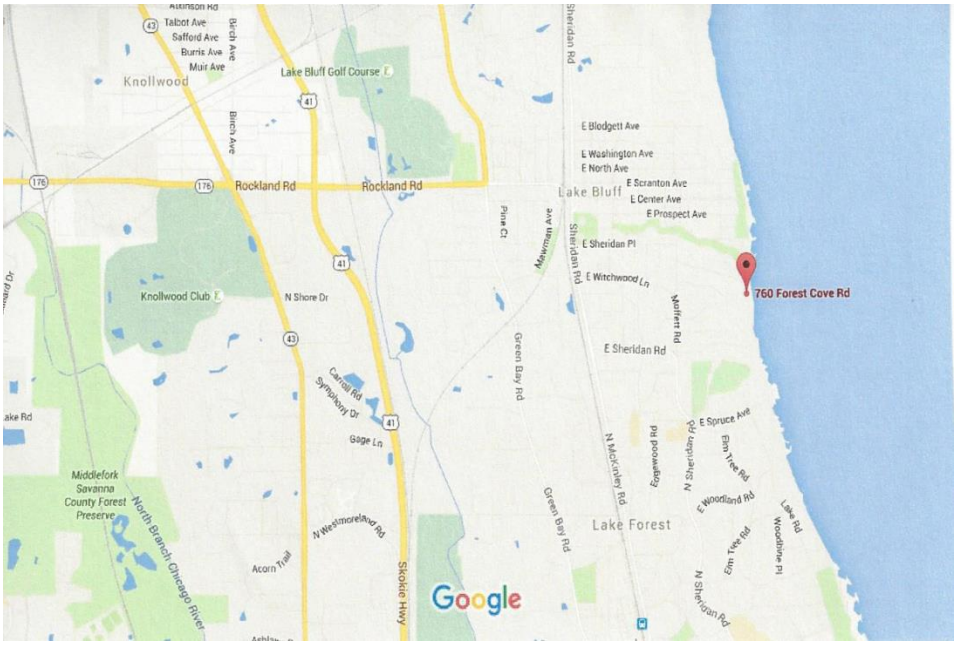
Shabica & Associates, Inc.
WE BUILD BEACHES

Federal Consistency Coordinator
Illinois Coastal Management Program
Illinois Department of Natural Resources
160 N. LaSalle Street, Suite 700
Chicago, IL 60601

To Whom It May Concern: July 19, 2016

In compliance with the Illinois Coastal Management Federal Consistency Review Procedures, we provide the following information for a proposed quarrystone breakwater-protected beach system for the property located at 760 Forest Cove Road, Lake Bluff, Illinois, 60044, owned by Jeff and Marianne Silver.

Location of Project
The proposed quarrystone breakwater-protected beach system will be built on the lakefront of the property located at 760 Forest Cove Road, Lake Bluff, Illinois, 60044, owned by Jeff and Marianne Silver.



550 Frontage Road • Suite 3735 • Northfield, Illinois 60093 • Tel 847.446.1436 • info@shabica.com
www.shabica.com

Project Start Date and Duration
Work will not begin until all necessary permits have been received. It is anticipated that the project can begin by June 1, 2017. This work will require approximately 9 weeks to complete.

Extent of Work to be Conducted

A 170' long (toe to toe) quarrystone breakwater will be constructed to 125' offshore from the bluff toe. The breakwater will have a crest elevation of 584' with slopes of 1.5:1. The breakwater will form a "T" off the existing steel groin (95' north and 75' south) which will be shortened to approximately 105' in length. The existing steel groin is too low crested to retain a viable beach therefore the groin elevation will be raised by attaching steel plate to the groin raising the crest from 586' landward tapering down to 583' lakeward. A 5' wide pier built on piles will be installed over the groin extended east to the breakwater crest, approximately 100' long. The existing deflated revetment will be maintained by adding quartzite armor to form a 2 layer, revetment with a crest elevation of 590' and a slope of +/- 1.5:1. Sandfill mitigation will be placed in and around the breakwater system placing 2,110 tons of clean quarried sand. Stair will be integrated into the revetment to provide access up and over the new pier.

Contact Information
All questions pertaining to this project can be submitted to:

Jon Shabica
Shabica & Associates, Inc.
550 Frontage Road, Suite 3735
Northfield, IL 60093
jon@shabica.com
847-446-1436 Tel

The proposed activity complies with Illinois' approved Coastal Management Program and will be conducted in a manner consistent with such policies.

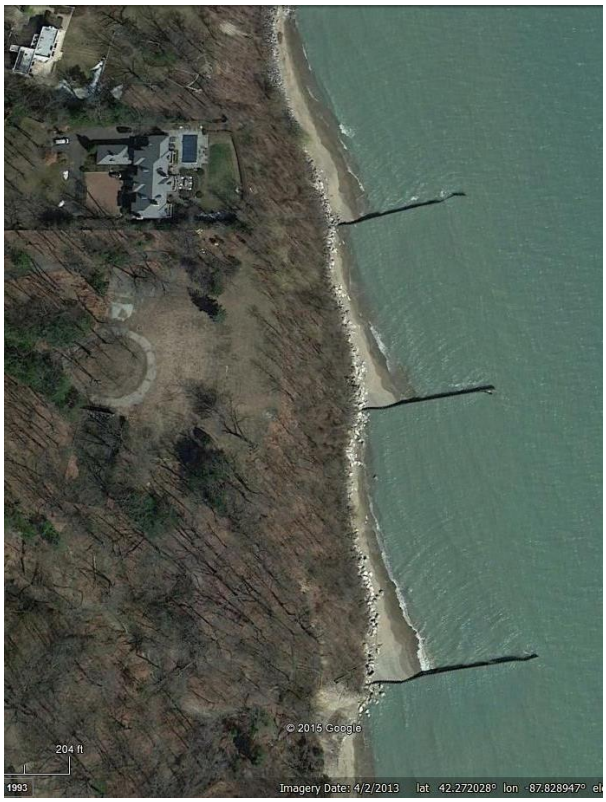
Sincerely,

Vice President

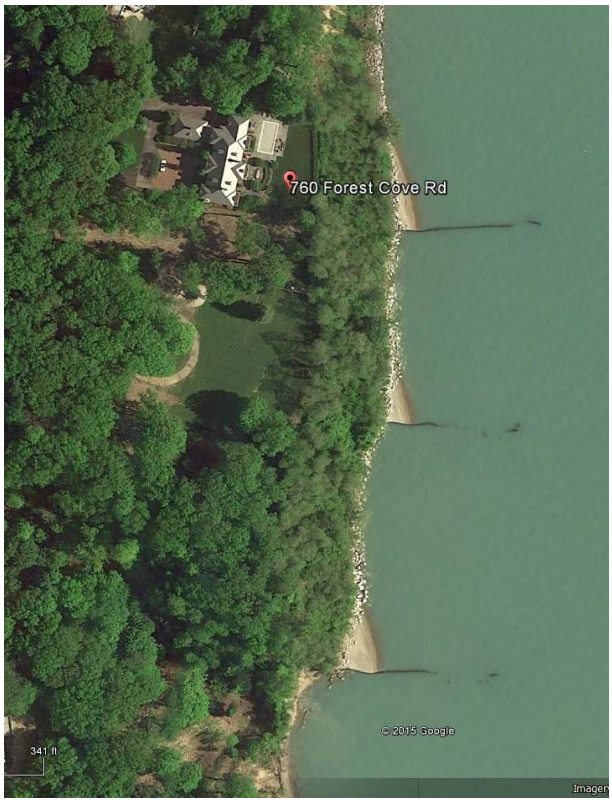
PHOTO 1

1997 Aerial Photo (Approximate Property Lines in Yellow)

PHOTO 2



Google Earth Photo 2013
Extreme Low Lake Level



Google earth Photo 2015
Average Lake Level – Note failing groins (arrow)

550 Frontage Road • Suite 3735 • Northfield, Illinois 60093 • Tel 847.446.1436 • info@shabica.com
www.shabica.com

Shabica & Associates, Inc.
WE BUILD BEACHES

Ms. Kathy Chernich
East Section Chief, Regulatory Branch
Chicago District
U.S. Army Corps of Engineers
231 S. LaSalle Street, Suite 1500
Chicago, IL 60604

Dear Ms. Chernich: July 19, 2016

Please find enclosed a permit application for shore protection for the property located at 760 Forest Cove Road, Lake Bluff, Illinois, 60044, owned by Jeff and Marianne Silver. Proposed work includes construction of a 170' long, shore parallel breakwater installed to 125' lakeward from the bluff toe intersecting the existing steel sheetpile groin (the lakeward section of the groin will be removed), installation of a pier, maintenance to the existing quarrystone revetment and sandfill, as required. The existing shoreline is erosional with exposed lakebed clay lakeward of the revetment and is sand starved due to the site's location south of Waukegan Harbor and Naval Station Great Lakes (near total littoral barriers) resulting in bluff vulnerability to stormwaves and fluctuating Lake Michigan water levels. The quarrystone breakwater is designed to reduce incident wave energy from eroding the bluff, sand and lakebed, to allow for a sustainable sand cover over the clay lakebed which reduces lakebed downcutting (deepening of the water) and helps to improve water quality caused by colloidal fines being suspended in the water during storms.

A *Design of Shoreline Erosion Protection* report has been attached to this cover letter as the coastal design specifications component of this permit. All references, photographs and figures referred to in the cover letter and the following report can be found in the Appendix.

The proposed activity complies with the approved Illinois Coastal Management Program (ICMP) and will be conducted in a manner consistent with such policies. A separate letter has been submitted to the ICMP office.

Project Purpose Statement
The property owners have retained Shabica & Associates (SA) to design and engineer a shore protection system for their property. This project will be constructed on the lakefront of 760 Forest Cove Road, Lake Bluff, where the homeowner wants to provide a much higher level of shore protection for the property as well as reduce lakebed downcutting that cause larger waves to break over the existing deflated revetment and erode the bluff. The existing steel groin that extends approximately 195' east of the revetment is failing in sections and the lakeward portion will be removed to keep the new shore protection system within 125' east of the existing revetment. The existing steel groin is low crested tapering from 583.3' landward to 580.4' lakeward. There is no sandy beach at this site due to the water depth, groin elevation, and the location being a sand starved section of the Lake Michigan coast. The current condition of the bluff slope is a combination of vegetated in areas and actively eroding clay. The bluff is not in a stable condition evidenced by fissures and slides visible on the bluff face and freshly exposed roots observed regularly over the past several years.

