Coastal Hazards Planning Guidance for Indiana Coastal Communities

July 2016

INDIANA LAKE MICHIGAN COASTAL PROGRAM

NOAA

DNR
Indiana Department of Natural Resources

About the Lake Michigan Coastal Program

The Lake Michigan Coastal Program (LMCP) supports coordination and partnerships among local, state and federal agencies, and local organizations to protect and sustainably use natural and cultural resources in the Lake Michigan region. Through the LMCP, Indiana participates in the Coastal Zone Management Program with 33 other coastal states and territories to protect, restore and responsibly develop Indiana's coastal area. Indiana's LMCP was approved in 2002. It relies on existing laws and programs as the basis for achieving its purpose.

The LMCP offers technical assistance to shoreline communities wanting to meet the concurrent, sometimes competing, goals of preservation, protection, conservation and development of the Indiana coastal region. Please email Kaitlyn McClain, coastal resource planner, at kmcclain@dnr.IN.gov, for technical assistance.

For more general information on the program, visit: http://www.in.gov/dnr/lakemich/

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Figure 1: Panoramic view of Indiana Dunes National Lakeshore

Section I: Introduction

A part of the culture and heritage of northwest Indiana, the Lake Michigan shoreline is of great importance to the state of Indiana. Shoreline communities and natural areas along Lake Michigan provide Hoosiers with environmental, economic and recreational benefits. But coastal hazards—phenomena that have the potential to harm or produce other undesirable consequences to persons or things[1]—may diminish these benefits in the future. The coastal region of Indiana experiences hazards that include flooding, fluctuating lake levels, strong storms that bring high winds and storm surges, and beach erosion.[2] One severe storm can generate multiple, sometimes compounding hazards that result in both short-term and long-term impacts.

Coastal hazards challenge municipalities and decision-makers when they are planning and evaluating shoreline development. An integrated approach to shoreline management that unifies the different levels of government agencies responsible for regulating shoreline management and balances shoreline development and conservation is the preferred approach to overcoming the uncertainty and barriers presented by coastal hazards. Additionally, the adoption of municipal ordinances that protect Indiana's shoreline from coastal hazards can ensure that coastal development proceeds in a manner that is most likely to lead to resilient, sustainable outcomes.

While adaptation measures are becoming increasingly necessary for existing structures and developed areas, early planning in areas of new development or redevelopment can minimize potential future damage to life and property along the Lake Michigan shoreline. Coastal and shoreline structure planning and zoning decisions are made at the local level and vary between municipalities. Broad in scope, *Coastal Hazards Planning Guidance for Indiana Coastal Communities* provides information for local governments about coastal hazards and planning techniques to help officials make informed coastal hazard planning and mitigation decisions. The document introduces coastal hazard concepts, provides information about planning underway in Indiana shoreline communities, and presents coastal hazards model ordinance provisions.

Figure 2: The Indiana shoreline is made up of industrial, recreational, residential and natural areas.

Indiana's Lake Michigan Shoreline

Intensive man-made industrial and navigational development has drastically altered Indiana's 45-mile Lake Michigan shoreline that stretches from the Illinois border to the Michigan border. Roughly one-third of Indiana's shoreline is protected by hard structures that have affected natural sand transport patterns along the coast. A significant exception to man-made alteration of the shoreline is at Indiana Dunes National Lakeshore and Indiana Dunes State Park, where coastal land is owned and managed by the federal and state government for preservation and recreation. There are also stretches of residential development adjacent to the shoreline. Because most land along the shore has been developed or preserved, few opportunities for new development along the shoreline exist. However, there are possibilities for sustainably focused, lakefront-sensitive redevelopment. The Marquette Plan has identified some of these possibilities for each of the three coastal counties, Lake, Porter and LaPorte.[3]

Indiana Dunes Sate Park and Indiana Dunes National Lakeshore provide most of the public access to the state's Lake Michigan beaches. Other portions of the shoreline are owned and operated as public beaches by local governments or privately held by individual landowners or industry. The shorelines of Ogden Dunes, Dune Acres, Porter and Beverly Shores are included in Indiana Dunes National Lakeshore. Hammond, Whiting, East Chicago, Gary and Michigan City own and maintain public beaches.

Figure 3: Indiana's shoreline has both natural and hardened areas in close proximity.

The *ordinary high watermark (OHW)* is the line on Lake Michigan and other navigable waterways that designates where regulatory jurisdiction lies and, in certain instances, determines where public use and ownership begins and/or ends. Although the actual elevation of Lake Michigan fluctuates, the elevation of the OHW is fixed at 581.5 feet by Indiana state statute. Elevation is used as the determinant because the wide diversity of natural and man-made shoreline features renders a physical description of the OHW practically meaningless. The OHW is significant to many governmental permitting activities, questions of ownership, and delineation of public access beaches. The portion of the coastline lying above the OHW is held by the respective property owner, which may be a municipality, a private citizen, or a commercial entity. The portion of the coastline lying below the OHW is held in public trust and is available for use by the public.[4]

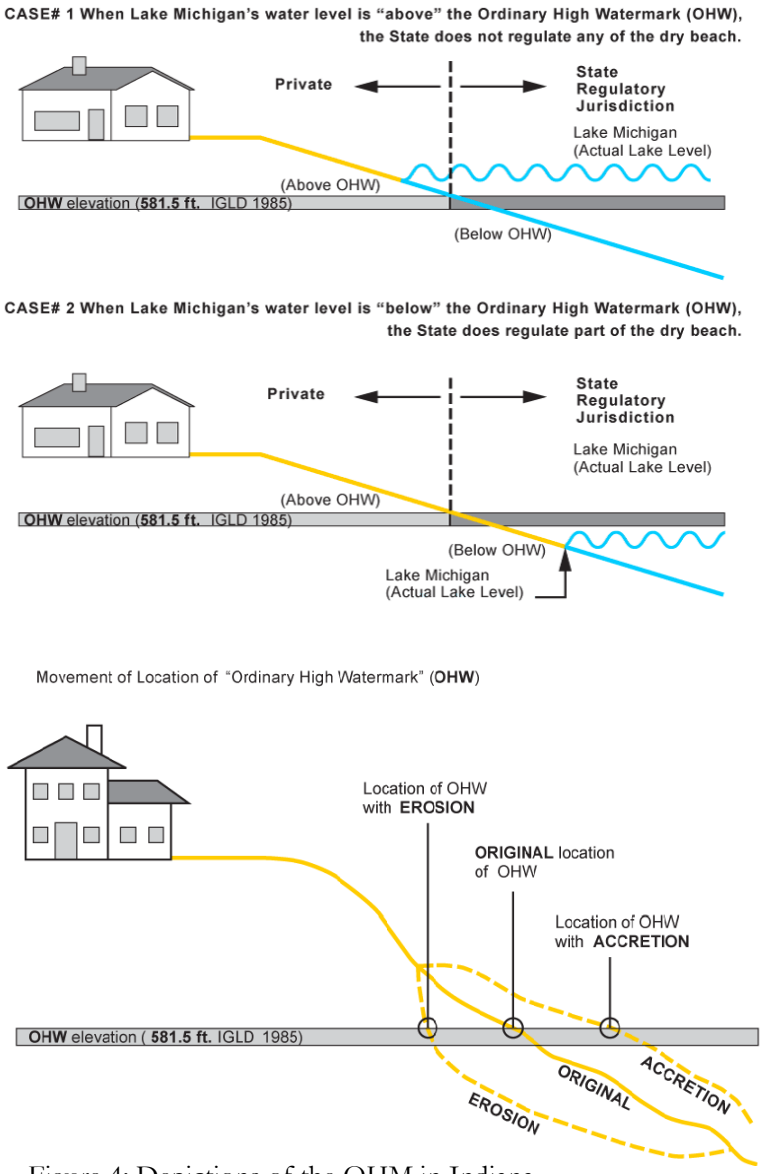


Figure 4: Depictions of the OHM in Indiana

Issues regarding the public trust doctrine and the appropriateness of the State's use of the OHW, as opposed to the Natural High Water Mark, are currently the subject of a lawsuit brought by private property owners against the State. The trial court ruled that the State owns below the OHW, regardless of whether the beach is covered by water, and the property is subject to the public trust doctrine. The local court further held that the OHW is the appropriate standard. The local court's decision has been appealed to the Indiana Court of Appeals. A decision is expected by the end of 2016.[5]

Indiana's Coastal Hazards

Processes and events that many consider to be "coastal hazards" are actually natural processes. These processes, such as fluctuating lake levels, wind and waves, and sand transport, only become hazardous when they affect human life and property. Because development has occurred directly adjacent to the shoreline, Indiana's coastal communities experience a number of coastal hazards. Many climate models project that annual precipitation and the frequency and intensity of heavy precipitation will increase in the region, which means that the intensity and frequency of hazardous events may increase.[6]

Figure 5: Winter storms are one of Indiana's coastal hazards.

