Lake Erie Shore Erosion Management Plan

Bratenahl to Grand River: Reach 06

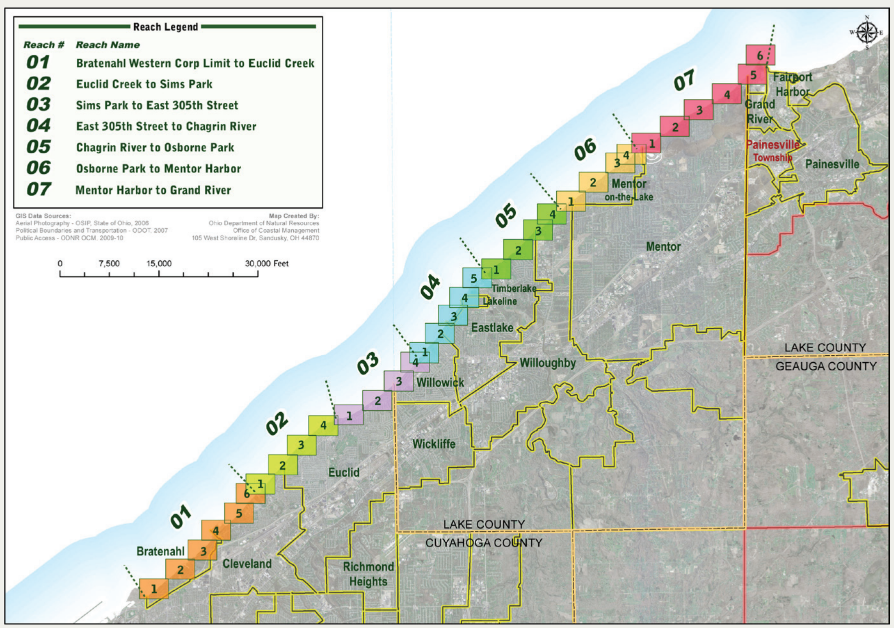
LESEMP

About the Program

In an on-going effort to assist property owners along Ohio's Lake Erie coast by providing free technical assistance, the *Lake Erie Shore Erosion Management Plan* (*LESEMP*) is being developed by the Ohio Department of Natural Resources through a partnership between the Office of Coastal Management, Division of Wildlife and Division of Geological Survey.

The *LESEMP* identifies the causes of erosion in specific areas called reaches which are stretches of shore with similar site conditions. The *LESEMP* then outlines the most likely means of successful erosion control based on reach-specific erosion issues, geology and habitat. The objective of the reach-based approach to erosion control is to simplify the decision process while enhancing the effectiveness of solutions to erosion related issues.

The *LESEMP* does not contain any regulatory oversight provisions.



The LESEMP is being developed by the project partners, Ohio Department of Natural Resources Office of Coastal Management, Division of Geological Survey and Division of Wildlife. Federal grant funding for this project is provided by the National Oceanic and Atmospheric Administration.

Description

The LESEMP Bratenahl to Grand River Region Reach 06 extends from the east end of Osborne Park to Mentor Harbor. This reach includes the lakefront residential communities in Mentor-on-the-Lake and the east end of the city of Willoughby. This reach contains approximately 14,500 feet of shore in the western portion of Lake County. Most of the Reach 06 lakeshore is privately owned with the exception of Overlook Beach Park and Mentor Beach Park in Mentor-on-the-Lake.

The shore of this reach is oriented from southwest to northeast along Lake Erie's Central Basin. The overall angle of the coast is fairly consistent but man-made structures have caused irregularities in the shore. On a localized scale the shore form is wavelike due to uneven armoring. The shore is generally characterized by 10 to 40-foot high bluffs as the relief of the upland gradually decreases from the west end of the reach to the Marsh Creek/Mentor Harbor floodplain at the east end of the reach. The bluffs are primarily composed of glacial till covered with laminated clay and sand. The clay layer gradually increases in thickness from west to east and is nearly 12-feet thick in the area just west of Mentor Harbor.

The shore in this reach is heavily armored with protective structures and often fronted by narrow beaches. The net direction of littoral transport in this reach is from west to east. Sand resources generally increase from west to east as sand accumulates updrift of the shore-perpendicular structures at Mentor Harbor. The largest beaches in this reach are near Overlook Beach Park and updrift of Mentor Harbor at the east end of the reach.

The nearshore is composed of till covered with a 6 to 9-foot thick layer of sand. Sand deposits in the area are variable, but much of the reach is fronted by two to three well defined sand bars. While sand bars are generally more prominent near the east end of the reach, the beaches and shallow nearshore demonstrate the availability of sand throughout the reach. Nearshore slopes are greatest within the first 50 to 200 feet from shore and gradually flatten to approximately 1 degree farther offshore. Due to the presence of sand bars, the shallow nearshore slopes become more variable near the east end of the reach.

At the west end of the reach the Great Lakes Erosion Control (GLEC) modules protecting the shore of Osborne Park continue along the shore lakeward of Orchard Road. The next 700 feet of shore to the east is fronted by a narrow beach. The toe of the bluff is covered with concrete blocks or rubble along most of this area. The western 150 feet of the beach is stabilized with cylindrical concrete modules placed in the nearshore. Approximately 150 feet of shore lakeward of Birchwood Drive is also protected with a combination of GLEC modules and steel sheet pile. The remaining shore in this area relies on concrete rubble placed along the toe of the bluff for shore protection.

To the east, the shore along Sunset Drive is more heavily armored. The shore protrudes approximately 40 feet lakeward along an armor stone revetment that continues along 150 feet of shore. The revetment is capped in concrete and includes a hinged steel ramp at the west end. Above the revetment the bluff face has been re-graded and is covered in stone. To the east, the concrete capped revetment steps about 40 feet landward and continues about 80 feet along the adjacent shore. The bluff in this area is stabilized with a concrete block retaining wall. The next 275 feet of shore to the east is protected with a row of GLEC modules. Much of the bluff in this area has been terraced with a series of low retaining walls. The next 425 feet of shore to the east is protected with a variety of concrete seawalls. The structures range in construction from large concrete modules placed along the shore to cast-in-place structures. A stacked concrete block revetment forms a small headland near the east end of Sunset Drive. An approximately 75-foot long pocket beach has accumulated updrift of the headland. Downdrift, the shore retreats about 100 feet landward along a variety of structures. A narrow, transient beach occasionally forms downdrift in a small embayment between the headland and a steel sheet pile groin to the east.