A 170' long (toe to toe) quarrystone breakwater will be constructed to 125' offshore from the bluff toe. The breakwater will have a crest elevation of 584' with slopes of 1.5:1. The breakwater will form a "T" off the existing steel groin (95' north and 75' south) which will be shortened to approximately 105' in length. The existing steel groin is too low crested to retain a viable beach therefore the groin elevation will be raised by attaching steel plate to the groin raising the crest from 586' landward tapering down to 583' lakeward. A 5' wide pier built on piles will

be installed over the groin extended east to the breakwater crest, approximately 100' long. The existing deflated revetment will be maintained by adding quartzite armor to form a 2 layer, revetment with a crest elevation of 590' and a slope of +/- 1.5:1. Sandfill mitigation will be placed in and around the breakwater system placing 2,110 tons of clean quarried sand. Stair will be integrated into the revetment to provide access up and over the new pier.

This section of coastline has historically lost sand due to lakebed downcutting, especially during prolonged periods of low lake levels. Nearshore sand deposits are non-existent here (Figures 1 and 2, Appendix) and scientists estimate that the rate of lakebed erosion averages 6 inches per year (Nairn, 1997). The net result is similar to the effects of global warming and rising sea level on marine coasts. This includes deeper water nearshore, larger stormwaves and progressively narrower beaches as the nearshore lakebed continues to erode. This has resulted in bluff toe erosion especially during average to high lake levels. While a narrow beach has been present north of the steel groin at this site during lower lake levels, stormwaves have scoured the beach at the toe of the revetment. If ignored, this will lead to destabilization of the bluff face and revetment causing loss of tableland and infrastructure.

The Illinois Lake Michigan shoreline is considered "sediment starved" by coastal scientists. This is in contrast to East Coast and Gulf Coast open ocean shores where tens of thousands of tons of sand are found in the nearshore system that provide a primary line of defense against stormwaves. On most Great Lakes shores including southern Lake Michigan, natural sand beaches are not able to protect the lakeshore (exceptions may be during very low lake levels like 1964 or 2013). Large quantities of sand have been trapped or diverted offshore by Great Lakes Naval Training Center Harbor that extends approximately 2,300 feet into the lake. Today, the main sand supply is wave erosion of the nearshore glacial clay lakebed that contains only about 10% sand (Shabica and Pranschke, 1994). The result is that groins are losing their effectiveness at holding a sandy beach during average to high lake levels. To retain a sand covering of the nearshore lakebed (where downcutting is most active), as well as to protect the revetment and bluff toe, SA has designed a pocket beach system to hold sand, as necessary, to protect the lakebed and bluff during higher lake levels.

If beach and nearshore sand is lost, degradation of the nearshore ecosystem will result. Meadows et al., (2005) reports an increase in zebra mussels *Dreissena polymorpha*, and a decrease in native zooplankton in waters where the lakebed is eroding clay and rocks. In comparison, a nearshore area with 100% sand cover supports a species-rich community. The report concludes, "it [is] nonetheless clear that sand-based areas were characterized by sufficient shallow water fish CPUE and species richness to suggest that these are important habitats within the context of the Great Lakes Basin and not simply 'wet deserts' as they are often considered."

Design Options

The site at 760 Forest Cove Road in Lake Bluff has been inspected and options for shore protection were determined using desktop coastal engineering, site conditions from the 2015 bathymetric survey, studying local prototypes, and several years of observations of the deteriorating shoreline conditions at this site. Given the sand loss over the last several years including during extreme low lake levels, as well as the uncertainty of future lake levels, it is prudent to engineer and design systems that will anticipate greater lakebed downcutting, higher amounts of beach erosion, more extreme storm events with larger waves, and potential loss of land. These four design options were considered:

OPTION 1

Do Nothing –

The first option of "Do Nothing" results in leaving the currently eroding shoreline in its existing state. This will allow lakebed erosion to continue allowing larger stormwaves to impact the coastline. The existing steel groin that has outlived its design life will continue to fail, falling in sections onto the lakebed. Over time, the beaches along Illinois' North Shore coastline have continued to narrow due to being in a sand starved system. This site is in need of proper shore protection as the lakebed elevation 100' from the

current bluff toe is 573' (IGLD 1985) and the breaking wave height is 8.9' based on a 20-year fall wave, angle class 2.

OPTION 2

Maintain the Revetment –

The second option considered is to reinforce the existing quarrystone revetment. This option provides enhanced stormwave protection for the bluff at the cost of the following:

1. Continued erosion of the lakebed, which will ultimately destabilize the revetment toe
2. Continued deterioration of the existing steel groin.
3. The narrow ephemeral beach will fully erode over time, as there is little sand in the system.

OPTION 3

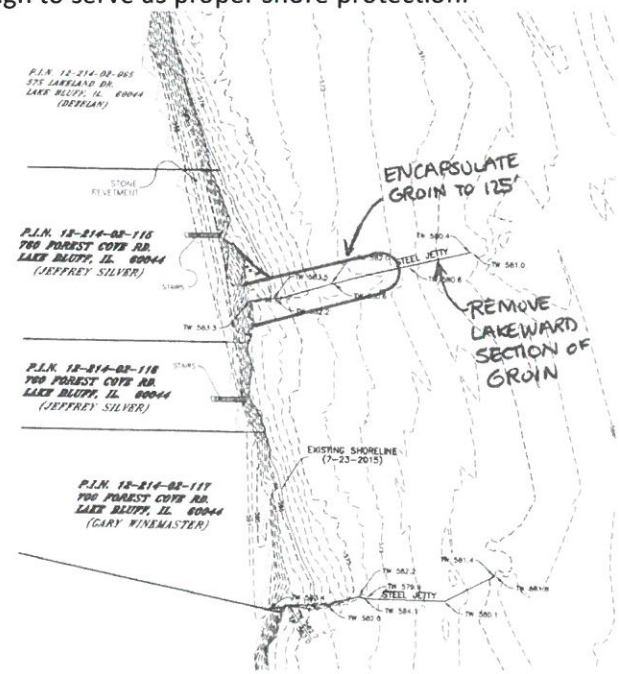
Preferred Option: Design a Breakwater Protected Beach System (125 ft offshore) –

The preferred option is to protect the property with a pocket beach breakwater system. Based on research of prototypes along the Illinois North Shore, structures that extend less than 125 feet offshore in areas of deep nearshore water do not dissipate enough wave energy to hold a stable beach during average to high lake levels. As this system meets the recommended 125 feet offshore, it will greatly enhance the level of shore protection at this property. The proposed 170'-long breakwater will extend north (95') and south (75') from the existing steel groin. The existing groin is too low to hold a functional beach, so the landward end of the steel groin will be raised to an elevation of 586'. The steel groin will have a low crested revetment built along the south side to mitigate the lateral forces from sand and waves on the north side of the groin. The proposed plan will help protect the glacial clay lakebed, as well as bluff, while allowing safe access to Lake Michigan via stairs and beach. With proper maintenance, a structure like this is expected to continue functioning for 50 plus years.

OPTION 4

Encapsulate the Groin in Quarrystone –

This option would minimally help to hold sand in the beach cell by softening the steel face of the groin but at a much reduced rate compared to the preferred option. This option would also stabilize the exiting steel groin. The beach cell however is to too wide with deep water would still have a wide gap that will not help the hold a beach wide enough to serve as proper shore protection.



Public Benefits of Sandy Beaches
The Great Lakes represent the most important natural resource in the United States. Sandy beaches play an important role in keeping the lakes clean and safely accessible. Furthermore, a sandy beach makes a better ecotone (transitional environment) for flora and fauna than seawalls and revetments. Summary arguments supporting a sandy beach system include:

1) Beaches are filters for non-point source runoff. See section on *E. coli.*
2) Beaches reduce lakebed downcutting, a source of fine clay pollutants.
3) Beaches support endangered species such as sea rocket, marram grass, and seaside spurge.
4) Beaches make better wildlife habitat than actively eroding bluffs or seawalls.
5) Stone headlands make better fish habitat than eroding lakebed clay.
6) Beaches protect the lakebed from erosion that causes larger stormwaves to impact the shore.
7) Beaches are far safer for swimmers and boaters than a coast lined with seawalls or revetments, especially in an emergency.
8) Beaches, unlike most steel or concrete seawalls, are not visual pollution.

Impacts to Downdrift Properties
Immediately downdrift of this property is a property in a similar condition. It has a revetment with no beach due to deep water, lack of sand in the system and failing steel groins. The proposed shore protection system will help to break wave energy from northeast storms on the north side of the adjacent property, therefore benefitting the south neighbor.

Impact to Littoral Drift System
The proposed plan for this site includes the construction of a quarrystone breakwater and placement of sandfill as required for permit. As the system will be filled to 20% over its sand holding capacity and monitored for 5 years, sand will be not stolen from the littoral drift system.

The existing section of Lake Michigan shoreline at 760 Forest Cove Road, Lake Bluff is almost fully engineered for more than 1,000 feet to the north and south with steel groins, piers and seawalls, as well as quarrystone revetments and headlands. The nearest structure to the north extending onto the bed of Lake Michigan is about 200 feet to the north. It is a 160-foot long steel groin that appears to be in decent condition, however it does not hold sand due to the sand starved environment and deep water. The nearest structure to the south extending onto the bed of Lake Michigan is about 200 feet to the south. It is a failing steel groin that projects about 200 feet lakeward from the bluff toe. Based on our experience, as the proposed structure will not extend beyond 125 feet offshore and will be filled with mitigational sand, it will not negatively impact the littoral system after the sandfill is placed (anticipated quantity plus 20% overfill). According to the Illinois State Coastal Geologist (Chrzastowski, 2005), "the design to contain placed sand is becoming necessary because of reduced volume of littoral sand in transport." He further states, "beach-cell systems may represent the future for beaches along much of the Illinois bluff coast from Waukegan south to Evanston."

The beach system will be nourished with sand including a 20% overfill placed north and south of the system. The new IDNR regulations for structures that will retain sand require pre- and post-construction surveys, as well as surveys at the one and five-year intervals. This new requirement will help assure that a sand equilibrium is met and that the new project is gaining and losing sand at a similar rate to neighboring properties.

Impact on Public Uses
Currently there is no public access along this section of shoreline due to the lake of stable beaches, existing failing structures such as seawalls, revetments and steel groins, and lack of public access points. If anything, public access will be improved as there will be a small sandy beach north and south of the existing steel groin. Stone steps will be added through the revetment to go up can cross the groin for pedestrian access. The beach will provide a safe place

for boaters and swimmers in distress. Fishing will not be impacted negatively, as the underwater area of the quarrystone protection will create an improved fish habitat. Additionally, navigation of water craft will be improved as the lakeward 90' of the existing failing steel groin will be removed as part of this project.

Impact on Natural Resources
Quarrystone structures in the nearshore waters of Lake Michigan and sandy beaches improve native species habitat. The LandOwner Resource Centre with support from the Canadian Wildlife Service and the Ontario Ministry of Natural Resources states that, "unstable shorelines can release silt that can choke nearby aquatic habitats." Additionally, underwater structures such as artificial reefs constructed of large boulders and clean riprap material "in large water bodies, such as the Great Lakes . . . are often the best method of creating habitat." As stated above, according to Meadows, et al., 2005, "a nearshore area with 100% sand cover support[s] a species rich community." As the design does not impact the bluff and vegetation, the local terrestrial wildlife will continue to inhabit this property.

