Joint Application Form to NYS/USACE for approval on June 3, 2019. To support the design, CME Associates, Inc. performed a subsurface investigation including three soil borings at the top of the Bluff Area. Laboratory testing included natural moisture contents (ASTM D2216) and Particle Size Analysis (ASTM D422).

Soils were generally classified as a medium dense to very dense brown/red silt with varying amounts of sand and gravel. Blow counts in native soil deposits ranged from 24 to 100+ blows per foot (BPF) and increased with depth. Red/brown rock fragments were encountered at auger refusal at depths ranging from 28.8 to 30.5 feet BGS. The corresponding top of weathered rock elevations based on NAVD 1988 range from El. +242.1' to El. +244.5' with an average El. +243.6'. Top of weathered rock based on the borings performed generally coincides with the ordinary low water of Lake Ontario (El. +243.3'). Based on regional experience, the top of bedrock in the area is approximately El. +192.0'.

The moisture profile developed from natural moisture content testing shows high natural moisture contents in fill material and low natural moisture contents in native soils. Trace amounts of clay were encountered in several soil samples but varved clay deposits were not encountered in the borings. As a result, perched water tables are not likely contributing to slope stability issues at the site but should be accounted for during design if slope revetment is not free draining or fill placement is required. Moisture contents in fill material ranges from 12.9 percent to 41.1 percent and natural moisture contents in native soils ranges from 0.6 percent to 9.1 percent with an average moisture content of 5.7 percent.

Glacial till material exposed along the face of the Bluff Area is classified in geologic maps as prone to land instability. While the glacial till material has high blow counts it is sensitive to moisture levels which eventually results in loss of structure and sloughing. Groundwater was measured after auger removal in the borings at approximately the bottom of each boring completed in the Bluff Area corresponding with the top of weathered rock.

2.3.3 Topography

Based on a UAV flight conducted by Ramboll on August 27, 2019, the eastern barrier bar crest elevations range from 248-251 IGLD85, with crest elevations typically 248 IGLD85 in areas that have flooded or breached. Given the extensive damaged that occurred within the project, some areas are currently breached and eroded and pre-breach elevations could not be determined. The western barrier bar is completely eroded and breached. The UAV flight was used to generate topographic information by processing photogrammetric data in Pix4D and relating relative topographic information to the water level recorded at the Oswego, NY (9052030) station on the day of the flight.

Drone imagery was utilized to develop approximate elevation data for the Bluff Area. Cross sections were developed in the drone software and the bluff geometry is summarized in **Table 2-1**. Stationing begins at the southern terminus of the Bluff Area and extends north, approximately along the water line, to the southern terminus of the existing shore revetment. Offset distances shown in the table are from the edge of Lake Ontario based on drone imagery from 8/27/19.

Table 2-1 *Bluff Geometry and stationing starting at the west end of bluff*

STA	TOE OF SLOPE		TOP OF SLOPE		TOP CLIFF		SLOPED FACE		VERTICAL FACE
	Offset (ft)	El. (ft)	Offset (ft)	El. (ft)	Offset (ft)	El. (ft)	L (ft)	Slope (H:V)	H (ft)
0+00	10.5	251.2	27.2	267.1	27.3	270.3	23.1	1.1:1	3.2
1+00	20	249.6	39	278.3	-	-	34.4	0.7:1	-
2+00	17.5	249.3	30	266.3	30.1	280.3	21.1	0.7:2	14
3+00	21	249.3	46	287.4	-	-	45.6	0.7:3	-
4+00	18	249.3	45	281.3	45	289.3	41.9	0.8:1	8
5+00	18	249.3	48	277.8	48.1	282.6	41.4	1.1:1	4.8
6+00	17.5	251.5	32	269	32.5	275	22.7	0.8:1	6
7+00	19	250.3	30	263.3	30.5	271.3	17.0	0.8:1	8
8+00	26	252.8	34.5	260.2	34.6	277.3	11.3	0.5:1	17.1
9+00	30.5	253.2	42	277.9	-	-	27.2	0.5:1	-
10+00	0	247.3	55	253.2	55.2	286.3	55.3	-	33.1
11+00	28	251.3	35.5	261.8	-	-	12.9	0.7:1	-

The bluff face ranges in length from 11.3 to 55.3 feet with an average length of 29.6 feet. The sloped face ranges from 0.5(H):1(V) to 1.1(H):1(V), with an average slope of 0.8(H):1(V). A vertical face was noted in the imagery and in 8 of the 12 cross sections analyzed. The vertical faces ranged from 3.2 to 33.1 feet based on the cross sections.

2.4 ENVIRONMENTAL CONDITIONS

2.4.1 Fisheries

Fishery assessments and gamefish surveys were conducted in Blind Sodus Bay during 1996, 2002 and 2013 by the NYSDEC and the Great Lakes Commission. Blind Sodus Bay is primarily a warm water fishery composing of walleye (*Sander vitreus*), northern pike (*Esox lucius*), chain pickerel (*Esox niger*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), pumpkinseed (*Lepomis gibbosus*), bluegill sunfish (*Lepomis macrochirus*), yellow perch (*Perca flavescens*), white perch (*Morone americana*), gizzard shad (*Dorosoma cepedianum*), and brown bullhead (*Amerius nebulosus*). In addition, migratory species such as Chinook salmon (*Onchorynchus tshawytscha*), coho salmon (*Onchorynchus kisutch*), brown trout (*Salmo trutta*), and rainbow trout (*Onchorynchus mykiss*) are found in the bay at certain times of the year and as they migrate through to spawning grounds in Blind Sodus Creek (Lane 1998).

From 1988 to 1997, Blind Sodus Bay was annually stocked with fingerling walleye by cooperating angler associations (1988 to 1992) and NYSDEC hatcheries (1993 to 1997). Bi-annual stocking of fingerling walleye has occurred since 2003 by the NYSDEC. Assessments have indicated that stocked fingerlings survive, and an adult walleye population is present in Blind Sodus Bay (NYSDEC 2019). Despite assessments indicating the presence of a walleye population, recreational fishing surveys found no anglers were targeting the species in Blind Sodus Bay (Sanderson 2014).

A roving recreational fishery survey (2012-2013) was conducted in Port, East, and Blind Sodus Bays to examine the current levels of angling effort and success (Sanderson 2014). During the 2012-2013 fishing year, an estimated total of 6,037 angler hours were spent fishing in Blind Sodus Bay. A total of 8,933 warm water gamefish (rate of 1.5 fish per angler hour) were caught during the survey.

Table 2-2 *Catches and Catch Rates from the 2012-2013 Blind Sodus Bay Fishing Survey*

Scientific Name	Common Name	Fishing Survey	
		Number of fish caught	Catch Rate (fish per angler hour)
Esox niger	Chain Pickerel	35	0.01
Esox Lucius	Northern Pike	267	0.04
Ameiurus nebulosus	Brown Bullhead	100	0.02
Ambloplites rupestris	Rock Bass	221	0.04
Lepomis gibbosus	Pumpkinseed	1,055	0.17
Lepomis macrochirus	Bluegill	2,217	0.37
Micropterus dolomieu	Smallmouth Bass	53	0.01
Micropterus salmoides	Largemouth Bass	2,081	0.34
Pomoxis nigromaculatus	Black Crappie	1,074	0.18
Perca flavescens	Yellow Perch	1,667	0.28
Sander vitreus	Walleye	0.0	0.00
	Other	163	0.03

Source: Table modified from Sanderson 2014.

2.4.2 Rare, Threatened and Endangered Species

The NYSDEC Environmental Resource Mapper (http://www.dec.ny.gov/gis/erm/) has identified the presence of rare plants and/or animals in Blind Sodus Bay (**Figure 2-5)**.

An unofficial list of rare and endangered species within the limits of the project area, encompassing Blind Sodus Bay and barrier bar, was obtained using the Information for Planning and Consulting (IPaC) on the U.S. Fish and Wildlife Service (USFWS) website (https://ecos.fws.gov/ipac/) (**Table 2-3**). For planning purposes, it is recommended that the USFWS be contacted directly for an Official Species List identifying all known or proposed rare, threatened and endangered species under their jurisdiction within the project area.

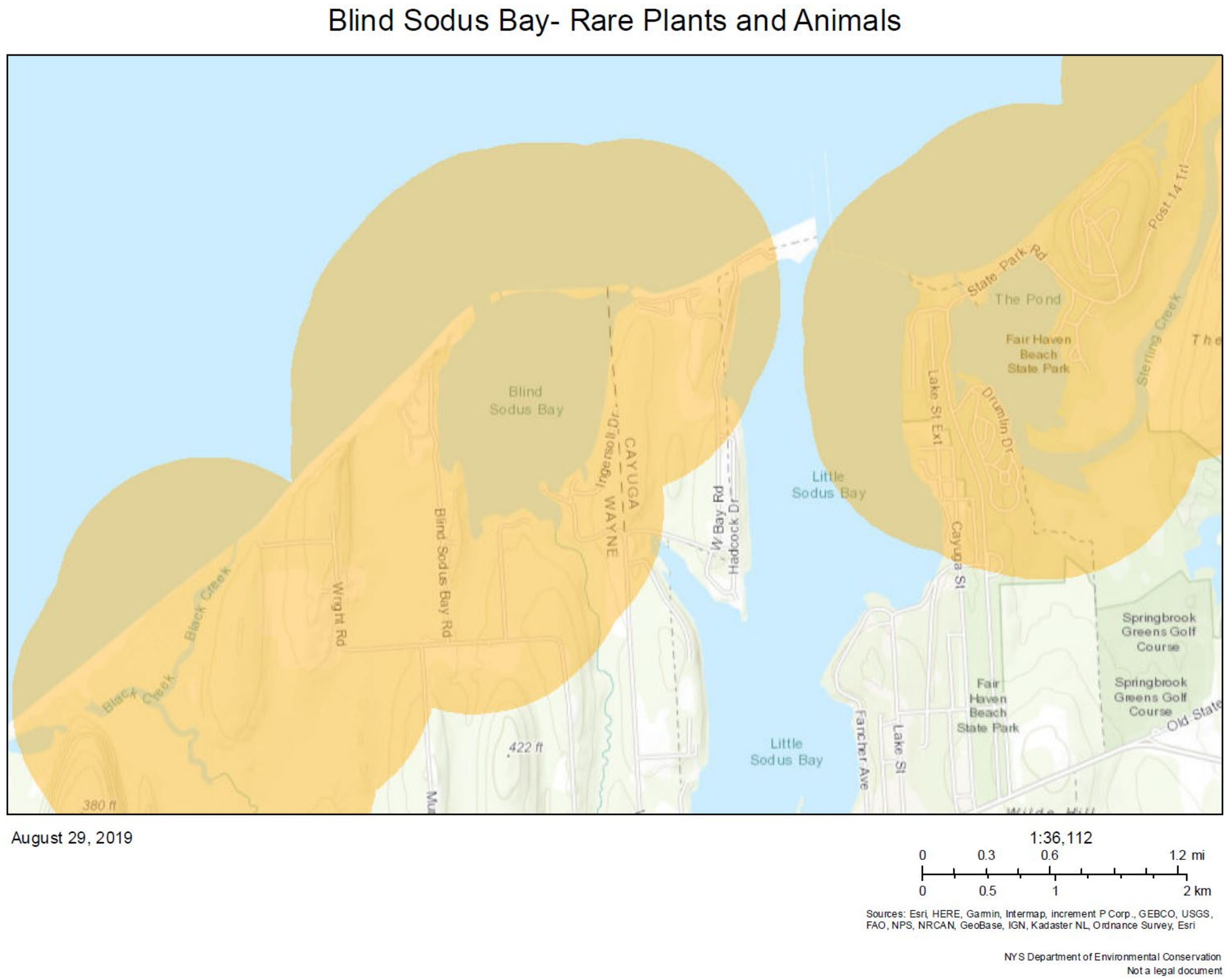


Figure 2-5 *Rare Animals and Plant per NYSDEC Environmental Mapper*

The National Oceanic and Atmospheric Administration (NOAA) Fisheries website (**https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=1bc332edc5204e03b250ac11f9914a27**) also provided insight on endangered species of fish and aquatic wildlife that are not covered under the USFWS jurisdiction. These include, Atlantic Sturgeon, Shortnose Sturgeon, Atlantic Salmon, Sea Turtles, and Atlantic Large Whales. Per the Section 7 Mapper for the Greater Atlantic Region none of these species were identified within the project area and the area encompassing Blind Sodus Bay is not considered a Critical Habitat per NOAA Fisheries.

The NYCDEC website provides a link to an EAF (Environmental Assessment Form) Mapper (**http://www.dec.ny.gov/eafmapper/**) that provides a list of identified rare, threatened and endangered species per the New York National Heritage Program (NYHNHP) within the project area.

Table 2-3 *Rare, Threatened and Endangered Species Unofficial List for Project Area*

Parameter	Notes
Critical Habitat	None
National Wildlife Refuge Lands	None
Fish Hatcheries	None

Parameter	Notes
Mammals	Northern Long-eared Bat (*Myotis septentrionalis*)
Migratory Birds	
American Golden-plover (*Pluvialis dominica*)	Breeds elsewhere- Bird of Conservation Concern (BCC) throughout the range in continental USA and Alaska
Bald Eagle (*Haliaeetus luecocephaius*)	Breeds Dec 1 – Aug 31
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	Breeds May 15 – Oct 10
Bobolink (*Dolichonyx oryzivorus*)	Breeds May 20 – Jul 31
Canada Warbler (*Cardelina canadensis*)	Breeds May 20 – Aug 10
Cerulean Warbler (*Dendroica ceruiea*)	Breeds Apr 20 – Jul 20
Dunlin (*Calidris aipina arcticoia*)	Breeds Elsewhere- Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCR) in
Golden Eagle (*Aquila chrysaetos*)	Breeds Jan 1 – Aug 31
Golden-winged Warbler (*Vermivora chrysoptera*)	Breeds May 1 – Jul 20
Lesser Yellowlegs (*Tringa flavipes*)	Breeds elsewhere- Bird of Conservation Concern (BCC) throughout the range in continental USA and Alaska
Prairie Warbler (*Dendroica discolor*)	Breeds May 1 – Jul 31
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	Breeds May 10 – Sep 10
Ruddy Turnstone (*Arenaria interpres morinella*)	Breeds Elsewhere- Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCR) in
Semipalmated Sandpiper (*Calidris pusilla*)	Breeds elsewhere- Bird of Conservation Concern (BCC) throughout the range in continental USA and Alaska
Snowy Owl (*Bubo scandiacus*)	Breeds elsewhere- Bird of Conservation Concern (BCC) throughout the range in continental USA and Alaska
Wood Thrush (*Hylocichia mustelina*)	Breeds May 10 – Aug 31

2.4.3 Significant Coastal Fish and Wildlife Habitats

Coastal Habitats are an important ecological feature serving as habitat and feeding areas for fish and wildlife and are also of economic importance to the communities in which they are located. The State of New York has many coastal habitats, where some are designated as Significant Coastal Fish and Wildlife Habitats (SCFWH) by the NYSDEC. There are several SCFWH surrounding the Great Lakes and St. Lawrence River, however, Blind Sodus Bay is not considered a Significant Coastal Fish and Wildlife Habitat per the NYSDEC.

2.4.4 Regulated Wetlands

The United States Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) of surface waters and wetlands was reviewed. The NWI indicated that the Blind Sodus Bay barrier bar overlaps three wetlands classified as L1UBH, L2UBH and R5UBH as shown on **Figure 2-6** (**https://www.fws.gov/wetlands/data/Mapper.html**). Although these maps are helpful in the preliminary identification of wetlands, they do not represent regulated state or federal wetland boundaries. The L1UBH wetland is a lacustrine (lake-like), limnetic (>2.5m deep) habitat with an unconsolidated bottom (≥25% of substrate is <6 cm diameter, and vegetated cover is <30%) that is permanently flooded. Wetland type L2UBH is a lacustrine, littoral (≤2.5 m deep) habitat with an unconsolidated bottom that is intermittently flooded. Wetland type R5UBH is a riverine (contained within a channel), unknown perennial system with an unconsolidated bottom that is permanently flooded.

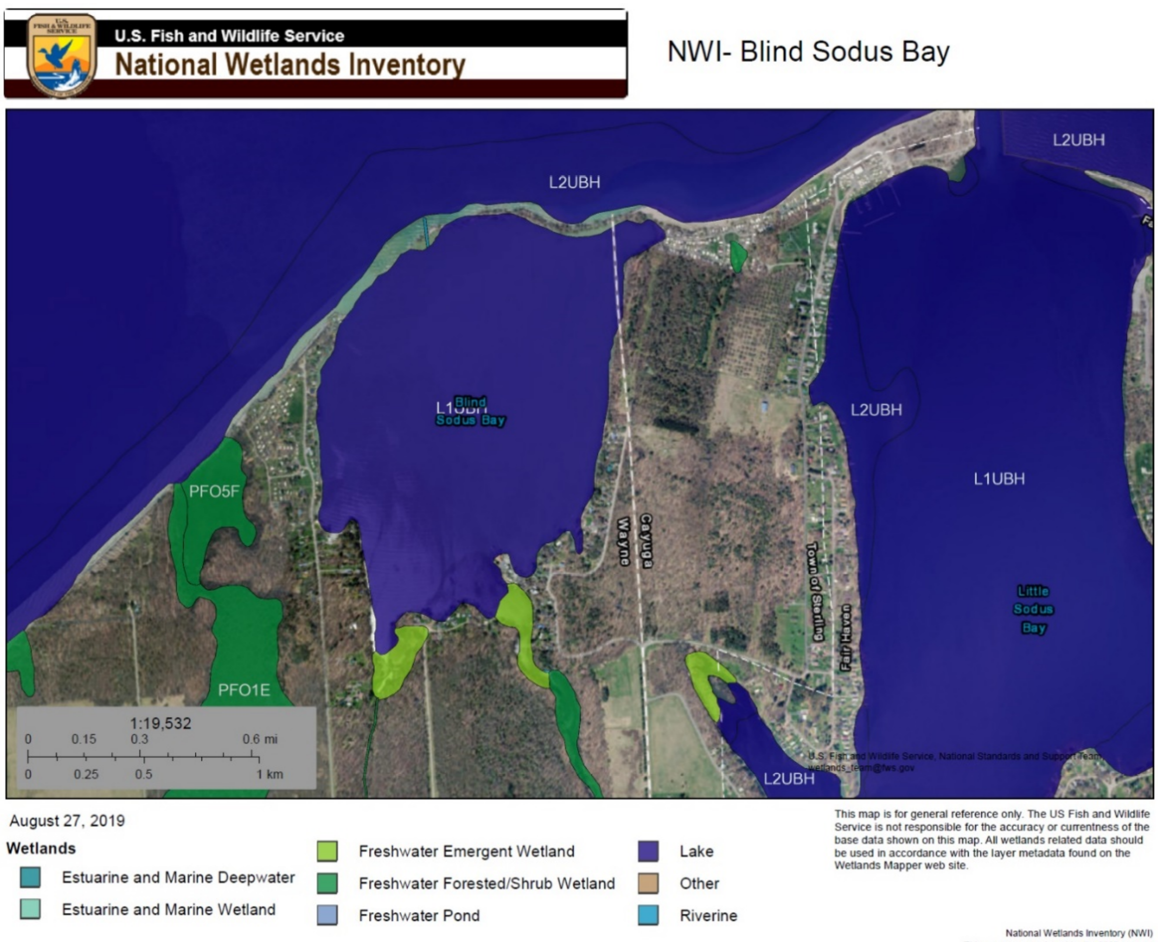


Figure 2-6 *NWI Federal Wetlands Near Blind Sodus Bay*

There are no New York State Regulated wetlands within or connected to Blind Sodus Bay barrier bar or the bay itself. However, there is one such wetland that is near to the bay as shown on **Figure 2-7** (**http://www.dec.ny.gov/gis/erm/**). New York State Wetland FH-1 is a Class 2 wetland of approximately 82 acres located to the west of the bay.