Lake Level Fluctuations

The Great Lakes' lake levels have fluctuated naturally since the lakes' formation at the end of the Ice Age. Lake levels affect the extent of coastal flooding during storms, shoreline erosion and shoreline property damage, wetland acreage, accessibility of public access sites, and depth of navigation channels. There is a difference of 6.30 feet between the highest and lowest water-level elevation in Lake Michigan's recorded history, which began in 1860.[7]

Changing lake levels present challenges for protection of shoreline land-use types, including industrial,

residential, recreational and natural areas. When lake levels are low, navigation channels may become impassable, and public access points to the lake may become inadequate, e.g., fishing piers that no longer sit within the lake. Structures like seawalls or breakwaters have been constructed in the lake or along the coast to offer protection from high lake levels for industrial, residential and commercial developments. Shoreline structures like these contribute to the alteration of the shoreline by affecting sand transport, illustrating that what protects one area of the coast can negatively affect another.

Changes in climate influence Lake Michigan levels. Observed climate impacts to the Great Lakes region, including Indiana, are increasing average air temperatures[8], decreasing duration of ice cover as air and water temperatures rise,[9] and increasing frequency and intensity of heavy precipitation.[10] Because future basin-wide precipitation inputs and outputs are uncertain, future lake-level projections are uncertain. Therefore, decision makers should base decisions upon the range of high and low levels in the historical record and multiple lake-level/hazard scenarios.[11]

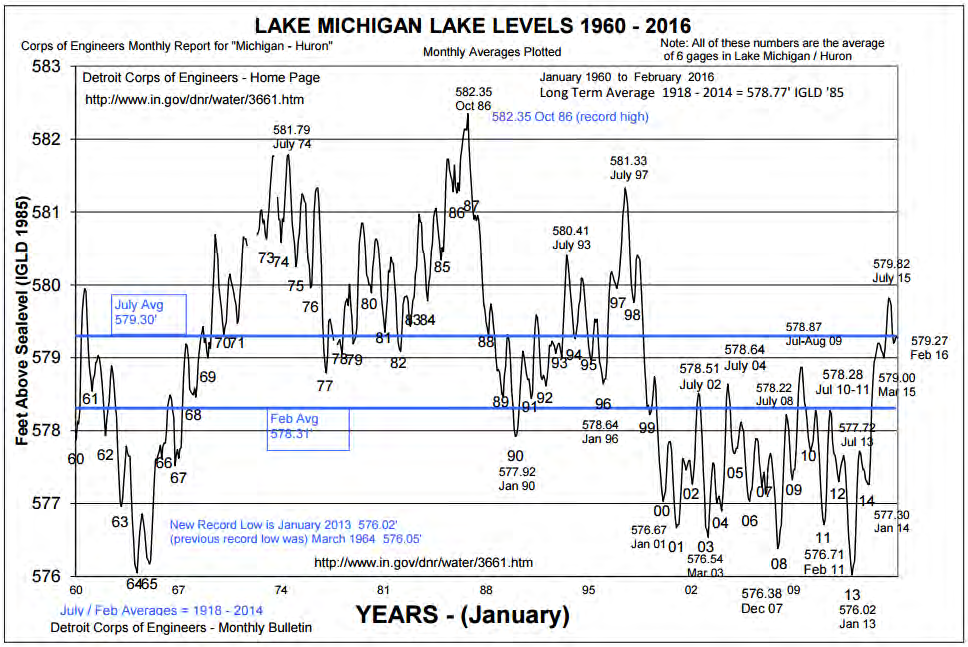


Figure 6: Lake Michigan Lake Levels 1960-2016[12]

Erosion

Wind and waves have shaped the southern shores of Lake Michigan over thousands of years and continue to do so. Waves and water currents move sand along the shoreline, balancing sand transport and sand deposition. Erosion is a complex process influenced by natural factors such as geologic characteristics of the shoreline, lake levels and weather patterns. In addition to this naturally occurring process, human influence along the shoreline must also be considered an element of coastal dynamics because we have greatly altered and hardened the shoreline.[13]

Coastal erosion can significantly increase when there are barriers to the natural sand transport (littoral drift) along the shore. Breakwalls have been built to keep sand from being transported naturally along the coast. At the same time, areas along the shore have been protected with hard structures such as bulkheads, seawalls or groins, preventing sand at the coastline from contributing to natural sand transport. Variable sand erosion (loss) and accretion (addition) rates occur along the coast because these structures have disrupted natural sediment transport patterns. As a result, significant erosion occurs in some areas and significant accretion follows in others. Coastal erosion is a serious problem for some of Indiana's coastal communities.

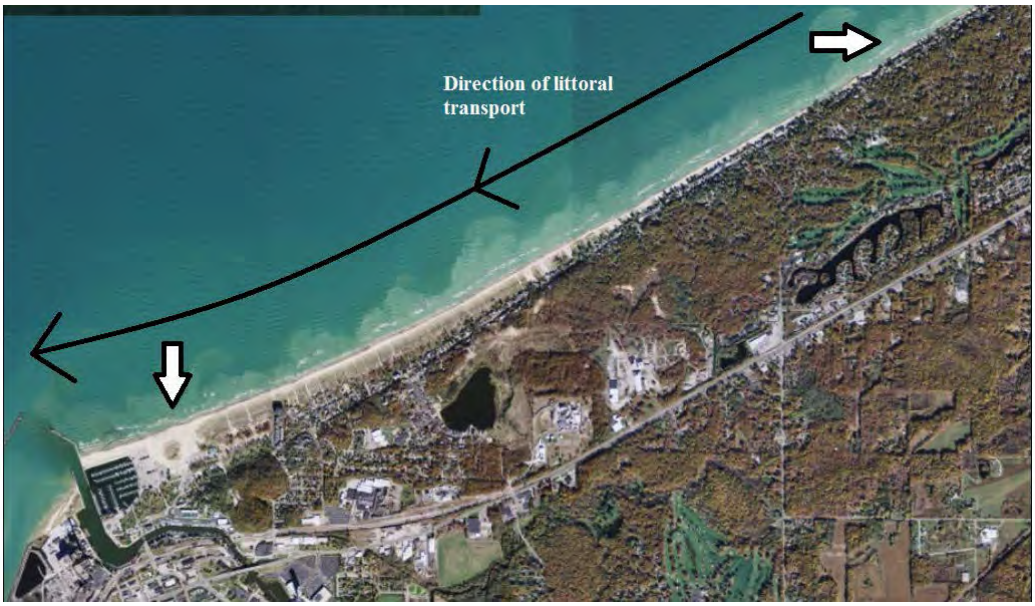


Figure 7: Shoreline structures can create areas of sand erosion and sand addition. This example depicts the area of sand erosion in Long Beach and the area of sand addition in Michigan City.[14]

Storms and Flooding

While storms are necessary for creating waves and currents that move sand along the coastline, severe storms can be detrimental. During storms, storm surges and high winds can cause property damage and beach erosion as a result of rough lake conditions and coastal flooding. Great Lakes coastal flooding is dependent upon local topographical characteristics, lake levels and extent of seasonal ice cover. Consistent coastal flooding can erode the coast's natural buffering system against waves and wind, creating a positive feedback loop that results in more severe flooding over time. Low-lying developments and developments that were built during periods of low lake levels without a proper setback based upon historical average lake levels are prone to coastal flooding. Heavy precipitation and runoff from inland areas within the coastal watershed can also cause coastal flooding or increase its severity. Surface runoff can contribute to water-quality degradation by providing a pathway for pollutants to enter coastal wetlands and Lake Michigan.[15]

Section II: Coastal Hazard Concepts

This section provides information about natural processes that can contribute to hazardous conditions in coastal areas and explains planning and management strategies that can minimize the impact of coastal hazards along Indiana's Lake Michigan shoreline.