Impact on *E. coli*
At this site the existing coastal environment, a low and ephemeral wet beach, will be greatly improved with a higher, more robust (and dryer) new sand beach system. The proposed project will not only reduce E. coli transfer to Lake Michigan but also reduce E. coli levels in the lake when beach grooming removes Cladophora washed up on the beach by storms. Further, the beach configuration, grooming and removal of Cladophora, and steeper slope will all deter gull loafing and roosting.

The project complies with requirements of the USEPA approved Total Maximum Daily Loads (TMDL) target of a water quality concentration limit load allocation (LA) for *E. Coli* bacteria of 126 colony forming units (cfu) per 100 ml. *Beach slope, beach orientation, embayment and substrate composition are among the physical variables that the beach TMDL suggests have statistically significant correlations with E. Coli concentrations at beaches. Therefore, for any particular shore protection project it is reasonable to assume that one or more of these variables undergoes some degree of alteration and with it, some alteration of E. coli loading to Lake Michigan.* See summary table below for proposed work at this site:

Site Condition	Existing Beach	Proposed Beach	TMDL Reduction
Substrate Comp.	thin, fine, eroding clay	Med. to coarse sand	Reduced *E. coli* level
Beach Slope	1:20	1:11	More dry beach
Swash Width	15 to 20 feet	8 feet	Reduced *E. coli* transfer
Swash Wave Energy	High	Reduction	Reduced *E. coli* transfer
Beach Grooming	None	Removes Cladophora	Removes *E. coli* from lake
Wave Energy	Open beach	Shore parallel breakwater	Reduced wave height
Wave Energy	High	Low	Reduced *E. coli* transfer
Gulls target ≤65/day	Beach widths<50ft	Same	Reduced *E. coli* level
Dry Beach	Thin veneer	Dry sand 3+ feet thick	Reduced *E. coli* level

Type of Permit
The scope of this project requires an individual permit.

Description and Schedule of Proposed Activity
All of the proposed work will be completed via marine access. A barge will deliver materials and machinery to the site. Pending the water depth at the time of construction, some of the work will be completed from the barge and some will be completed by a backhoe working from land. All stone and sand will be delivered by barge to the site. Work will not begin until all necessary permits have been received. This work will require approximately 8 weeks to complete.

Type and Quantity of Fill/Measures Taken to Avoid Impact/Erosion and Sediment Control Plan
All material will be clean and from inland quarries. 3,565 tons of quarried quartzite will be placed in the structures. 2,110 tons of clean sand will be placed on the existing beach. All clay displaced from the lakebed for installation of the breakwater toe stone will be placed on the barge and removed from the site and disposed of properly. Acreage of stone placed on the lakebed east of the OHWM is approximately 0.167 acres.

Summary
All of the above described activities and plans will follow IPP terms and conditions. All of the proposed work adheres to the guidelines prescribed by the Illinois Environmental Protection Agency and its Anti-Degradation Assessment. U.S. Fish & Wildlife Service and the Illinois Historic Preservation Association will be updated on all relevant correspondence.

If you have any questions, please feel free to call me at the phone number below.

Sincerely,

Jon Shabica, Vice President

C: IDNR (Casey)
IEPA (Heacock)
U.S. Fish & Wildlife Service
Illinois Historic Preservation Agency (Leibowitz)

DESIGN OF SHORELINE EROSION PROTECTION

Introduction

The following report summarizes assumptions and design criteria for a quarrystone breakwater and sandfill mitigation to help reduce erosion and protect the property located at 760 Forest Cove Road in Lake Bluff, Illinois 60044. The design is based on the drawings included in the permit application to the U.S. Army Corps of Engineers dated July 19, 2016.

The site lies within a nearly completely engineered section of suburban lakeshore that is typically protected with revetments, seawalls, impermeable piers, steel sheetpile groins and breakwater protected beaches that may hold narrow beaches. There is a short section of eroding bluff two properties south of this project.

This section of coast is sand-starved due to municipal and military structures (littoral barriers) constructed over the past 100 years that extend lakeward beyond the littoral zone and reduce sand bypass. Although there is a series of long steel sheetpile groins here and on the property to the south, the groins are failing and do not retain much sand. According to the Illinois State Geological Survey, there is almost no sand moving along this section of coast. All structures in the area have been steadily losing their effectiveness at holding beach sand. This problem is exacerbated by lakebed erosion. In many cases where all the sand has been lost, the adjacent bluffs have begun to erode. To provide adequate protection for the upland property, solutions have typically been of two types: breakwater- or groin-anchored beaches to protect the bluffs, or large quarrystone revetments placed against the toe of the bluff that prevent stormwave erosion but at the expense of the beach.

Project Description

Construction of a quarrystone breakwater and sandfill mitigation, as well as maintenance to the revetment, are proposed that fulfill the design requirements of 20-year stormwave erosion protection. The proposed system is designed for all lake level conditions.

Summary Specifications

Using the Army Corps of Engineers Shore Protection Manual (1984), performance of nearby prototypes and other sources, the following specifications were developed for this site (elevations are based on IGLD 1985):

Stone Breakwater Specifications	
Lakeward Crest Elevation:	584 ft
Toe of Structure:	573 ft (average)
Crest Width:	7 ft
Average Armor Size:	3 tons
"B" Stone	200 lbs to 1000 lbs
Slope:	1:1.5
Tons/linear feet:	21 tons

Assumptions	
• Design High Water (DHW):	582.5 ft *
• Design Water Level:	580.0 ft
• Design Low Water (DLW):	577.5 ft *
• Existing clay till elevation at breakwater toe:	572.0 ft
• 20-yr lakebed erosion at toe of breakwater:	3 ft**
• Design wave height (Hs):	8.9 ft
• Nearshore Slope:	± 1:90
• Design Wave Period (T):	9.3 s ***
• Depth at Structure Toe DHW (Ds):	9.5'

- Design Deepwater Wave (Ho): 18.0'
- Design Wave Length (Lo): 501.8'
- Structure Porosity: 37%

* DHW includes 2 ft storm setup; DLW is equivalent to Low Water Datum
** 2.5 ft sand and gravel (thickness varies) plus 2 ft clay till, Nairn, 1997
*** Resio & Vincent, 1976

Stone Breakwater Stability, Armorstone
The proposed quarrystone breakwater will be constructed with an armor layer of 1 – 5 ton armorstone built on a 1:1.5. The lakeward face will be 2-layer random placement and the landward face will be special placement. Overtopping of the structure is expected during storms and higher water levels.

For a quarrystone breakwater, structural integrity may depend on the ability of the foundation to resist the erosive scour by the highest waves. Therefore, it is suggested that the selected design wave height H_s for such structures be based on the design wave height H being the average height of the top 10 percent of waves expected during an extreme event. Based on the deepwater significant wave height H_s corrected for refraction and shoaling.

The stability number (K_d) is primarily affected by the depth of the stone foundation and toe protection below the still water level and the depth of the structure.

The equation below is Hudson's formula and is used to determine the armor stone weight needed to support a particular structure.

$$W = (W_r * H_s^3) / ((K_d[W_r/W_w]-1) * \cot(\beta))$$

W = weight of individual armor units in lbs
W_r = Unit weight of armor units
W_w = unit weight of water
H_s = the design wave height for the structure
K_d = the design stability coefficient for rubble and toe protection
β = the angle of incline of the structure

Quartzite armorstone is recommended as it is highly durable and is locally available in most gradations under 5 tons. Hudson's formula was used to estimate armorstone size. As the breakwater will be built with special placement, an armorstone of 2.4 tons is predicted for special placement stone based on the design conditions.

Sand Calculations
Sand quantities are calculated based on desktop coastal engineering using the assumption that sand placed will hold an 11:1 angle of repose starting at the base elevation at the center of the breakwater system gap. The base elevation used is taken from the most recent topography/bathymetry and then modified in some circumstances if the sand elevation has deflated or should be deflating based on conditions such as lake level change and storms. The assumed lakebed is only modified if the project should call for more sand than that based on the survey.

Three dimensional geometric shapes are determined to calculate the volume to be filled with sand. Once the shapes are determined and volume calculated, the volume is multiplied by 1.25 tons/cubic yard and then multiplied by 20% for the overfill volume.

As soon as the stone and/or steel shore protection structures have been built, the predetermined quantity of sand is placed in the system and spread to a stable angle. If at the time of construction, it appears that the system will

hold more sand than was permitted, the USACE and IDNR will be notified that additional sand will be brought in to fill the system. This can occur is there is substantial loss of sand in the time between the survey/permit submission and the time of construction. The post-construction profile is not necessarily the long-term sand profile. Once the sand is placed many factors alter the sand including: lake level, storms, slugs of sand in the littoral system, wind, and adjacent structures. As on all beaches, the sand profile can change on a daily basis as evidenced by the loss of 9 feet of sand at a Winnetka site during the Halloween storm of 2014.

Shoreline / Bathymetry

Bathymetric surveying was performed on July 23, 2015. More than 8 survey lines with data points stored at a horizontal spacing of 7 feet were completed in the project area and on adjacent properties (minimum of 3 survey lines per 100 feet of lot frontage). The survey data points were taken to approximately 900 feet east from the existing shoreline. The shoreline portion of survey was performed using a robotic total station, with control established by GPS observations. The water portion of the survey is performed from a boat using a single beam echo sounder (Hydrolite TM) tied in with a Trimble R8 receiver. All data points are collected in NAVD88 datum and then converted to IGLD85.

Water Levels

The following table summarizes water level data representing daily highest extremes measured at Calumet Harbor, Illinois, approximately 40 miles to the south of Lake Bluff. Note: Low water datum = 577.5 ft (IGLD 1985).

Lake Level	LWD	IGLD 1985
Record High	+5.5	583.0
Record Low	-1.4	576.1

Lakebed Erosion

Lakebed erosion, active in water depths of 10 ft or less, is a design component of this plan. This section of Lake Bluff lakeshore is considered sediment-starved with deep water. Sand deposits were measured near this site (Figures 1 and 2: Lake Bluff Sunrise Park) from the backshore to a depth of 6.3 m (21 ft). Sand deposits were thin to non-existent for the majority of the profile. The exception is at a distance of approximately 250 feet offshore where the sand was 1.5 feet thick (Shabica & Pranschke, 1994). Also, the site is underlain by highly-erodable, cohesive glacial clay-till. This condition increases the rate of irreversible lakebed erosion that causes deepening of the water and larger waves to impact the shoreline. According to Robert Nairn, approximately 200 m^3 of sand cover per meter of lakeshore (out to a depth of 4 m) is necessary to protect the underlying cohesive profile from lakebed erosion under most conditions. Sand and coarser sediments represent typically less than 15% of the material eroding from the lakebed and bluffs.