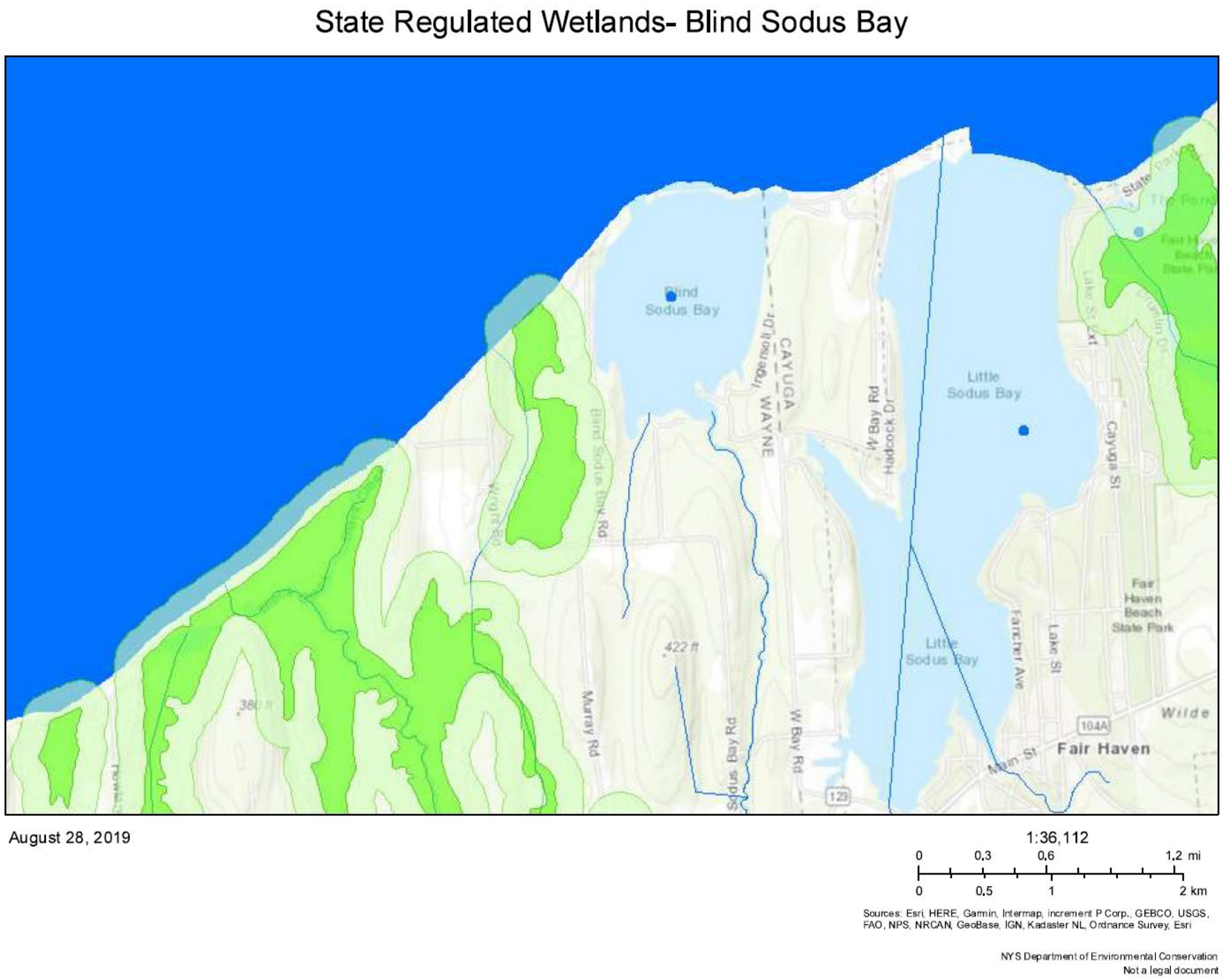


Figure 2-7 *New York State Regulated Wetlands Near Blind Sodus Bay*

2.4.5 Aquatic Plants, Harmful Algal Blooms and Invasive Species

A 1988 survey conducted by Golman and Smith in three bays (East, Port and Sodus) neighboring Blind Sodus Bay are home to at least 30 native plant species, including species of the genera: *Calamagrostis*, *Ceratophyllum* (coontail), *Chara* (stonewort), *Elodea*, *Fontinalis*, *Heteranthera*, *Isoetes*, *Justiaca* (water willow), *Lemna* (duckweed), *Myriophyllum* (native whorled water milfoil, non-native Eurasian milfoil), *Najas*, *Nuphar* (water lillies), *Nymphaea* (water lillies), *Pontederia* (pickerel weed), *Potamogeton* (pond weed), *Ranunculus* (water buttercup), *Spirodela*, *Typha*, *Vallisneria* (eelgrass), *Wolffia, Riccia* (liverwort)*, Azolla* (water fern)*, Cabomba* (Fanwort) and *Trapa natans* (water chestnut)*,* alongside other unspecified macroalge. Although the survey by Gilman and Smith (1988) did not evaluate macrophytic plants in Blind Sodus Bay, three-quarters of the above genera were observed in East Bay and Port Bay, while all but 4 were observed in Sodus Bay. The distribution of plant genera was heavily dependent on depth and time of year. With the exception of coontail in Sodus Bay, the majority of plant growth stopped at depths lower than 3 m in the three bays covered by Gilman and Smith 1988). With Blind Sodus Bay having an average depth of 3 m, plant growth is likely occurring in a large percentage of the bay.

Several genera of invasive plants are found on the section of Lake Ontario bordering Wayne County including Eurasian milfoil, water chestnut, purple loosestrife (*Lythrum salicaria*), European frog-bit (*Hydrocharis morsus-*

ranae), curly leaf pondweed (*Potamogeton crispus*), and fanwort (*Cabomba sp.*) (SWCD 2007; NYSDOS 2010). Of these, only curly leaf pondweed is known to be growing in Blind Sodus Bay (CSLAP 2016).

In addition to invasive plants, several invasive organisms are known to be present in Blind Sodus Bay including round gobies (*Neogobius melanostomus*), zebra mussels (*Dreissena polymorpha*) & quagga mussels (*Dreissena bugensis*), spiny and fishhook waterfleas (*Bythotrephes sp.*), alewife (*Alosa pseudoharengus*), common carp (*Cyprinus carpio*), and the New Zealand mud snail (*Potamopyrgus antipodarum*)(NYSDOS 2010).

Harmful Algal Blooms (HABs) are an ongoing problem in Blind Sodus Bay, with the most recent recorded blooms collected for toxin and/or chlorophyll analysis in 2016. These samples were collected by the Citizens Statewide Lake Assessment Program (CSLAP) in the center of the bay four times, with each sample containing extracted chlorophyll at or above the threshold for a eutrophic classification (CSLAP 2016). Total phosphorus in the same samples were above the 20 µg/L threshold for eutrophic classification in 3 out of 4 samples, altough the majority of total phosphorus is often associated with cyanobacteria or other algae in the water body. With high levels of surface level chlorophyll, total phosphorus may not definitively relate to trophic state. High productivity and associated algal blooms lead to hypoxia in the deep portions of the bay. Data from the 2016 Blind Sodus Bay Citizens Statewide Lake Assessment Program (CSLAP) indicated that the bay began to stratify between late June and early July. The thermocline was at approximately 3 m, with oxygen levels beginning to drop at approximately 2 m and reaching 0 mg/L well above the deepest point of the bay (8 m). In addition to the four lake samples, two samples were also collected from shoreline blooms in 2016 for cyanobacterial toxin analysis. These samples tested negative for microcystins, paralytic shellfish toxins, cylindrospermopsins, and β-Methylamino- L-alanine, but tested positive for the neurotoxin anatoxin-a (Greg Boyer & Zach Smith, SUNY College of Environmental Science and Forestry, Personal Communication). Preliminary results from nutrient and toxin models in Sodus Bay suggest that cold water intrusion from Lake Ontario through the breaches has a significant impact on reducing the likelihood for bloom formation (NY Sea Grant 2016, Joseph Atkinson, University of Buffalo, Personal Communication). A similar reduction in HAB intensity from cold water intrusion may also be occurring in Blind Sodus Bay.

2.4.6 Phosphorus Pollution and Water Quality

Water quality in Blind Sodus Bay, similar to neighboring bays, is impaired largely due to excessive phosphorus runoff from tributaries, with high levels of phosphorus and total suspended solids in the bay itself (NYSDOS 2010, CSLAP 2016). Excess phosphorus can cause harmful and nuisance algal blooms. Some blooms can contain compounds toxic to humans and animals, while blooms can damage the aesthetics of the bay and cause economic problems for the local community (EPA and NYSDEC 2007, Carmichael and Boyer 2016). Excess phosphorus can also lead to excessive aquatic plant growth, and damage to fisheries due to anoxia in deeper waters (NYSDOS 2010). The models produced in 2007 to derive a TMDL for phosphorus in Blind Sodus Bay did not include internal loading as a portion of the total phosphorus contribution, which may have contributed to model estimates of annual total phosphorus that did not change significantly, unlike the measured values of TP in the same years (EPA and NYSDEC 2007). The portion of phosphorus in Blind Sodus Bay associated with internal loading is unknown but is likely significant as total phosphorus measured in the bottom waters was 40 µg/L while the bottom waters were oxygenated in June, but increased to ~100 µg/L one month later in July when the hypolimnion had become anoxic leading to the liberation of phosphorus from the sediments (CSLAP 2016).

2.4.7 Floodplain Considerations

The work along the barrier bars will take place within the 100-year floodplain. According to Federal Emergency Management Agency (FEMA) Preliminary Coastal Work Maps and FIRMs for Lake Erie and Lake Ontario, New York, the barrier is classified as AO2, which means that the area is subject to inundation from one to three feet deep at a 1% annual chance. The lake side of the barrier is classified as VE254, which means that the area is subject to inundation by the 1% annual chance flood with a base flood elevation of 254 ft IGLD85.

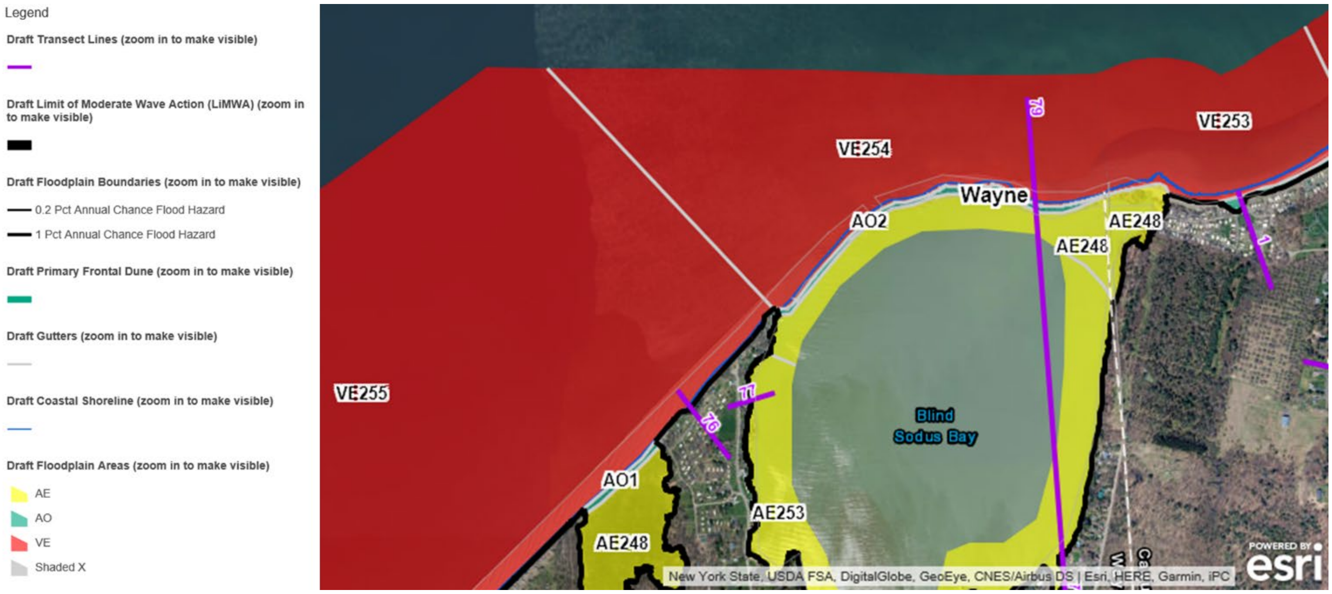


Figure 2-8 *Federal Emergency Management Agency (FEMA) Preliminary Coastal Work Maps and FIRMs for Lake Erie and Lake Ontario, New York*

2.4.8 Water Levels

The National Oceanic and Atmospheric Administration (NOAA) is responsible for monitoring, recording and forecasting weather events, temperature, currents and water levels across the U.S. There are several monitoring stations along Lake Ontario where data is collected. The NOAA station closest to Blind Sodus Bay is located in Oswego, NY (NOAA Station ID 9052030). In addition, two United States Geological Survey (USGS) gauge locations are in proximity to Blind Sodus Bay, including a location at Sodus Point to the west (USGS 0423207760) and a recent location at the breakwater in Fair Haven directly to the east (USGS 04232093, installed in October 2019).

Water levels at the Great Lakes have been regularly and systematically recorded since 1918 and show long-term water-level fluctuation. Lake Ontario has experienced both extreme high-water and low-water levels that have coincided with climatic variability, including changes in precipitation, evaporation rates, and the amount and duration of ice cover (USACE 1999, Gronewold et al. n.d.).

Extreme low water levels have generally occurred in 20 to 30-year cycles: in the mid-1890s, mid 1920s, mid-1930s, mid-1960s, 1999, early 2010s, and 2016, while extreme highs were experienced in the 1870s, late 1920s, early 1950s, early 1970s, mid-1980, mid-1990s, and late 2010s, with record highs occurring in 2017 and 2019 **(Figure 2-9)** (Wilcox et al. 2007, USACE 1999). Water regulations which started in Lake Ontario in about 1960 have reduced water level extremes (Wilcox et al. 2007, USACE 1999). For example, prior to regulation in 1952, Lake Ontario water levels ranged 6.6 feet, between 242.0 feet to 248.6 feet in one hydrologic season. Follow the implementation of water level regulation, seasonal water level ranges have reduced average annual variability to 1.7 feet (Wilcox et al. 2007). Starting in 2017, occurring again in 2019, Lake Ontario experienced record high water levels as a result of persistent precipitation, variable winter temperatures, ice patterns, and extreme water supply conditions, leading to lake levels rising to a new high over 249 feet (**Figure 2-9**).

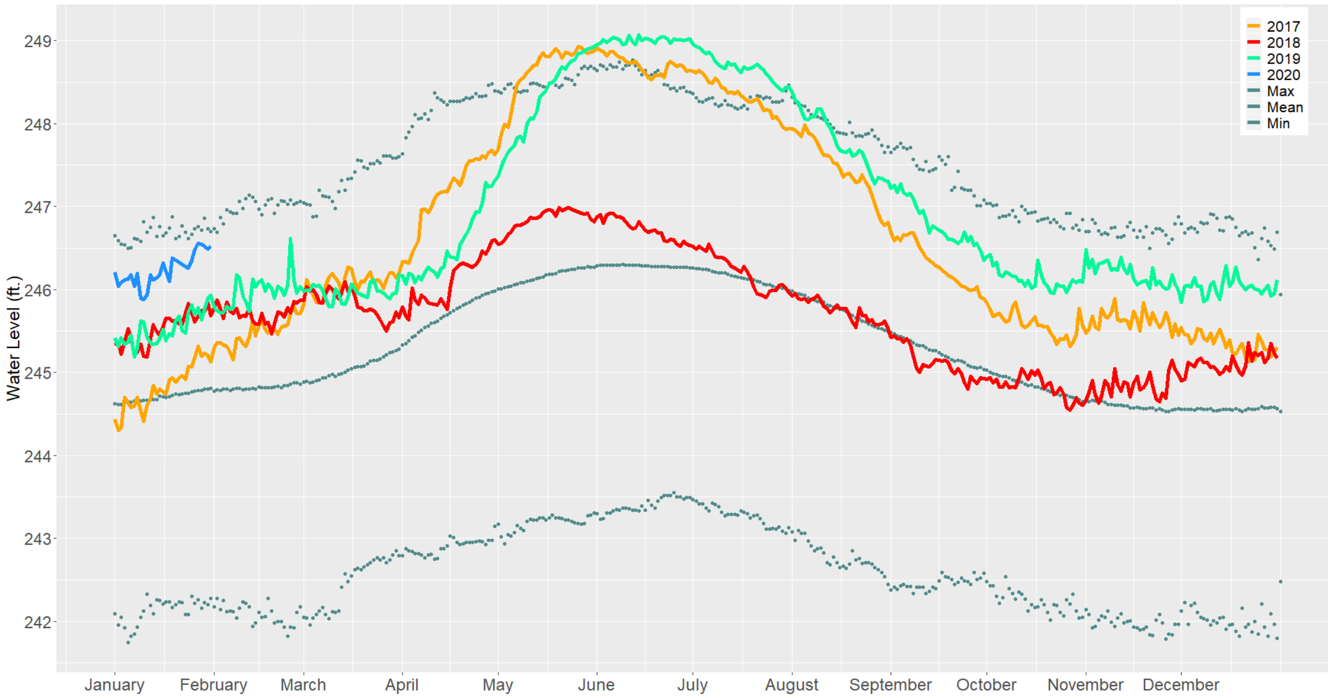


Figure 2-9: *Lake Ontario Daily Water Levels in 2017 through January 2020 (ft. IGLD 1985, International Joint Commission). Historic daily water levels (average and maximum/minimum) based on period from 1918-2020 for Lake Ontario. Maximum water levels did not include 2017 and 2019.*

The United Stated Geological Survey (USGS) managed gauge station located at Sodus Point, NY has provided water elevation data since July 2017. Similar to the Oswego NOAA station, maximum water elevations reached during the 2019 high water event exceeded 248 ft (IGLD85, **Figure 2-10**)

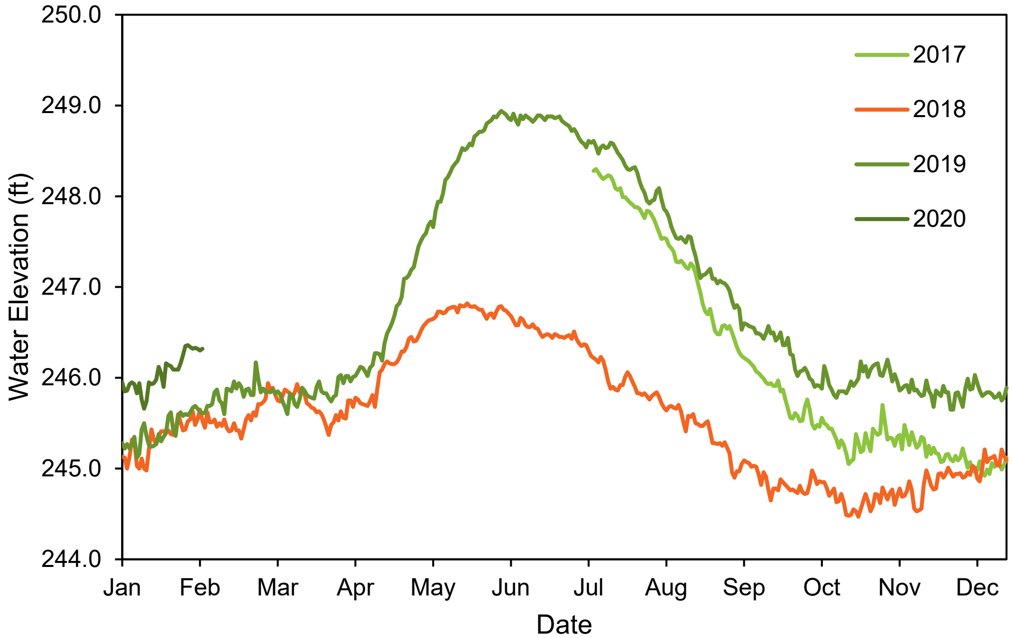


Figure 2-10 *Daily mean water elevations (IGLD85) collected at Sodus Point, NY (USGS 0423207760 Lake Ontario at Sodus Point, NY) from July 14, 2017 to February 3, 2020.*

2.4.9 Typical Current Velocities

There are no long-term monitoring gauges measuring current (water velocity) in proximity to Blind Sodus Bay. To estimate current velocities in Lake Ontario near the project site, NOAA data for two of the lake stations were explored. Based on the Lake Ontario OFS Stations Current Nowcast, (**https://tidesandcurrents.noaa.gov/ofs/ofs_animation.shtml?ofsregion=lo&subdomain=0&model_type=currents_stations_nowcast**) typical current velocities for the Lake range from 0.3 knots to 1.0 knots. It is recommended that field observations of site-specific current velocities be collected prior to any hydrodynamic modeling or detailed engineering design.

2.4.10 Wind Generated Waves

The Blind Sodus Bay barrier bar shoreline along Lake Ontario is subject to erosion from wave action and storm water runoff. The barrier bar that protects the bay acts as a natural erosion control structure. There is no engineered infrastructure to prevent or curtail the erosion, which places the bay, and associated aquatic and terrestrial habitats, as well as lakefront properties, at risk.

The storm water and wave action combine to undermine the face of the bluffs, causing large sections to seasonally collapse into Lake Ontario. Bluff degradation is also subject to ground and surface water discharge over and through the natural channels in the bluff. The seasonal shift, freeze/thaw action causes loss each season and wave/wind capturing the eroded material. As the natural barrier has eroded, wave action has produced visibly uprooted trees along the Lake.

The Bay and outlet are subject to shoaling caused by soil erosion and wave action. Soil and sediment have been deposited in the single outlet connecting the bays to Lake Ontario. The shallow depth (mean = 11-ft) at Blind Sodus Bay causes its narrow outlet connecting to the bay to be fully blocked at times due to sediment deposits (**http://www.townofwolcottny.org/FINAL_LWRP_VISION_PLAN.pdf**).

As a result, routine dredging is required to keep the outlet open and the channel navigable. The blocked outlet prevents boaters from entering or leaving the bay, while blocking of the outlet can contribute to the bay flooding when watershed inflow into the bay may exceed outflow into the lake. Most of the properties are residential and use a combination of on-site septic systems and sewer systems. Flooding can result in the leaching of raw sewage, which may degrade water quality in the bay. Dredging the bay has been necessary to prevent flooding.

Figure 2-11 shows the lake waves breaking over the breached sections of the barrier bar entering the bay (provided by the BSBIA Homeowners).

USACE measures and records wind action throughout the Great Lakes, where there are 265 stations within Lake Ontario alone. Wave action has been recorded between 1970-1978 and 1979-2014. Information on wave action can be retrieved from the Wave Information Studies on the USACE website: (http://wis.usace.army.mil/hindcasts.html?dmn=lakes), with the four stations closest to Blind Sodus Bay being 91049, 91050, 91051 and 91052. This information can be analyzed during the next stage of the engineering design process to further refine site-specific criteria and information.

Figure 2-11 *(a,b) Wave Action and Eroded Barrier Bar in 2019.*

2.4.11 Storm Surge

Storm surge is the rise of the lake as a result of atmospheric pressure changes (barometric pressure variations) and wind action over the water surface. The Port Bay Barrier Bar Assessment Draft Report (Bergman 2019) listed the top ten storm surges occurring between 1976 and 2006. (Source: Baird, Pete Zuzek, undated presentation: "Update on Great Lakes Coastal Methodology—Event versus Response Approach.") The total lake water levels for these top ten surges ranged from 245.03 ft to 247.12 ft (IGLD85) which were much lower than lake levels observed in 2017 and 2019. The majority of these surges occurred between November and April and lasted between 8 to 43 hours. The maximum surge was 1.18 ft and occurred on 04/06/1979, lasting 31 hours (**Table 2-4**). By comparison, the greatest change in water level in 2019 over 24 h was 0.34 ft.

During surge events, the County may issue a state of emergency in anticipation of flooding due to high water level. During this time, motorized boat traffic is only permitted to operate at idle speeds, causing no wake on the county's bays and harbors. In 2017 and 2019, a special state of emergency was declared for all Wayne County bays and harbors including Blind Sodus Bay. At that time Lake Ontario and Wayne County bays and harbors were reported to be at or above flooding level of 247.3 feet (IGLD85).