Figure 8: Impacts to property and shoreline from Indiana's coastal hazards.[16]

Wave Dynamics

Wind generates waves by transferring some of the wind energy to the surface of the lake. The wind energy is stored in the form of waves moving across the surface; higher amounts of energy create larger waves. *Wave dynamics*—how wave energy moves throughout a body of water—is part of what shapes Indiana's coastline.

Breaking Waves

In deep water, little wave energy is lost from waves as they move across the lake's surface. When waves reach shallow areas near the coast, the stored wave energy is converted into *breaking waves* that are capable of eroding and transporting sand. The areas of the Indiana coast with the strongest and fastest currents—and the greatest volume of sand transport—are in narrow breaking-wave zones. These areas are concentrated around the edges of the lake starting in water depths between 18 to 20 feet and extending to the beach.

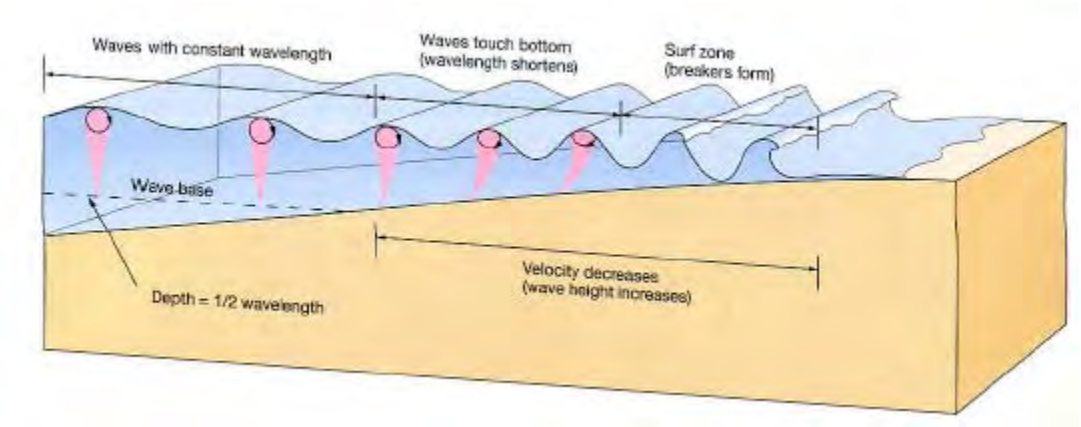


Figure 9: As waves reach shallow areas near the coast, wave speed decreases and wave height and steepness increases, resulting in a breaking wave.[17]

If waves approach the shore parallel to the beach, sand moves primarily onshore and offshore. If waves approach the coast at an angle, water currents move along the shore and carry sand in the direction the waves are moving. The orientation of the shoreline and the direction of waves both influence where beach erosion and sand addition occurs. In a natural setting, irregular shorelines are straightened by wave action over time. However, a high level of human influence, including shoreline structures and hardened shoreline, is present in northwest Indiana and complicates natural sand transport, beach erosion and sand addition patterns.

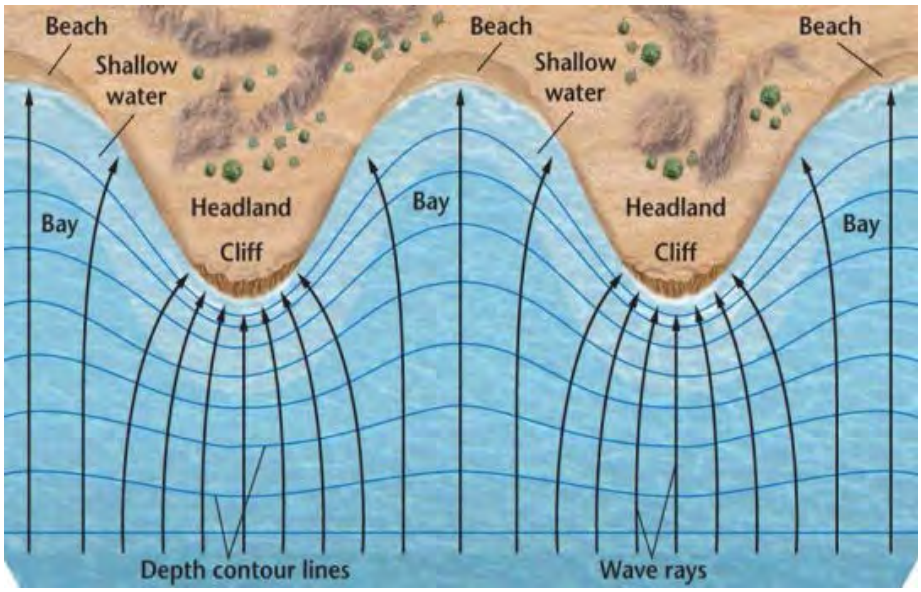


Figure 10: Wave energy is concentrated on the headlands (erosion) and dispersed in bays (accretion).[18]

Storm Surge

Most storms in the Great Lakes region, including the Indiana coastal area, move from west to east. As storm winds blow across many miles of open water on Lake Michigan, they pull some water toward the downwind side of the lakes. This phenomenon, known as *storm surge*, causes a temporary rise in water levels along the downwind shore and a lowering of water levels of the upwind shore. For example, as a storm moves from east to west, water is moved from the eastern side to the western side of the lake, causing the water level at the western side of the lake to rise (see Figure 11).[19] Storm surges typically last as long as storm winds are blowing onshore.

Figure 11: Water is pulled downwind resulting in a storm surge.[20]

Total Water Level = Storm Surge + Waves + Rivers + Other Additional Factors

Figure 12: The severity of coastal flooding depends upon a number of factors.[21]

Winter storms are frequent in northwest Indiana and are especially destructive compared to summer storms.

The seasonal difference in intensity causes a yearly cycle of more-narrow winter beaches and wider summer beaches. When the lake temperature is near freezing, lake ice starts to form—usually in December or January. Sometimes the lake ice complex that forms is as wide as the breaking-wave zone. This lake ice acts as a natural buffer between winter storm waves and the erodible beach. In years in which the temperature is too warm for lake ice to form, there is no natural protection for shoreline areas, and property and structures not built to handle winter storm waves may experience extensive damage.[22]

Seiche

A *seiche* is a standing wave that oscillates, or moves back and forth, in a lake as a result of strong winds and changes in atmospheric pressure that push water from one end of the lake to the other, creating huge changes in water levels. This phenomenon can be observed on a small scale when water sloshes back and forth in a swimming pool or cup of water.[23] Historically, some of the most deadly seiches in the Great Lakes have been reported on Lake Michigan; however, hazardous and deadly seiches are rare, and most seiches go unnoticed. In the Great Lakes, the "high" and "low" of a seiche can occur hours apart, and they are often mistaken as a storm surge. A big difference between a storm surge and a seiche is the addition of significant changes in atmospheric pressure that move the water back and forth.[24]

Beach Dynamics

As Lake Michigan formed by the advance and retreat of glaciers, dunes and beach systems began to develop at the southern end of the Lake Michigan basin approximately 12,000 years ago. The dunes present on the Indiana shoreline today are estimated to be 2,000 to 3,000 years old.[25] The coastline continues to transform in part through natural processes known as *beach dynamics*. Wind, waves and currents naturally transport sediment and sand along Indiana's coastline. Understanding these processes can lead to more informed decision-making about coastal-hazard mitigation by coastal communities.