Using the historic rate of lakebed downcutting of 0.15 ft/yr (Nairn, 1997), an irreversible lowering of the nearshore lakebed clay of approximately 3.0 ft over a 20-year period is predicted in unprotected areas. With the stone breakwater, revetment and sandfill installed, the lakebed erosion will be reduced.

Project Supporting Data

To help facilitate project review, SA offers the following supporting data based on standard coastal engineering practices:

1. **Sediment Transport Around Structure** The structure is designed to lie within the surf zone (zone of breaking waves), therefore allowing sediment transport around the structure. The range of breaking wave heights is from 7.4 ft based on a 6-second wave with a wave length of 184 ft (using 1/25 Lo) to 18 ft based on a 9.9-second wave with a wave length of 501.8 ft (Resio and Vincent, 1976). The commonly accepted zone of sediment transport is to 18 ft (depth of closure) in this section of Lake Michigan, which is a function of the design wave parameters. Based on this data, once the structure has been filled with sand, it will

continue to bypass littoral drift sand. Bathymetric survey monitoring will be conducted, as required by the IDNR, to assure that the system performs as designed.

The IDNR requires sand fill in areas where sediment will be trapped by the new system. Sand volume quantities have been calculated as shown in the permit drawings. As required by the IDNR, a 20% overfill will be added to the calculated volume. Additionally, the new pre- and post-construction monitoring will be performed and submitted to the IDNR to verify the impacts to the system.

2. **Effect on Adjacent Shorelines** A wave diffraction diagram (Figure 3, Appendix) has been overlain on the proposed shore protection system. Using a refracted incident wave angle of 90 degrees (USACE, Shore Protection Manual), with average and design waves, there will be a decrease in wave energy on adjacent properties. The wave diffraction pattern shows that the coefficient of diffraction (K) reduces the wave energy to a distance of about ½ the wave length downdrift and does not have an impact further downdrift. For the average 6-second wave, that distance of reduced wave energy is about 90 ft and for the design wave, the protected distance is about 250 ft. This protected area close to the structure has diminished wave energy that will in turn reduce erosion in the area.

3. **Wave Reduction in Rubble-Mound Structures** The Iribarren number (ξ), or surf similarity number, is used to determine the wave reflection coefficient. For rubble-mound structures, wave reflection (and wave energy) is reduced by one half or more (0.2 to 0.53) (Figure 4, Appendix). For example, a wave reflection of 0.25 means that the wave energy is reduced by 75%. The range of wave reflection for beaches peaks at about 0.44. The range for plane slopes, however, quickly rises to 0.5 and peaks at .91. This illustrates that rubble-mound structures reduce wave energy almost as well as beaches.

Project Monitoring

As the performance of shore protection structures cannot be predicted with absolute certainty, the shore protection system for 760 Forest Cove Road will be inspected as required by IDNR guidelines. This includes topographic and hydrographic surveys beginning at an elevation of 581.5 ft (IGLD 1985) and progressing to 300 ft lakeward of the lakeward end of the project, within the north and south property lines. Additionally, all structures should be inspected to assure that they continue to meet design specifications.

References

Anglin, C.D., and K. J. Macintosh, *Southport Marina, Kenosha, Wisconsin: Design and Construction of Breakwaters, in Coastal Engineering for the Great Lakes*, a short course, University of Wisconsin, March 11-13, 1991.

W.F Baird & Associates and Warzyn Engineering, 1986, *Shoreline Development at Forest Park, Lake Forest, Illinois, Model Studies*, Unpublished Final Report to the City of Lake Forest.

Chrzastowski, M.J. and C.B. Trask, 1995, Illinois State Geological Survey, Open File Series, 1996-7, 57 p. plus eight appendices.

Chrzastowski, M.J. and C.B. Trask, 1996, *Review of the City of Lake Forest Final Report for the 1995 beach and nearshore monitoring program, Forest Park Beach, Lake Forest, Illinois*: Illinois State Geological Survey, Open File Series, 1996-6, 57 p. plus eight appendices.

Chrzastowski, M.J., 2005, *Chicagoland Geology and the Making of a Metropolis*, Illinois State Geological Survey Open File Series OFS 2005-9.

Johnson, Charles, 1997, USACE, Chicago, personal communication.

LandOwner Resource Centre, Canadian Wildlife Service, Ontario Ministry of Natural Resources, 1999, *Improving Fish Habitat,* Extension Notes: Ontario, LRC 45.

Meadows, Guy; Mackay, S.; Goforth, R.; Mickelson, D.; Edil, T.; Fuller, J.; Guy, D.; Meadows, L.; Brown, E.; Carman, S.; Liebenthal, D.; 2005, *Cumulative Habitat Impacts of Nearshore Engineering,* Journal of Great Lakes Research; vol.31, Supplement 1, 2005, pp.90-112.

Nairn, Robert B. 1997, *Cohesive Shores,* Shore & Beach Vol. 65 No. 2: 17-21.

Resio, Donald T. and Charles L. Vincent, 1976, *Design Wave Information For The Great Lakes: Technical Report 3, Lake Michigan*.

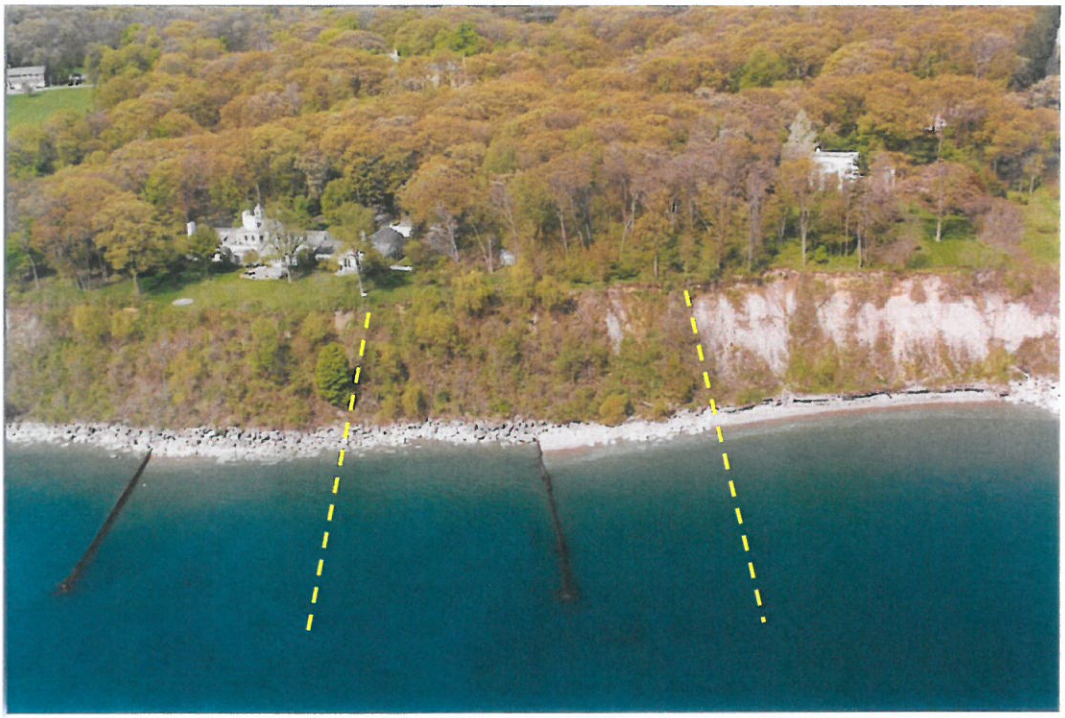
Shabica, C.W., F. Pranschke and M. Chrzastowski. 1991, *Survey of Littoral Drift Sand deposits Along the Illinois Shore of Michigan from Fort Sheridan to Evanston*, Illinois/Indi ana Sea Grant Program, IL-IN-SG-R-91-3.

Shabica, C.W., F. Pranschke, 1994, *Survey of Littoral Drift Sand Deposits Along the Illinois and Indiana Shores of Lake Michigan*, U.S. Geological Survey Symposium Volume, Journal of Great Lakes Research, vol. 20, no.1, pp 61-72.

Shabica, Charles and Assoc., 1997, *Lake Bluff Beach Monitoring and Mitigation Report 5*, US Army Corps of Engineers, Chicago District.

US Army Corps of Engineers, 1984, *Shore Protection Manual*, Coastal Engineering Research Center, Vicksburg, Mississippi.

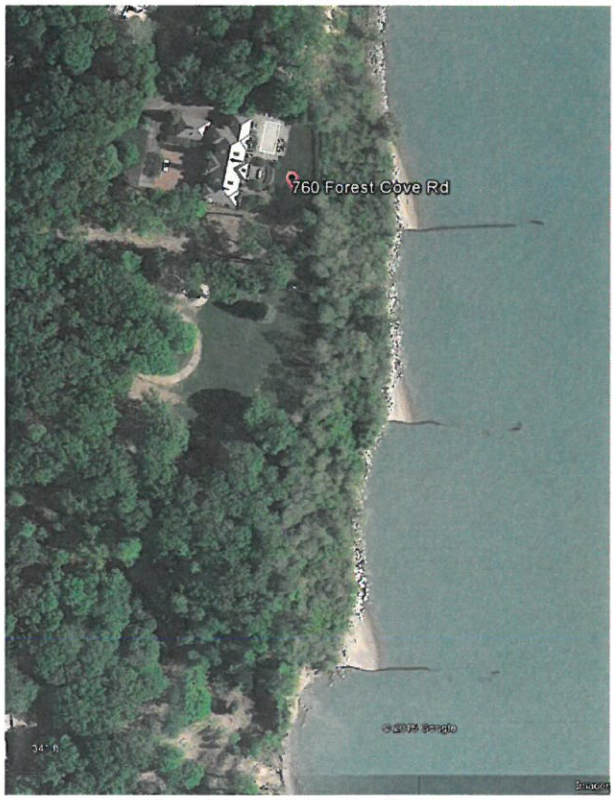
PHOTO 1



1997 Aerial Photo (Approximate Property Lines in Yellow)

PHOTO 2

Google Earth Photo 2013
Extreme Low Lake Level



Google earth Photo 2015
Average Lake Level – Note failing groins (arrow)

PHOTO 3

2016 Photo of the existing failing steel groin. Lakeward end to be removed.

PHOTO 4

2016 Photo looking south of the existing deflated limestone revetment protecting the toe of the bluff

FIGURE 1

ENTERED

NIU LAKESHORE PROJECT 1990
TRANSECTS FROM WAUKEGAN TO FORT SHERIDAN

DATA RECORD SHEET NO. 5 OF 6 SHEETS DATE: 7/24/90

TRANSECT DESIGNATION SUNRISE PARK, LAKE BLUFF CODE LETTER E

DESCRIPTION OF OBSERVATION SITE SEE TOPOGRAPHIC MAP AND A SKETCH OF THE LOCATION.