Table 2-4 *Lists the Top Ten Storm Surges in Oswego, Lake Ontario, During 1976– 2006*

Rank	Maximum Time	Maximum Surge (ft)	Duration (hrs)	Total Water Level (ft, IGLD85)
1	1979/04/06 15:00	1.18	31	247.12
2	2006/02/17 09:00	1.16	43	246.76
3	1992/11/13 01:00	1.10	12	246.55
4	1991/12/14 18:00	0.97	18	245.03
5	1980/01/12 09:00	0.88	15	245.67
6	2005/09/29 09:00	0.83	13	245.74
7	2003/11/13 17:00	0.82	27	245.72
8	1974/01/31 17:00	0.81	8	246.67
9	1996/01/28 02:00	0.81	23	245.83
10	1976/03/05 12:00	0.80	17	246.65

Source: Baird, Pete Zuzek, undated presentation: "Update on Great Lakes Coastal Methodology—Event versus Response Approach."

2.4.12 Coastal Sediment Transport

Evidence of Actual Sediment Transport

In August 2019, several aerial photographs were taken of Blind Sodus Bay and its eroded barrier bar as well as the bluff section that show evidence of sediment transport and breach within the Bay and Lake Ontario shoreline.

Figure 2-12, obtained from Lake Ontario Natural and Nature Based Features (NNBF) opportunity viewer, indicated significant historical erosion on the bluff side as well as on the bar. The rates are as high as 1.7 ft/year and above for the western half of the project area. Modeled erosion rates, shown in **Figure 2-13**, indicated a loss of less than 1 ft/year, which suggests one portion of this reach has stabilized. A more detailed analysis of shoreline evolution and sediment transport is recommended for the next stage of the design process.

Aerial images presented in Section 2.5 also indicates evidence of sediment movement over the years with periodic close of the inlet. Drone images collected by Ramboll indicate breached and heavily eroded bluffs, as well as accreted areas. Historical dredging records provide additional evidence of sediment transport along the Blind Sodus Bay's Lakefront coastline.

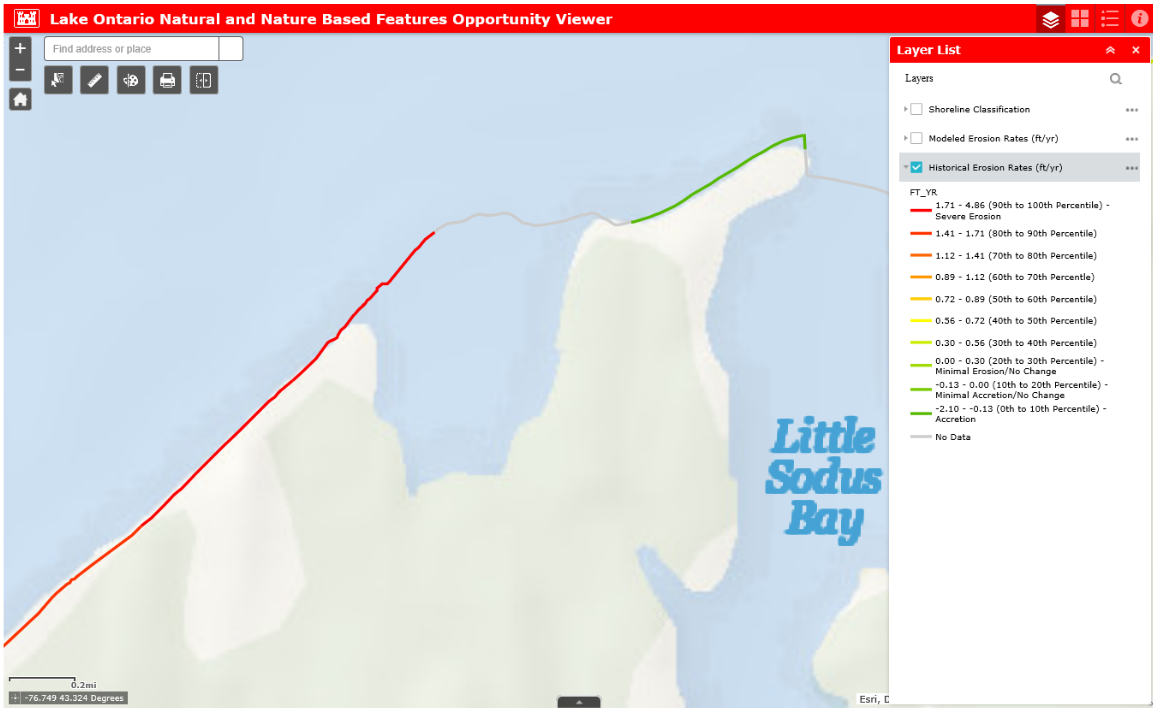


Figure 2-12 *Historical Erosion Rates*

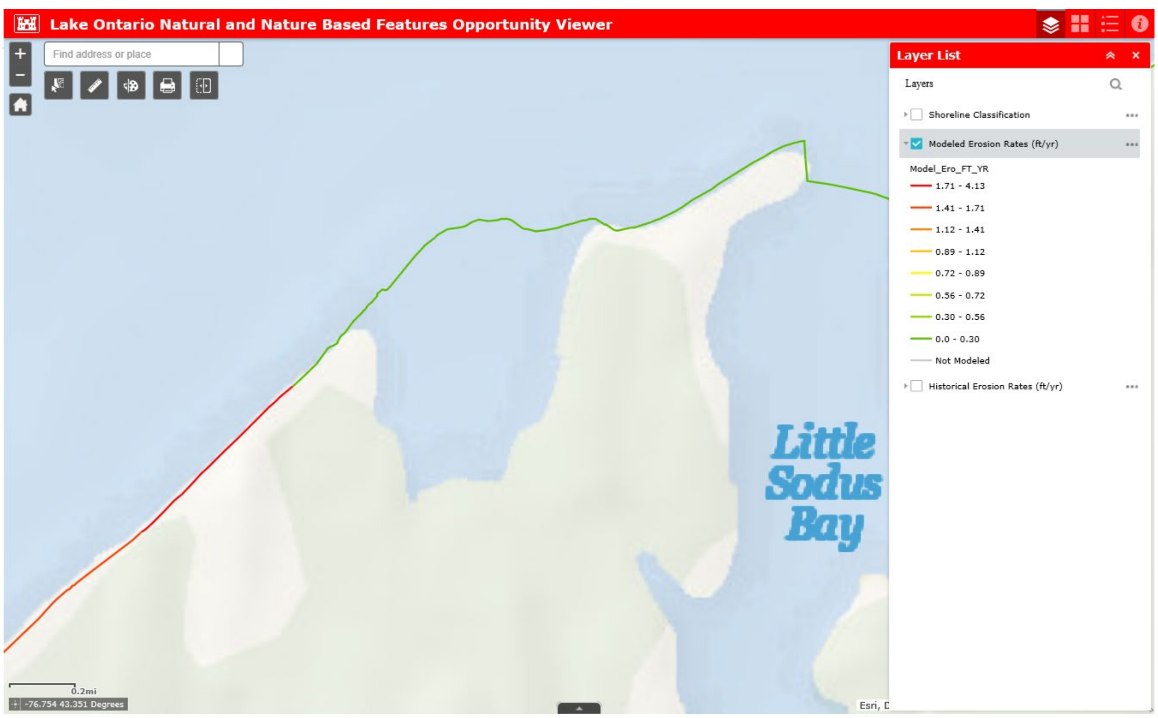


Figure 2-13 *Modeled Erosion Rates*

Shoreline Sediment Composition

Specific composition of the sediments within Blind Sodus Bay and adjacent regions of Lake Ontario have not been determined. This gap needs to be addressed early in the design process.

Review of Sediment Transport

Baird (2011) simulated the potential Longshore Sediment Transport (LST) along the south shore of Lake Ontario and conducted limited field investigations (Baird 2011, 14). Blind Sodus Bay is located between Sodus Bay (on the west) and adjacent to Little Sodus (on the east). Simulations have not been analyzed in detail for this location and should be evaluated further in the design process. The Lake Ontario Annual Sediment Budget is summarized in Table 2-5.

The simulations can be summarized as follows:

- A beach fillet sink occurs from the northeast of Blind Sodus Bay that may lead to a large portion of the LST being lost in that area of the bay;
- There are both eastward and westward LST along Blind Sodus Bay but the net LST comes from the west and is directed eastward.
- Near Blind Sodus Bay, the potential LST (~300,000 m3/yr.) is more than 10 times (~13 times) the supply-limited LST (~22,000 m3/yr (29,000 CY/yr).) (Table 2-3)

Table 2-5 Lake *Ontario Annual Sediment Budget*

Existing		Sources		Sinks		All values in 1,000 m^3/yr	
Sub-Cell	Input from Updrift Sub-Cell**	Bluff Recession	Lakebed Downcutting	Fillet Beaches	Harbor Sedimentation	Output to Downdrift Sub-Cell**	Δ
Bay	0.0	4.2	0.1	0.7	0.0	3.7	3.7
Sodus Bay–Little Sodus	3.7	18.8	0.1	0.6	0.1	21.9	18.3
Little Sodus–Oswego	21.9	7.9	0.1	0.0	1.6	28.3	6.4
Oswego–Eastern Lake Ontario	28.3	10.5	0.1	0.0	0.0	38.9	10.5

Source: From Baird (2011)

* Unknown input required to balance budget

** Assumes sediment bypassing at harbors (no numerical modeling completed to confirm this assumption)

*** Potential inputs from shoreline west of the Niagara River not quantified in this study

The USACE Sediment Budget Mapper provides a similar estimate of longshore transport of approximately 20,000 to 27,000 CY/year as presented in **Table 2-5** (**Figure 2-14**). Also notable in the USACE Sediment Budget is the modeled accumulation of sediment to the east of the piers at Little Sodus Bay and in between the piers. These areas of accumulation may be important borrow areas for sediment to be used for reconstructing the barrier bars.

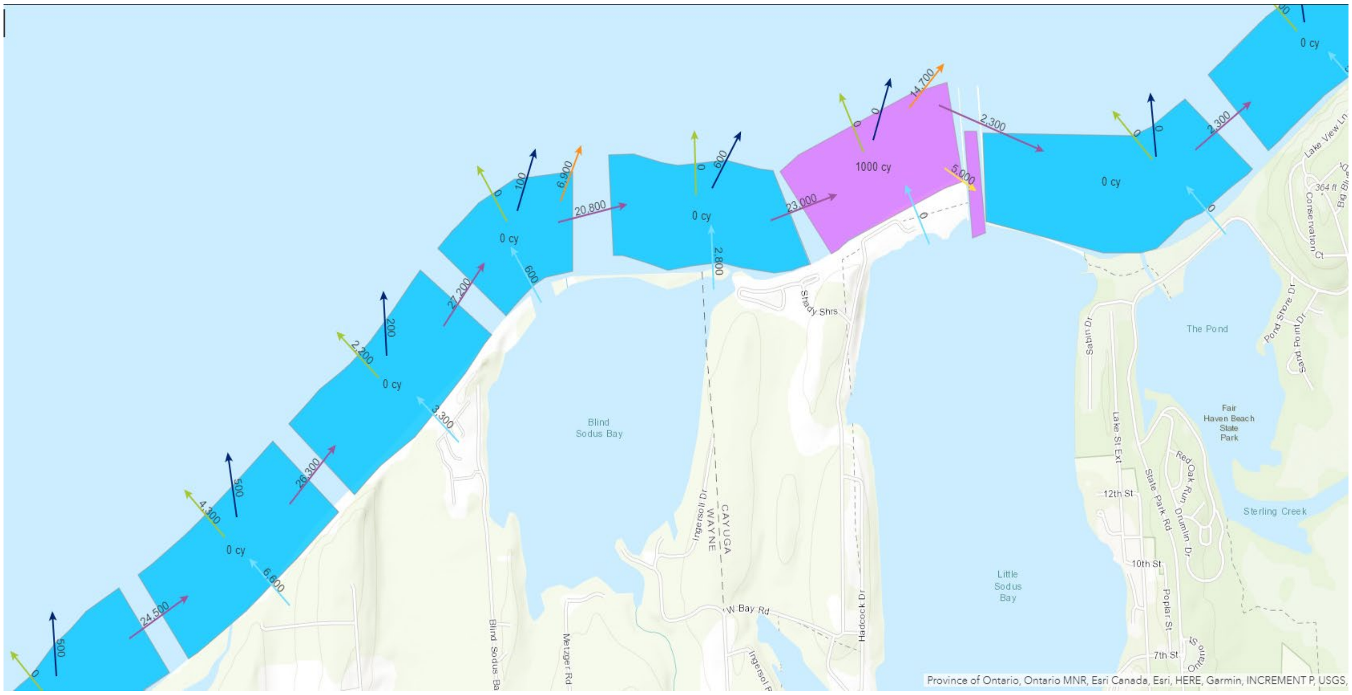


Figure 2-14 *U.S. Army Corps. of Engineers (USACE) Sediment Budget Mapper for Lake Ontario adjacent to Blind Sodus Bay barrier bar and bluff.*

2.5 EXISTING FACILITIES AND PRESENT CONDITIONS

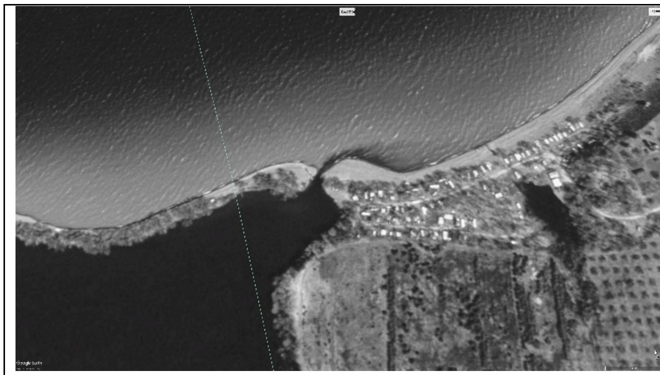
2.5.1 Condition of the Shoreline – Overall Evolution

Blind Sodus Bay is approximately 280 acres in size and located in the Town of Wolcott, Wayne County, New York. NYSDEC notes a shoreline length of approximately 3-miles, an elevation of 247-ft (NAVD88) and a depth of 27-ft. The area surrounding the bay is mostly residential with one commercial operation, a seasonal recreational campground.

Figure 2-15 shows the change in the Blind Sodus Bay barrier bar between April 1994 to July 2015. Aerial photos illustrate that the barrier bar was intact with some variation in width, and one inlet opening at the east end of the bar for navigation. The 1988 Coastal Erosion Hazard Area map for the area shows at that time the opening was approximately in the middle of the barrier.

Over the years the width of the barrier bar has narrowed in some places due to erosion. These weakened sections of the bar were likely breach locations. This report includes some anecdotal information about the breaches, however, a more detailed evolution analysis with proper historical evidence-based surveying may be needed.

In December 2014, a Regional Dredging Management Plan was developed to provide a comprehensive approach to the on-going dredging needs for harbor access channels along the south shore of Lake Ontario, including Blind Sodus Bay. This report should be considered in the sediment management for the barrier bar. Recent photos of the Bay (**Figure 2-15**) show complete erosion of the middle section of the barrier bar for approximately 1300-ft (measured on Google Earth), obvious narrowing of the barrier bar in other areas subject to wave action, as well as the complete closing off of the inlet to the west of the barrier bar due to sedimentation.



April 1994

July 2003

April 2006

November 2006

October 2008

September 2009

June 2011

July 2011

Figure 2-15 *Evolution of Blind Sodus Bay Barrier Bar and Channel*

2.5.2 Recent Breaches

Previous impacts to the barrier bar at Blind Sodus Bay include inundation of the eastern portion of the barrier bar, and breaches (i.e., loss of substrate material and trees) to the west side of the bar. Aerial photos show the erosion along the barrier bar when compared to earlier Google Earth images. Breaches, which include the loss of material from the barrier bar, are most likely to occur during storm events and high-water levels at the lake.

In 2017, a state of emergency was declared for all of Wayne County due to high water levels in the bay and Lake Ontario. At that time bays and harbors had water levels above 247.3-ft (IGLD85), 1.3-ft higher than the elevation at the barrier bar as determined on Google Earth (246-ft).

Another breach occurred in the spring of 2019 as a state of emergency for Wayne County was declared on May 10th that year (https://13wham.com/news/local/as-lake-levels-continue-to-rise-state-of emergency-declared-for-wayne-county-bays), where lake levels were as high as 247.9 ft during that time.

Ramboll drone images of the breached barrier bar are shown in **Figure 2-16** and **Figure 2-17**.

Figure 2-16 *Photos of 2019 breach on the west side of the barrier bar. Trees that were present on this side of the barrier are no longer present. On site observations suggest significant redistribution of sediment*

Figure 2-17 *Photos of 2019 inundation of the eastern end of the barrier bar. Sediment is still largely in place.*

2.5.3 Channel Deposition and Dredging

East Bay, Port Bay and Blind Sodus Bay account for approximately 1,500 cu yd/year of dredged material. Each site dredges once per year (F.E.S. Associates 2000). The materials disposed of during the dredging process includes coarse gravel, stone & cobble; clean. The material is suitable for adjacent shoreline stabilization, sale for building product, or other beneficial use. Currently, the Blind Sodus Bay Associates funds all dredging efforts for the Bay.

Blind Sodus Bay has one outlet channel to the east of the barrier bar. Routine dredging is required to keep the outlets open and the channels navigable. Dredging may also provide access to the bay for fish species that migrate between the bay and Lake Ontario, particularly Cisco (*Coregonus artedi*), a species known to spawn in bay habitats. Blind Sodus Bay is the most severely affected by sedimentation deposits due to its shallow depth. Recent quantities for dredged materials have not been recorded. However, the 2000 Regional Dredging Management report for Wayne County indicated that approximately 1,500 cu yd/year is dredged from Blind Sodus Bay, East Bay and Port Bay combined.

2.6 DEFINITION OF THE PROBLEM

The Blind Sodus Bay barrier bar is a highly dynamic system; the eastern portion of the barrier has inundated and overtopped as a result of high-water levels. The western portion of the barrier has experienced breach events from storm events and high-water levels, resulting in the loss of material and tree cover. The complex barrier bar system is vulnerable to rapid and dramatic changes that has residents and management authorities concerned about its long-term sustainability and resilience. Modeling estimates that the bluff to the west of Blind Sodus Bay recedes at over 2 ft per year, putting a variety of public and private assets at risk. Particularly, project stakeholders want to better understand the long-term effects and solutions for the barrier bar system in terms of sediment supply and transport, property damage, water quality, and ecology in the bay. It is unclear if the periodic breaching of the system would stabilize the project area, trend towards closure, or expand over time if no management and maintenance actions were taken.

2.7 FINANCIAL STATUS

The project will be financed by Wayne County and 95% of the cost will be reimbursed by the REDI Program. The proposed financing plan is shown in the **Table 2-6**.

Table 2-6 *Project Financing Plan*

Description	Cost
Total Estimated Project Cost	$12,170,000
REDI Grant Amount (95% of Estimated Project Cost)	$11,561,500
Minimum Required Local Share (5%)	$608,500

3. PERMIT AND REGULATORY COMPLIANCE

This project will involve permitting from USACE, NYSDEC, New York State Office of General Services (NYSOGS) and approval from New York State Department of State (NYSDOS). The barrier bar is state-owned land administered by NYSOGS.

Table 3-1 outlines potential permits and regulatory agency involvement that may be associated with permitting of the recommended alternatives. It is unclear at this time if slope stabilization efforts will require in-water work. Breach repairs may require USACE authorization. Due to the potential impact of warm-water species, construction activities will be restricted from March 15 to July 15. This will reduce impacts to spawning population near Blind Sodus Bay.

Table 3-1 *Permitting and Regulatory Requirements*

Agency	Permit	Regulated Activity
US Army Corps of Engineers	Section 404/Section 10 Permits	Section 404 - Regulates fill and/or discharge of dredged material in Waters of the United States (WOTUS). Required for work within WOTUS. Section 10 - Regulates activities in federally-designated navigable waterbodies.
US Fish and Wildlife Service	Consultation under Section 7 of the Endangered Species Act	Threatened and Endangered Species Act compliance. Required for work near regulated species.
NOAA/National Marine Fisheries Service	Consultation	Essential fish habitat review. Recommended for work near regulated fish habitat.
NYSDEC (and other State and local Involved Agencies)	State Environmental Quality Review Act (SEQRA) (Joint Application)	Environmental impact assessment. Preparation of Short or Full Environmental Assessment Form
	Article 15- Protection of Waters	Disturbance to bed/banks of Blind Sodus Bay (Class B) and Lake Ontario (Class A) and Excavation or Fill in a Navigable Water
	Article 34- Coastal Erosion Hazard Permit Area	Disturbance within a designated Coastal Erosion Hazard Area (CEHA)

Agency	Permit	Regulated Activity
	Section 401 Water Quality Certification	Discharge to waters of the United States
	State pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharge from construction activities.	For site disturbances ≥ 1 acre (includes preparation of a Stormwater Pollution Prevention Plan (SWPPP)
Local Municipality Level	Article 36 – – Floodplain Development and Floodway Guidance	Disturbance within a designated 100-year flood zone
NYS Natural Heritage Program	Consultation	State listed T&E Species and Significant Natural Communities.
NYS Department of State	State or Federal Consistency Review	Conformance with NYS Coastal Management Program or Local Waterfront Revitalization Program (LWRP)
NYS Office of General Services	Authorization	State lands underwater
NYS Office of Parks, Recreation and Historical Preservation – Field Services Bureau (State Historic Preservation Office, SHPO)	Consultation	Review under Section 106 of the National Historic Preservation Act and Section 14.09 of the New York State Historic Preservation Act (satisfied if Section 106 is satisfied)
Town of Wolcott	Consultation, zoning, right-to-build permits	Review in accordance with Local zoning requirements
	Consultation, Federal Coastal Zone Management Act & NYS Coastal Management Program (6 NYCRR Part 600)	Review in accordance with Local Waterfront Revitalization Program (NYSDOS 2010)

4. ALTERNATIVES ANALYSIS

Alternatives were evaluated for the bluff area and the barrier bar separately due to natural differences in their condition, shoreline characteristics, and feasible approaches to address project objectives. Section 4.1 summarizes and provides potential alternatives for the bluff section, also considering the current gabion design. Section 4.2 provides alternatives for the barrier bar section.