As Cedarwood Road curves to parallel the lakeshore, approximately 320 feet of shore is protected with a row of concrete Campbell Modules. The modules have been placed in the nearshore approximately 50 feet from the toe of the bluff and have formed a perched beach along this area. Landward of the beach the toe of the bluff is protected with a row of concrete blocks. In addition to the concrete blocks, the east end of the beach is covered in concrete rubble that extends along approximately 80 feet of shore to the east. The next 150 feet of shore along Cedarwood Road is protected with a row of GLEC modules before transitioning to a series of steel sheet pile bulkheads along about 300 feet of shore. The bulkhead protrudes approximately 20 feet lakeward for about 80 feet near the west end. Near the east end of Cedarwood Road about 80 feet of shore is protected by GLEC modules and about 200 feet of armor stone revetment. The bluff in this area has also been re-graded to a stable slope. The shore retreats approximately 60 feet landward along the east end of the revetment creating a shallow embayment along the shore of the Cedarwood Beach Club between Cedarwood Road and Thunderbird Drive. An armor stone breakwater extending approximately 65 feet east from the revetment and a 50-foot long groin help stabilize about 400 feet of beach in the shallow embayment.

The shore at the west end of the reach is protected with a row of Great Lakes Erosion Control (GLEC) modules extending east from Osborne Park in Willoughby.

To the east approximately 300 feet of shore is covered with concrete rubble and concrete slabs in the area where Thunderbird Drive curves parallel to the lakeshore. The next 300 feet of shore is protected by a variety of concrete structures (seawalls, modules, groins and rubble) forming a small headland. To the east a narrow, transient beach spans approximately 750 feet of shore along Thunderbird Drive. The beach width varies considerably with water levels, storm events and sand resources, although beach width generally increases to the east. The beach is stabilized by several small groins and concrete modules placed in the nearshore, particularly near the west end. The toe of the bluff is typically stabilized by a concrete seawall, although concrete modules such as GLEC modules are also used. The bluff transitions to a more natural slope as the beach widens near the east end of Thunderbird Drive. The beach is widest along the shore of Overlook Beach Park. A small headwall and storm sewer outfall are located at the west end of the park. To the east the shore is protected by a 40 to 60-foot wide beach. The bluff along the park has been re-graded to a stable slope and is vegetated.

At the west end of Salida Road approximately 400 feet of shore is protected with a row of Campbell Modules placed in the nearshore. A perched beach is generally trapped landward of the Campbell Modules although the shore landward of the modules has been partially filled with concrete rubble, particularly at the west end. The beach continues along approximately 500 feet of shore to the east of the Campbell Modules. Landward of the beach, the toe of the bluff is stabilized with a variety of structures including steel sheet pile bulkheads, concrete modules and concrete rubble.

To the east, the shore along Salida Road gradually curves lakeward along a broad headland spanning approximately 750 feet of shore near the end of Lake Street. The headland extends the farthest lakeward near the west end. The shore along the headland is covered in concrete rubble along the toe of the bluff. Approximately 300 feet of shore near the end of Lake Street is also protected with a row of Campbell Modules placed in the nearshore. The shore curves back landward just east of approximately 100 feet of steel sheet pile bulkhead. East of the headland, an approximately 350-foot long beach fills a shallow embayment. Much of the shore of the embayment is natural beach although concrete modules and concrete rubble have been placed in some areas, particularly at the east and west ends.

The shore to the east includes approximately 75 feet of steel sheet pile bulkhead, 200 feet of concrete rubble and a 200-foot long row of concrete GLEC modules. Concrete rubble is also present along the toe of the bluff landward of the steel sheet pile bulkhead and GLEC modules. The concrete rubble continues along the shore of Salida Road for approximately 250 feet to the east near the end of Monterey Bay Drive. To the east the shore is protected by about 150 feet of steel sheet pile bulkhead. The bluff landward of the bulkhead has been re-graded and covered in stone. Several large steel structures have been placed along the shore and perpendicular to the shore to form groins to the east. The shore in this area is also protected by a concrete seawall near the toe of the bluff.

A narrow beach has formed in a 250-foot long shallow embayment between the steel groins to the west and a concrete seawall protruding approximately 50 feet into the lake to the east. The beach is stabilized by concrete groins. The bluff along the embayment is armored with concrete seawalls and has

A storm sewer outfall is stabilized with concrete Campbell modules near the west end of the beach at Overlook Beach Park in Mentor-on-the-Lake been re-graded to include an access path near the east end. The concrete seawall at the east end of the embayment spans approximately 200 feet of shore and includes a series of concrete piers extending into the lake. The next 650 feet of shore to the east is fronted by a narrow beach lakeward of a variety of shore structures at the toe of the bluff. The beach is stabilized by several concrete block groins extending approximately 50 to 60 feet into the lake. From west of Davis Drive, the next 225 feet of shore to the east is protected by a row of GLEC modules placed in the nearshore. The GLEC modules support a perched beach along the toe of the bluff. Approximately 75 feet of shore near the end of Ivy Drive/Twilight Drive is protected with a steel sheet pile bulkhead and a revetment which protect a sanitary sewer pump station.

The shore of Mentor Beach Park north of Twilight Drive is protected with a variety of structures. The west end of the park is protected by an armor stone revetment at the toe of a re-graded, vegetated bluff. A narrow beach forms lakeward of the revetment due to a row of Campbell Modules placed 30 to 60-feet into the nearshore. A small steel sheet pile pier helps stabilize the west end of the beach. East of the revetment the shore protrudes about 60 feet lakeward for 120 feet along a row of GLEC modules. East of the GLEC modules approximately 850 feet of shore is protected by an armor stone revetment. The revetment protrudes about 50 feet lakeward for about 250 feet near its center. A narrow beach often forms in the shallow embayments on either side of the headland created at the center of the revetment.

East of Mentor Beach Park, approximately 250 feet of shore is protected with a row of GLEC modules. The bluff landward of the modules is partially re-graded to a gentle slope and partially terraced with a concrete retaining wall. The narrow beach at Mentor Beach Park generally continues along the GLEC modules. The next 2,800 feet of shore to the east is fronted by a wide beach updrift of the shore-perpendicular structures at Mentor Harbor. The beach is narrowest at the west end and gradually widens to approximately 300 feet immediately updrift of Mentor Harbor. The western 450 feet of beach fronts the residential community along Lake Shore Boulevard (State Route 283). The beach transitions to a barrier beach as Marsh Creek nears the shore just east of Chestnut Street. The entrance to Mentor Harbor is stabilized with modular steel sheet pile jetties extending approximately 400 feet into the lake. The shore just west of the jetties includes the marina facilities for the Mentor Harbor Yacht Club.

Recession/Erosion

The ODNR Division of Geological Survey has evaluated the recession of Ohio's Lake Erie shore over three time periods: 1876 to 1973, 1973 to 1990, and 1990 to 2004. Changes in the rates measured during each of the time periods are generally attributed to development along the coast and natural factors such as lake level changes.