Erosion

As discussed in Section 1: Introduction, *erosion* is a natural coastal process that can become hazardous when it creates barriers to natural sand transport and with the construction of structures too close to the shoreline. The amount of sand that is transported along the coastline depends upon sand availability, the size of the waves, and the duration of time waves are present to influence the direction of currents. The net direction of sediment movement is the direction that the largest volume of sand moves over a given period of time. From the Michigan state line to Gary, the net direction of sand movement along the coast is from east to west. From the Illinois state line to Gary, the net direction of sand movement is from west to east. The sand converges in the Gary area because the strong winds typically blow out of the north and create waves that run

into the northeast-by-southwest-oriented shoreline of east Gary and the northwest-by-southeast-oriented shoreline of west Gary.

The average background erosion rate for the Great Lakes is 3 feet annually, but erosion rates vary considerably between localities. For example, the background erosion rate for Mount Baldy in Michigan City is about 10 feet annually. In order to adequately plan for coastal development and plan for coastal hazards, long-term erosion rates for a specific location can be found by averaging the historical episodes of high and low erosion rates. This average should provide a fairly accurate baseline estimate of future background erosion rates.

Source: Christin Nance Lazerus, Post-Tribune

Figure 13: Erosion threatens the Portage Lakefront and Riverwalk.

High Erosion Hazard Areas

A *High Erosion Hazard Area* (HEHA) is a segment of shoreline with a long-term erosion rate greater than 1 foot annually, as determined by the State. The Indiana lakeshore of Lake Michigan includes several HEHAs; however, many of the areas are currently protected from erosion by man-made structures or are included in the Indiana Dunes National Lakeshore or Indiana Dunes State Park, where the natural shoreline is preserved.

HEHAs identified in LaPorte County include areas in Michiana Shores and Long Beach, east of Michigan City. This segment of shoreline is armored with a rock revetment to protect Lake Shore Drive and seawalls built by private homeowners. West of Michigan City, portions of the shoreline are owned by Indiana Dunes National Lakeshore. Areas such as Crescent Dune and Mount Baldy are preserved as natural shoreline. In these areas, nonstructural methods of mitigating erosion, aka beach nourishment, have been used periodically during the 1970s through the 2010s. In 2014, the National Park Service (NPS) was granted approval to create a restoration plan that includes annual beach-nourishment activities.

In Porter County, HEHAs along Indiana Dunes State Park are also maintained as natural shoreline. To the west, a short segment of property contained within the Town of Porter is designated as a HEHA. Continuing west, the entire shoreline within the Town of Dune Acres is designated as a HEHA, but only a small portion of shore is left unprotected by hard structures. West of the Portage-Burns Waterway, less than 1 mile of

shoreline is designated a HEHA. Most of this area is either protected by a breakwater, preserved by the National Lakeshore, or protected by hard structures built by private property owners in Ogden Dunes. In 1997, the easternmost homes of Ogden Dunes were further protected by a new seawall built by the State of Indiana.

In Lake County, very little shoreline is designated as a HEHA. This is largely because of extensive shore structures that protect industrial areas along the shore. The easternmost segment of Lake County shoreline near Wells Street Beach is designated as a HEHA.

Accretion

Accretion is the gradual enlargement of land through the deposition of sand upon a beach. The shoreline along Gary's coast is an area of natural accretion due to the orientation of the shoreline and the direction of the lake currents. In areas of natural accretion, there is no need for man-made erosion-control structures or beach-nourishment activities because the abundance of sand naturally repairs any damage to the beach caused by storms. In areas of artificially high erosion, accretion may not be able to fully restore the original volume of beach after a storm. Without intervention, beach loss will result over time.

Beach Nourishment

An alternative non-structural erosion-prevention method is feeding sand from another shoreline, offshore area or inland source onto the beach. This process is known as *beach nourishment*. Beach nourishment works by supplying the sand where it is needed for waves and currents to rebuild and maintain the natural protective beach and sandbar system. This natural buffering system can protect against future erosion, property damage, and loss of recreational areas. In practice, beach nourishment must be undertaken on a regular schedule because the areas in which it is needed are sand-starved due to permanent stressors such as man-made structures like breakwalls and groins. Eventually the beach-nourishment sand is carried completely downdrift.

Beach-nourishment activities are encouraged through the Sand Nourishment Fund established by IC 14-25-12. However, this fund currently does not have a designated, regular source of revenue. That makes finding funding for beach-nourishment projects challenging. In addition to the previously discussed beach-nourishment activities taken on by the NPS, Northern Indiana Public Service Company (NIPSCO) frequently dredges sand at its Bailly Plant facility, bypasses 75 percent to Ogden Dunes and back-passes 25 percent to Beverly Shores.

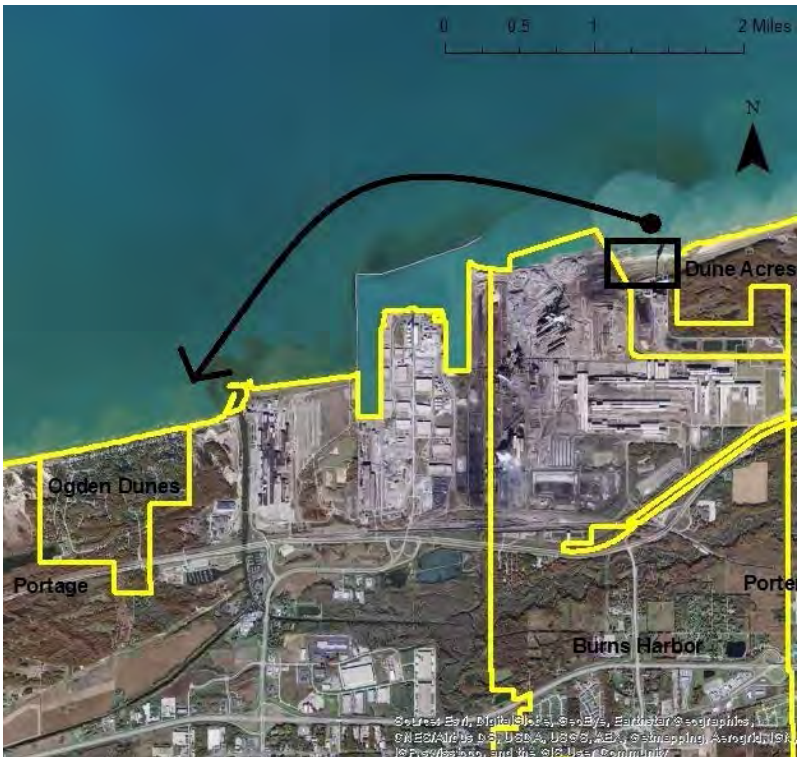


Figure 14: Sand is dredged from the Bailly Plant and is deposited at the sand-starved Ogden Dunes shoreline[26]

Beach Structures

Parallel

While parallel shoreline structures do not stop sand from moving between reaches, they increase erosion rates in adjacent areas. These shoreline-hardening structures prevent erosion that would have normally contributed sand necessary to maintain natural buffers like wide beaches and offshore sandbars. The result is sand-starved conditions in front and downdrift of the structure.[27]

Revetment

A *revetment* is a sloping structure designed to protect the banks of a coastline against waves and currents. It is a hardened protective layer that is built to endure years of wave energy. Fabric, quarry stone and concrete are common building materials. The more gentle the slope, the less scour that is likely to occur at the lakebed. However, gentle slopes are not as effective as steep slopes at preventing waves from overtopping the structure. Even gentle sloping revetments are too steep for recreational activities and the landing or hauling of small boats. These structures should not be used in areas where the beach is used for recreation.

Figure 15: An example of a concrete, gently sloping revetment.