INTERNATIONAL GREAT LAKE DATUM (CALUMET) _____ ft

DISTANCE BETWEEN RANGE MEASURING DEVICE & SHORE LINE 68 ft

POINT ON TRANSECT	NOMINAL DISTANCE	ACTUAL DISTANCE	WATER DEPTH	SAND DEPTH
01	Beach	____ ft	____ ft	____ ft
02	Beach	-10 ft	~~-2~~ ft	4 ft
03	10 ft	10 ft	3 ft	GRAVEL ft
04	40 ft	40 ft	4.5 ft	~~NOURISHED WITH~~ GRAVEL ft
05	250 ft	259 ft	9.5 ft	1.5 ft
06	500 ft	516 ft	14.5 ft	0 ft
07	750 ft	765 ft	17 ft	0 ft
08	1000 ft	1010 ft	19 ft	0 ft
09	1250 ft	1270 ft	20 ft	0 ft
10	1500 ft	1520 ft	22 ft	0 ft
11	1750 ft	1746 ft	23 ft	0 ft
12	2000 ft	2004 ft	24.5 ft	0 ft
13	2250 ft	____ ft	____ ft	____ ft
14	2500 ft	____ ft	____ ft	____ ft
15	3000 ft	____ ft	____ ft	____ ft

CLAY
Sand Varies

NOTES & COMMENTS: BEACH NOURISHMENT - BEACH WAS COVERED WITH COARSE GRAVEL WITH RIP RAP PROTRUDING THROUGH THE GRAVEL & SAND

FIGURE 2

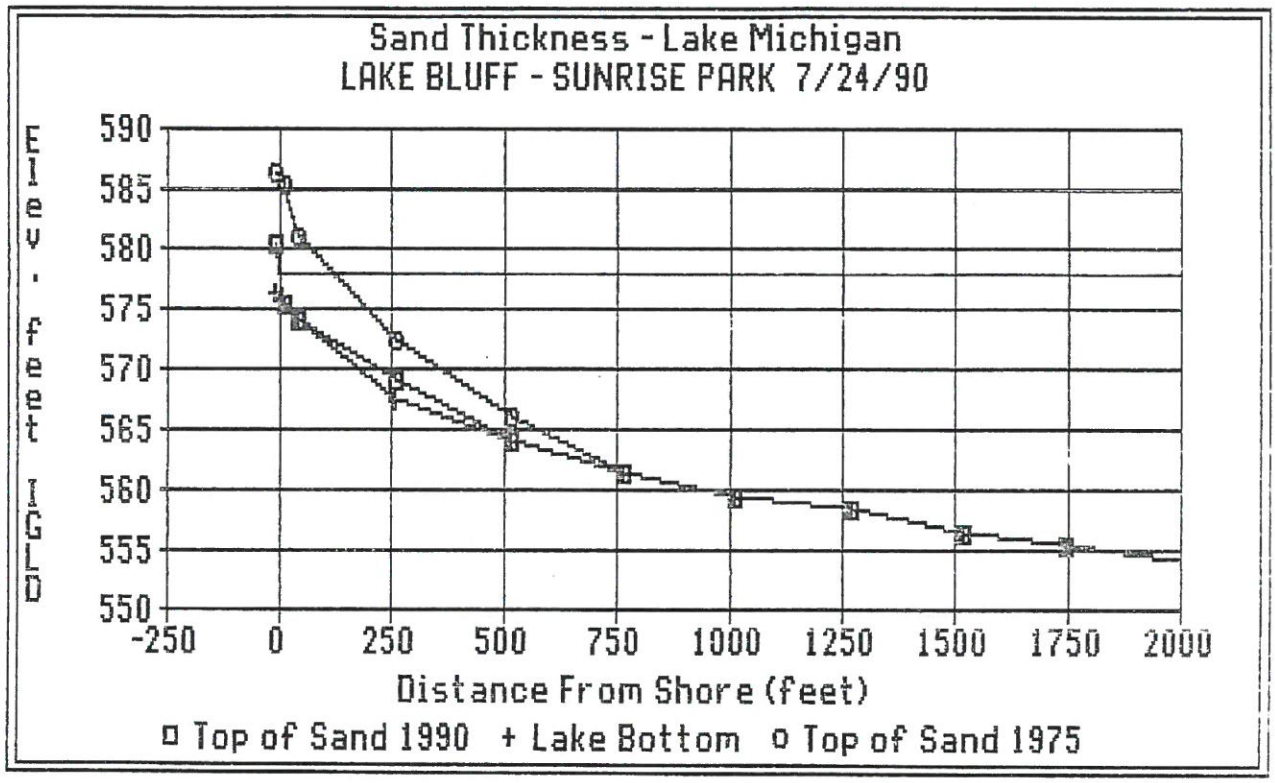
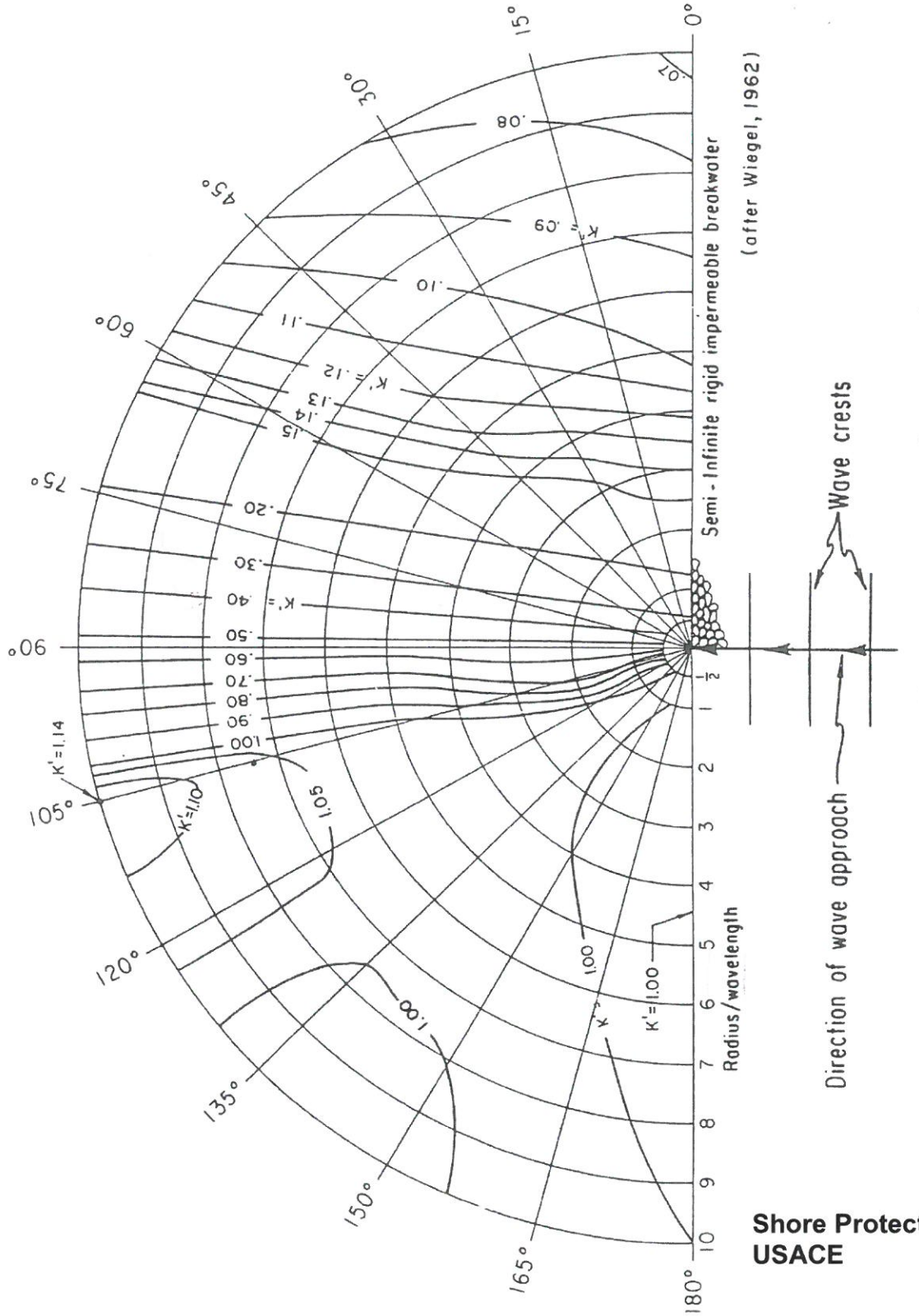
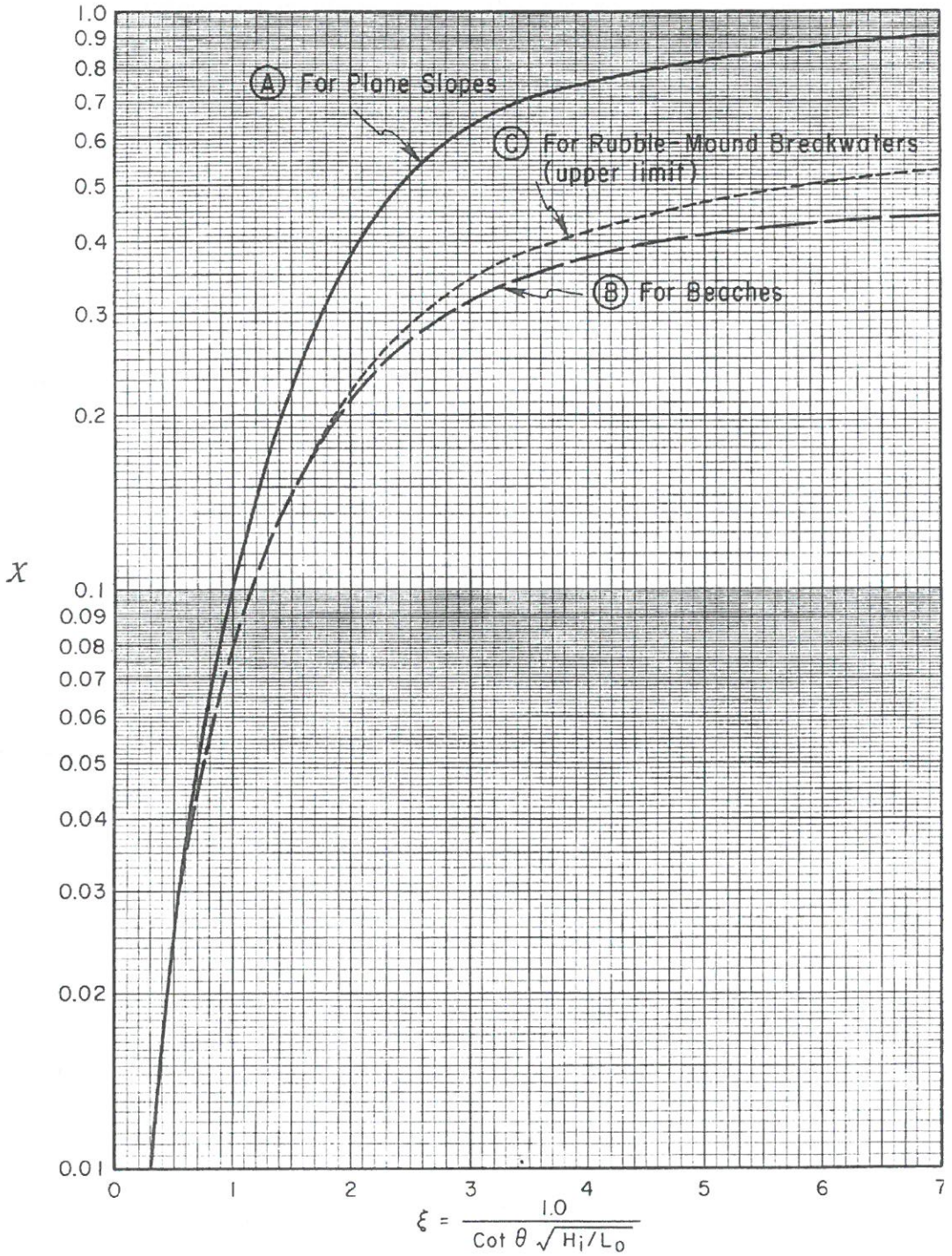