4.1 DESCRIPTION

4.1.1 Bluff Section

MRB Group Gabion Wall Design

MRB Group completed a design and set of plans for a gabion wall for 260 linear feet of the bluff along the unpaved access road, approximately from STA 5+50 to 8+10. The gabion design is battered at 10 degrees with gabions offset 9 inches from the front face of the underlying basket. The wall is bearing at El. +239.6, which based on the borings is likely top of rock, though no note requiring top of rock to be exposed is shown. Riprap is to be placed and grouted in front of the gabion wall to El. +254.6. See **Figure 4-1** below, Sheet 4 of 5 from the Contract Drawings.

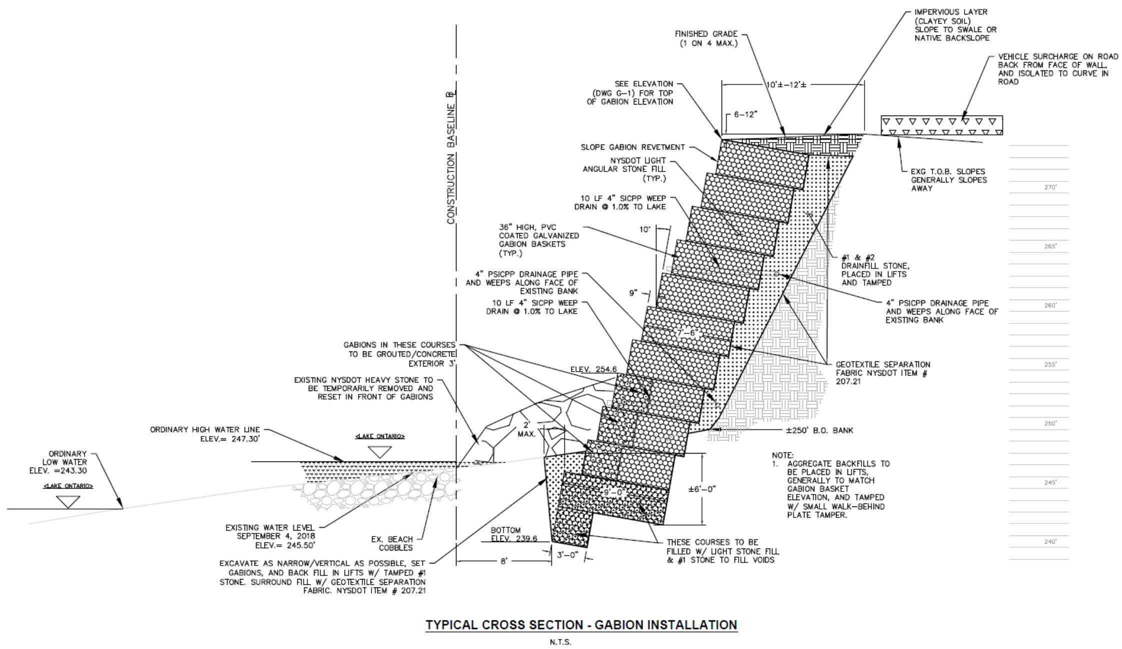


Figure 4-1 *Shoreline Repair Detail Sheet – MRB Group*

The gabion wall was recently constructed and is depicted in **Figure 4-2.**

Figure 4-2 *Recently constructed gabion wall*

Qualitative evaluation of the gabion wall (**Figure 4-2**) suggests that wave flanking and erosion around the sides of the gabion wall are an important concern. Forthcoming design efforts for the remainder of the bluff will need to carefully consider how to best tie into this structure and to mitigate for potential erosion around the sides of hardened features.

Construction Access

Due to limited space and potential geotechnical concerns, it is likely that construction of the bluff stabilization measures would occur from the bottom of the bluff. A likely scenario for access to the bottom of the bluff is from the end of Blind Sodus Bay Road where the approximate 10 ft bluff could be graded to allow equipment access to the beach. If geotechnical concerns on Blind Sodus Bay Road limit the size of equipment such that an excavator with sufficient reach (to work the top of the bluff) could not access the beach in this way, it may have to access the site by barge of via the eastern end of the barrier bar after reconstruction work is complete.

Similarly, delivery of large stone or other hard materials may have to occur via barge to limit weight and truck activity on Blind Sodus Bay Road. There is likely an opportunity to coordinate delivery of material for the bluff stabilization with that of the reef breakwater construction discussed as a part of the barrier bar stabilization.

Design Alternatives

Subsurface Investigation

To prepare the designs discussed below, at a minimum, borings should be completed every 100 feet along the bluff. If access can be acquired, at least two (2) tripod borings should be completed at the toe of the slope along the lakeshore. If the currently approved gabion design alternative is being constructed during the subsurface investigation, then test pitting should be performed in lieu of tripod borings. This investigation has been included in the cost estimates for the bluff alternatives.

No Action

This alternative assumes no further action, which under the historical and modeled scenarios (**Figures 2-12** and **2-13**, respectively) erosion of the bluff will continue at approximately 2 ft or more every year and will likely pose a significant risk to the public and private assets in the area. Additionally, the gabion wall currently being installed in a limited portion of the bluff would likely be flanked over time and fail as well.

Riprap Revetment

A riprap revetment is a sloped, hard structural solution to erosion prevention which is appropriate in this situation with public and private assets highly exposed near the edge of the bluff. Properly designed and installed rock revetments are generally preferred over vertical walls due to their ability to better absorb and dissipate wave energy and to provide shoreline habitat. Rock revetments typically extend to the top of bank. However, due to the height and steep slope of this bluff, the rock revetment would only extend a portion up the bluff to sufficiently protect against a conservative design water level and wave assumption requiring detailed analysis in design. The bluff above the revetment may be further stabilized by grading and vegetating the bluff face, and potentially intercepting groundwater discharging on the bluff face. This current evaluation is based on a scaled, conservative cost based on revetments designed and constructed around the Great Lakes. The schematics below (**Figure 4-3**) show a typical offshore and onshore revetment design detail.

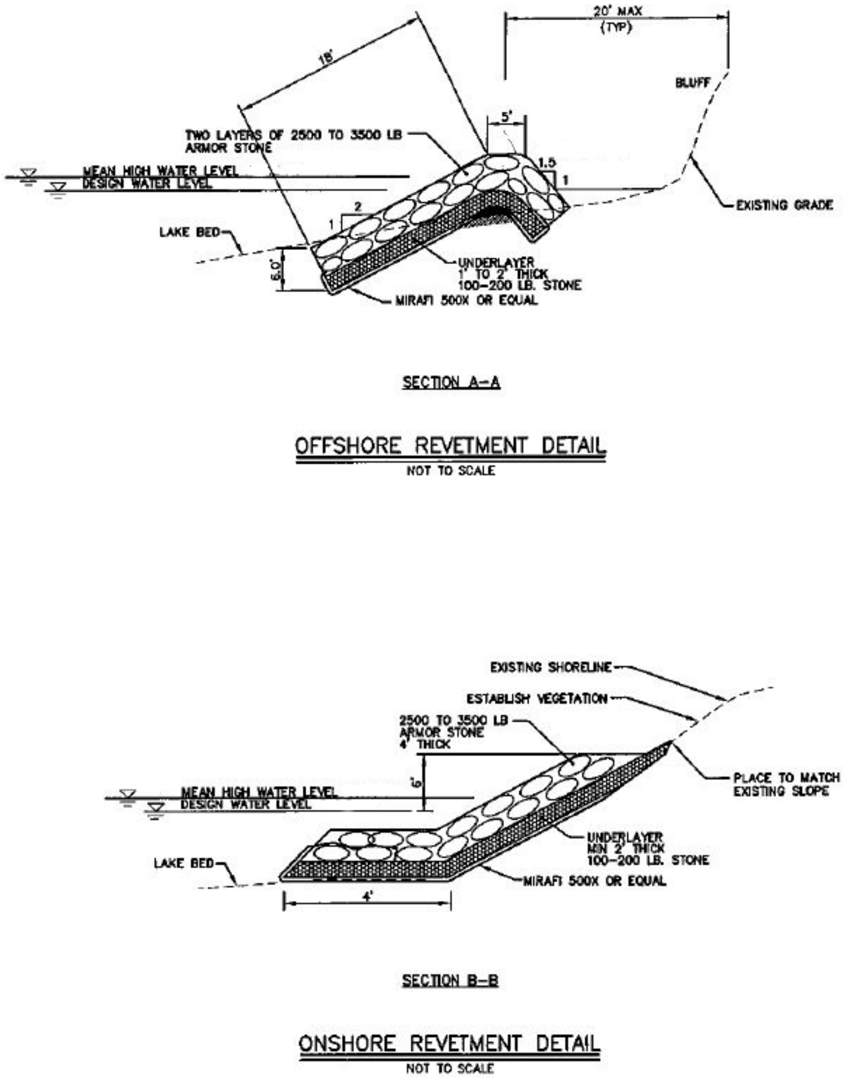


Figure 4-3 *Typical Revetment Details*

Gabion Wall (Modular Gravity Wall)

This alternative consists of extending the gabion wall the full 1,100 linear feet of bluff face. Design would be similar to that completed by MRB Group. The gabion wall would be required to bear on bedrock measured from auger refusal. See detail in **Figure 4-1** and included in **Appendix A**. The total area of additional gabion wall required is approximately 34,000 square feet (SF) including the square footage of wall below grade. This quantity does not include approximately 10,300 SF of wall proposed from STA 5+50 to STA 8+10 (**Figure 2-4**).

Gabion walls are flexible and pervious, offering advantages in shoreline stabilization for frost and wave action. However, wire baskets are subject to corrosion, construction is labor intensive, and costs are dependent on source of select stone infill. Gabion walls can be planted with native vegetation to assist in long-term stability and resiliency, while also increasing the aesthetic value of the site. In addition, established vegetation in the gabion wall can increase the stability of the feature through root zone stabilization and increase the likelihood of the intended bluff stabilization.

Regrading Slope

To the extent possible given the location of public and private assets in the area, current slopes of the existing bluff would be more stable if regraded to at a maximum slope of 1.25(H):1(V). The proposed maximum slope is based on a successfully completed stabilization project at Lake Bluff near Sodus Bay. The final slope would be vegetated with temporary heavy-duty erosion control matting or including geocells anchored to the slope. Based on the drone flyover elevations and offsets the existing Bluff would need to be cut back into the existing slope on average 28 feet to establish a 1.25(H):1(V) slope. This design option is dependent on the permanent easement along the bluff as well as potentially moving the road, buried sewer line and other structures.

If identified as necessary during design, a groundwater collection trench with drainage stone and a perforated pipe would be designed to cut off perched groundwater at the top of the slope. The trench cutoff would divert groundwater to solid pipes daylighted at the toe of the slope. Based on the borings completed in the area of the proposed gabion wall the maximum depth of fill is 6 feet below the top of the bluff. See **Figure 4-4** below for a design slope schematic. A rock blanket may be needed to dovetail the regarded slope with the gabion wall currently being constructed in one portion of the bluff.

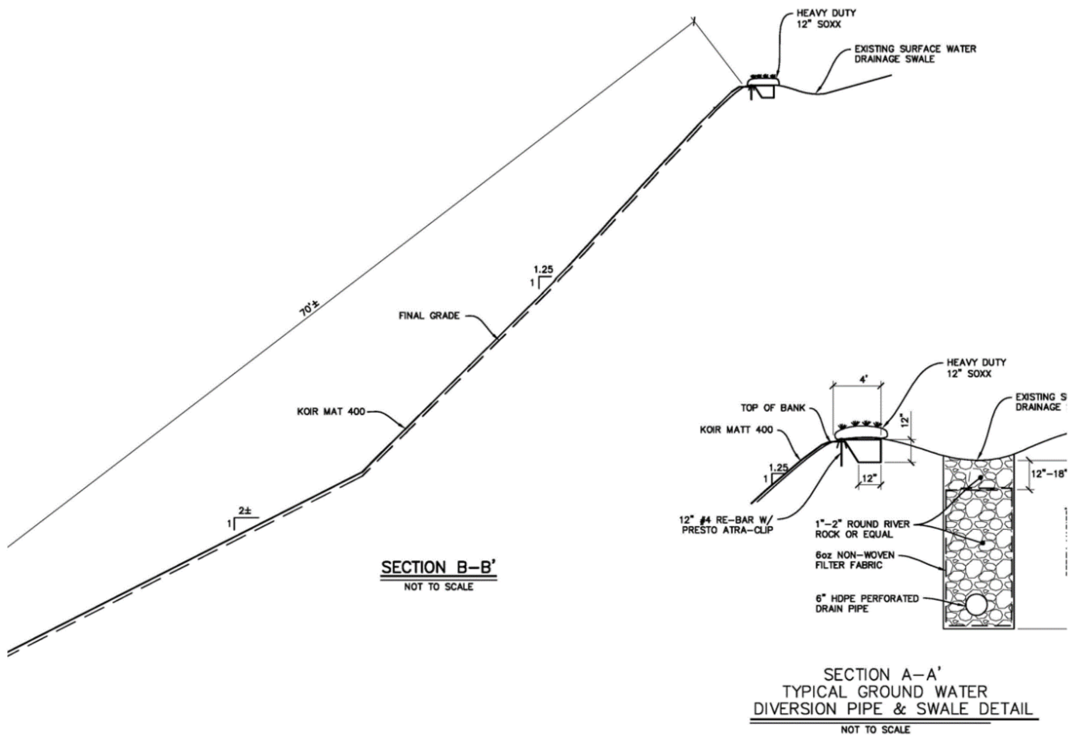


Figure 4-4 *Regraded Slope*

Advantages of this approach include vegetated slopes or geocells which will resist erosion and dissipate wave energy efficiently. A previously completed project by Ramboll using this method has performed well in the area. Disadvantages include the addition of fill at the toe of the slope or the need to cut into existing bluff face to establish safe slopes. Additionally, the regarded slope offers an opportunity to establish native vegetation (**Table 4-1**) and provide habitat value.

Table 4-1 *Native Species Generally Applicable to Bluff and Bank Stabilization Projects*

Scientific Name	Common Name	Growth Form
Andropogon gerardii	big bluestem	Grass
Asclepias syriaca	common milkweed	Forb

Scientific Name	Common Name	Growth Form
Asclepias tuberosa	butterfly weed	Forb
Baptisia tinctoria	yellow wild indigo	Forb
Bouteloua curtipendula	sideoats grama	Grass
Carex lurida	shallow sedge	Grasslike
Carex scoparia	blunt broom sedge	Grasslike
Carex vulpinoidea	fox sedge	Grasslike
Chamaecrista fasciculata	partridge pea	Forb
Coreopsis lanceolata	lanceleaf coreopsis	Forb
Dalea purpurea	purple prairie clover	Forb
Dichanthelium clandestinum	deertounge	Grass
Elymus canadensis	Canada wildrye	Grass
Juncus tenuis	path rush	Grasslike
Heliopsis helianthoides	false sunflower	Forb
Lupinus perennis	wild blue lupine	Forb
Monarda fistulosa	wild bergamot	Forb
Panicum virgatum	switchgrass	Grass
Rudbeckia hirta	blackeyed Susan	forb
Schizachyrium scoparium	little bluestem	grass
Sisyrichium montanum	Blueeyed grass	forb
Solidago rigida	stiff-leaved golderod	forb
Sorghastrum nutans	Indian grass	grass
Spartina pectinata	prairie cordgrass	grass
Symphyotrichium novae-angliae	New England aster	forb
Symphyotrichium novi-belgii	New York aster	forb
Verbena hastata	blue vervain	forb
Cornus sericea	redosier dogwood	Shrub
Cornus amomum	silky dogwood	Shrub
Rubus alleghniensis	common blackberry	Shrub
Salix discolor	pussy willow	Shrub

Concrete Cantilever Wall

A precast or cast-in-place concrete wall would bear on top of rock or weathered rock and likely require a key for overturning stability and to prevent undermining. Backfill could be light weight aggregate or geofoam to reduce the active earth pressures on the wall (See **Figure 4-5** below).

Drainage would be designed for the existing fill material in the slope and/or a back drain would be designed for the wall system.

If keying the wall into bedrock or lightweight fill is cost prohibitive tie down anchors could be designed. The wall would be designed for a factor of safety (FS) =1.3 during construction and the tie downs would provide the required FS = 2.0 for the long-term case.

Bearing capacity would be adequate at weathered rock and load balancing or tie downs could create an economic design alternative. Disadvantages include the reliance on maintaining good drainage and the potential for blinding of back drains or outlet pipes, maintenance schedule for long term care and concrete repair, and would require a significant amount of backfill due to the required heel. In discussions with involved permitting agencies, significant concerns regarding the environmental impacts of placing a concrete wall on the bluff (lack of habitat value, wave energy refraction, total elimination of sediment contribution, long term maintenance) lead to this alternative being eliminated out of hand and it was not carried forward into cost analysis.

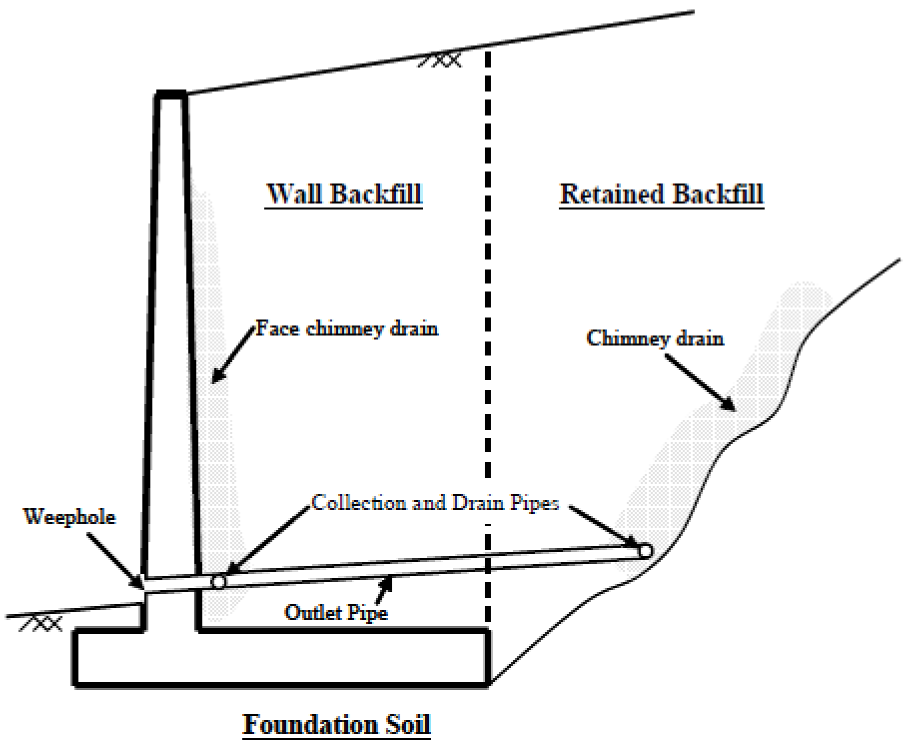


Figure 4-5 *Concrete Cantilever Wall (FHWA NHI-07-071)*

4.1.2 Barrier Bar

This section of the report describes the alternatives developed for the barrier bar and further provides recommendations on scoping and next steps. In addition, this section provides a proposed plan view and typical details of the alternative for comparison.

Each of the alternatives described below include adaptive management as it relates to the content of the alternative and aspects of the barrier bar system impacted by the alternative.

The three alternatives considered for managing the Blind Sodus Bay barrier bar include:

- Alternative A, no action
- Alternative B, nature-based barrier bar
- Alternative C, reef breakwater

It is important to note that the alternatives described in this report are at a schematic level of detail only. This level of schematic design focuses on providing protection for the Blind Sodus Bay barrier bar, starting from the edge of the bulkhead to the edge of the inlet on the east end. These schematic designs were advanced to a point to achieve general material and scale details in order to estimate an order of magnitude construction cost. Concept level sizing and design parameters were determined based on existing information such as the UAV data collected on August 27, 2019 and on best professional judgement. Studies demonstrating breach-specific impacts (based on past data or modeling) may need to be performed to advance engineering design. Similarly, all alternatives would likely require site-specific elevational data and hydrodynamic and sediment flux analysis to support design and permitting. A material sourcing study would likely have to be completed for Alternatives B and C given the volumes of material that are likely needed.

Alternative A - No Action

Alternative A, the no action alternative, presented in **Figure 4-6**, shows recent drone aerial image by Ramboll showing the eroded/breached barrier bar. As of the publication date of this report, barrier bar erosion has progressed such that approximately 25% remains visible above water. The combination of high-water levels and lack of ice cover appear facilitate ongoing loss of the barrier. This alternative represents a no additional measures option, and management of the bar continues as it has previously. There will be no future reactive measures, maintenance measures or modifications. Hence, the alternative has no cost implications from construction and maintenance perspective. Adaptive management under this alternative includes ongoing monitoring and maintenance dredging of the channel, though that action may not be needed if the barrier bar does not return naturally.

This alternative provides no additional protection, from an added feature perspective, to resist the occurrence of future breaches, or impacts to surrounding bay shoreline properties, bay users and habitat. The alternative leaves the entire barrier bar to erode or repair itself naturally over time. There would be no additional construction related impacts as there will be no work beyond natural processes. Material estimates to rebuild the western portion of the barrier bar that is currently gone are approximately 61,000 CY; given the approximately rate of sediment flux through the area of approximately 20,000 CY/year (**Figure 2-14**, **Table 2-5**) the best case scenario is that the barrier bar is reconstructed naturally in three years. However, some portion of the sediment delivered to this location is likely to remain in flux (or in-place material added to the longshore system) hence the timeframe for natural recovery is likely well beyond three years and would need to be modeled to reasonably set expectations.

While the western portion of the barrier bar has been absent, significant erosion has been ongoing in the bay due to wave action (and likely high-water levels; **Figure 4-6**).