From 1876 to 1973 this reach experienced average recession rates ranging from less than 1-foot per year to 3-5 feet per year. Moderate recession was

Mentor Beach Park's shore is protected by a variety of structures including stone revetments, concrete modules, a concrete seawall and a steel sheet pile pier/groin. The left photo shows the western side of the park near the terminus of Twilight Drive. The right photo shows GLEC modules around a water intake structure at the center of the park.

most common later in the time period. As the shores along Sunset Drive, Cedarwood Road, Thunderbird Drive and Salida Road were developed and armored with shore structures, the small unprotected areas between the roads experienced increased erosion. This has led to the wavelike shape of the current shoreline with broad headlands along each road and slight embayments as the western road ends and eastern road curves to parallel the shore.

From 1973 to 1990 most of this reach experienced slow to moderate recession, although a few areas experienced rapid recession. Average recession rates ranged from 0 feet per year to 8.9 feet per year. Recession was greatest along the barrier beach fronting Marsh Creek, particularly at the west end. Average recession rates also reached 4.6 feet per year in the embayment along Salida Road (just east of Lake Street) and 4.5 feet per year just east of Osborne Park. The embayment between the end of Cedarwood Road and the area where Thunderbird Drive curves to parallel the shore also averaged 3.6 feet per year of recession. Average recession rates also reached 3.2 feet per year at Mentor Beach Park and 3.1 feet per year in the area near Overlook Beach Park. Average recession rates throughout the rest of the reach were generally between 0 and 3 feet per year. Overall, recession was typically greatest in areas without shore structures and areas relying on concrete rubble for shore protection.

From 1990 to 2004 average recession rates ranged from 0 feet per year to 5.2 feet per year but most of the reach experienced very slow to slow recession. Recession was greatest near the west end of the barrier beach fronting Marsh Creek. Average recession rates also reached 4 feet per year at Overlook Beach Park and 2.1 feet per year in the shallow embayment between Cedarwood Road and Thunderbird Drive. Otherwise, average recession rates were less than 2 feet per year throughout the reach. Recession rates generally decreased as the shore continued to be armored with protected structures.

Beaches/Sand Supply

There is sand available in the littoral system throughout the reach from Osborne Park to Mentor Harbor. A 6 to 9-foot layer of sand covers the nearshore zone along most of the reach. In 1876 the entire reach was fronted by a beach. As the shore was developed a wide variety of structures were constructed to prevent erosion and protect upland property. The large-scale hardening of Lake Erie's shore has prevented sand from entering the littoral system from erosion of the bluffs, resulting in an overall reduction of beach material. Lakebed down cutting and wave reflection as a result of shore structures has also caused a general increase in water depths wave energy in the area resulting in the gradual migration of beach sand from the shore to the nearshore. The construction of groins to stabilize eroding beaches in the area has also helped divert the littoral drift farther offshore (around the structures). This has contributed to the migration of sand resources to the nearshore by preventing sand from reaching the shore in many areas.

Today narrow, transient beaches front most of the reach. Beach widths are

The shore of Mentor Beach Park is protected by a variety of structures. The left photo was taken looking west from the stone revetment that wraps around the headland at the park. The right photo is taken from the east side of the headland looking east at a stone revetment along the shore.

generally dependent on water levels, storm events and localized variations in sand resources. Beaches are widest where stabilized by groins or in shallow embayments between structures. Sand resources generally increase from west to east as sand accumulates updrift of the shore-perpendicular structures at Mentor Harbor. The presence of nearshore sandbars, particularly near the east end of the reach, also demonstrates the availability of sand in this reach.

Use of Shore Structures

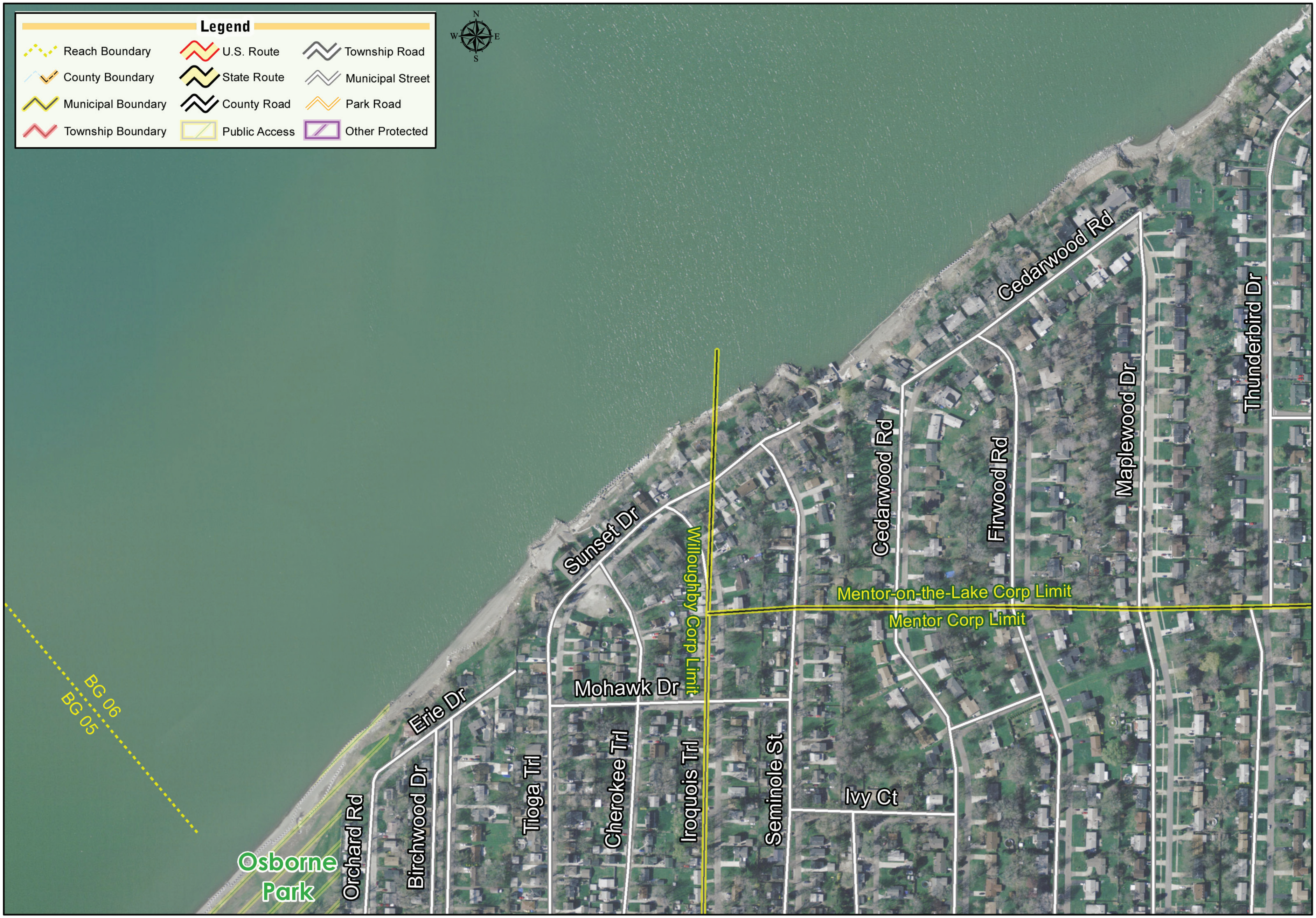
With the exception of the wide beach updrift of the structures at Mentor Harbor, much of the shore from Osborne Park to Mentor Harbor is protected by some form of shore structure. Most of this reach is residential property with each property owner responsible for their own shore protection. This is the case along Sunset Drive, Cedarwood Road, Thunderbird Drive and Salida Road, resulting in a wide variety of shore structures. Shore protection in these areas ranges from well-constructed seawalls and revetments to less effective measures such as dumping concrete rubble along the shore.