Sand Thickness - Lake Michigan
LAKE BLUFF - SUNRISE PARK 7/24/90
Elev - feet IGLD
590
585
580
575
570
565
560
555
550
-250
0
250
500
750
1000
1250
1500
1750
2000
Distance From Shore (feet)
Top of Sand 1990
Lake Bottom
Top of Sand 1975

FIGURE 3



Shore Protection Manual
USACE

FIGURE 4



Wave reflection coefficients for slopes, beaches, and rubble-mound breakwaters as a function of the surf similarity parameter ξ .

Shore Protection Manual USACE

JOINT APPLICATION FORM FOR ILLINOIS

ITEMS 1 AND 2 FOR AGENCY USE

1. Application Number	2. Date Received

3. and 4. (SEE SPECIAL INSTRUCTIONS) NAME, MAILING ADDRESS AND TELEPHONE NUMBERS

3a. Applicant's Name:	3b. Co-Applicant/Property Owner Name (if needed or if different from applicant):	4. Authorized Agent (an agent is not required):
Marianne Silver		Jon Shabica
Company Name (if any) : To be completed	Company Name (if any):	Company Name (if any): Shabica & Associates, Inc.
Address: 760 Forest Cove Road Lake Bluff, Il 60044	Address:	Address: 550 Frontage Road Suite 3735 Northfield, IL 60093
Email Address:	Email Address:	Email Address:

Applicant's Phone Nos. w/area code	Applicant's Phone Nos. w/area code	Agent's Phone Nos. w/area code
Business:	Business:	Business:
Residence:	Residence:	Residence:
Cell:	Cell:	Cell:
Fax:	Fax:	Fax:

STATEMENT OF AUTHORIZATION

I hereby authorize Shabica & Associates, Inc. to act in my behalf as my agent in the processing of this application and to furnish, upon request

Applicant's Signature

4/5/16
Date

5. ADJOINING PROPERTY OWNERS (Upstream and Downstream of the water body and within Visual Reach of Project)

Name	Mailing Address	Phone No. w/area code
a. see attached vicinity map		
b.		
c.		
d.		

6. PROJECT TITLE:
Breakwater Protected Beach System for Shore Protection

7. PROJECT LOCATION:
760 Forest Cove Road, Lake Bluff, IL

LATITUDE: 42.27279 °N	UTMs
LONGITUDE: -87.82869 °W	Northing: 4680398.51m Easting: 16T431671.60m

STREET, ROAD, OR OTHER DESCRIPTIVE LOCATION	LEGAL DESCRIPT	QUARTER	SECTION	TOWNSHIP NO.	RANGE
Lakefront at 760 Forest Cove Road, Lake Bluff		SE	21	44N	12E

☒ IN OR ☐ NEAR CITY OF TOWN (check appropriate box) Municipality Name	WATERWAY	RIVER MILE (if applicable)
Lake Bluff	Lake Michigan	

COUNTY	STATE	ZIP CODE
Lake	Illinois	60044

Revised 2010

☐ Corps of Engineers ☐ IL Dep't of Natural Resources ☐ IL Environmental Protection Agency ☐ Applicant's Copy

8. PROJECT DESCRIPTION (Include all features):

A 170' long (toe to toe) quarrystone breakwater will be constructed to 125' offshore from the bluff toe. The breakwater will have a crest elevation of 584' with slopes of 1.5:1. The breakwater will form a "T" off the existing steel groin (95' north and 75' south) which will be shortened to approximately 105' in length. The existing steel groin is too low crested to retain a viable beach therefore the groin elevation will be raised by attaching steel plate to the groin raising the crest from 586' landward tapering down to 583' lakeward. A 5' wide pier built on piles will be installed over the groin extended east to the breakwater crest, approximately 100' long. The existing deflated revetment will be maintained by adding quartzite armor to form a 2 layer, revetment with a crest elevation of 590' and a slope of +/- 1.5:1. Sandfill mitigation will be placed in and around the breakwater system placing 2,110 tons of clean quarried sand. Stair will be integrated into the revetment to provide access up and over the new pier.

9. PURPOSE AND NEED OF PROJECT:

Shore protection.

COMPLETE THE FOLLOWING FOUR BLOCKS IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

10. REASON(S) FOR DISCHARGE:

Shore protection.

11. TYPE(S) OF MATERIAL BEING DISCHARGED AND THE AMOUNT OF EACH TYPE IN CUBIC YARDS FOR WATERWAYS:

TYPE: Stone and sand

AMOUNT IN CUBIC YARDS:

Stone: 1,100 cu. yds; Sand: 1,686 cu. yds

12. SURFACE AREA IN ACRES OF WETLANDS OR OTHER WATERS FILLED (See Instructions)

less than .167 acres

13. DESCRIPTION OF AVOIDANCE, MINIMIZATION AND COMPENSATION (See instructions)

Remove lakeward end of existing steel groin. Work will be completed via barge on Lake Michigan to minimize disturbance on land.

14. Date activity is proposed to commence: June 1, 2017

Date activity is expected to be completed: July 31, 2017

15. Is any portion of the activity for which authorization is sought now complete? Yes [ ] No [X]

NOTE: If answer is "YES" give reasons in the Project Description and Remarks section. Indicate the existing work on drawings.

Month and Year the activity was completed

16. List all approvals or certification and denials received from other Federal, interstate, state, or local agencies for structures, construction, discharges or other activities described in this application.

Issuing Agency	Type of Approval	Identification No.	Date of Application	Date of Approval	Date of Denial

17. CONSENT TO ENTER PROPERTY LISTED IN PART 7 ABOVE IS HEREBY GRANTED. Yes [X] No

18. APPLICATION VERIFICATION (SEE SPECIAL INSTRUCTIONS)

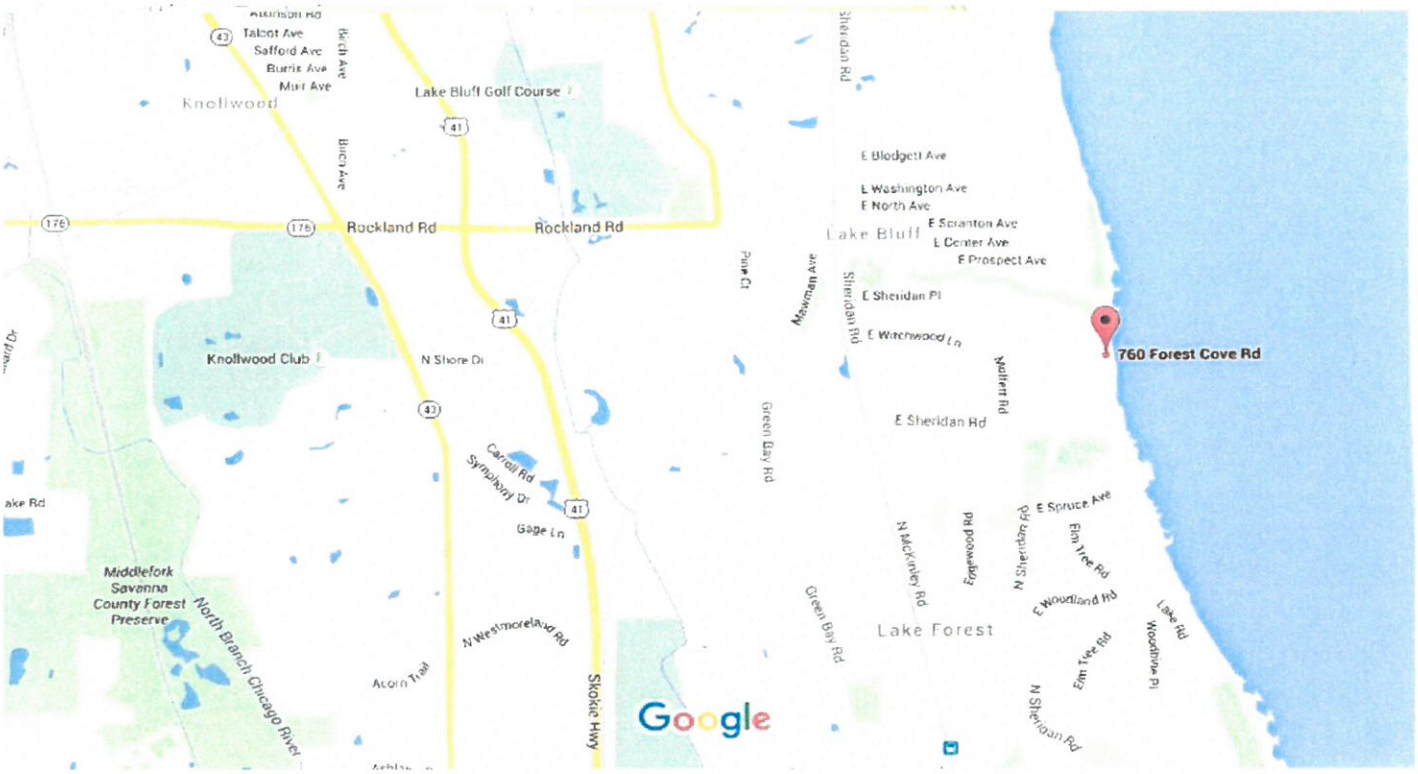
Application is hereby made for the activities described herein. I certify that I am familiar with the information contained in the application, and that to the best o[illegible]ate. I further certify that I possess the authority to undertake the proposed activiti[illegible]

Signature of Applicant or Authorized Agent	7/20/16 Date
Signature of Applicant or Authorized Agent	Date
Signature of Applicant or Authorized Agent	Date