Because the eastern portion of the barrier bar remained largely intact during the 2019 high water, no action for this area could be warranted. However, most of this barrier was flooded, likely causing stress to the trees present on the barrier. Should tree health decline, increased erosion is possible due to the loss of the existing ecological services and sediment stabilization provided by the existing tree roots. Observations of tree health in this area during the 2020 growing season will be important to guide design decisions and next steps for the eastern portion of the barrier bar.


Figure 4-6 *Alternative A, No Action. The barrier bar used to extend across the entire north end of the bay. The time required for natural recovery of the barrier bar is likely at least three years if not longer (right). During that timeframe the shoreline in the bay will likely be subject to severe erosion (right; image provided by the Wayne County Soil and Water Conservation District).*

Alternative B – Nature Based Barrier Bar

Figures 4-7 and **4-8** below represents this alternative for the western and eastern ends of the barrier bar, respectively.

This alternative would implement sediment management measures as well as vegetation planting and management measures to repair the western portion of the barrier bar, repair limited breaches in the eastern portion of the barrier bar and otherwise enhance the eastern reach of the barrier bar that remained largely intact through 2019.

Periodic maintenance of the equipment access may be required for the various sections of the barrier bar; however, it is assumed that it should be able to be replenished with possible dredge materials and additional material to be hauled to the site.

This alternative focuses on maintaining the natural conditions along the barrier bar but providing supplemental material to increase the resiliency of the system by increasing the barrier bar height and width in comparison to historical and current conditions for the west and east reaches of the barrier bar, respectively. The nature-based methods may include buried live stumps, buried logs, placement of additional gravel material, and supplemental plantings. While this option offers limited protection against breaches in comparison to hardened alternatives (e.g., stone revetment on the lake side or a reinforced core) it maintains the natural character of the system, enhances natural protective capacity and avoids the significant cost and environmental impacts of placing stone across the entire 3,700 ft length of the barrier bar.

Note that previous accounts have indicated that spiny softshell turtles (*Apalone spinifera*) have historically utilized the western portion of the barrier bar to nest in the sandy substrate (per input from NYSDEC). An additional design alternative for consideration of the western extent could include unvegetated areas supplemented with sandy nesting zones (above ordinary high water, see **Figure 4-7**) to increase available nesting zone habitat on the bay side of the nature-based barrier bar.

This alternative envisions raising the bar elevation to 252 ft while maintaining shallow lake-side grades to aide in wave energy attenuation. Additional sediment material would likely need to be utilized to build the barrier bar. The materials would be cobbles and gravels with an overall size similar to or larger than the size of the material presently located on the bar.

Given the design cross sections for the western and eastern reaches of the barrier (descried below), there is an estimated need of approximately 120,000 CY of material needed to implement this alternative. The cost estimate for this alternative currently assumes that the material will be hydraulically dredged and deposited on the barrier bar where a team of operators and laborers on the barrier bar will shape the material to meet the design parameters. The USACE sediment budget mapper (**Figure 2-14**) suggests that potential borrow areas include the Little Sodus Bay channel and an approximate 14-acre area immediately to the west of the western pier at the Little Sodus Bay channel. An additional potential borrow are is immediately bayside of the western barrier bar. An important opportunity to evaluate will be coordination with the REDI dredging program to evaluate and potentially use material dredged from the Little Sodus Bay channel. The current cost estimate includes a material sourcing study to identify borrow areas and perform needed geotechnical testing to vet usability of the material.

On the western portion of Blind Sodus Bay, the barrier bar will be rebuilt to an elevation of 252 feet (IGLD 85) along approximately 1,820 linear feet and tie into the existing bulkhead located on the western side of the bay. This crest elevation is considered to be the minimum to achieve protectiveness of the bay, given the FEMA AO classification of the be barrier bar (**Figure 2-8**) and to optimize material needs, however consideration of a 254 ft. crest is likely to be warranted in design or as an adaptive management measure. The base of the rebuilt bar will be approximately 160 feet wide which will give the barrier an approximate 20-foot wide crest and slopes ranging from 11% on the north side (lake side) of the bar to 20% on the south side (bay side) of the bar. The gentle slopes and wide base of the bar will help to increase resiliency of the system by encouraging waves to break further offshore and will provide additional material to feed longshore transport. Rebuilding the barrier bar on the western portion of the bay would likely require approximately 61,000 CY of material.

On the eastern portion of Blind Sodus Bay, the elevation of the existing barrier bar will increase to 252 feet (IGLD 85) along approximately 1800 linear feet. Similar to the western reach of the barrier bar, this crest elevation is considered to be the minimum to achieve protectiveness of the bay, to optimize material needs, and to minimize the chances of suffocating the roots of the woody plants on the barrier bar, however consideration of a 254 ft. crest is likely to be warranted in design or as an adaptive management measure. This alternative also includes filling an existing 270-foot long breach as well as shifting the crest of the existing barrier bar 10 feet towards Lake Ontario. By shifting the crest toward the lake, this alternative will limit additional stress to the existing trees as well as encourage waves to break further offshore. Since the trees are currently providing ecosystem services such as sediment stabilization, it is important to consider maintaining trees during construction, as feasible. The proposed updates would increase the base of the bar by approximately 70 feet and include gentle slopes (11%) on the north side of the bar. The proposed work on the eastern portion of the barrier bar would likely require approximately 58,500 CY of material. In future detailed engineering, the centerline and side slopes of the designed barrier bars can be adjusted to optimize the design and minimize impacts to aquatic resources of the lake and the bay. The current design assumes ongoing maintenance of the channel on the east end of the barrier bar though the location, orientation and dimensions of the channel may warrant reconsideration in design in order to minimize shoaling.

Vegetative plantings are an important part of coastal restoration, providing a buffer to isolate waves and dissipate energy. During storm events, established vegetation can serve as a natural barrier to reduce flooding and erosion. Land use change and interruption of vegetated systems may have a substantial negative effect on system stability and biodiversity. The associated negative factors may include habitat loss, the loss of bank stability, erosion, reduction in ecological connectivity, reduction in species vigor, and a loss of species richness. The enhancement of natural systems can serve to increase biodiversity through the increase of site-specific flora and the re-attraction of indigenous fauna, hence, helping to restore, enhance, and protect a myriad of ecological functions and services.

Natural revegetation can require long periods of time, hence augmentation through seeding and planting is an important means of accelerating vegetation establishment. The proposed alternative recommends multiple techniques to restore and reconnect natural systems including 1) re-introduction and enhancement of grasses, graminoids, forbs, shrubs, and trees though seeding, divisions, and/or placement of containerized plantings; 2) re-introduction of beneficial soil biota through amendments and 3) adding ecological complexity through land shaping and creation of microsites. Consideration of site-specific revegetation, whether by containerized plant, division, and/or seed, should also be made at the planning and design stage to allow for proper timing and budget considerations. Additionally, plant materials (seed, divisions, or containers) should be ordered from purveying nurseries and seedsman early in the project process and reserved through deposit to guarantee most reasonable pricing and help ensure availability.

As Blind Sodus Bay will be initiating revegetation on newly placed sediment, seeding and planting considerations will be especially important due to the lack of existing plant material. The combination of seed, plants, and divisions can be optimized by microsite and budget.

In addition to maintenance of the channel as well as monitoring of the overall condition of the barrier bar and vegetation, adaptive management of this alternative includes periodic (5 to 10 year) reapplication of sediment to the crest and side slopes of the barrier bar. As an initial estimate the, **Figure 2-14** suggests that the annual loss of material from the barrier is approximately 3,000 CY per year which means that sediment nourishment on the 5 to 10 year timespan would entail approximately 15,000 to 30,000 CY per year. Adaptive management for the barrier bar includes measures to mitigate cormorant impacts to vegetation, potentially inhibit white-tailed deer browse, and to facilitate opportunities for woody plant regeneration through designed disturbances (e.g., creation of late spring open patches on bare mineral substrate to facilitate eastern cottonwood seed germination). UAV monitoring is recommended to track the overall condition and topographic contours of the barrier bar. Operations and maintenance costs are provided in **Appendix B**.

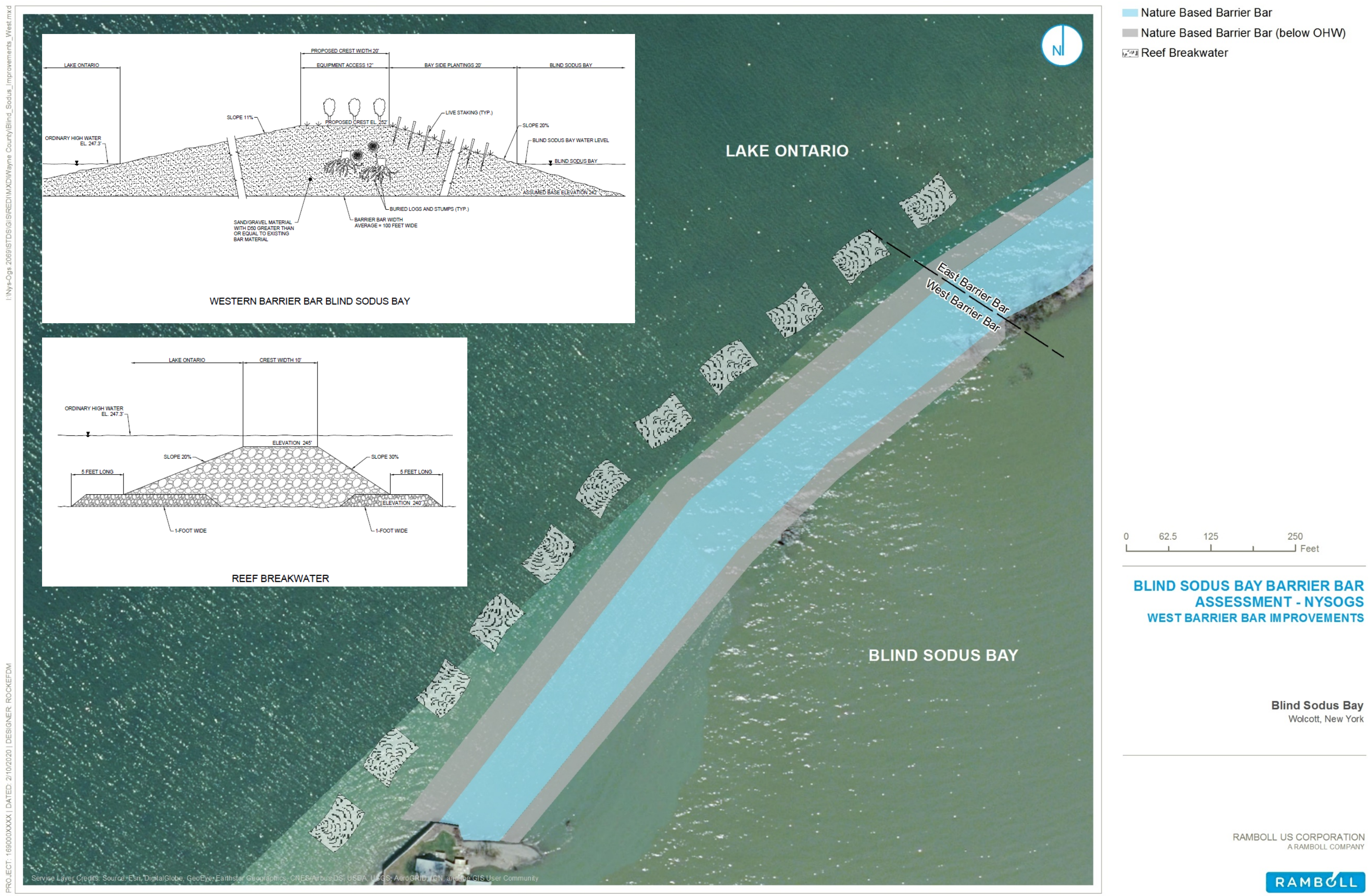


Figure 4-7 *Alternative B – Nature Based Barrier Bar, West Side. This figure also illustrates the reef breakwaters included as Alternative C.*

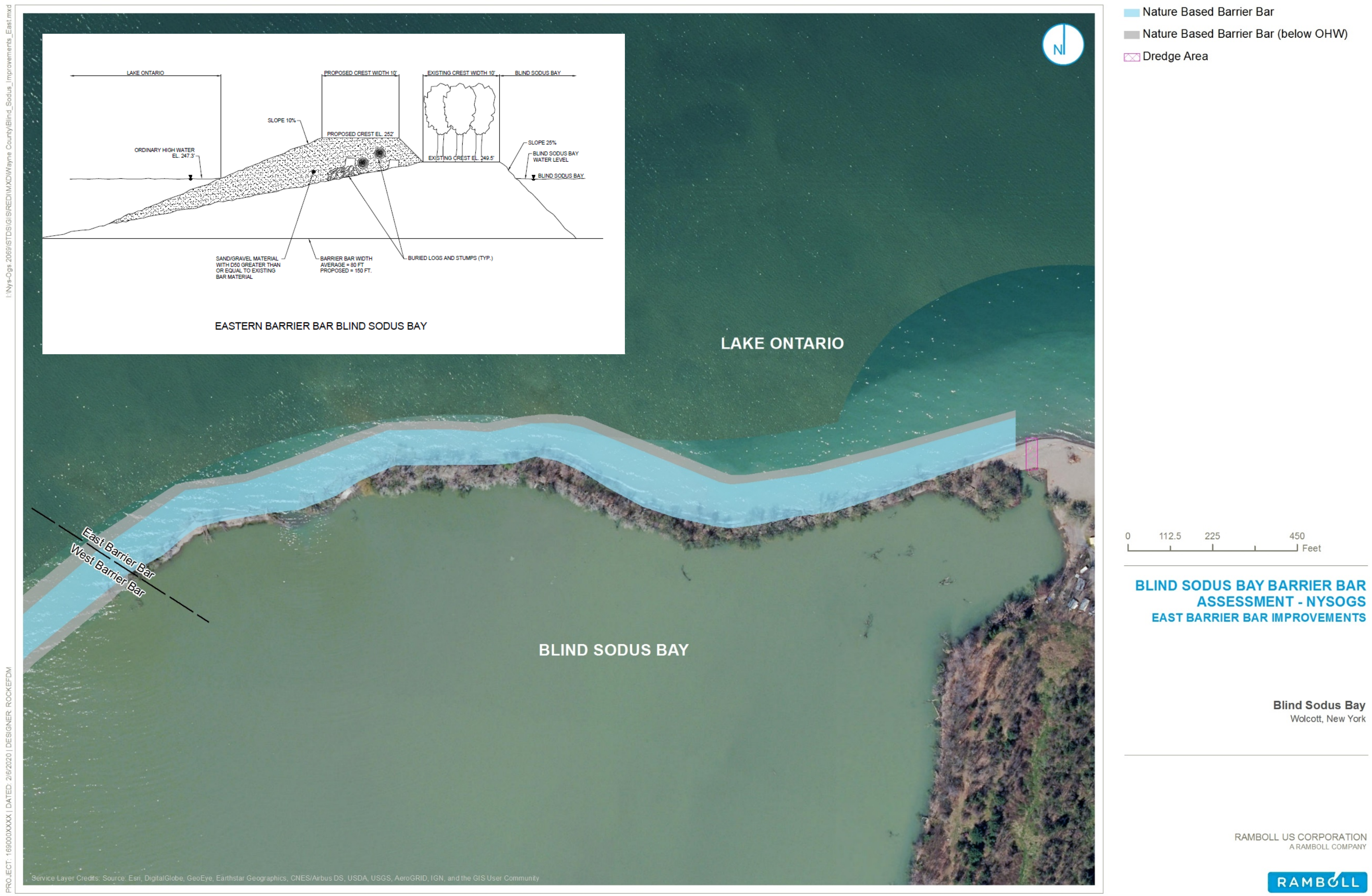


Figure 4-8 *Alternative B – Nature Based Barrier Bar, East Side*

Alternative C – Reef Breakwater

The Blind Sodus Bay barrier bar project provides an opportunity to implement natural and nature-based features including fish habitat that also provide wave energy attenuation. Artificial reefs have been constructed in freshwater and marine systems to attract fish for recreational purposes and to provide spawning, nursery, and adult habitats, in order to increase fish abundance as well as to protect shorelines by providing wave attenuation. Artificial reefs, intentionally and unintentionally constructed, have been observed to increase recreational opportunities and provide spawning habitat for a variety of fishes in the Great Lakes system (McLean et al. 2015) including walleye (*Sander vitreus*), smallmouth bass (*Micropterus dolomieu*), lake sturgeon (*Acipenser fulvescens*) and lake trout (*Salvelinus namaycush*). The offshore breakwater will be designed to provide walleye and smallmouth bass spawning habitat, whose habitats aligns with the desired outcome of the Blind Sodus Bay barrier bar engineering project.

Walleye typically spawn in well oxygenated rocky areas of rivers and lakes and are known to spawn in areas with moderate wave action, which decreases the sedimentation of habitat substrate and provides high oxygen concentrations for incubating eggs. Similarly designed breakwater structures in Brevoort Lake, Michigan (Bassett 1994) are known to support walleye spawning. Smallmouth bass can use similar substrate to spawn as walleye and may also use the lake side of the breakwater as spawning habitat. In addition, substrate placed at the toe of the breakwater on the bay side will provide habitat for other Centrarchid species (Bassett 1994; Saunders et al. 2002; Musch 2007; Kirby 2009; Dow 2018).

The placement and orientation of artificial reefs will be optimized to reduce erosion along the western portion of the barrier bar, which will increase the likelihood that vegetation will establish along this section of the barrier bar. Based on a preliminary analysis of the reef design exposure ratio and other proportions according to USACE (1993), the following design parameters for the reef were developed with the intent of facilitating the formation of a salient pattern along the shoreline. Reef sections are currently envisioned to be approximately 75 ft long and be spaced approximately 50 ft apart, located approximately 75 ft from the shoreline. A typical cross section of the artificial reef is provided in **Figure 4-7** and shows general details. This figure also illustrates the conceptual placement of the reef breakwaters, although numerous parameters would need to be evaluated through the site investigation (e.g., bathymetry), design and modeling process. Approximately eight reef segments would be needed to extend along approximately 1,000 ft along the western reach of the barrier bar. This design effort may be beyond the current budget capacity (see **Table 4-2**), however at the current cost rate, approximately five segments may be constructed within the budget constraints. Additionally, in design, the reefs could potentially be reshaped to look more naturalistic and/or modified to make most efficient use of material. While the crest of the current design sits just below the average water level of 245.3 ft in order to limit material usage and aesthetic impacts to the lake view, the structures may have greater wave attenuation capacity if they were to be built taller. In design, the costs and benefits of making these structures taller should be evaluated. Lastly, while this design assumes the use of stone to construct the reef breakwaters, other prefabricated materials may warrant consideration, especially those that could be temporary or moveable in order to experiment with structure heights, spacing and orientation (or other parameters) and to potentially remove the structures altogether if the impacts to the nearshore system are found to be undesirable (e.g., excessive slowing of longshore transport and local sedimentation).

In order to help protect the rebuilt western barrier bar, it may be beneficial to install the reef breakwater first. The cost estimate assumes barge-based construction and there may be an opportunity to coordinate construction of the reef breakwaters with construction of the bluff stabilization measures in order to limit multiple mobilizations.

Adaptive management for this alternative includes:

- monitoring of wave attenuation and fish utilization of the structures
- monitoring of sediment erosion and deposition patterns around the reef segments and along the shoreline
- potential repair of structures if undermined by scour

- potential moving or removal of structures if made to be moveable

4.2 COST ESTIMATE

Table 4-2 below summarizes the total project cost with construction costs, non-construction costs, and contingency as separately stated. The cost estimates are provided as rough order of magnitude for comparison purposes only. Project construction costs were estimated for the alternatives based on conceptualized designs. Rough order of magnitude quantities have been developed and unit costs have been derived from similar NYSDOT item costs, recommended manufacturer costs and other similar project known costs. The costs are assumed to represent scale differences between the alternatives but are by no means considered accurate for detailed construction estimates. Cost estimate (as well as operations and maintenance) details are given in **Appendix B**.

Table 4-2 *Rough Order of Magnitude Cost Summary*

Alternative	Cost
Bluff Stabilization	
Gabion Wall	$ 8,931,000
Rock Revetment + Regraded Slope	$ 2,523,000
Barrier Bar	
Alternative B - Nature Based Barrier Bar East Barrier Section	$ 3,481,000
Alternative B - Nature Based Barrier Bar West Barrier Section	$ 3,760,000
Alternative C - Reef Breakwater	$ 3,885,000
Recommendation (Revetment + Nature Based Barrier Bar + Reef Breakwater)*	$ 13,649,000*

**Note that the overall recommendation cost is over the current REDI grant amount however a first phase of reef breakwater segments (i.e., approximately five as currently sized) may be installed to fit within the REDI grant amount.*

With respect to the bluff, the rock revetment and regraded slope alternatives were combined in cost analysis because together they would provide comparable overall function to the gabion wall. Assuming the current costs to install the gabion wall on site apply to the rest of the bluff, the gabion wall is significantly more costly than the rock revetment and regraded slope.

Under Alternative B, the western and eastern reaches of the barrier bar construction total approximately $7.2M and assume a combination of marine/onshore construction approaches. Together the reaches average approximately $2,000 per linear foot and $60 per CY in construction costs. These unit cost estimates are in line with those developed for the Port Bay Barrier Bar (Bergman 2019). These costs assume a productivity of 500 CY per day resulting in approximately 120 days of construction work for each of the western and eastern reaches of the barrier bar. Phasing and timing of the construction work should consider the schedule of the Little Sodus Bay dredging as well as mobilization synergies with the bluff stabilization work.

The reef breakwater cost assumes a marine-based construction and conservative costs for stone given potential scarcities of material. The cost estimate for the reef breakwaters assumes that the cost estimate for needed hydrodynamic and sediment flux testing is covered across similar modeling that would likely be needed for the east and west barrier bar reaches.

As discussed further in the next section, the recommendation arising from this evaluation is to advance the revetment, graded slope, nature-based barrier bar and the reef breakwater. Based on the information available and conceptual design and costing to date, these measures should fit within the REDI grant award for this project. Currently the estimates costs exceed the REDI grant amount, however a portion of the reef breakwater (approximately five segments) may fit into the REDI grant amount. Other creative phasing strategies may also be used to implement bluff and barrier bar work in priority order.