Although it is often combined with additional structures, concrete rubble is used along the shore extensively throughout this reach. The most common shore structure in this reach is concrete rubble or randomly placed concrete modules near the toe of the bluff. In many cases the concrete rubble has been displaced by wave action and is dispersed throughout the nearshore. The placement of pre-cast concrete modules, particularly Campbell modules or GLEC modules, at the toe of the bluff or in the nearshore is also common.

Summary

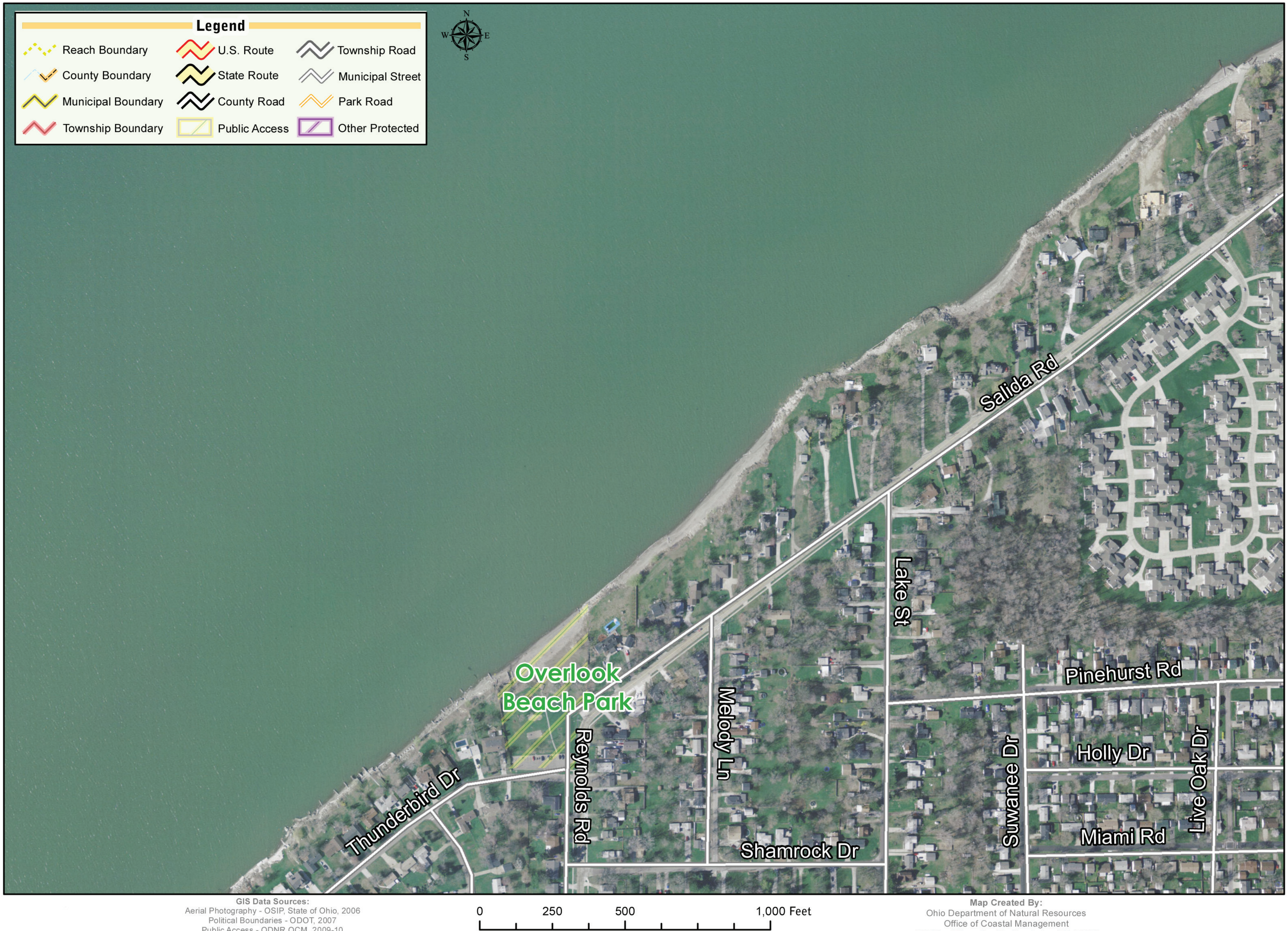
The reach from Osborne Park in Willoughby to Mentor Harbor consists primarily of residential development with the exception of Overlook Beach Park and Mentor Beach Park. The relief of the upland gradually decreases from 40-foot bluffs near the west end of the reach to less than 10 feet in the barrier beach area updrift of Mentor Harbor. Sand resources generally increase from west to east as sand accumulates updrift of the shore-perpendicular structures at Mentor Harbor. Much of the shore of this reach is armored with protective structures. Although ineffective as shore protection, concrete rubble is commonly placed along the shore of this reach. In some areas more effective structures such as revetments and seawalls are also present. Narrow beaches are present where stabilized by structures or in shallow embayments between structures. Beaches are generally wider as sand resources increase near the east end of the reach. This reach has historically experienced slow to moderate recession rates although more rapid recession has occurred on the barrier beach fronting Marsh Creek and in the shallow embayments between the residential areas along Sunset Drive, Cedarwood Road, Thunderbird Drive and Salida Road.

The jetties at Mentor Harbor help support the barrier beach between Marsh Creek and Lake Erie. The west jetty is shown in the left photo with the northeastern portion of wide beach that is updrift of the jetty. The right photo shows the revetment, GLEC modules and the southwestern end of the 2,800 foot long beach.