[ ] Corps of Engineers Revised 2010 [ ] IL Dep't of Natural Resources [ ] IL Environmental Protection Agency [ ] Applicant's Copy

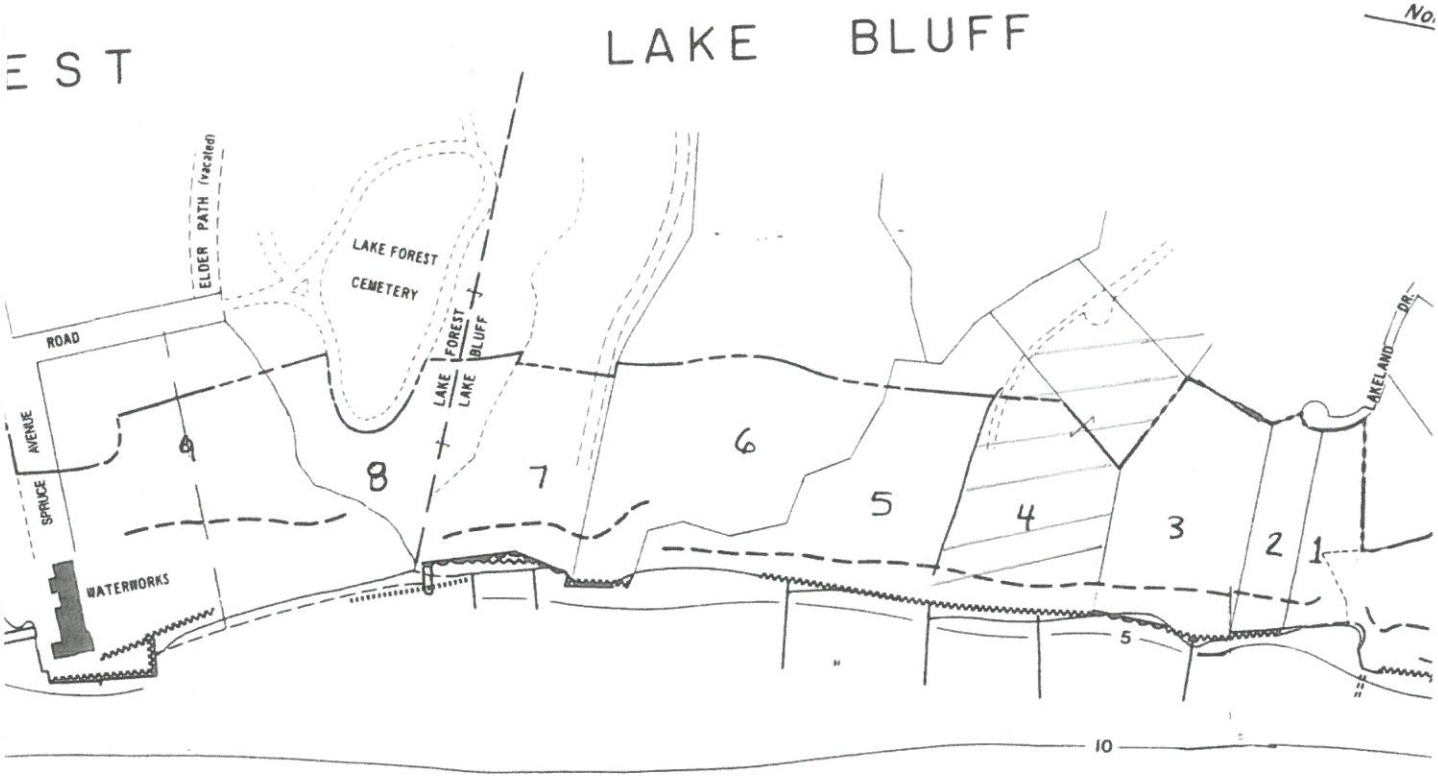
SEE INSTRUCTIONS FOR ADDRESS

Vicinity Map



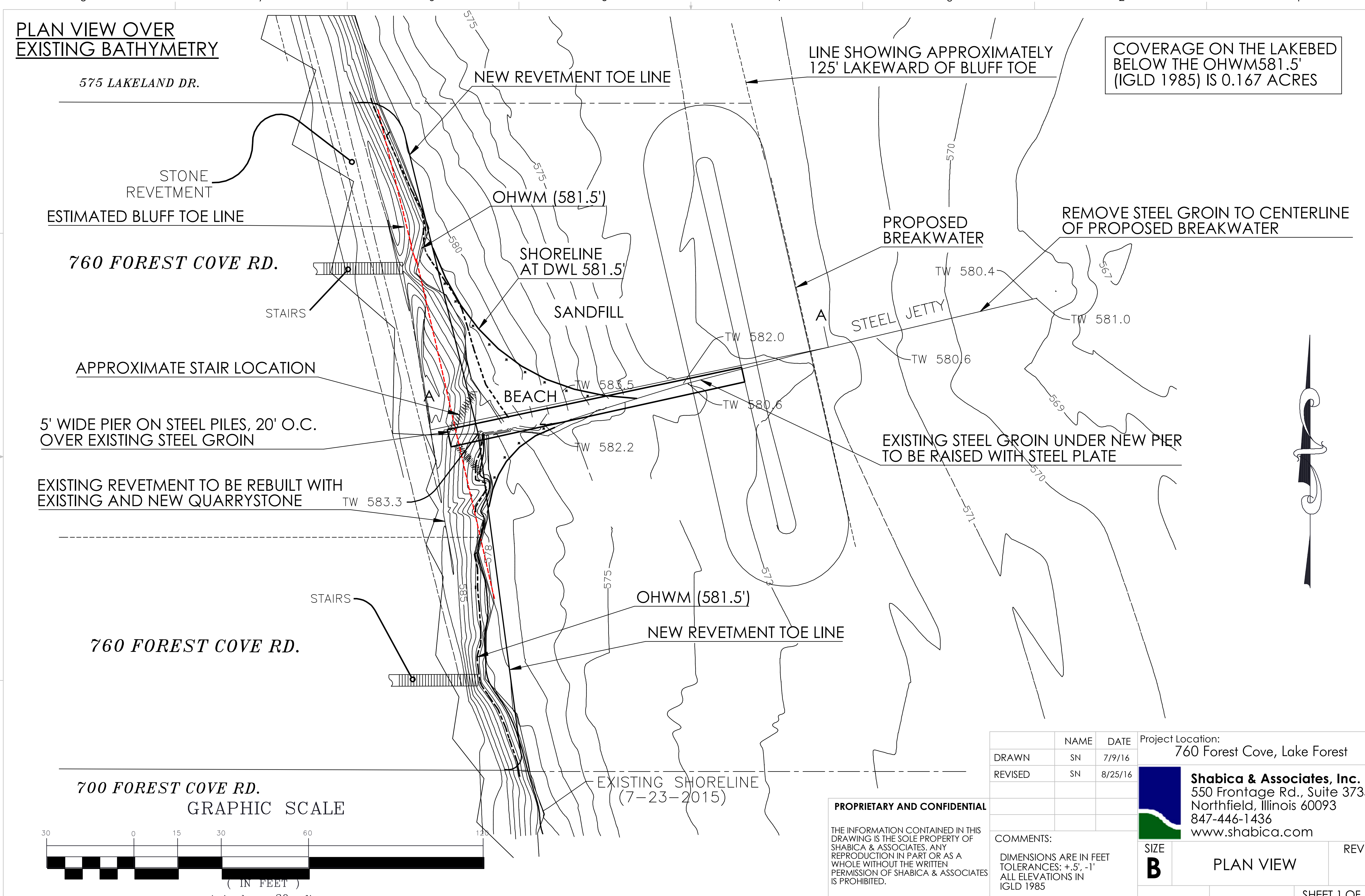
Breakwater-Protected Beach

760 Forest Cove Road
Lake Bluff, IL 60044



MICHIGAN

SCALE
200



PROPRIETARY AND CONFIDENTIAL

THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF SHABICA & ASSOCIATES. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF SHABICA & ASSOCIATES IS PROHIBITED.

	NAME	DATE
DRAWN	SN	7/9/16
REVISED	SN	8/25/16

COMMENTS:
DIMENSIONS ARE IN FEET
TOLERANCES: +.5', -1'
ALL ELEVATIONS IN IGLD 1985

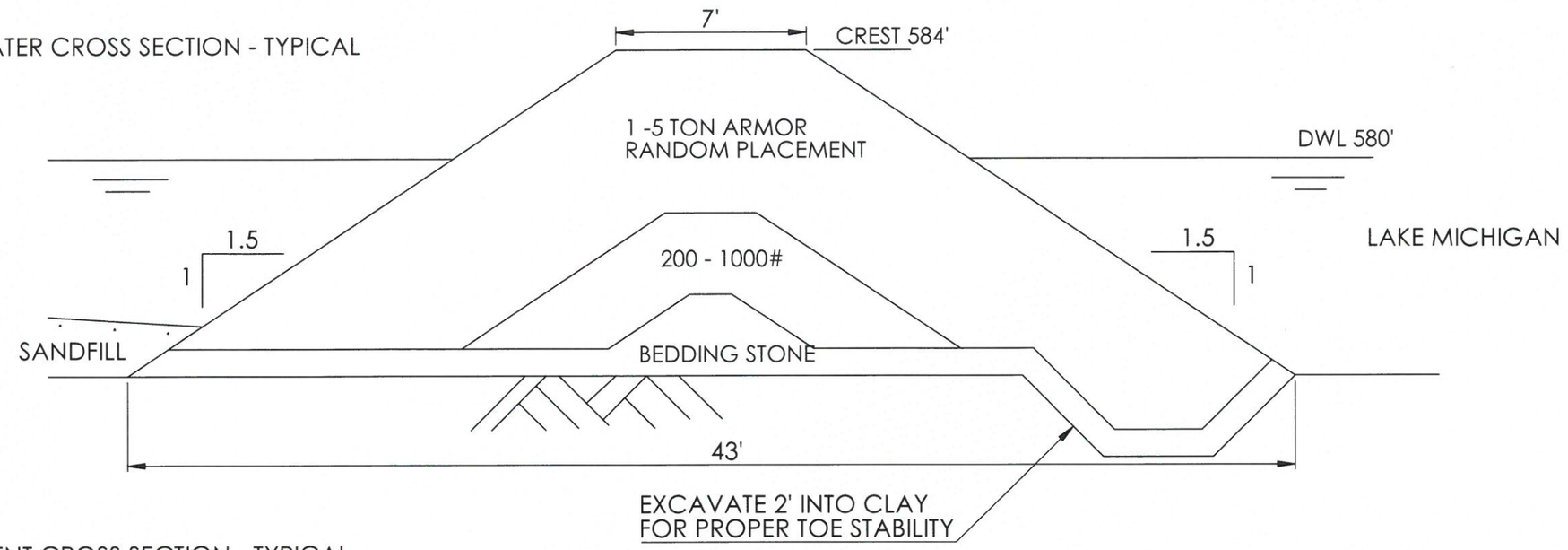
Project Location:
760 Forest Cove, Lake Forest