Seawall

Seawalls, also known as bulkheads, are vertical structures that are designed to protect the land and property behind the wall from wave damage and to prevent land from sliding onto the beach or into the water. Seawalls are gravity structures that rely upon their own weight and bedrock anchors to maintain their vertical position. These structures are often found at locations of exposed city fronts where erosion protection is needed and space is scarce. They are often built as solid structures to reflect wave energy, but this leads them to be more vulnerable to scour and erosion than revetments because they are vertical and reflect more wave energy. It is not uncommon for the beach to disappear entirely in front of a seawall after a number of years, requiring the strengthening of the foot of the seawall with another structure like a revetment. The use of undersized stone to anchor the structure may also contribute to storm damage. This problem was observed at the Whiting Lakefront Park after a strong storm in October 2014.

Figure 16: A seawall is built to protect property and land from wave erosion.

Perpendicular

Perpendicular shoreline structures can partially restrict or completely block sand transport between reaches. Structures extending beyond the breaking-wave zone block nearly all sand movement. The sand located in this closed reach may move back and forth within the reach, but it cannot pass around the structure. Smaller structures that do not extend beyond the breaking-wave zone only partially block sand transport to other reaches because sand can leak around the end of the structure.[28] Extreme erosion can occur on the downdrift side of perpendicular structures.

Jetty

Jetties are stabilizing structures built at inlets. These structures prevent the transport of sand across the inlet and keep channels at navigable depths for watercraft. Jetties are commonly constructed from stone or sheet piling. Recreational piers are sometimes built on top of jetties.

Breakwater

Breakwaters are structures built to protect harbors, navigation channels, and areas with homes or businesses close to the shoreline. These rubble-mound structures reduce the amount of wave energy affecting the sheltered area. The rock or concrete on the outside of the structure absorbs most of the energy, and gravel at the core prevents the wave energy from continuing through the structure.

Figure 17: Jetty (forefront) and breakwater (background) at the Portage Lakefront and Riverwalk.

Groin

A *groin* is a shoreline structure that is meant to intercept the longshore transport of sand and widen the beach on the updrift side of the groin. Groins are usually shorter than jetties and are built to change the pattern of beach erosion, rather than for navigational purposes like jetties. Boulders, concrete, steel and wood are common building materials.

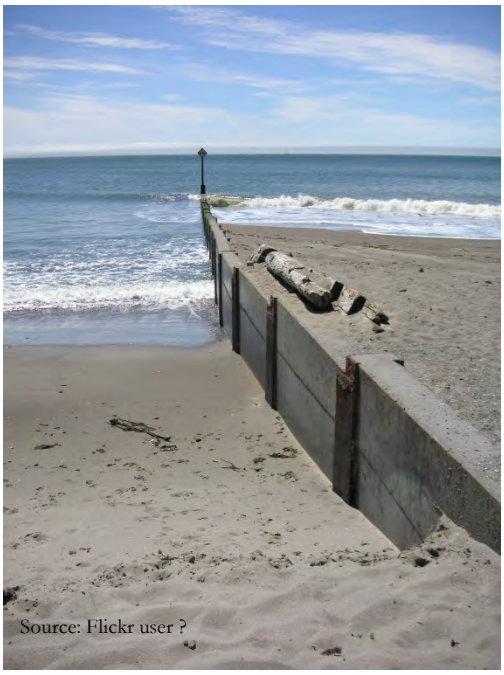


Figure 18: Extreme erosion can take place on the downdrift side of the groin as accretion takes place on the updrift side of the groin.

Systems Approach to Geomorphic Engineering (SAGE) and Living Shorelines[29]

Systems Approach to Geomorphic Engineering (SAGE) promotes the use of both green (natural and nature-based) and gray (hard, structural engineering) approaches to make coastal areas more resilient. The SAGE community of practice, led by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Corps of Engineers, is a collaborative effort among federal and state agencies, nonprofits, academic institutions, private businesses and engineering firms. By sharing information about using natural systems and hybrid green and gray systems, the SAGE community of practice focuses on helping communities develop affordable, integrated solutions to coastal hazards and shoreline protection. The goals and principles of SAGE are:

- Understand impacts on people and nature along coastline
- Advance landscape-scale solutions to coastal resiliency
- Protect and enhance natural coastal features when appropriate
- Collaborate with both public and private sectors
- Develop innovative techniques and solutions to adapt coasts
- Share science, tools and demos to inform best practices
- Apply lessons learned both domestically and internationally

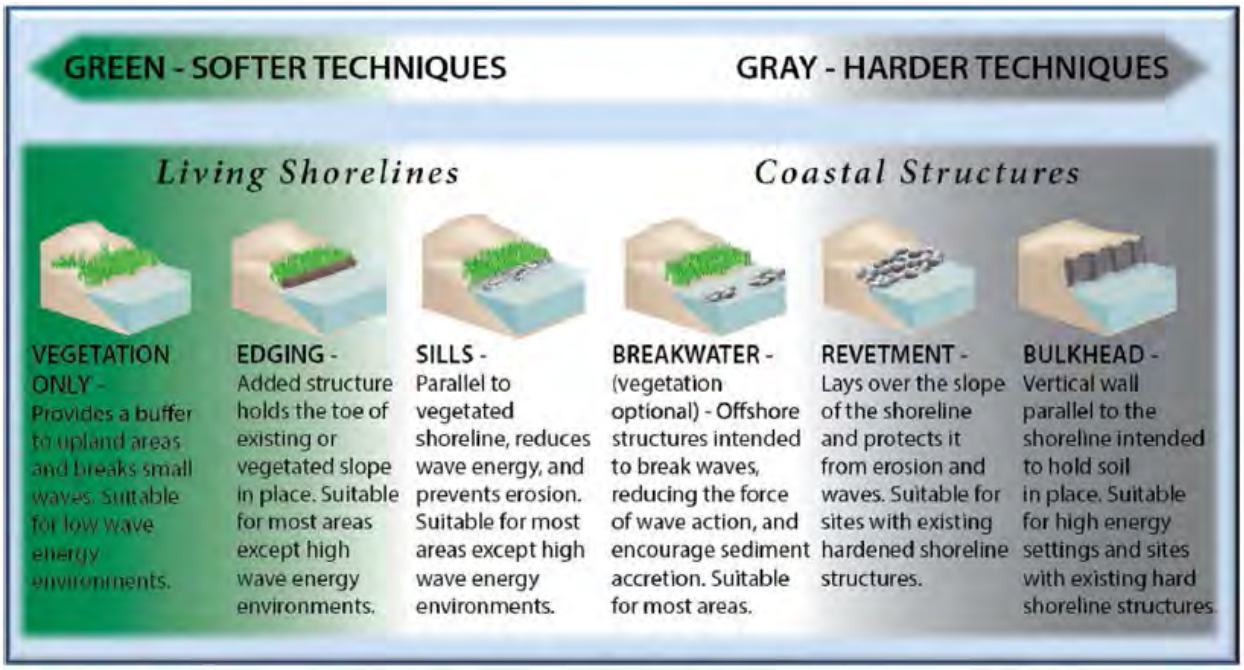


Figure 19: The SAGE continuum of green to gray shoreline stabilization techniques.[30]

Included within the SAGE coastal engineering approach are *living shorelines*. This shoreline stabilization technique uses soft, nature-based elements like native plants and materials and less rock and hard structures that cause extreme erosion. Living shorelines achieve multiple goals such as:

- Stabilizing the shoreline and reducing current rates of shoreline erosion and storm damage
- Providing ecosystem services, such as habitat for fish and other aquatic species, and increasing flood-storage capacity
- Maintaining connections between land and water ecosystems to enhance resilience

NOAA encourages the use of green, softer techniques to stabilize shoreline wherever possible. Living shorelines work best in areas with a sheltered shoreline but are not appropriate for areas with high wave energy. Physical site conditions, balance between gray and green elements, maintenance for gray and green structures, and proximity to buildings and infrastructure are important considerations in determining what type of shoreline structure is most appropriate for a given area.