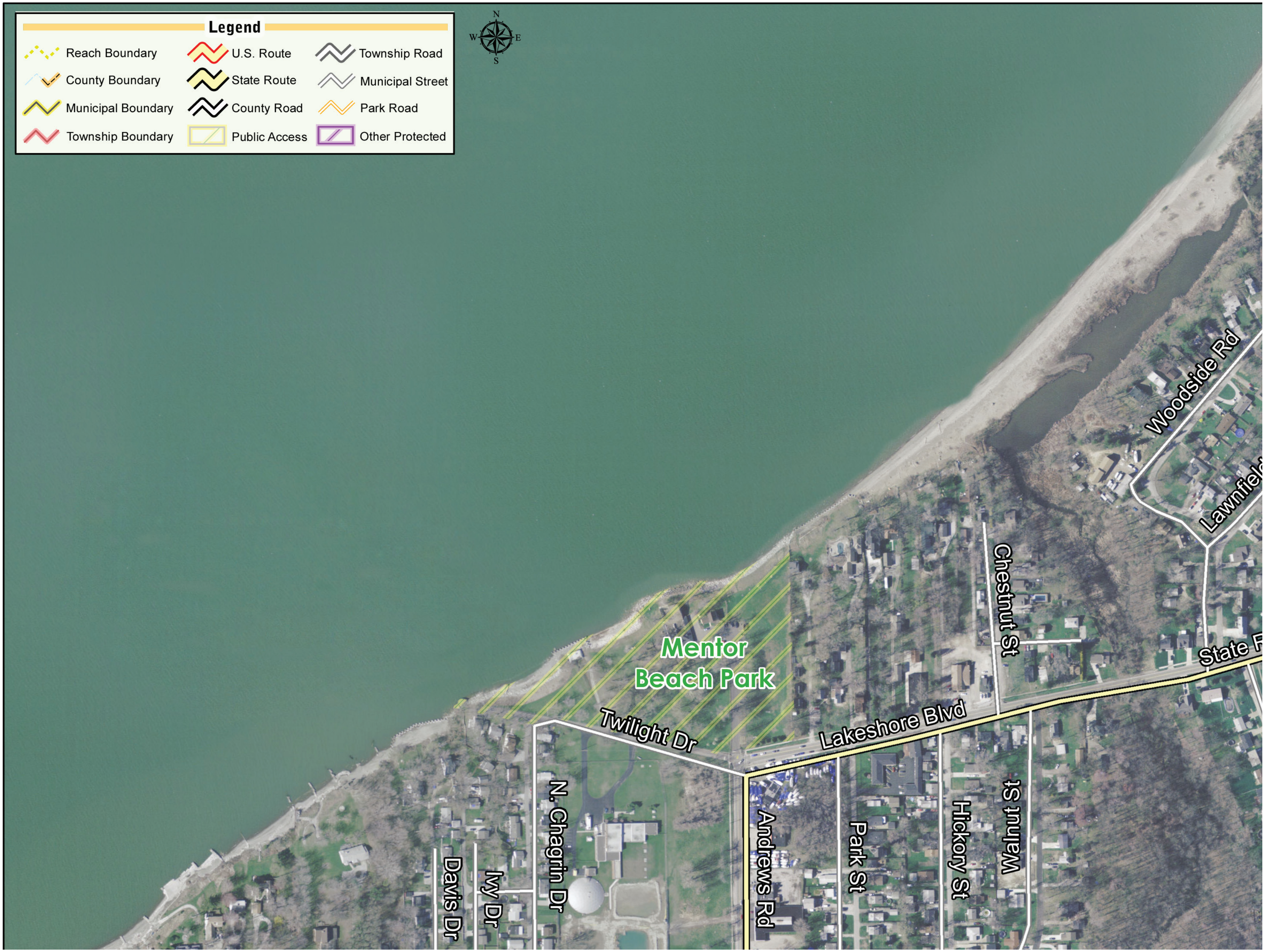
GIS Data Sources:
Aerial Photography - OSIP, State of Ohio, 2006
Political Boundaries - ODOT, 2007
Public Access - ODNR OCM, 2009-10
Transportation - LBRS, Erie County and State of Ohio, 2005-07

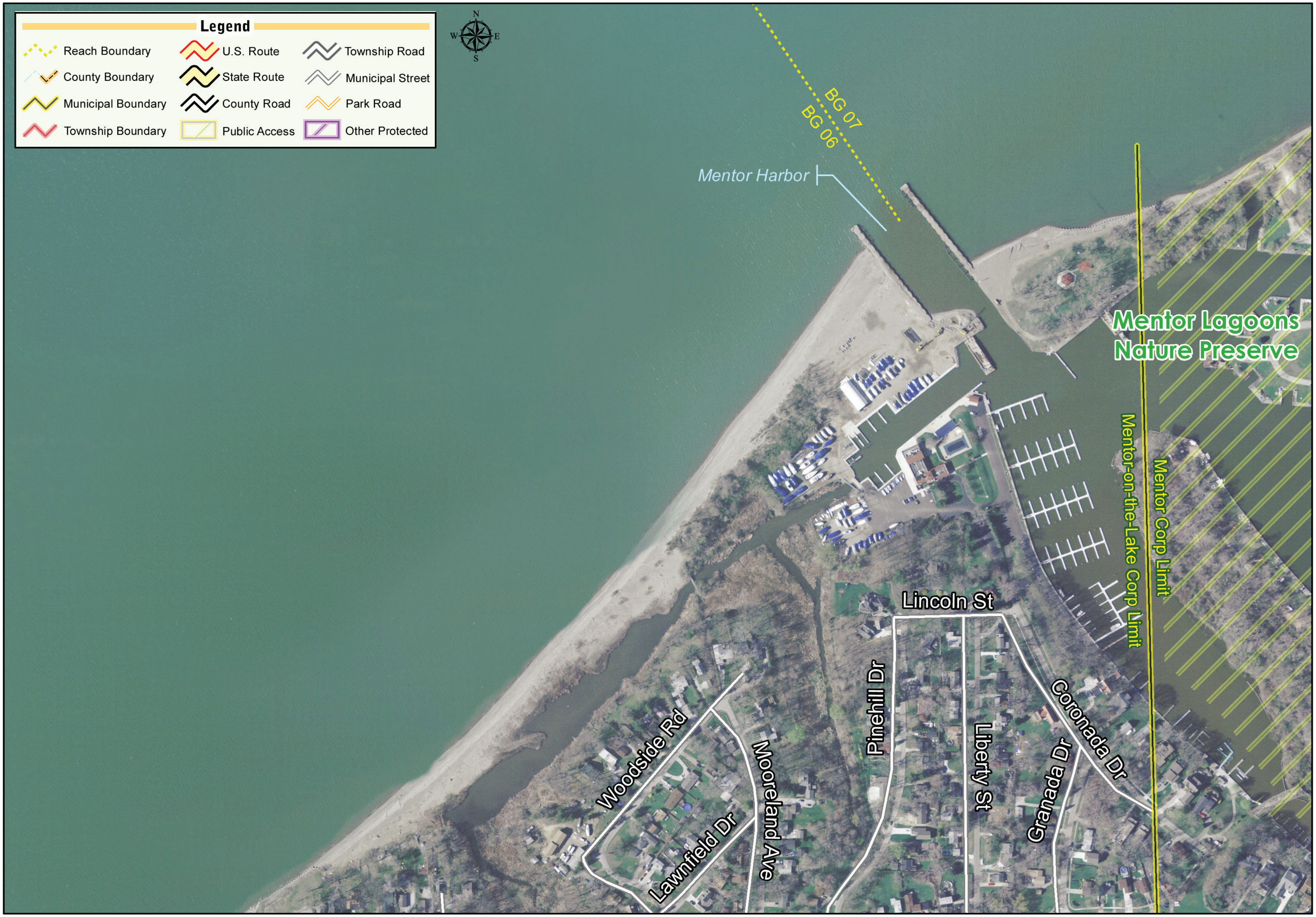
Map Created By:
Ohio Department of Natural Resources
Office of Coastal Management
105 West Shoreline Dr, Sandusky, OH 44870