Shabica & Associates, Inc.
550 Frontage Rd., Suite 3735
Northfield, Illinois 60093
847-446-1436
www.shabica.com

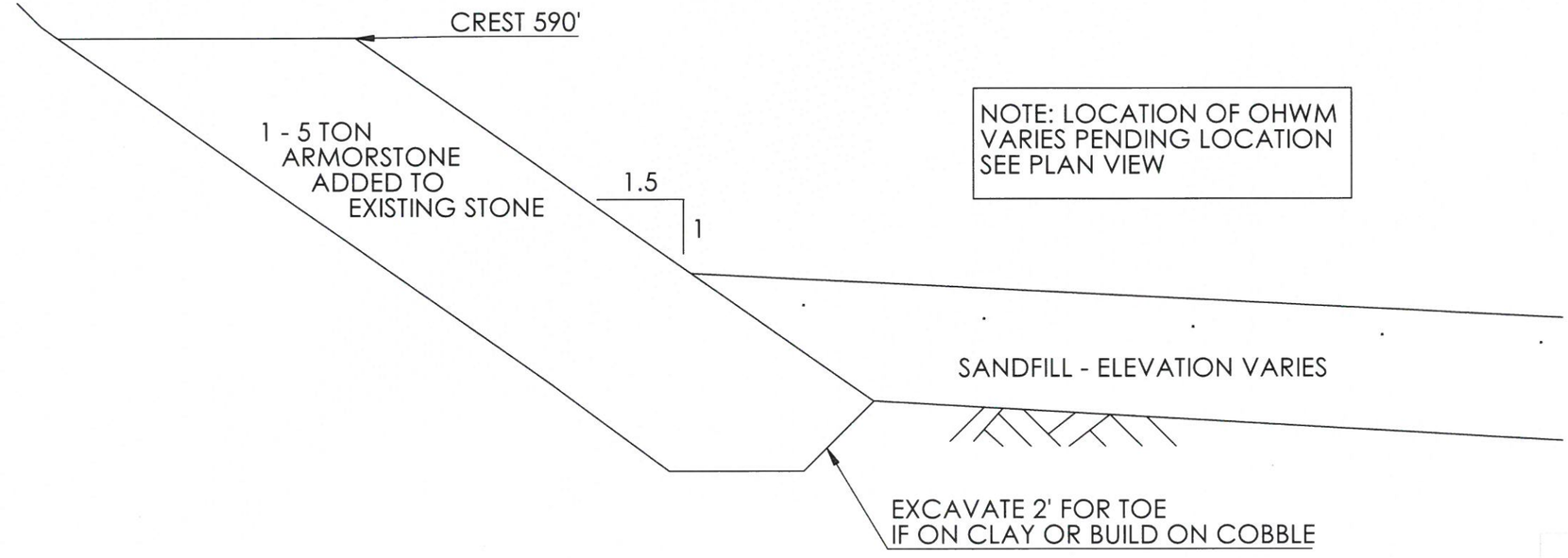
SIZE **B** | PLAN VIEW | REV

SHEET 1 OF 5

BREAKWATER CROSS SECTION - TYPICAL



REVETMENT CROSS SECTION - TYPICAL



5'
SCALE

	NAME	DATE
DRAWN	SN	7/9/16
CHECKED		

COMMENTS:

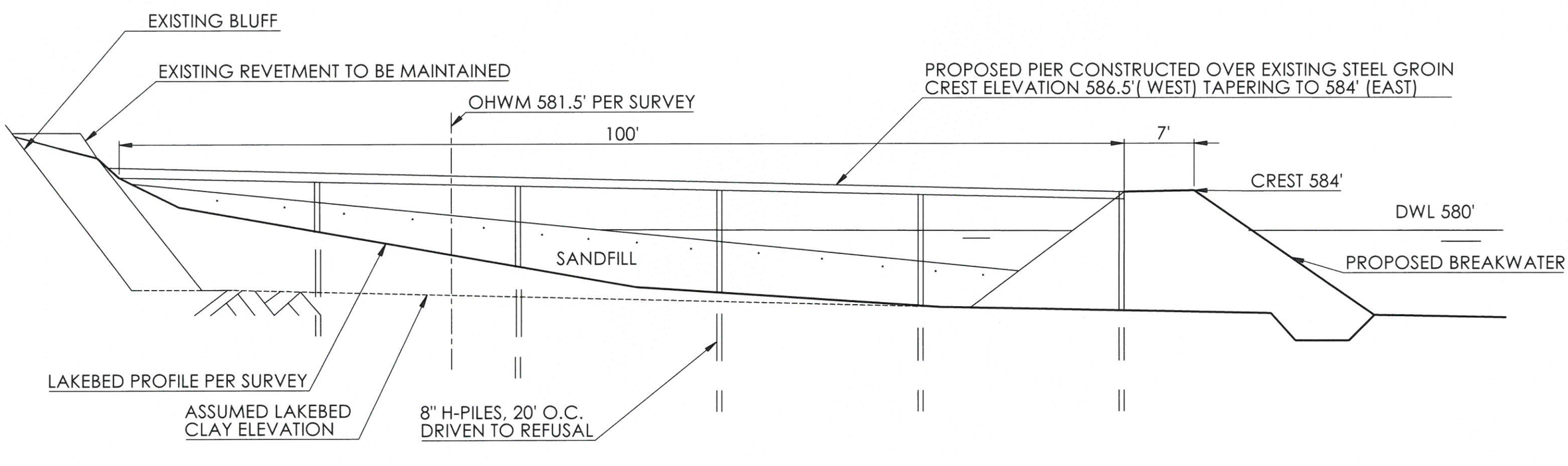
DIMENSIONS ARE IN FEET
TOLERANCES: +.5', -1'
ALL ELEVATIONS IN
IGLD 1985

Project Location:
760 FOREST COVE, LAKE FOREST

Shabica & Associates, Inc.
550 Frontage Rd., Suite 3735
Northfield, Illinois 60093
847-446-1436
www.shabica.com

SIZE B | CROSS SECTIONS | REV

PROFILE THROUGH PIER AND SANDFILL - A-A



10'
SCALE

	NAME	DATE
DRAWN	SN	7/15/16
CHECKED		

COMMENTS:

DIMENSIONS ARE IN FEET
TOLERANCES: +.5', -1'
ALL ELEVATIONS IN
IGLD 1985

Project Location:
760 FOREST COVE, LAKE FOREST

Shabica & Associates, Inc.
550 Frontage Rd., Suite 3735
Northfield, Illinois 60093
847-446-1436
www.shabica.com

SIZE B

PROFILE THROUGH PIER/SANDFILL A-A

REV

SAND PLAN VIEW

575 LAKELAND DR.

760 FOREST COVE RD.

760 FOREST COVE RD.

700 FOREST COVE RD.

NEW REVETMENT TOE LINE

LINE SHOWING APPROXIMATELY 125' LAKEWARD OF BLUFF TOE

STONE REVETMENT

OHWM (581.5')

STAIRS

A/B

C

SANDFILL

PROPOSED BREAKWATER

REMOVE STEEL GROIN TO CENTERLINE OF PROPOSED BREAKWATER

STEEL JETTY

SHORELINE AT DWL 581.5'

BEACH

TW 582.0

TW 580.4

TW 581.0

TW 580.6

TW 582.5

TW 580.6

TW 582.2

D

EXISTING REVETMENT TO BE REBUILT WITH EXISTING AND NEW QUARRYSTONE

TW 583.3

STAIRS

OHWM (581.5')

NEW REVETMENT TOE LINE

EXISTING SHORELINE (7-23-2015)

567

569

571

573

575

577

579

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)

1 inch = 30 ft

PROPRIETARY AND CONFIDENTIAL

	NAME	DATE
DRAWN	SN	7/9/16
CHECKED		

COMMENTS:

DIMENSIONS ARE IN FEET
TOLERANCES: +.5', -1'
ALL ELEVATIONS IN IGLD 1985

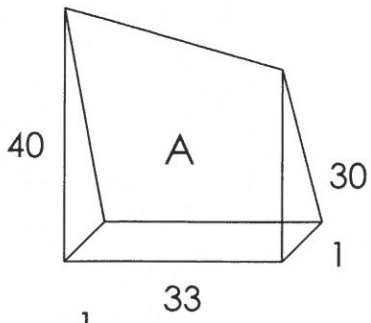
Project Location:
760 FOREST COVE, LAKE FOREST

Shabica & Associates, Inc.
550 Frontage Rd., Suite 3735
Northfield, Illinois 60093
847-446-1436
www.shabica.com

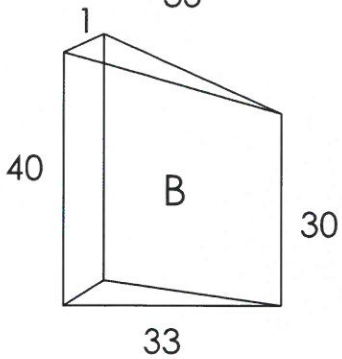
SIZE B

SAND PLAN VIEW

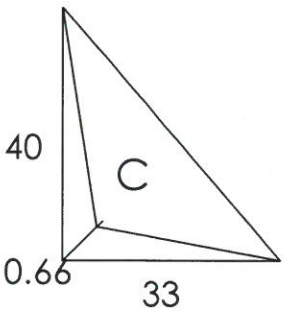
REV



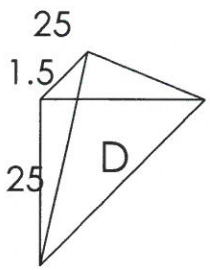
$$\frac{35 \times 33 \times 1}{2} = 578 \text{ YARDS}$$



$$\frac{35 \times 33 \times 1}{2} = 578 \text{ YARDS}$$



$$\frac{35 \times 33 \times 0.75}{6} = 144 \text{ YARDS}$$



$$\frac{25 \times 25 \times 1.5}{6} = 105 \text{ YARDS}$$

578 + 578 + 144 + 104 = 1,404 CUBIC YARDS

1,404 X 1.25 YDS/TON = 1,755 TONS

1,755 TONS X 20% OVERFILL = 351

1,755 + 351 = 2,106 TONS

PLACE 2,110 TONS OF CLEAN QUARRIED SAND

ALL NUMBERS ARE IN YARDS ON THE DRAWINGS

	NAME	DATE
DRAWN	SN	7/9/16
CHECKED		

COMMENTS:

DIMENSIONS ARE IN FEET
TOLERANCES: +.5', -1'
ALL ELEVATIONS IN
IGLD 1985

Project Location:
760 FOREST COVE, LAKE FOREST

Shabica & Associates, Inc.
550 Frontage Rd., Suite 3735
Northfield, Illinois 60093
847-446-1436
www.shabica.com

SIZE A

SAND CALCULATIONS

REV.

SCALE 1"=5'