Figure 20: The image on the left shows an existing shoreline, and the image on the right shows what it could look if it were redesigned as a living shoreline.[31]

Setbacks

The purpose of a *setback* ordinance is to maintain a buffer between private structures and natural habitat areas. Setbacks help to ensure minimal property damage because development is not allowed in areas likely to be affected by coastal hazards. Examples of such places are exposed beach and foredune. The setback distance helps protect stabilizing native vegetation and habitat from construction disturbance, stormwater runoff and vehicle traffic. It also protects property owners from erosion and sand that can shift and cover structures. In Indiana, each municipality can enact setback requirements as part of its municipal code. However, only two communities, Michigan City and Long Beach, have enacted coastal-setback ordinances. One of the goals of the Marquette Plan for Indiana's Lake Michigan shoreline is to establish a minimum setback from the lake's edge of 200 feet.[32]

Exposure, Vulnerability, and Risk[33]

Colloquially, hazard and risk are often used interchangeably. However, from a technical planning and management perspective, *risk* is the likelihood of harm caused by a hazard. Coastal hazards are usually the main driver of risk, but risk is also strongly influenced by socio-economic conditions along the coastline. A simple expression for coastal hazard risk is:

Risk = Hazard x Vulnerability x Exposure

A *hazard* is the physical manifestation of a natural event (may occur in connection with human influence). Examples include the hazards discussed in Section I—fluctuating lake levels, erosion, storms and floods.

Vulnerability refers to the lack of capacity of an ecosystem or community to recover from or absorb adverse impacts from a hazardous event. It is greatly influenced by social factors. Factors that determine vulnerability include the level of affluence of a community, the quality of community awareness and hazard planning, and the capacity of the local government and nonprofit community to respond to hazards.

Exposure refers to the ecosystems, assets and lives that can be harmed by hazards. There is no risk where there are no lives or property that can be harmed; therefore, land-use planning is crucial to minimizing the level of exposure and risk. Exposure can be reduced if proper zoning and development policies are put in place and enforced. Examples of these policies are provided in Section IV.

All-Hazards Approach

This planning philosophy emphasizes that there are many different coastal hazards. The probability of a specific hazard affecting a property or community is hard to determine, so it is best to consider the risk associated with a variety of different hazards. *All-hazards planning* does not mean that a manager must plan for every possibility. It instead means that he or she conducts risk analyses for different hazard types and

develops the capacity to handle multiple hazards at one time. In light of limited local government resources, it is best to prioritize planning for the hazards that present the greatest risk.[34] The State of Indiana, Lake County and Porter County each have a multi-hazard mitigation plan.

Resilience and Sustainability

The concepts of resilience and sustainability are emerging priorities in natural-resource, land-use and community-development planning at the federal, state and local level. While these terms are familiar to many land managers, planners, elected officials and citizens, their real-world application remains limited in many communities, including those within Indiana's coastal area.

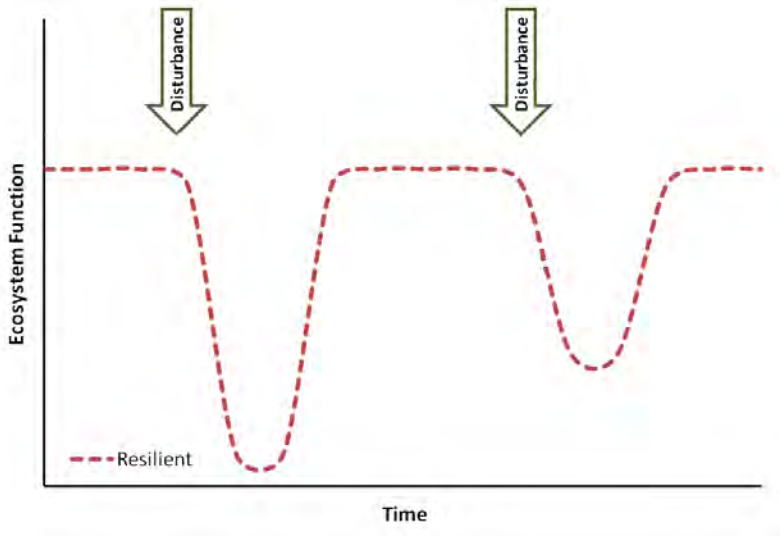
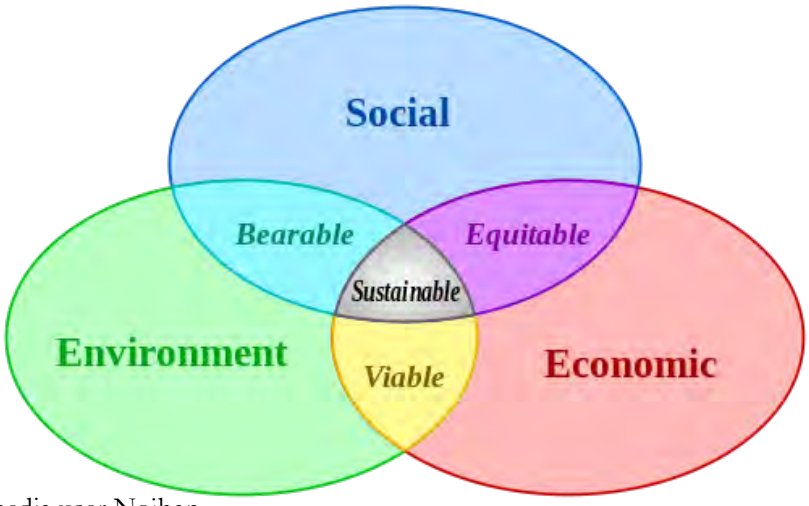


Figure 21: A resilient system is one that is able to recover after a disturbance.[35]

Resilience refers to the ability of an entity to resist or recover from damage. A community's or development's level of resilience is determined by how much stress or damage it can cope with before its ability to properly function is degraded.[36] In addition to factors like topography and geology, the level of resilience depends upon social factors such as community cohesion and connectedness, and availability of information about the local ecosystem and its needs. Resilience is an important part of sustainable communities. For example, the Community Rating System (CRS) is a proxy for a community's level of resilience to flooding. The better a community scores on CRS floodplain-management criteria, the greater the rate of reduction in flood-insurance premiums for policyholders within the community. Thus, building resilient communities isn't just good for the environment. It is good economic practice.[37]

People often associate *sustainability* with environmental issues, but it actually refers to a wide range of socio-economic issues that affect a community's ability to persist and improve. Often, communities draw a box

around natural things to preserve—wetlands, trees, dunes, etc.—but fail to consider how human activity adjacent to the box affects an area's resilience.[38] Resilience, and ultimately sustainability, of coastal communities and development increases when natural buffering systems are functioning at a high level. Comprehensive planning and implementation of smart growth policies can aid community sustainability and coastal resilience.



Source: Wikipedia user Nojhan

Figure 22: The components of sustainable development.

No Adverse Impact[39]

Current national standards for floodplain management allow development activity to negatively affect adjacent users within a watershed through activities such as the diversion of floodwaters onto other properties and the changing of an area's hydrology. Many local governments assume that the minimum National Flood Insurance Program (NFIP) standards provide acceptable flood protection and also allow themselves to become financially disconnected from the consequences and impacts of their land-use decisions. The result is that the burden of those impacts—increased flood damage—is transferred from those who make and benefit from the local decisions about land use to those who pay for the flood damage, primarily the federal taxpayers. Some communities' own actions may be intensifying the potential for coastal flood damage. Traditional floodplain-management strategies will result in continually rising costs over time, are not equitable to those whose property is affected, and have been shown to be economically and environmentally unsustainable. Furthermore, development activities that divert flows onto other properties and negatively affect them are generally not supported by the court system.

No Adverse Impact (NAI) Floodplain Management is a managing principle that has been developed and promoted by the Association of State Floodplain Managers. It gives communities a way to promote responsible

floodplain development through local instead of federal decision making. Ideally, each community or watershed will assemble a comprehensive development plan that identifies acceptable levels of flood impact, specifies appropriate measures to mitigate those adverse impacts, and establishes an implementation plan. Under NAI management principles, the actions of one property owner are not allowed to adversely affect the rights of other property owners. This strategy can allow communities to reduce their potential for common law liability because they can demonstrate that they have taken reasonable precautions regarding flooding. NAI limits the potential for lawsuits involving private landowners who have experienced increased flooding/erosion damage on their property and municipalities that allowed construction and permitting of the development that caused the damage.