GIS Data Sources:
Aerial Photography - OSIP, State of Ohio, 2006
Political Boundaries - ODOT, 2007
Public Access - ODNR OCM, 2009-10
Transportation - LBRS, Erie County and State of Ohio, 2005-07

Map Created By:
Ohio Department of Natural Resources
Office of Coastal Management
105 West Shoreline Dr, Sandusky, OH 44870


Legend
Reach Boundary
County Boundary
Municipal Boundary
Township Boundary
U.S. Route
State Route
County Road
Public Access
Township Road
Municipal Street
Park Road
Other Protected
N
S
E
W
Mentor Beach Park
Woodside Rd
Lawnfield
Chestnut St
State R
Lakeshore Blvd
Twilight Dr
N. Chagrin Dr
Ivy Dr
Davis Dr
Andrews Rd
Park St
Hickory St
Walnut St



GIS Data Sources:
Aerial Photography - OSIP, State of Ohio, 2006
Political Boundaries - ODOT, 2007
Public Access - ODNR OCM, 2009-10
Transportation - LBRS, Erie County and State of Ohio, 2005-07

0 250 500 1,000 Feet

Map Created By:
Ohio Department of Natural Resources
Office of Coastal Management
105 West Shoreline Dr, Sandusky, OH 44870

Recommendations

The recommendations included below are options that may be applicable within this reach and should only be used for planning purposes. Based on the physical characteristics of the reach, the following recommendations are suggested for the reach between Osborne Park and Mentor Harbor. Each recommendation includes a brief overview of the solution prior to addressing areas within the reach where the recommendation is best suited. For more information on any of the items listed below, please refer to the LESEMP Glossary and Erosion Control Methods Appendix.

In addition to the recommendations listed below, a "do nothing" alternative should also be considered. This may be a viable, and even favorable, alternative for much of Ohio's Lake Erie shore. Areas with existing shore structures and relatively low erosion rates, such as the shore along the east end of Cedarwood Road, may not require additional protection. In these areas attention should be focused on monitoring and maintaining the structures. In other areas, particularly those with a natural shoreline and relatively low erosion rates, the best option may be to hold development back from the shore and allow natural erosion/accretion processes to occur. This option should be considered on the unarmored beaches updrift of Mentor Harbor.

Sand Management:

1. <u>Conserve Sand Resources</u>: Conserve sand resources within the shore and nearshore areas. Sand is a limited resource in constant fluctuation. Avoid removing sand from the system. Sand moved or excavated from along the shore during construction should be placed in the nearshore, not on the upland. The sand should also not be incorporated into the construction project.

While there is sand is available in the littoral system this recommendation should be considered throughout the reach from Osborne Park to Mentor Harbor. Several properties along Lake Shore Boulevard near the east end of the reach or in the shallow embayments rely on the beach for shore protection. A decrease in sand resources could significantly increase erosion in this area.

The low bluffs near the east end of Overlook Beach Park experience erosion due to wave action at the toe of the bluff as well as erosion of the upper portion of the bluff from surface and ground water (left). Although ineffective as shore protection, concrete rubble is often dumped along the shore. Concrete rubble is easily fractured and displaced by wave action near the toe of the bluff and can cause slope failures by adding excessive weight to the bluff face (right).

Planting native vegetation on the beach helps encourage sand accumulation and dune formation. Dunes provide a natural sand reserve to restore beaches during periods of erosion due to storms or high water. Planting dune grass (top), an establshed dune (middle) and beach pea (bottom) are shown.

Narrow, transient beaches also form lakeward of shore structures throughout the reach, particularly in areas with groins or other structures to stabilize the beach. Sand accumulation lakeward of the structures and in the nearshore helps to reduce water depths and causes waves to break farther offshore. A reduction of sand in the littoral system would cause a corresponding increase of wave energy along the shore and reduce the effectiveness of many protective structures.

2. Beach Nourishment: Supplement the current sand supply with beach nourishment, also known as beach fill or pre-fill. Beaches protected by groins and detached breakwaters will benefit from initial nourishment (pre-fill during or directly after construction) and periodic re-nourishment. The sand used in these projects should be acquired from an upland source.

The beaches in this area would benefit from nourishment, particularly along the barrier beach at the west end of the reach. Beach nourishment could be used to supplement the existing barrier beach without altering the natural barrier beach habitat with artificial structures.

The addition of beach nourishment would also be beneficial if added to sites with existing structures to stabilize it or as part of new construction for detached breakwaters. This should be considered along Thunderbird Drive and Salida Road. Beach nourishment would also be beneficial to supplement the beaches at Overlook Beach Park and Mentor Beach Park.

3. Dune Construction: Natural sand dunes prevent erosion by providing protection to the landward areas from waves and wind while acting as a sand reserve for the beach and nearshore areas. With sufficient sand supply beaches will naturally form dunes as sand accretes on the beach during calm wave conditions and is eventually piled along the shore by wind. The sand formations are gradually stabilized by vegetation and provide natural protection to the shore. The formation of mature sand dunes requires excess sediment supply for a considerable time period and is rare along Ohio's Lake Erie coast. An effective dune system can be created through dune construction by beach nourishment and vegetation. Dune ladders, sand bags and snow fences are also commonly used to hold sand and aid the formation of sand dunes. An artificial dune system will require regular monitoring and occasional maintenance through the addition of sand or planting of vegetation.