4.3 COMMUNITY BENEFITS AND OTHER IMPACTS

Stabilizing the barrier bar using nature-based approaches provides non-monetary benefits such as improved riparian, littoral, wildlife, and fisheries habitat along both the lakeside and bayside of the barrier bars. In addition, stabilization using natural features will improve aesthetics and recreational opportunities by encouraging productive fisheries habitat. Furthermore, native vegetation will help to reduce erosion by protecting sediment in addition to potential enhancements of water quality through nutrient uptake.

5. SUMMARY AND COMPARISON OF RESILIENCY, NATURAL AND NATURE BASED ALTERNATIVES

5.1 BLUFF

The revetment and regarded slope alternatives are, together, recommended for advancement over the no action and concrete cantilever wall alternatives. The recommended measures provide the optimal combination of protectiveness and habitat value while being significantly more cost effective than the gabion wall alternative. As mentioned in Section 4, significant care will be needed to effectively dovetail this approach with the limited section of gabion wall currently being installed.

5.2 BARRIER BAR

The no action alternative for the barrier bar is not considered to be a viable option as there is currently no evidence to suggest that the system will recover naturally and that, in the absence of recovery, significant changes to the bay environment would likely occur while erosion of bay shorelines is anticipated to continue (**Figure 4-6**). Implementing a nature-based barrier bar as envisioned here will recover the natural protective capacity of the barrier; by increasing the crest height and the width of the barrier overall (versus existing conditions), the resiliency of the system is expected to be enhanced.

The reef breakwater is not envisioned to be a substitute or more desirable alternative for recreating the western reach of the barrier bar because of the apparent limitations in sediment supply in comparison to the volume of material needed to recreate this feature (i.e., the reef breakwaters may help to manage a favorable sediment budget for the western reach of the barrier bar, but the reef breakwater alone may not be sufficient to facilitate recovery of the barrier). Rather, the reef breakwater is envisioned to be a desirable addition over a do-nothing alternative because the reef is anticipated to help with protection of the wester barrier bar, especially during early re-establishment of the system, and for significant fish habitat and sportfishing opportunities.

6. RECOMMENDATIONS

Based on the data available to date, public input, conversations among involved agencies and the grantee, as well as the considerations provided herein, we recommend a stone revetment and regraded bluff to stabilize the bluff while a nature-based barrier bar with reef breakwaters to recover the barrier bar system.

NEXT STEPS AND ANTICIPATED TIMEFRAMES

- Studies including but potentially not limited to (Q2 and Q3 2020):
  - Geotechnical evaluations of the bluff to support design and construction decisions
  - Bathymetric survey as well as hydrodynamic and sediment flux modeling of the barrier bar and reef area to evaluate design scenarios
  - Material sourcing study for the barrier bar reconstruction
- Special coordination, planned community/stakeholder/agency engagement with particular focus on regrading the bluff for increased stability (Q2 and Q3 2020)
- Full design and permitting process for the selected alternative (Q2 through Q4 2020 into 2021)
- Refinement of cost estimates, schedule and life cycle costs (Q2 through Q4 2020 into 2021)

- Construction (Q3 2021, or as work windows allow)

CITATIONS

Bain, M.B. and Helfrich, L.A., 1983. Role of male parental care in survival of larval bluegills. Transactions of the American Fisheries Society, 112(1), pp.47-52.

Bassett, C.E., 1994. Use and evaluation of fish habitat structures in lakes of the eastern United States by the USDA Forest Service. Bulletin of Marine Science, 55(2-3), pp.1137-1148.

Bergmann. 2019. Port Bay Barrier Bar Assessment. Prepared for NYS Office of General Services and NYS Department of Environmental Conservation. Draft May 2019 Version.

Carmichael, W.W. and Boyer, G.L., 2016. Health impacts from cyanobacteria harmful algae blooms: Implications for the North American Great Lakes. Harmful algae, 54, pp.194-212.

Citizens Statewide Lake Assessment Program (CSLAP). 2016. 2016 Blind Sodus Bay CSLAP Report.

Dow, B., 2018. Assessment and Mapping of the Milwaukee Estuary Habitat. (Doctoral dissertation, University of Wisconsin).

Gilman, B. and F. Smith. 1988. An Inventory of Macrophyte Communities in the Wayne County Bays of Lake Ontario, NY. Wayne County Soil and Water Conservation District, Lyons, NY.

Gross, M.R. and Nowell, W.A., 1980. The reproductive biology of rock bass, *Ambloplites rupestris* (Centrarchidae), in Lake Opinicon, Ontario. Copeia, pp.482-494.

Kirby, L.J., 2009. Nesting and recruitment of centrarchids and the oligotrophication of Onondaga Lake, New York. (Master Thesis, State University of New York College of Environmental Science and Forestry).

Lane, G. A. 1998. Status of Blind Sodus Bay fish stocks 1996. NYSDEC Region 8 draft file report. Avon, NY. 28 pp.

McLean, M., Roseman, E.F., Pritt, J.J., Kennedy, G. and Manny, B.A., 2015. Artificial reefs and reef restoration in the Laurentian Great Lakes. Journal of Great Lakes Research, 41(1), pp.1-8.

Meixler, M.S. and Bain, M.B. 2003. A test of the Variability of usefulness of SOLEC environmental indicators in the coastal wetlands of eastern Lake Ontario. Great Lakes Commission Final Report.

Musch, A.E., 2007. Spawning habitat selection of sympatric smallmouth bass (*Micropterus dolomieu*) and rock bass (*Ambloplites rupestris*) in north temperate lakes: habitat separation in space and time (Doctoral dissertation, University of Wisconsin--Stevens Point).

NY Sea Grant. 2016. NYSG: Harmful Algal Blooms (News-SUNY ESF Investigators Monitor NY Waters of Sodus Bay, July 2016

New York State Department of State (NYDOS). 2010. Town of Wolcott Local Waterfront Revitalization Program. **http://www.townofwolcottny.org/FINAL_LWRP_VISION_PLAN.pdf**

United States Army Corps of Engineers. 1993. Engineering Design Guidance for Detached Breakwaters as Shoreline Stabilization Structures, WES, Technical Report CERC–93-19, December. **https://scholar.google.com/scholar?hl=en&as_sdt=0%2C33&q=Engineering+Design+Guidance+for+Detached+Breakwaters+as+Shoreline+Stabilization+Structure&btnG=**

United States Environmental Protection Agency (USEPA) and NYSDEC. 2007. Total Maximum Daily Load (TMDL) *for Phosphorus in Blind Sodus Bay.* **https://www.dec.ny.gov/docs/water_pdf/tmdlphosbsod.pdf**

Sanderson, M. 2014. A recreational fishery survey of Port, East, and Blind Sodus Bays. NYSDEC Final Report. **https://www.dec.ny.gov/docs/fish_marine_pdf/lobayscreel.pdf**

Saunders, R., Bozek, M.A., Edwards, C.J., Jennings, M.J. and Newman, S.P., 2002. Habitat features affecting smallmouth bass *Micropterus dolomieu* nesting success in four northern Wisconsin lakes. In American Fisheries Society Symposium 31: 123-134 (Vol. 31).

Wayne County Soil and Water Conservation District (CSWC). 2007. Final Report: The great Sodus embayment resource preservation and watershed enhancement plan.

.

Appendix A

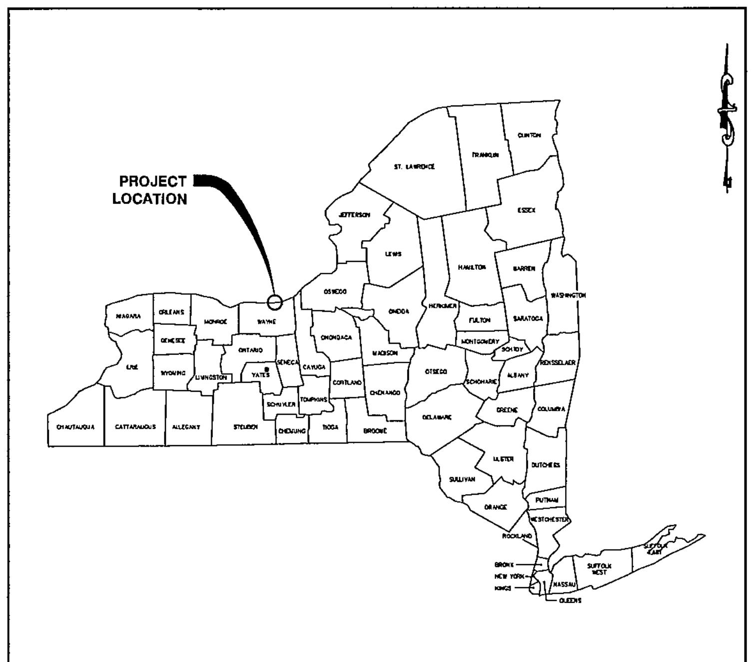
Contract Drawings
Shoreline Repair Blind
Sodus Bay Road –

MRB Group

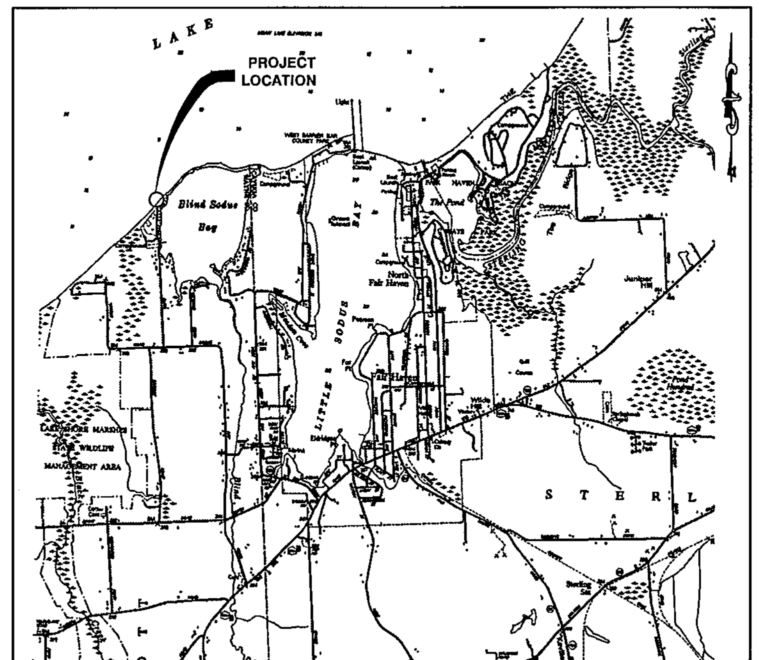
CONTRACT DRAWINGS FOR THE

LAKE ONTARIO SHORE LINE REPAIR PROJECT BLIND SODUS BAY ROAD

LAKE ONTARIO - ST. LAWRENCE SEAWAY FLOOD RELIEF AND RECOVERY GRANT NO. 1268IT224-17



LOCATION MAP



LOCATION MAP

TOWN OF WOLCOTT
WAYNE COUNTY
NEW YORK

PROJECT # 2312.19001

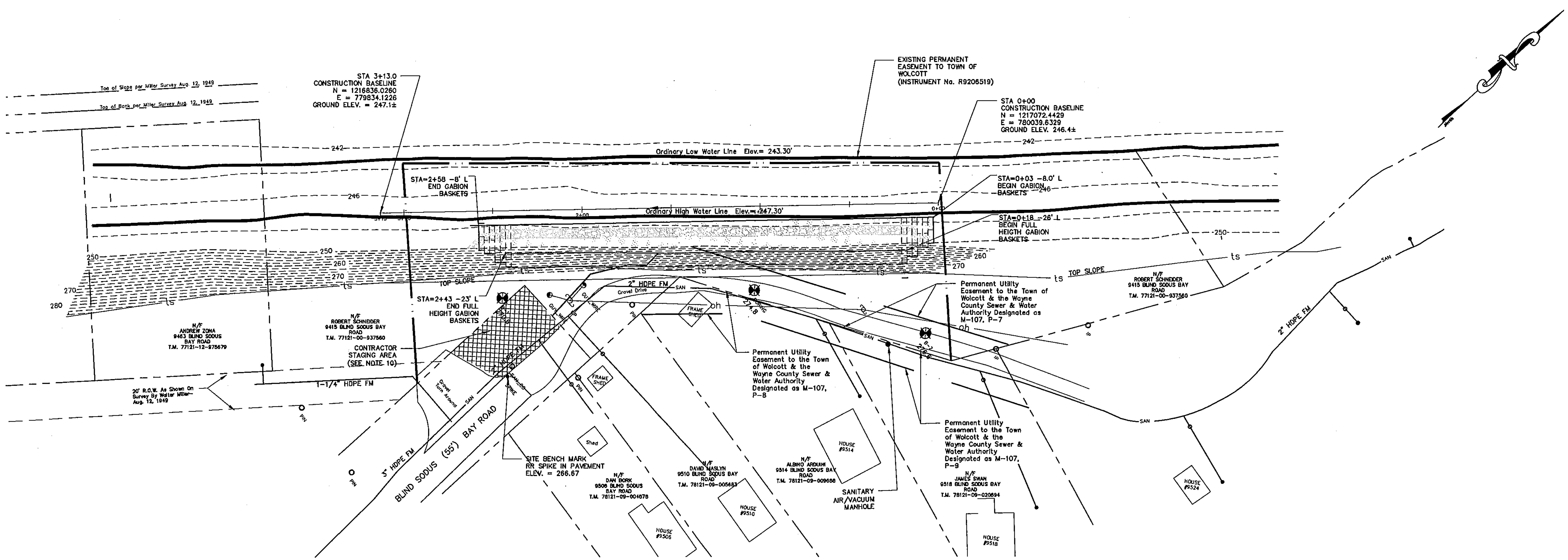
DRAWING INDEX:

JULY 2019

MRB group
Engineering, Architecture & Surveying, D.P.C.
The Culver Road Armory, 145 Culver Road, Suite 160, Rochester, New York 14620
Phone: 585-381-9250
www.mrbgroup.com

BISON ENGINEERING &
ENTERPRISES, PLLC.
12 BRYDEN PARK
WEBSTER, NY 14580
585-330-7123
BISONEE@ROCHESTER.RR.COM

2312.19001.000 SHORE LINE REPAIR PROJECT- BLIND SODUS BAY RD - TOWN OF WOLCOTT



GENERAL NOTES:

1. SURVEY AND BASE MAPPING INFORMATION, DATED 9/6/18, PROVIDED BY :
   KOCHER SURVEYING, P.C.
   116 WEST MILLER STREET, NEWARK, NY 14513
   PHONE: 315.331.2800
   FAX: 315.331.2445
   WEBSITE: WWW.KOCHERSURVEYING.COM

   THE SURVEY AND BASE MAPPING WERE UPDATED 3/19/2019. REFERENCE DATUM IS NEW YORK STATE PLANE COORDINATE, CENTRAL ZONE, NORTH AMERICAN VERTICAL DATUM 1988 (IGLD 1985)
2. CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING ALL DIMENSIONS, GRADES, QUANTITIES AND FIELD CONDITIONS PRIOR TO BIDDING THE WORK OR ORDERING MATERIALS.
3. WORK WILL BE PERFORMED IN ACCORDANCE WITH FEDERAL AND STATE ISSUED PERMITS
4. CONSTRUCTION BEST MANAGEMENT PRACTICES (BMP'S): UNLESS SPECIFICALLY APPROVED OTHERWISE THROUGH ISSUANCE OF A VARIANCE BY THE ARMY CORPS OF ENGINEERS DISTRICT ENGINEER, THE FOLLOWING BMP'S MUST BE IMPLEMENTED TO THE MAXIMUM DEGREE PRACTICABLE, TO MINIMIZE EROSION, MIGRATION OF SEDIMENTS, AND ADVERSE ENVIRONMENTAL IMPACTS. NOTE THAT AT A MINIMUM, ALL EROSION AND SEDIMENT CONTROL AND STORM WATER MANAGEMENT PRACTICES MUST BE DESIGNED, INSTALLED AND MAINTAINED THROUGHOUT THE ENTIRE CONSTRUCTION PROJECT IN ACCORDANCE WITH THE LATEST VERSION OF THE "NEW YORK STANDARDS AND SPECIFICATIONS FOR EROSION AND SEDIMENT CONTROL" AND THE "NEW YORK STATE STORM WATER MANAGEMENT DESIGN MANUAL". THESE DOCUMENTS ARE AVAILABLE AT: HTTP://WWW.DEC.NY.GOV/CHEMICAL/29066.HTML AND HTTP://WWW.DEC.NY.GOV/CHEMICAL/29072.HTML, RESPECTIVELY. PRIOR TO THE DISCHARGE OF ANY DREDGED OR FILL MATERIAL INTO WATERS OF THE UNITED STATES, INCLUDING WETLANDS, AUTHORIZED BY NWP, THE PERMITTEE MUST INSTALL AND MAINTAIN EROSION AND SEDIMENTATION CONTROLS IN AND/OR ADJACENT TO WETLANDS OR OTHER WATERS OF THE UNITED STATES.
   - a). ALL SYNTHETIC EROSION CONTROL FEATURES (E.G., SILT FENCING, NETTING, MATS), WHICH ARE INTENDED FOR TEMPORARY USE DURING CONSTRUCTION, SHALL BE COMPLETELY REMOVED AND PROPERLY DISPOSED OF AFTER THEIR INITIAL PURPOSE HAS BEEN SERVED. ONLY NATURAL FIBER MATERIALS, WHICH WILL DEGRADE OVER TIME, MAY BE ABANDONED IN PLACE.
   - b). MATERIALS RESULTING FROM TRENCH EXCAVATION FOR UTILITY LINE INSTALLATION OR DITCH RESHAPING ACTIVITIES WHICH ARE TEMPORARILY SIDECAST OR STOCKPILED INTO WATERS OF THE UNITED STATES MUST BE BACKFILLED OR REMOVED TO AN UPLAND AREA WITHIN 30 DAYS OF THE DATE OF DEPOSITION. NOTE: UPLAND OPTIONS SHALL BE UTILIZED PRIOR TO TEMPORARY PLACEMENT WITHIN WATERS OF THE U.S., UNLESS IT CAN BE DEMONSTRATED THAT IT WOULD NOT BE PRACTICABLE OR IF THE IMPACTS OF COMPLYING WITH THIS UPLAND OPTION REQUIREMENT WOULD RESULT IN MORE ADVERSE IMPACTS TO THE AQUATIC ENVIRONMENT.
   - c). FOR TRENCHING ACTIVITIES IN WETLANDS THE APPLICANT SHALL INSTALL IMPERMEABLE TRENCH DAMS OR TRENCH BREAKERS AT THE WETLAND BOUNDARIES AND EVERY 100 FEET WITHIN WETLAND AREAS TO PREVENT INADVERTENT DRAINAGE OF WETLANDS OR OTHER WATERS OF THE UNITED STATES.
   - d). DRY STREAM CROSSING METHODS (E.G., DIVERSION, DAM AND PUMP, FLUME, BORE) SHALL BE UTILIZED FOR CULVERT OR OTHER PIPE, OR UTILITY INSTALLATIONS TO REDUCE DOWNSTREAM IMPACTS FROM TURBIDITY AND SEDIMENTATION. THIS MAY REQUIRE PIPING OR PUMPING THE STREAM FLOW AROUND THE WORK AREA AND THE USE OF COFFERDAMS.
   - e). NO IN-STREAM WORK SHALL OCCUR DURING PERIODS OF HIGH FLOW, EXCEPT FOR WORK THAT OCCURS IN DEWATERED AREAS BEHIND TEMPORARY DIVERSIONS, COFFERDAMS OR CAUSEWAYS.
   - f). CONSTRUCTION ACCESS AND STAGING AREAS SHALL BE BY MEANS THAT AVOID OR MINIMIZE IMPACTS TO AQUATIC SITES (E.G. USE OF UPLAND AREAS FOR ACCESS & STAGING, FLOATING BARGES, MATS, ETC.). DISCHARGES OF FILL MATERIAL ASSOCIATED WITH THE CONSTRUCTION OF TEMPORARY ACCESS ROADS, STAGING AREAS AND WORK PADS IN WETLANDS SHALL BE PLACED ON FILTER FABRIC. ALL TEMPORARY FILLS SHALL BE REMOVED UPON COMPLETION OF THE WORK AND THE DISTURBED AREA RESTORED TO PRE-CONSTRUCTION CONTOURS, ELEVATIONS AND WETLAND CONDITIONS, INCLUDING COVER TYPE. ALL VEGETATION UTILIZED IN THE RESTORATION ACTIVITY SHALL CONSIST OF NATIVE SPECIES.
   - g). ALL RETURN FLOW FROM DREDGED MATERIAL DISPOSAL AREAS SHALL NOT RESULT IN AN INCREASE IN TURBIDITY IN THE RECEIVING WATER BODY THAT WILL CAUSE A SUBSTANTIAL VISIBLE CONTRAST TO NATURAL CONDITIONS. (SEE NWP #16)
   - h). FOR ACTIVITIES INVOLVING THE PLACEMENT OF CONCRETE INTO WATERS OF THE U.S., THE PERMITTEE MUST EMPLOY WATERTIGHT FORMS. THE FORMS SHALL BE DEWATERED PRIOR TO THE PLACEMENT OF THE CONCRETE. THE USE OF TREMIE CONCRETE IS ALLOWED, PROVIDED THAT IT COMPLIES WITH NEW YORK STATE WATER QUALITY STANDARDS.
   - i). NEW STORMWATER MANAGEMENT FACILITIES SHALL BE LOCATED OUTSIDE OF WATERS OF THE U.S. A VARIANCE OF THIS REQUIREMENT MAY BE REQUESTED WITH THE SUBMISSION OF A PCN. THE PCN MUST INCLUDE JUSTIFICATION WHICH DEMONSTRATES THAT AVOIDANCE AND MINIMIZATION EFFORTS HAVE BEEN MET.
   - j.) TO THE MAXIMUM EXTENT PRACTICABLE, THE PLACEMENT OF FILL IN WETLANDS MUST BE DESIGNED TO MAINTAIN PRE-CONSTRUCTION SURFACE WATER FLOWS/CONDITIONS BETWEEN REMAINING ON OR OFF-SITE WATERS AND TO PREVENT DRAINING OF THE WETLAND OR PERMANENT HYDROLOGIC ALTERATION. THIS MAY REQUIRE THE USE OF CULVERTS AND/OR OTHER MEASURES. FURTHERMORE, THE ACTIVITY MUST NOT RESTRICT OR IMPEDE THE PASSAGE OF NORMAL OR EXPECTED HIGH FLOWS (UNLESS THE PRIMARY PURPOSE OF THE FILL IS TO IMPOUND WATERS). THE ACTIVITY MAY ALTER THE PRE-CONSTRUCTION FLOWS/CONDITIONS IF IT CAN BE SHOWN THAT IT BENEFITS THE AQUATIC ENVIRONMENT (I.E. WETLAND RESTORATION AND/OR ENHANCEMENT).
5. NON-CONTAMINATION OF WATERS: ALL NECESSARY PRECAUTIONS SHALL BE TAKEN TO PRECLUDE CONTAMINATION OF ANY WETLAND WATERWAY OR GROUNDWATER BY SUSPENDED SOLIDS, RESINS, SEDIMENTS, FUELS, SOLVENTS, LUBRICANTS, EPOXY COATINGS, PAINTS, CONCRETE, LEACHATE, INADVERTENT RETURNS OF DRILLING MUDS (FRAC-OUTS) OR ANY OTHER ENVIRONMENTALLY DELETERIOUS MATERIALS ASSOCIATED WITH THE PROJECT.
6. ALL CONSTRUCTION EQUIPMENT SHALL BE OPERATED FROM DRY LAND OR ON A BARGE. NO BLUFF EXCAVATION FOR TEMPORARY CONSTRUCTION ACCESS IS PERMITTED.
7. DUE TO THE CONSTRAINTS OF UTILITY FACILITIES, PRIVATE PROPERTIES, NARROW ROAD RIGHT OF WAY, STEEPNESS AND HEIGHT OF THE EMBANKMENT, ALL BIDS SHALL BE PROVIDED ASSUMING ACCESS, DELIVERY OF EQUIPMENT AND CONSTRUCTION FROM THE WATER UTILIZING BARGES AND BOATS.
8. ALL INCIDENTAL EXCAVATED SEDIMENTS AND REMOVED TREES/BRUSH SHALL BE DISPOSED UPLAND (NOT IN ANY WATERWAY, WETLAND, ETC.). THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROPER DISPOSAL.
9. WATER QUALITY CERTIFICATION TO PREVENT THE UNINTENTIONAL INTRODUCTION OR SPREAD OF INVASIVE SPECIES THE CONTRACTOR SHALL ENSURE THAT ALL CONSTRUCTION EQUIPMENT BE CLEANED OF MUD, SEEDS, VEGETATION AND OTHER DEBRIS BEFORE ENTERING ANY APPROVED CONSTRUCTION AREA WITHIN WATERS OF THE U.S. WHEN USING CONSTRUCTION EQUIPMENT FOR PROJECTS AUTHORIZED UNDER THIS CERTIFICATION THE CONTRACTOR SHALL TAKE REASONABLE PRECAUTIONS TO PREVENT THE SPREAD OF AQUATIC INVASIVE SPECIES REQUIRED UNDER NYS LAW
10. THE CONTRACTOR SHALL PHASE OPERATIONS TO PERMIT VEHICLE ACCESS TO PRIVATE PROPERTIES IN VICINITY OF THE PROJECT AREA.
11. LINEAR OPEN EXCAVATION PHASES FOR PROPOSED GABION BASKETS IS LIMITED TO A MAXIMUM OF 40 LF. THE NEXT OPEN EXCAVATION PHASE WILL NOT BE PERMITTED UNTIL THE TOP OF GABION WALL FOR THE PREVIOUS PHASE EXCEEDS ELEVATION 254. (FIRST FIVE ROWS OF GABIONS)