Section III: Indiana's Lake Michigan Shoreline Communities

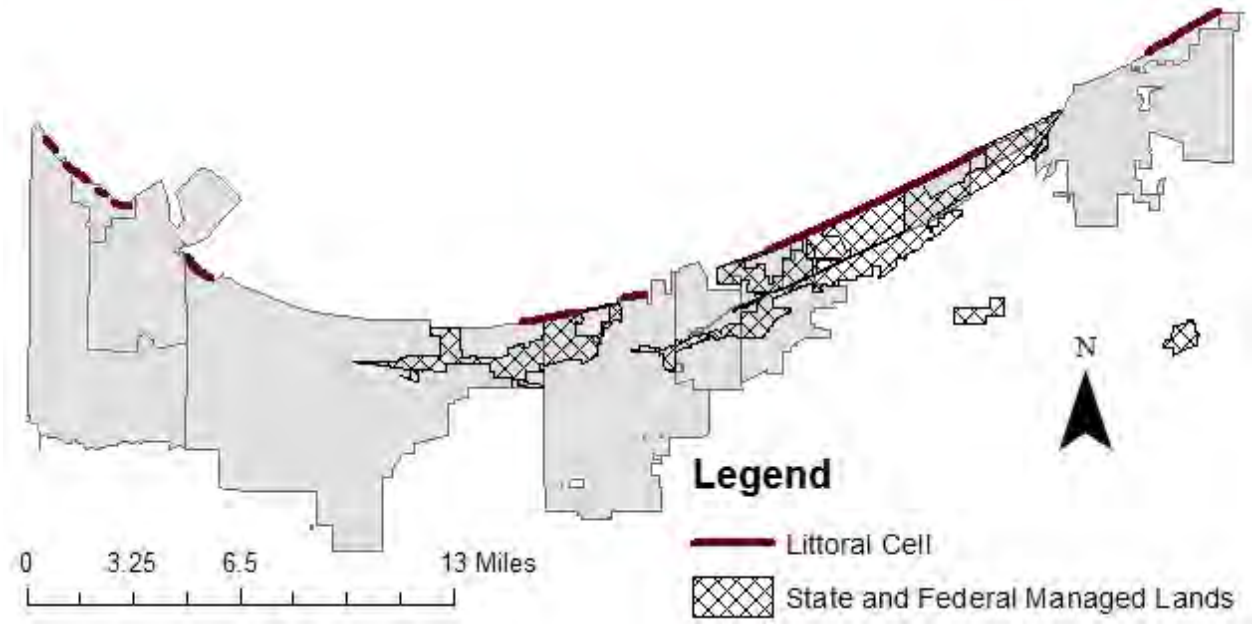


Figure 23: Nine closed littoral cells exist along the shoreline

Thirteen Indiana municipalities border Lake Michigan. Indiana Dunes National Lakeshore and Indiana Dunes State Park are also located along the coast. Nine closed littoral cells exist along the Indiana shoreline. A *littoral cell* is a closed compartment in which sand may move back and forth but cannot escape. Littoral cells are created by man-made structures described in Section II: Coastal Hazard Concepts. Moving east to west, the nine cells are located at:

- Hammond Lakefront Park, Bird Sanctuary and Marina
- Whihala Beach
- Whiting Lakefront Park
- Whiting Beach
- Jeorse Beach and Gary Beach
- Miller Beach area and West Beach
- U.S. Steel Midwest Plant
- Indiana Dunes State Park
- Long Beach/Duneland Beach

Each of the following northwest Indiana communities is vulnerable to shoreline hazards. Most have already experienced damages due to such hazards. This section provides an overview of the physical shoreline characteristics and structures that are present in each community to aid decision-makers in making policy and planning. Unless otherwise noted, municipalities have not yet adopted coastal-hazard ordinances detailed in Section IV. All aerial-view maps in Section III were created by using a file geodatabase produced for the Lake Michigan Coastal program by 39°N and a world imagery basemap sourced by Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, United States Department of Agriculture, United States Geological Survey, AEX, Getmapping, Aerogrid, Institut Géographique National, IGP, swisstopo, and the GIS User Community.

Hammond

Figure 24: Aerial view of shoreline structures in Hammond.

The City of Hammond has 7,650 feet of shoreline, nearly all of which is protected by structures such as seawalls, breakwaters, riprap and rocks. The Hammond Lakefront Park and Bird Sanctuary is located just to the west of the Hammond Marina. The City of Hammond acquired this property from NIPSCO in the early 1990s. When the Hammond Marina was built, dredge material was placed along the shoreline, lakeward of the bird sanctuary, as beach nourishment. Erosion of this material carried a portion of this sand northwest, forming a beach next to the Commonwealth Edison State Line Generating Station's southeast breakwater. A closed littoral cell exists at the Hammond Lakefront Park and Bird Sanctuary between the energy facility and the Hammond Marina. The Hammond Water Filtration Plant is at the southeast edge of Hammond's shoreline. The Lake County Parks and Recreation Department has built a fishing pier extending into Lake Michigan from the lakeward end of the filtration plant.

Whiting

Figure 25: Aerial view of shoreline structures in Whiting.

The City of Whiting has 2,500 feet of rock revetment-protected shoreline and a 720-foot stretch of natural shoreline at Whihala Beach. The recently restored revetment at Whihala Beach was damaged by a strong storm in October 2014, demonstrating the damage inflicted by increasingly severe storms and wind. The southeastern portion of Whiting's Lakefront Park is home to the Whiting/Robertsdale Boat Club and has a breakwater and a jetty that protect the staging basin from storm waves but prevent sand transport. Occasional maintenance dredging is required, and some of the sand is used as beach nourishment at Whihala Beach, to the northwest. West of the fishing pier and launch basin, a rock revetment protects the City of Whiting Park parking lot. BP Amoco owns a number of facilities along the shoreline just southeast of the beach and park. A revetment protects BP Amoco's water treatment plant, which is built out into Lake Michigan on lakefill. Beaches are located between the Lakefront Park and the water treatment facility, and between the water treatment facility and the Indiana Harbor complex. Both beaches are closed littoral cells, hardened by rock revetments.