Dune Construction would be most beneficial along the wide beach up-drift of Mentor Harbor. This recommendation also applies to the narrower beaches at Overlook Beach Park and in the embayment between Cedarwood

Road and Thunderbird Drive. In addition to providing a sand reserve for the beach, snow fences and other artificial dune stabilization techniques can be effective at keeping beach sand from blowing onto upland property. This would be beneficial along the barrier beach fronting the coastal wetlands at Marsh Creek and could help prevent sand from being removed from the littoral system.

4. Vegetation: Encourage growth of native vegetation on the back beach. Beach vegetation encourages the formation of a dune system by holding sand in place and providing protection from wind. It is also possible to simply allow the natural succession of native plant species to grow along the beach.

This recommendation is most applicable on the wider beaches updrift of Mentor Harbor, at Overlook Beach Park and in the embayment between Cedarwood Road and Thunderbird Drive. Native vegetation on the beach helps encourage sand accumulation and dune formation. Dunes provide a natural sand reserve to restore beaches during periods of erosion due to storms or high water. Native varieties of American beach grass, little bluestem, sand dropseed or beach pea are well suited for beach vegetation in this area.

Toe Protection:

5. Revetments: Revetments along the toe of a bank will aid in protecting against wave-based erosion. In areas without beaches, a structural measure may be necessary to protect the toe of the bank. The low-relief banks within this reach have relatively gradual slopes, which are ideal for revetment development. In essence the revetments form a stable bank slope, providing protection to the soil underneath while breaking up wave attacks. Since material eroded off the bank is one source of beach-building sand, some regulatory agencies may require that one of the design components for a revetment be the inclusion of sand pre-filling in the amount equal to that which would have been added to the system over the life of the structure.

Where constructed, revetments have been effective at stabilizing the shoreline and minimizing erosion in the area. Revetments are intended to dissipate wave energy along the rough angular slope of the structure and should be constructed with armor stone large enough to be stable when impacted by significant wave forces. To provide long term shore protection revetments are typically constructed with carefully placed limestone, sandstone or engineered concrete modules.

In many areas of this reach randomly placed or dumped concrete rubble is relied on for shore protection. Reviewing recent recession rates throughout the reach demonstrates that concrete rubble does not provide adequate protection from wave action. In general, areas in this reach relying on concrete rubble for shore protection have higher average recession rates than properties with well-constructed revetments or seawalls. This is often because concrete rubble is too light to withstand the wave forces along the shore and is easily displaced and transported by littoral currents. Rubble on the upper bluff will frequently slide down to the toe and increase the continuing erosion of the bluff. Individual pieces of concrete typically weigh less than a few hundred pounds as compared to the several-ton armor stone used in revetment construction. Concrete rubble also fractures much more easily than the solid stone armor units used in properly constructed

Concrete rubble is too light to withstand wave forces along the shore and is easily transported by littoral currents. Fractured concrete rubble provides little protection and is a significant hazard along the coast.

revetments. Much of the concrete placed along the shore is in the form of slabs and broken pavement. Randomly placed concrete rubble often has large voids causing concrete slabs to be unevenly supported and easily fractured. When concrete cracks it also crumbles more easily than limestone or sandstone resulting in very small pieces that are easily moved by waves, providing little protection to the shore. In some cases concrete rubble can be used in the base layers of a revetment if covered by suitably sized armor stone.

6. <u>Detached Breakwaters</u>: Detached breakwaters may be useful in areas where beaches are present or likely to form. Detached breakwaters aid in retaining a beach by limiting the wave energy reaching the shore causing sediment to settle out and be deposited. As opposed to groins which trap sand moving along the shore, properly designed and constructed detached breakwaters are intended to allow alongshore movement of sand. An initial beach nourishment (pre-fill) and periodic re-nourishment will often be advantageous to creating and retaining the beach landward of the breakwater while limiting impacts to neighboring shorelines. Some regulatory agencies may require pre-fill and periodic nourishment as one of the design components for a project that includes detached breakwaters.

Detached breakwaters would function well in the shallow water throughout the reach and would be particularly effective near the east end of the reach. Many properties in this reach have seawalls or low revetments placed landward of beaches to protect upland structures while preserving existing beaches. Detached breakwaters are another alternative that would provide erosion protection while preserving existing beach areas.

Detached breakwater projects are most effective when constructed over a long stretch of shore. Initial beach nourishment and provisions for sand by-pass as well as potential beach re-nourishment should be included in the design of a detached breakwater. The intent of a detached breakwater project is to stabilize a beach by reducing wave energy along the shore so monitoring and periodic maintenance may be required to prevent the structure from trapping littoral material and increasing the risk of erosion on adjacent properties.

Bluff/Bank Modifications:

7. <u>Re-Grading/Terracing</u>: Re-grade or terrace less stable bluffs/banks to a more gradual slope. By creating a lower (flatter) slope angle or terracing the slope to a series of steps, instability caused by gravity's forces on the upper bluff/bank is decreased. Re-grading is a non-structural approach to stabilize the bluff that leaves the shore relatively unaltered. When re-grading, also review the toe of the bluff/bank to determine if a structural (revetment) or non-structural (beach nourishment) solution would be preferable.

This recommendation is applicable to the 30 to 40-foot bluffs along most of this reach. The bluffs from Osborne Park to Mentor Harbor are primarily

The shore of Overlook Beach Park has been re-graded to a stable slope and vegetated. The re-graded slope also provides a switchback path for accessing the beach (left). The addition of a drainage system can help reduce erosion due to surface and ground water. Any water collected should be drained as close to the toe of the bluff as possible (right).

composed of till covered with layers of laminated clay and sand. These materials are highly susceptible to slumping if the toe of the bluff is eroded by wave action. Slope failures can also occur as a result of ground water seepage. There are several examples throughout this reach where re-grading has been effectively used to stabilize the bluff. The bluffs at Overlook Beach Park and Mentor Beach Park have been re-graded to a stable slope and covered with vegetation.

In some areas upland structures are present very close to the edge of the bluff. In this case, terracing of the bluff face may be considered. Several properties along Sunset Drive have a stable, terraced bluff face.

***8. Surface Water Management*: Route surface water away from the face of the bluff/bank. In areas where gullies or rills are forming, surface water is slowly eroding the face of the bluff/bank. Where possible, re-route water away from the bluff/bank. Sometimes this may involve changing gutter or driveway drainage. Terracing of the bluff/bank can also be used as a means of intercepting and diverting seeped ground water. Sources of surface water include, but are not limited to roof gutter downspouts, runoff from driveways and sidewalks, precipitation and sprinkler systems.**

The re-routing of surface water should occur throughout the Osborne Park to Mentor Harbor reach. The till, laminated clay and sand that comprise the bluffs in this reach are highly susceptible to surface water erosion. Attention to the signs of surface water will allow for early action on limiting the affects of run-off. Surface water erosion can be reduced by collecting upland run-off and draining it to the toe of the bluff.