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

DRAWING ALTERATION
THE FOLLOWING IS AN EXCERPT FROM THE NEW YORK EDUCATION LAW ARTICLE 145 SECTION 7209 AND APPLIES TO THIS DRAWING.
"IT IS A VIOLATION OF THIS LAW FOR ANY PERSON UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE SEAL OF AN ENGINEER OR LAND SURVEYOR IS ALTERED, THE ALTERING ENGINEER OR LAND SURVEYOR SHALL AFFIX TO THE ITEM HIS SEAL AND THE NOTATION "ALTERED BY" FOLLOWED BY HIS SIGNATURE AND THE DATE OF SUCH ALTERATION AND A SPECIFIC DESCRIPTION OF THE ALTERATION".

BISON ENGINEERING & ENTERPRISES, PLLC.
12 BRYDEN PARK
WEBSTER, NY 14580
585-330-7123
BISONEE@ROCHESTER.RR.COM

MRB group
Engineering, Architecture & Surveying, D.P.C.
The Culver Road Armory, 145 Culver Road, Suite 160, Rochester, New York 14620
Phone: 585-381-9250
www.mrbgroup.com

No.	Revisions and Descriptions	By	Date

Project Title:
SHORELINE REPAIR PROJECT
LAKE ONTARIO
BLIND SODUS BAY RD, WOLCOTT, NY

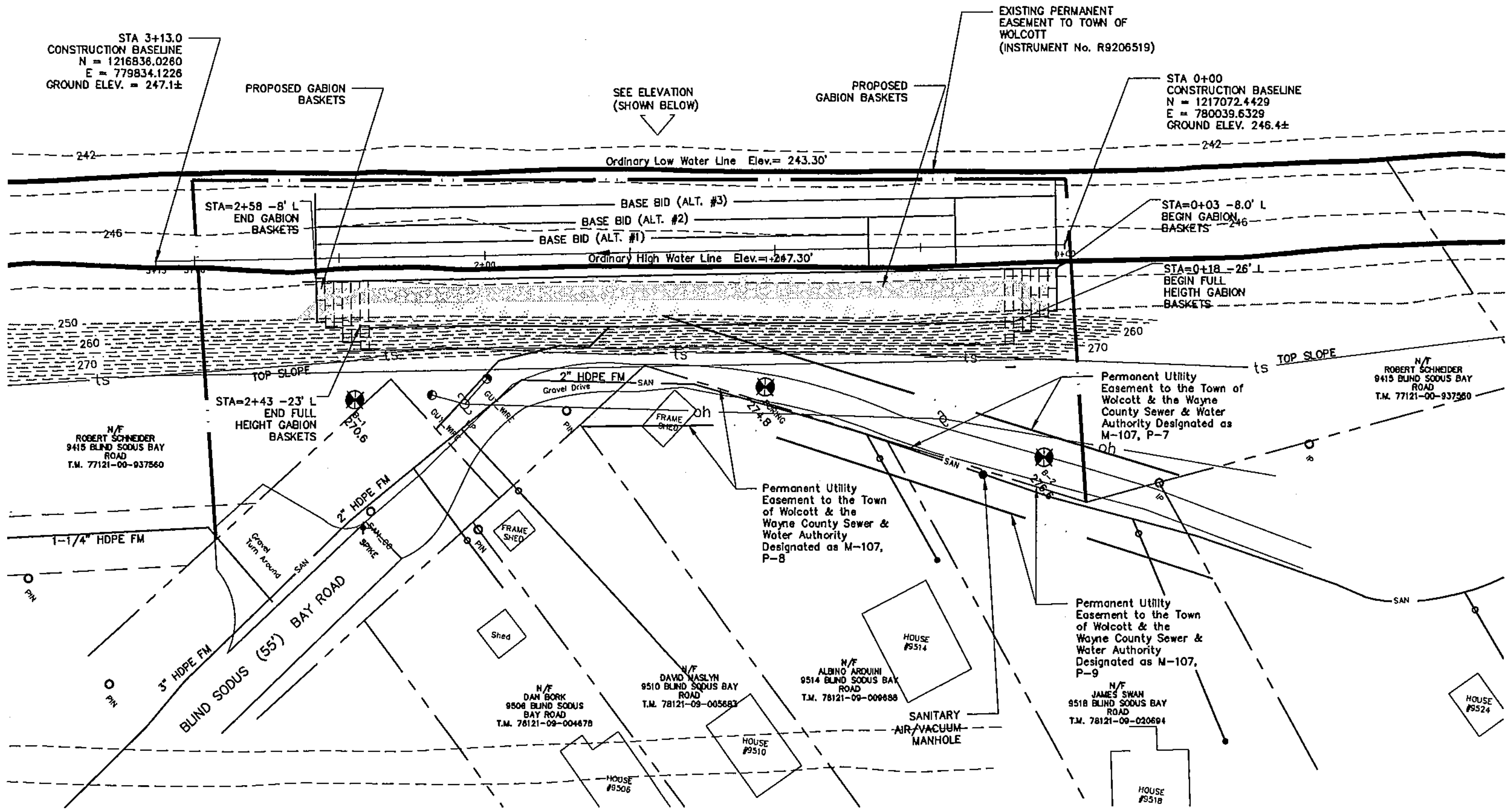
Drawing Title:
WORK ZONE AND CONSTRUCTION STAGING

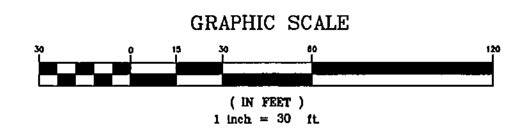
Drawn By: MRB
Checked By: SRB
Scale: AS SHOWN
Date: JULY 2019

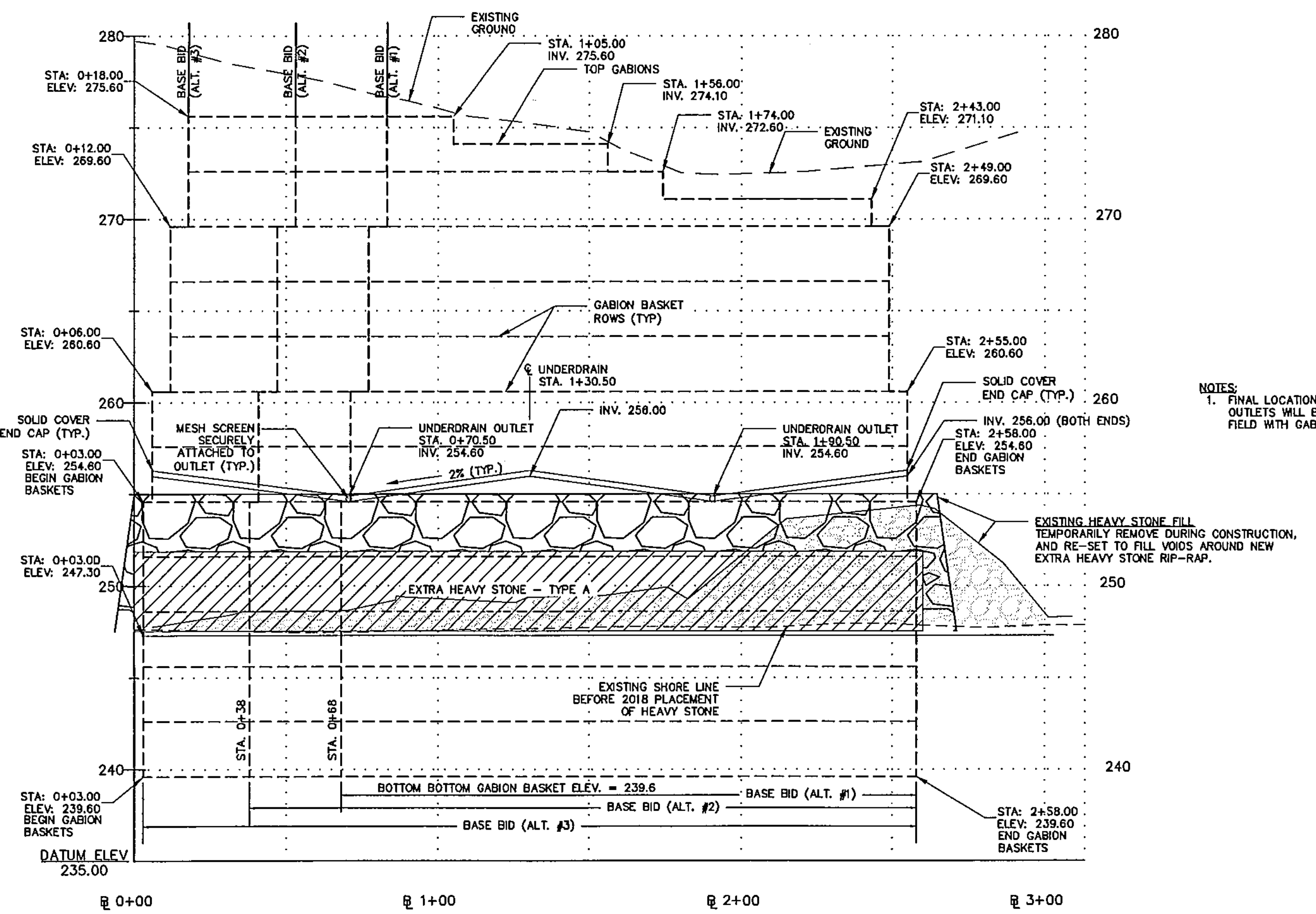
Sheet No. WZTC-1

2 of 5

Project No.
2312.19001







ELEVATION OF GABION FACE LOOKING SOUTH EAST

PROFILE SCALE:
1" = 30' HORIZ
1" = 5' VERT.

NOTES:
1. FINAL LOCATION OF UNDERDRAIN OUTLETS WILL BE COORDINATED IN THE FIELD WITH GABION BASKET LAYOUT.

DRAWING ALTERATION
THE FOLLOWING IS AN EXCERPT FROM THE NEW YORK EDUCATION LAW ARTICLE 145 SECTION 7209 AND APPLIES TO THIS DRAWING.
"IT IS A VIOLATION OF THIS LAW FOR ANY PERSON UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE SEAL OF AN ENGINEER OR LAND SURVEYOR IS ALTERED, THE ALTERING ENGINEER OR LAND SURVEYOR SHALL AFFIX TO THE ITEM HIS SEAL AND THE NOTATION "ALTERED BY" FOLLOWED BY HIS SIGNATURE AND THE DATE OF SUCH ALTERATION AND A SPECIFIC DESCRIPTION OF THE ALTERATION".

BISON ENGINEERING & ENTERPRISES, PLLC.
12 BRYDEN PARK
WEBSTER, NY 14580
585-330-7123
BISONEE@ROCHESTER.RR.COM

MRB group
Engineering, Architecture & Surveying, D.P.C.
The Culver Road Armory, 145 Culver Road, Suite 160, Rochester, New York 14620
Phone: 585-381-9250
www.mrbgroup.com

No.	Revisions and Descriptions	By	Date

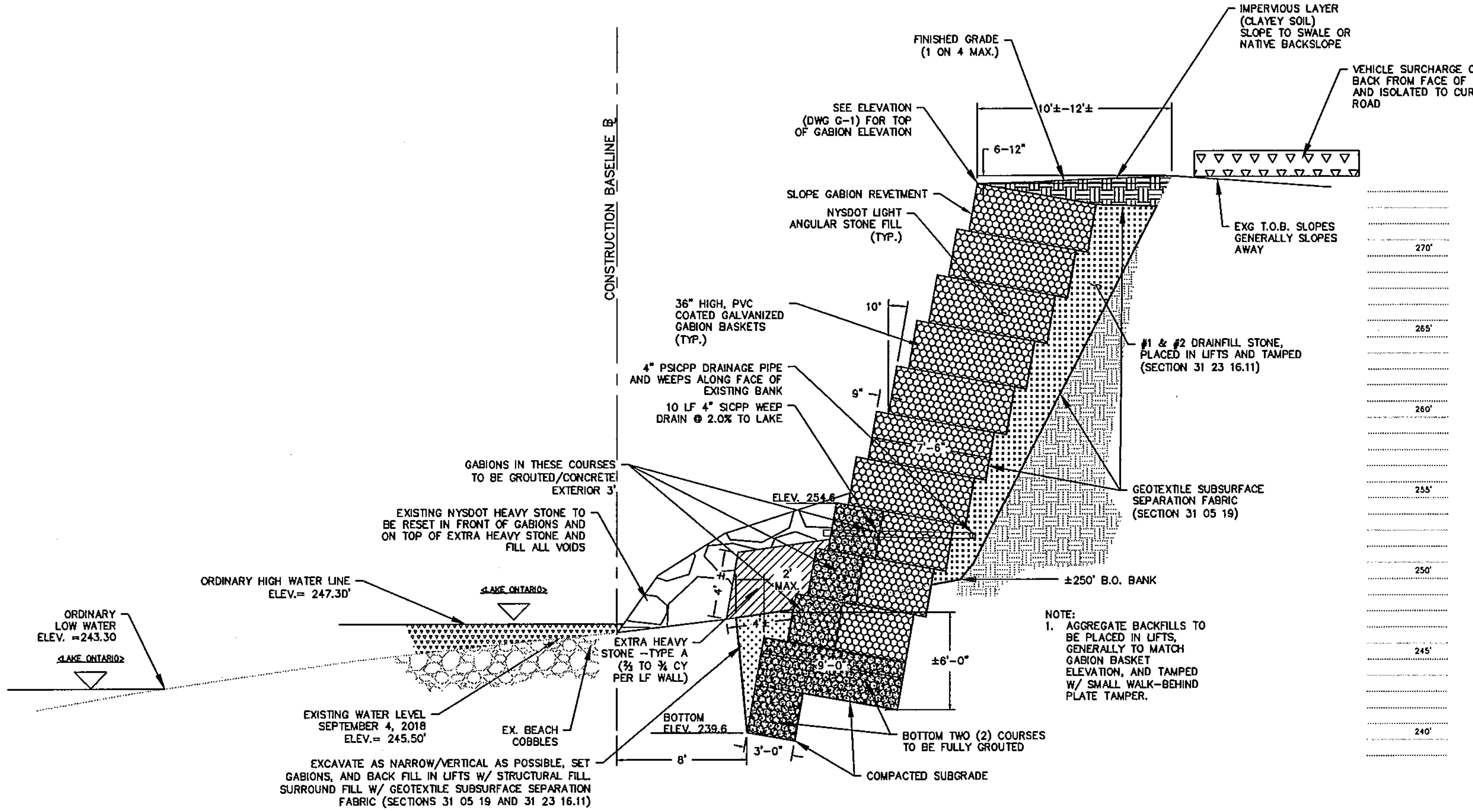
Project Title:
SHORELINE REPAIR PROJECT
LAKE ONTARIO
BLIND SODUS BAY RD, WOLCOTT, NY

Drawing Title:
PROPOSED SITE PLAN & ELEVATION

Drawn By: MRB
Checked By: SRB
Scale: AS SHOWN
Date: JULY 2019

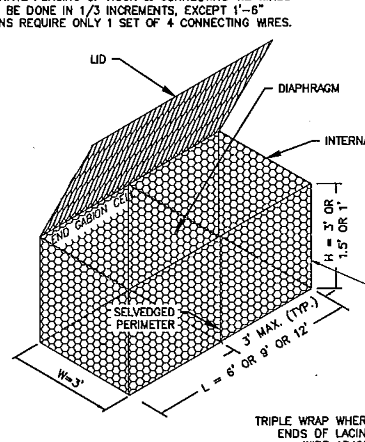
Sheet No. G-1
3 of 5

Project No. 2312.19001

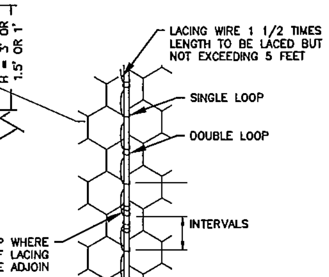


TYPICAL CROSS SECTION - GABION INSTALLATION

N.T.S.

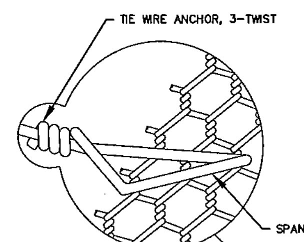


GABION BASKET ISOMETRIC

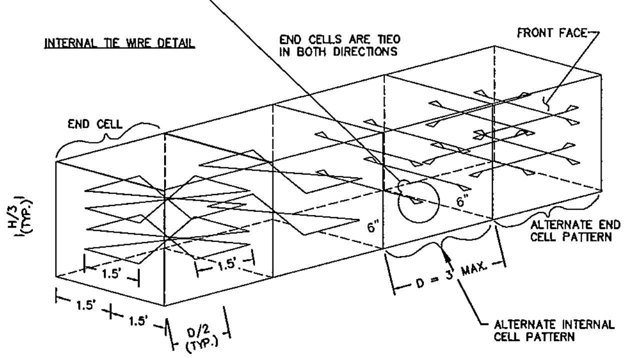


THIS LACING WIRE DETAIL SHALL BE UTILIZED FOR VERTICAL EDGE SEAMS, VERTICAL DIAPHRAGM SEAMS, TOP SEAMS & EDGES WHERE ADJACENT GABIONS MEET.

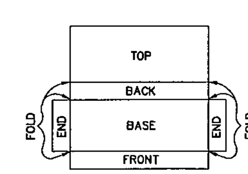
LACING WIRE DETAIL



INTERNAL TIE WIRE DETAIL

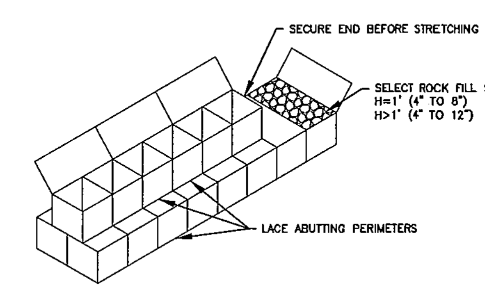


INTERNAL TIE WIRE ISOMETRIC



PLAN OF TYPICAL GABION BASKET SHOWING FOLDS NECESSARY TO ASSEMBLE & TIE

GABION DEVELOPMENT



TYPICAL GABION STRUCTURE ISOMETRIC

TYPICAL GABION DETAILS

N.T.S.