9. *Ground Water Management:* Remove ground water from within the bluff. Drainage should be installed in areas with excess water in the bluff, visible as seeps or springs in the middle of the bank. A subsurface drainage system should remove water from an upper layer within the bluff, often a sandy layer, and should exit at the lake level to limit lower bluff erosion. Sources of ground water include, but are not limited to leaking septic systems, underground pipes and/or swimming pools.

Ground water seepage can be a significant cause of erosion throughout this reach. The 30 to 40-foot bluffs in this reach typically contain layers of sand and laminated clay. Ground water can cause slipping and slope failures along the layer of clay and can cause sand to be washed out from the bluff face. A subsurface drainage system should be considered for properties prone to rotational slumps or with visible signs of ground water seepage. Drainage systems are often installed as a component of a re-grading or terracing project to create a stable slope.

***10. Vegetation*: Encourage growth of vegetation along the bank slope. Where possible plant vegetation, preferably native species, along the bank to remove excess ground water while retaining soil strength. It is also possible to simply allow the natural succession of native plant species to grow along the bank.**

This recommendation is applicable throughout the Osborne Park to Mentor Harbor reach. Allowing native vegetation to grow on the natural bluff face or on the re-graded slope above the seawalls, revetments and other shore structures in this reach would reduce excess ground water and help stabilize the bluffs and low banks. Well-rooted vegetation also helps hold soil in place to prevent erosion from runoff and can protect the bluff face from weathering.

The till and clay bluffs in this area are sloped, exposed to harsh weathering processes and are relatively low in nutrients. Native plants from a local source are best adapted to survive in these conditions. It is typically most effective to cultivate plants already growing along the shore or to survey established vegetation along nearby properties and plant similar varieties. In general, well-rooted grasses, shrubs and small trees are most effective as they remove surface and ground water without adding excessive weight to the bluff face. Native varieties of indian grass, big bluestem grass, mesic grapes, sumacs, gray dogwood, heartleaved willow and cottonwood trees are well adapted to survive along the till and glaciolacustrine bluffs common in this area.

While beneficial along the bluff, vegetation growing on shore structures should be closely monitored. For example, vegetation growing on a rip-rap or armor stone revetment could damage the structure by causing stones to be broken or displaced.

Management and Monitoring:

***11. Bank-Top Management*: Keep heavy materials, equipment or structures well back from the edge of the bank-top. Any structure (concrete decks, stone walls) or heavy object (vehicles or construction equipment) placed near the bank edge will increase the stress within the soil and can lead to slope failure.**

This recommendation applies to the 30 to 40-foot bluffs throughout this reach. Care should be taken when accessing the top of the bluff with heavy materials or machinery while maintaining existing shore structures to prevent sliding failures. This recommendation should also be carefully considered when planning new structures on the upland or along the shore.

This recommendation also applies to the placement of debris or yard waste near or over the edge of the bluff. Leaves and grass clippings can become saturated with water and greatly increase the weight on the bank's slope, directly causing slumping. Concrete rubble and construction debris should never be placed along or near the slope of the bluff.

12. Coordination of Projects: Continuation of similar erosion control measures along a stretch of shore will often yield more effective protection than the installation of multiple types of structures adjacent to one another. Most erosion control measures function better when utilized over large areas of the shore.

This recommendation is applicable throughout this reach. In residential areas, shoreline property is often divided into parcels as small as 50 feet wide with each property owner responsible for their own shore protection. This is common in the residential communities along Sunset Drive, Cedarwood Road, Thunderbird Drive and Salida Road and has led to the construction of a mix of shore protection structures of varying designs, construction quality and condition. Complex interaction between structures in certain wave conditions often limits their effectiveness and at times can cause increased erosion at the site or on adjacent properties. This is best avoided by coordinating projects over a length of shore. In addition to creating more effective shore protection, coordinating projects limits the amount of time the littoral system is disturbed and can also allow some engineering and construction expenses to be spread over several properties.

When structures can not be continued across multiple properties, conditions at the ends of the structure should be carefully considered in the design. The structures should be designed to prevent intersections causing increased wave energy or gaps between structures where increased erosion is likely.

***13. Shore Structure Management/Monitoring**: Monitor and maintain shore structures. Routine monitoring of shore structures will allow for early detection of any potential failures. Smaller repairs performed more frequently will be less costly and can often increase how long the structure will be effective at controlling erosion. Should removal of an aged or deteriorating structure be necessary, consider the above recommended items as potential future solutions.*

Many of the structures in this reach were constructed more than 30 years ago. The condition of the structures should be closely monitored and repairs should be made when necessary. Periodic monitoring of existing structures should include a visual inspection for displaced armor stone, cracked armor stone or concrete, uneven settling of the structure, slumping or gullies in the upland or bluff face and flanking at the ends of structures. Inspections should also include a review of sand resources or beach widths in the area and should note conditions on adjacent properties. If the base of a structure is visible during periods of low water, inspections should also be made to check for scour and possible undermining of the structure.

If new erosion control measures are installed, the recommendations listed above should be considered. A combination of recommendations may be the most effective solution. For example, to effectively protect a steep bluff with concrete rubble placed at the toe, re-grading the bluff and constructing an armor stone revetment may be considered. In many cases the existing concrete rubble along the shore can be re-used in the base of the structure if covered with appropriately sized armor stone.

References

- Carter, Charles H. Lake Erie Shore Erosion, Lake County, Ohio: Setting, Processes and Recession Rates from 1876 to 1973.
- Campbell, Mike, Cross, Marlene and Martz, Marti. Vegetative Best Management Practices: A Manual for Pennsylvania/Lake Erie Bluff Landowners. Pennsylvania Coastal Zone Management Program. 2007.
- Ohio Department of Natural Resources, 1998 Final Coastal Erosion Area (CEA) Mapping.
- Ohio Department of Natural Resources, 2010 Final Coastal Erosion Area (CEA) Mapping.

Learn More:

LESEMP Webpages: ***ohiodnr.com/tabid/20501.default.aspx***

ODNR Office of Coastal Management
105 West Shoreline Drive, Sandusky OH 44870
419.626.7980 | ***coastal@dnr.state.oh.us*** | ***ohiodnr.com/coastal***

ODNR Division of Wildlife ***ohiodnr.com/wildlife***

ODNR Division of Geological Survey ***ohiodnr.com/geosurvey***