NOTES:
1. INTERNAL GABIONS SHALL HAVE ONE SET OF INTERNAL TIE WIRES PLACED AT MID-HEIGHT OF THE GABIONS.
2. ABBREVIATIONS:
   W=WIDTH OF GABION BASKET
   L=LENGTH OF GABION BASKET
   H=HEIGHT OF GABION BASKET
   D=LENGTH OF INDIVIDUAL GABION CELL
3. ASSEMBLE AND INSTALL GABIONS IN COMPLIANCE WITH MANUFACTURER'S RECOMMENDATIONS. THE DETAILS ARE PRESENTED TO INDICATE TYPICAL WORK. THEY SHALL BE CONSIDERED SECONDARY AND USED ONLY IN THE ABSENCE OF ANY MANUFACTURER RECOMMENDATIONS OR DIRECTIONS.

BISON ENGINEERING & ENTERPRISES, PLLC.
12 BRYDEN PARK
WEBSTER, NY 14580
585-330-7123
BISONEE@ROCHESTER.RR.COM

MRB | group
Engineering, Architecture & Surveying, D.P.C.
The Culver Road Armory, 145 Culver Road, Suite 160, Rochester, New York 14620
Phone: 585-381-9250
www.mrbgroup.com

Drawn By:	JC
Checked By:	SB
Scale:	N.T.S.
Date:	JULY 2019

Project Title:
SHORELINE REPAIR PROJECT
LAKE ONTARIO
BLIND SODUS BAY RD, WOLCOTT, NY

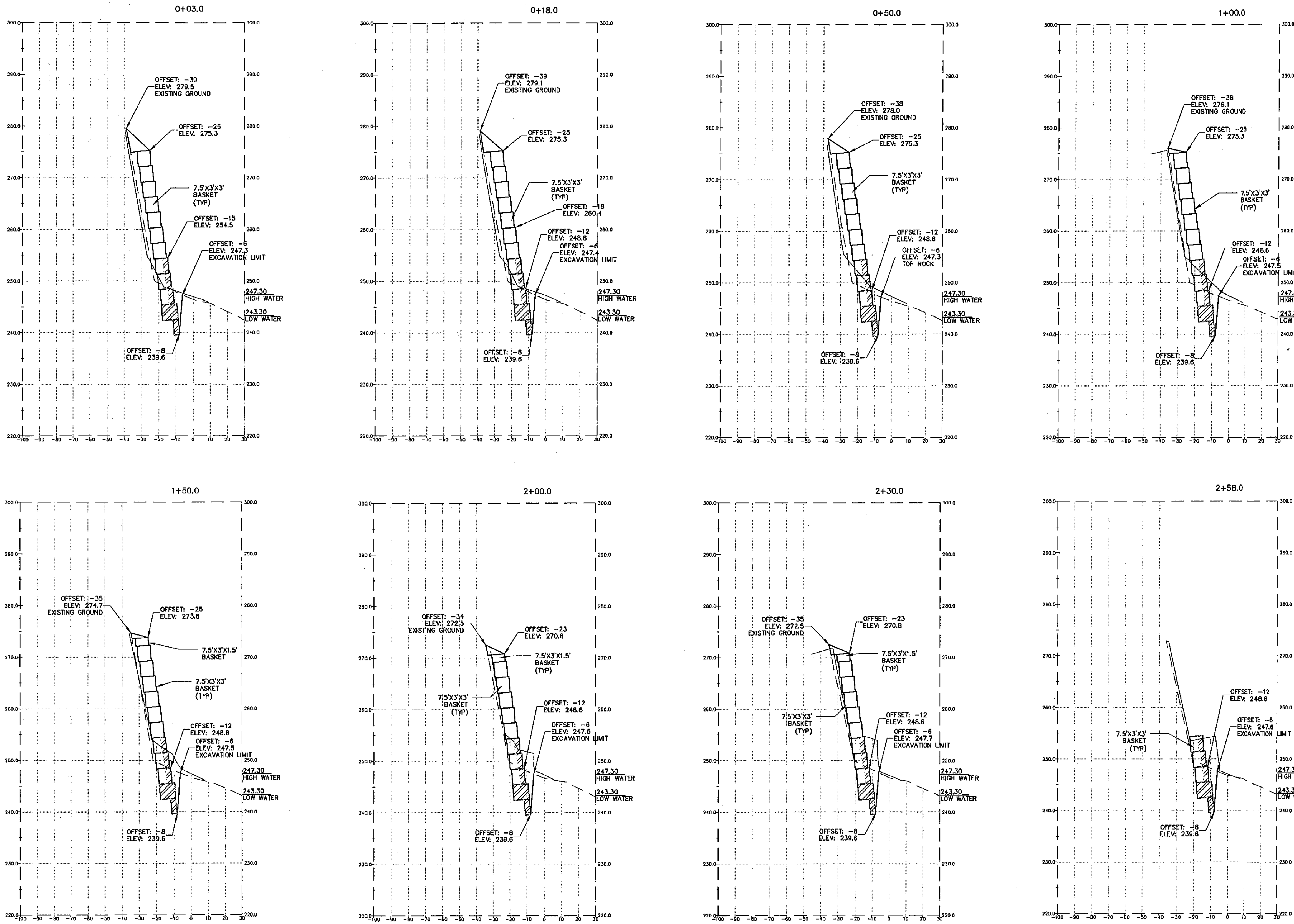
Drawing Title:
TYPICAL SECTION AND DETAILS

No.	Revisions and Descriptions	By	Date

Sheet No. D-1

Project No. 2312.19001

NOTE: ALL SECTIONS SHOWN ARE FOR BASE BID (ALT. #3)



SECTION SCALE
1" = 30' HORIZ
1" = 10' VERT

DRAWING ALTERATION
THE FOLLOWING IS AN EXCERPT FROM THE NEW YORK EDUCATION LAW ARTICLE 145 SECTION 7209 AND APPLIES TO THIS DRAWING.
"IT IS A VIOLATION OF THIS LAW FOR ANY PERSON UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE SEAL OF AN ENGINEER OR LAND SURVEYOR IS ALTERED, THE ALTERING ENGINEER OR LAND SURVEYOR SHALL AFFIX TO THE ITEM HIS SEAL AND THE NOTATION "ALTERED BY" FOLLOWED BY HIS SIGNATURE AND THE DATE OF SUCH ALTERATION AND A SPECIFIC DESCRIPTION OF THE ALTERATION".

BISON ENGINEERING & ENTERPRISES, PLLC.
12 BRYDEN PARK
WEBSTER, NY 14580
585-330-7123
BISONEE@ROCHESTER.RR.COM

MRB group
Engineering, Architecture & Surveying, D.P.C.
The Culver Road Armory, 145 Culver Road, Suite 160, Rochester, New York 14620
Phone: 585-381-9250
www.mrbgroup.com

No.	Revisions and Descriptions	By	Date

Project Title:
SHORELINE REPAIR PROJECT
LAKE ONTARIO
BLIND SODUS BAY RD, WOLCOTT, NY

Drawing Title:
PROPOSED SITE PLAN

Drawn By: MRB
Checked By: MRB
Scale: AS SHOWN
Date: JULY 2019

Sheet No. **S-1**
5 of 5

Project No. **2312.19001**

Appendix B

Cost Estimate Details

Blind Sodus Bay - Gabion wall
Rough Order of Magnitude (ROM) Cost Estimate

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Unit cost estimate				**$4,920,000**	
Gabion wall	1,640	LF	$3,000	$4,920,000	Based on bid for current gabion wall
Engineering / CM Costs					
Subsurface investigation	1	LS	$50,000	$50,000	
Engineering	10	%		$492,000	
Construction Management	10	%		$492,000	
Subtotal - Engineering / CM Costs				**$1,034,000**	
Summary					
Construction Costs				$4,920,000	
Engineering / CM Costs				$1,034,000	
Contingency	50	%		$2,977,000	
Total				**$8,931,000**	

Notes:

Scaled from a simlar project including:

Riprap Protection

- Armore Stone (Heavy Riprap)

Gabion Seawall

- Excavation
- Gabion Baskets Filled with Small Riprap
- Geotextile Filter Fabric
- Backfill - Drainage Stone
- Backfill - Run of Bank Gravel

*Assumed to have minimal maintenance if constructed the full length of the bluff. As currently constructed annual maintenance to monitor and mitigate flanking may be warranted

Blind Sodus Bay - Revetment with regraded bank
Rough Order of Magnitude (ROM) Cost Estimate

	Description	Qty	Unit	Unit Cost	Total Cost	Notes
Unit cost estimate					**$1,640,000**	
	Rock revetment with vegetated bluff	1,640	LF	$1,000	$1,640,000	
Engineering / CM Costs						
	Subsurface investigation	1	LS	$50,000	$50,000	
	Engineering	10	%		$164,000	
	Construction Management	10	%		$164,000	
Subtotal - Engineering / CM Costs					**$378,000**	
Summary						
	Construction Costs				$1,640,000	
	Engineering / CM Costs				$378,000	
	Contingency	25	%		$504,500	
Total					**$2,523,000**	
				Per LF	$1,538	

Notes:
Scaled cost from similar projects including:
Mirafi 500x Stabilization Fabric
Base Stone (Light Riprap)
Armore Stone (Heavy Riprap- 1-2 Ton)
Anchor Trench Excavation
Drainage Trench Excavation
6" Perforated Drain Pipe
Mirafi 500x Stabilization Fabric
Topsoil Material
Geocell with Topsoil Infill Installation
Anchor Trench Backfill (Crushed Stone)
Drainage Trench Backfill
Seeding/Planting

Annual maintenance costs

Annual maintenance tasks	Qty	Unit	Unit Cost	Total Cost	
Vegetation maintenance	1	LS	$5,000	$5,000	
Monitoring (onsite observations, UAV photo monitoring, and reporting)	2	Visits per year	$0	$0	*UAV monitoring of the barrier bar includes this location
				$5,000	

Blind Sodus Bay Alternative B - West Barrier Bar
Rough Order of Magnitude (ROM) Cost Estimate

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Materials + installation				**$1,449,824**	
					Assumptions: 252' IGLD top elevation, 242' IGLD base elevation, 20'foot wide crest, 160 foot wide, 11% lakeside slope, and 20% bayside slope, 1820
Supply Import Fill / Cover	61,000	CY	$20	$1,220,000	Linear feet of barrier bar = 60,666 Cubic Yards
Supply Trees for Root Wad Revetment	0	EA	$1,000	$0	Due to high productivity needed, assumes no installation of root wad revetment
Supply Plantings for Bay Side Vegetation	1.7	AC	$60,000	$99,174	Assume 1800 LF * 40 LF -> 72,000 SF, live stakes on 4' spacing; cottonwood poles on 8' spacing; one row
Grading of Material	7	Mos	$20,100	$130,650	Assumes dozer and excavator + operators + two laborers over project duration
Construction Subtotal				**$1,449,824**	
Consumables (Fuel)	10	%		$144,982	
Sales Tax on Materials and Equipment Rentals	8	%		$115,986	
General Conditions / Project Management	10	%		$144,982	
Access to east side + mobilization	1	LS		$350,000	
Contractor OH&P	15	%		$217,474	
Total Construction Cost				**$2,423,248**	
Engineering / CM Costs					
Hydrodynamic and sediment flux analysis	1	LS	$75,000	$75,000	
Material sourcing study	1	LS	$25,000	$25,000	
Engineering	10	%		$242,325	
Construction Management	10	%		$242,325	
Subtotal - Engineering / CM Costs				**$584,650**	
Summary					
Construction Costs				$2,423,248	
Engineering / CM Costs				$584,650	
Contingency	25	%		$751,974	
Total (rounded to nearest $1,000)				**$3,760,000**	

Notes:

Assumes 61,000 CY of material to be placed hydraulically from dredge	Per LF	$2,089
Assumes 500 CY per day productivity	Per CY	$61.64
Overall duration at 500 CY per day is 122 days		

Annual maintenance costs

Annual maintenance tasks	Qty	Unit	Unit Cost	Total Cost	
Monitoring (onsite observations, UAV photo monitoring, and reporting)	2	Visits per year	$2,000	$4,000	Costs spread across east and west reaches of the barrier bar, which can be flown in one day
Barrier bar maintenance	1	Annual average cost	$5,000	$5,000	Yearly average over 10 years; typical year approximatley three days of a laborer, operator and equipment. Vegetation management, regrading
Sediment management	1500	CY	$30	$45,000	Per Figure 2-14 approximately 3,000 CY/yr net flux of sediment from the barrier bar. Assuming 50% from the western reach
				$54,000	

Blind Sodus Bay Alternative B - East Barrier Bar
Rough Order of Magnitude (ROM) Cost Estimate

Description	Qty	Unit	Unit Cost	Total Cost	Notes
Materials + installation				**$1,389,774**	
Supply Import Fill / Cover	58,500	CY	$20	$1,170,000	252' IGLD top elevation, 245.3' IGLD Base elevation, 10' wide crest shifted toward Lake Ontario, an average 71 foot wide base shifted out toward lake Ontario, average slope of 11%. 1800 Linear feet of barrier bar. This calculation also includes 270-feet of breached barrier which will have 8% lakeside slope and 20% bayside slope with base elevations of 244' = 58,499 CY
Supply Trees for Root Wad Revetment	0	EA	$1,000	$0	Due to high productivity needed, assumes no installation of root wad revetment
Supply Plantings for Bay Side Vegetation	1.7	AC	$60,000	$99,174	Assume 1800 LF * 40 LF -> 72,000 SF, live stakes on 4' spacing; cottonwood poles on 8' spacing; one row
Grading of Material	6	Mos	$20,100	$120,600	Assumes dozer and excavator + operators + two laborers over project duration
Construction Subtotal				**$1,389,774**	
Consumables (Fuel)	10	%		$138,977	
Sales Tax on Materials and Equipment Rentals	8	%		$111,182	
General Conditions / Project Management	10	%		$138,977	
Access to west side + mobilization	1	LS		$250,000	Assumes access already viable from dredging work, minor upgares needed to pass channel
Contractor OH&P	15	%		$208,466	
Total Construction Cost				**$2,237,376**	
Engineering / CM Costs					
Hydrodynamic and sediment flux analysis	1	LS	$75,000	$75,000	
Material sourcing study	1	LS	$25,000	$25,000	
Engineering	10	%		$223,738	
Construction Management	10	%		$223,738	
Subtotal - Engineering / CM Costs				**$547,475**	
Summary					
Construction Costs				$2,237,376	
Engineering / CM Costs				$547,475	
Contingency	25	%		$696,213	
Total (rounded to nearest $1,000)				**$3,481,000**	

Notes:

Assumes 58,500 CY of material to be placed hydraulically from dredge	Per LF	$1,934
Assumes 500 CY per day productivity	Per CY	$59.50
Overall duration at 500 CY per day is 117 days		

Annual maintenance costs

Annual maintenance tasks	Qty	Unit	Unit Cost	Total Cost	Notes
Monitoring (onsite observations, UAV photo monitoring, and reporting)	2	Visits per year	$2,000	$4,000	Costs spread across east and west reaches of the barrier bar, which can be flown in one day
Barrier bar maintenance	1	Annual average cost	$5,000	$5,000	Yearly average over 10 years; typical year approximatley three days of a laborer, operator and equipment. Vegetation management, regrading
Channel maintenance	1	LS	$20,000	$20,000	Channel maintenance permit allows for 200 CY of removal. This material is typically placed to the east of the barrier bar channel
Sediment management	1500	CY	$30	$45,000	Per Figure 2-14 approximately 3,000 CY/yr net flux of sediment from the barrier bar. Assuming 50% from the eastern reach
				$74,000	

Blind Sodus Bay Alternative C - Reef Breakwater
Rough Order of Magnitude (ROM) Cost Estimate

Description		Qty	Unit	Unit Cost	Total Cost	Notes
Unit cost estimate					**$2,590,000**	
	Reef - heavy riprap and scour protection stone placed from barge	7,000	TON	$370	$2,590,000	Assumes base elevation of 240, top eleveation of 250, 10' crest width, 20% slope on lake side, 33% slope on bay side, 8 75' long segments, scour protection/habitat 1' deep x 10' wide
Engineering / CM Costs						
	Engineering	10	%		$259,000	
	Construction Management	10	%		$259,000	
Subtotal - Engineering / CM Costs					**$518,000**	
Summary						
	Construction Costs				$2,590,000	
	Engineering / CM Costs				$518,000	
	Contingency	25	%		$777,000	
Total					**$3,885,000**	

Notes:
*Hydrodynamic and sediment flux study carried with barrier bar estimate

Per LF $3,885

Annual maintenance costs

Annual maintenance tasks	Qty	Unit	Unit Cost	Total Cost	
Monitoring (onsite observations, UAV photo monitoring, and reporting)	2	Visits per year	$3,000	$6,000	*UAV monitoring of the barrier bar includes this location. Assume supplemental funds needed to evaluate conditions associated with the reef segments
				$6,000	

Appendix C

Smart Growth Assessment Form

NEW YORK STATE OF OPPORTUNITY. | Department of Health | Environmental Facilities Corporation

Smart Growth Assessment Form

This form should be completed by the applicant's project engineer or other design professional.[1]

Applicant Information

Applicant: Wayne County | Project No.: WA.37

Project Name: Blind Sodus Bay

Is project construction complete? ☐ Yes, date: ☑ No

Project Summary: (provide a short project summary in plain language including the location of the area the project serves)

This Blind Sodus Bay project seeks to address the barrier bar and the bay bluff, by addressing shoreline erosion on Blind Sodus Bay due to the degradation of the barrier bar previously protecting the bay. The degradation of the barrier bar has also changed the bay's aquatic ecosystem, creating potential hazards to public and private owners.

Section 1 – Screening Questions

1. Prior Approvals

1A. Has the project been previously approved for EFC financial assistance? ☐ Yes ☑ No

1B. If so, what was the project number(s) for the prior approval(s)? Project No.:

Is the scope of the project substantially the same as that which was approved? ☐ Yes ☐ No

IF THE PROJECT WAS PREVIOUSLY APPROVED BY EFC'S BOARD AND THE SCOPE OF THE PROJECT HAS NOT MATERIALLY CHANGED, THE PROJECT IS **NOT** SUBJECT TO SMART GROWTH REVIEW. SKIP TO SIGNATURE BLOCK.

2. New or Expanded Infrastructure

2A. Does the project add new wastewater collection/new water mains or a new wastewater treatment system/water treatment plant? ☐ Yes ☑ No

Note: A new infrastructure project adds wastewater collection/water mains or a wastewater treatment/water treatment plant where none existed previously

2B. Will the project result in either: ☐ Yes ☑ No

An increase of the State Pollutant Discharge Elimination System (SPDES) permitted flow capacity for an existing treatment system;

OR

An increase such that a NYSDEC water withdrawal permit will need to be obtained or modified, or result in the NYSDOH approving an increase in the capacity of the water treatment plant?

Note: An expanded infrastructure project results in an increase of the SPDES permitted flow capacity for the wastewater treatment system, or an increase of the permitted water withdrawal or the permitted flow capacity for the water treatment system.

[1] If project construction is complete and the project was not previously financed through EFC, an authorized municipal representative may complete and sign this assessment.

IF THE ANSWER IS “NO” TO BOTH “2A” and “2B” ON THE PREVIOUS PAGE, THE PROJECT IS NOT SUBJECT TO FURTHER SMART GROWTH REVIEW. SKIP TO SIGNATURE BLOCK.

3. Court or Administrative Consent Orders

3A. Is the project expressly required by a court or administrative consent order? ☐ Yes ☐ No

3B. If so, have you previously submitted the order to NYS EFC or DOH? If not, please attach. ☐ Yes ☐ No

Section 2 – Additional Information Needed for Relevant Smart Growth Criteria

EFC has determined that the following smart growth criteria are relevant for EFC-funded projects and that projects must meet each of these criteria to the extent practicable:

1. Uses or Improves Existing Infrastructure

1A. Does the project use or improve existing infrastructure? ☐ Yes ☐ No
Please describe:

2. Serves a Municipal Center

Projects must serve an area in either 2A, 2B or 2C to the extent practicable.

2A. Does the project serve an area **limited** to one or more of the following municipal centers?

i. A City or incorporated Village ☐Yes ☐No
ii. A central business district ☐Yes ☐No
iii. A main street ☐Yes ☐No
iv. A downtown area ☐Yes ☐No
v. A Brownfield Opportunity Area ☐Yes ☐No
(for more information, go to www.dos.ny.gov & search “Brownfield”)
vi. A downtown area of a Local Waterfront Revitalization Program Area ☐Yes ☐No
(for more information, go to www.dos.ny.gov and search “Waterfront Revitalization”)
vii. An area of transit-oriented development ☐Yes ☐No
viii. An Environmental Justice Area ☐Yes ☐No
(for more information, go to www.dec.ny.gov/public/899.html)
ix. A Hardship/Poverty Area ☐Yes ☐No
Note: Projects that primarily serve census tracts and block numbering areas with a poverty rate of at least twenty percent according to the latest census data

Please describe all selections:

2B. If the project serves an area located outside of a municipal center, does it serve an area located adjacent to a municipal center which has clearly defined borders, designated for concentrated development in a municipal or regional comprehensive plan and exhibit strong land use, transportation, infrastructure and economic connections to an existing municipal center? ☐Yes ☐No

Please describe:

2C. If the project is not located in a municipal center as defined above, is the area designated by a comprehensive plan and identified in zoning ordinance as a future municipal center? ☐Yes ☐No

Please describe and reference applicable plans:

3. Resiliency Criteria

3A. Was there consideration of future physical climate risk due to sea-level rise, storm surge, and/or flooding during the planning of this project? ☐Yes ☐No

Please describe:

Signature Block: By entering your name in the box below, you agree that you are authorized to act on behalf of the applicant and that the information contained in this Smart Growth Assessment is true, correct and complete to the best of your knowledge and belief.

Applicant: Wayne County	Phone Number: (315) 956-6464
Terrance P. Madden, PE - Sr. Vice President	
(Name & Title of Project Engineer or Design Professional or Authorized Municipal Representative)	
Terrance P. Madden	2/14/2020
(Signature)	(Date)