East Chicago

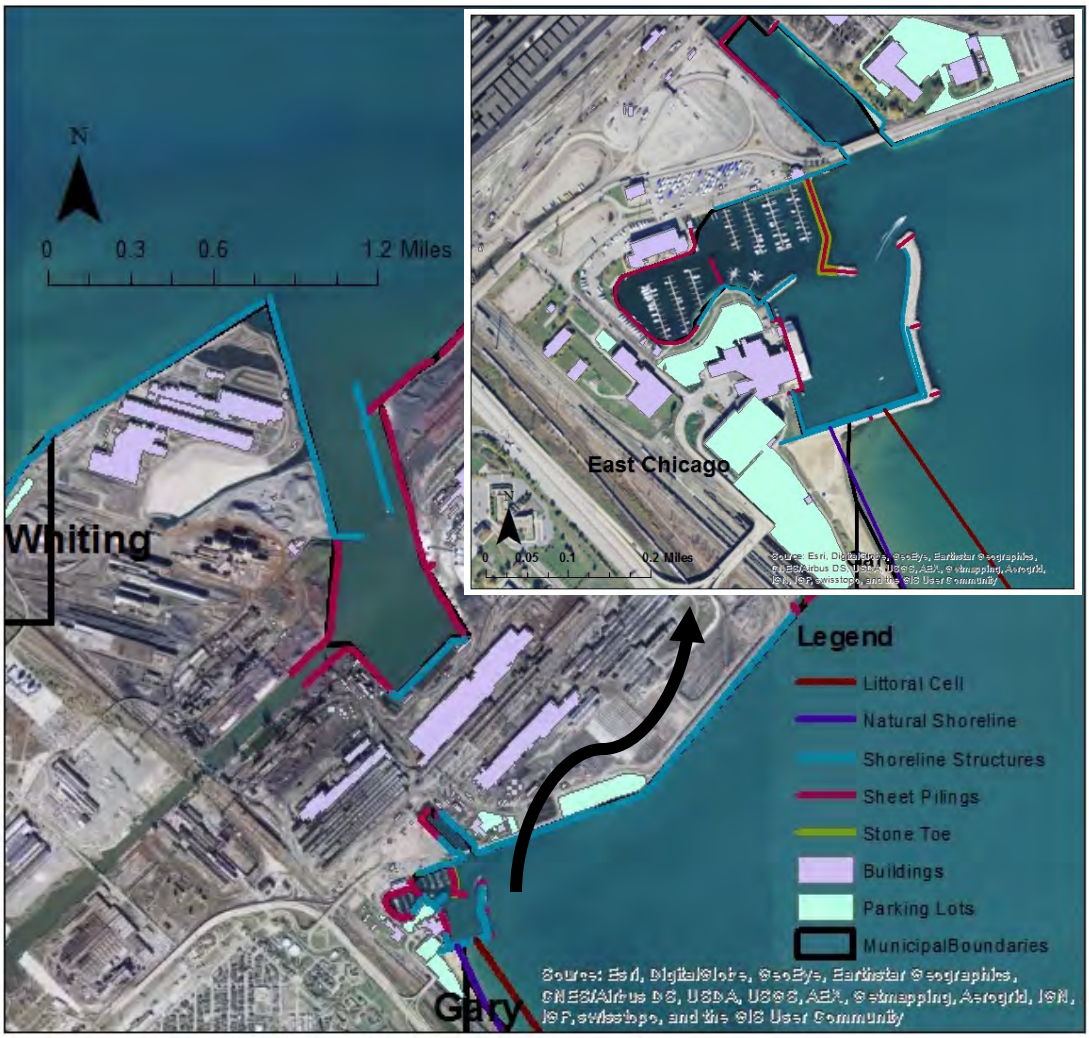


Figure 26: Aerial view of shoreline structures in East Chicago.

A majority of East Chicago's shoreline is at the Indiana Harbor and Ship Canal lakefill complex. The complex has 37,850 feet of hardened, man-made shoreline and extends 2.65 miles into Lake Michigan. This area is heavily industrial. The East Chicago marina basin and boat-launch facilities are on the southern portion of the complex. The east side of the marina basin is formed by the west side of the Ameristar Casino and Hotel gaming-boat facility and a 300-foot rock-stub breakwater attached to the shoreline of the park. The stub breakwater forms the south side of the entrance channel to the marina basin. The north marina basin wall is formed by a rubble-mound breakwater that is attached to the Indiana Harbor complex to the west. A second outer breakwater surrounds the marina, creating a large outer basin to house the gaming boat. This southeast breakwall extends 1,000 feet into Lake Michigan. The wall turns west and extends 1,000 feet northwest, forming the main wave-protection structure of the new basin. The outer

entrance channel is formed between the west end of the new main breakwater and the Indiana Harbor lakefill complex.

Jeorse Park Beach is located just southeast of the Ameristar grounds. The beach has been expanded using dredge material from the basin construction activities. The Jeorse Park working group is exploring options to restore the beach and associated water quality. Small changes to these structures may help correct water circulation and stagnation problems within this stretch that are thought to be linked to high levels of e-coli from bird waste.

Gary

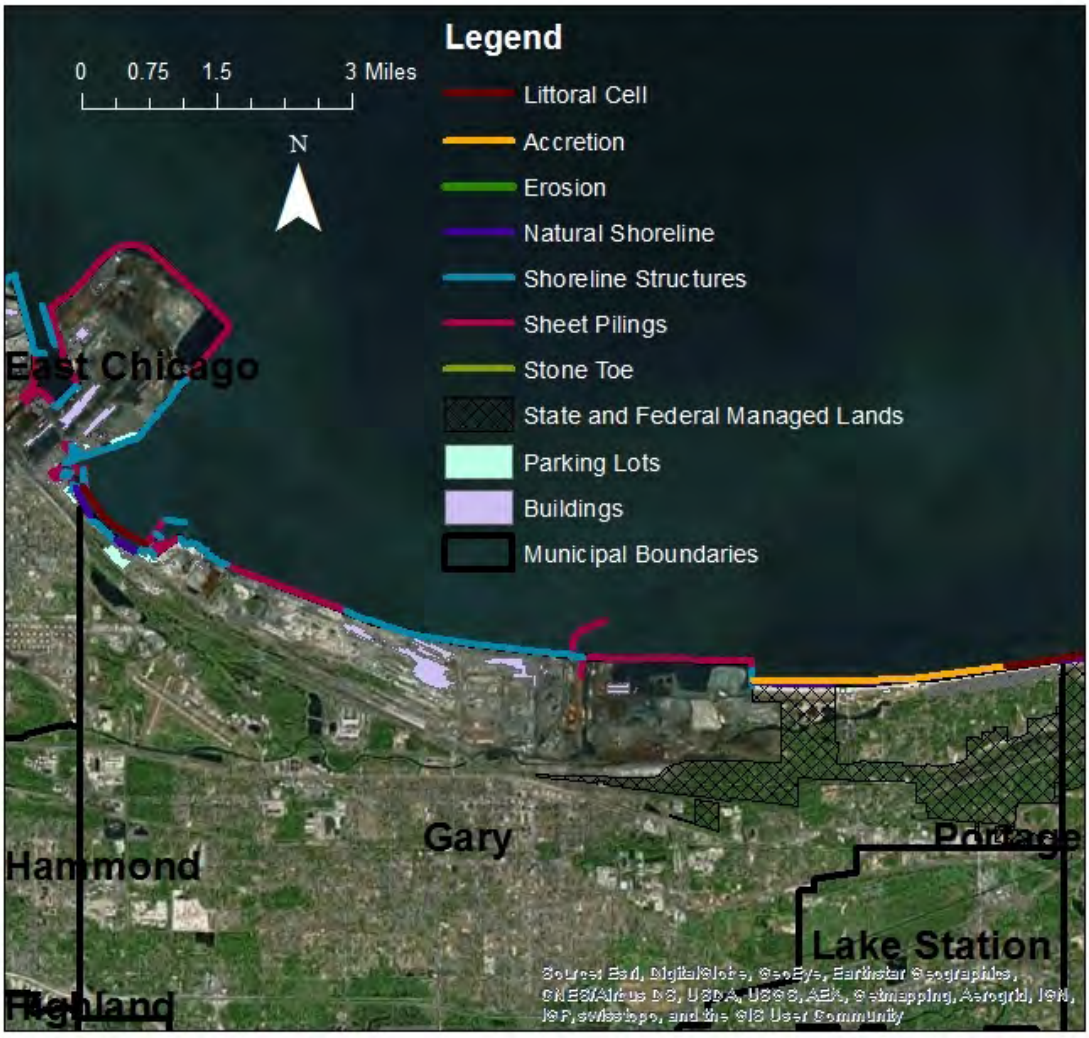


Figure 27: Aerial view of shoreline structures in Gary.

The City of Gary has more than 40,000 feet of hardened shoreline. At the western edge of the Gary shoreline, just east of the Buffington Harbor rubble-mound breakwater, no sand is available for transport because of the U.S. Steel lakefill that has both rock revetments and sheet piling. The natural net movement of sand would be eastward, but the man-made shoreline structures prevent normal erosion and natural sand transport.

Part of Indiana Dunes National Lakeshore, 2,750 feet of natural shoreline, is within Gary. The City of Gary owns the length of shoreline east of the National Lakeshore. The eastern portion of Gary's shoreline beginning at Wells Street Beach and extending to Montgomery Street is fronted by private property in the

Gary neighborhood of Miller; however, the beach area is owned by the City of Gary. This area of the shoreline along the National Lakeshore and Miller neighborhood has wide beaches due to the breakwall of the U.S. Steel complex, which traps the westward moving sand. Wells Street Beach area in Gary, located just west of the Lake-Porter County line, is the only portion of this area that suffers from erosion.

Ogden Dunes

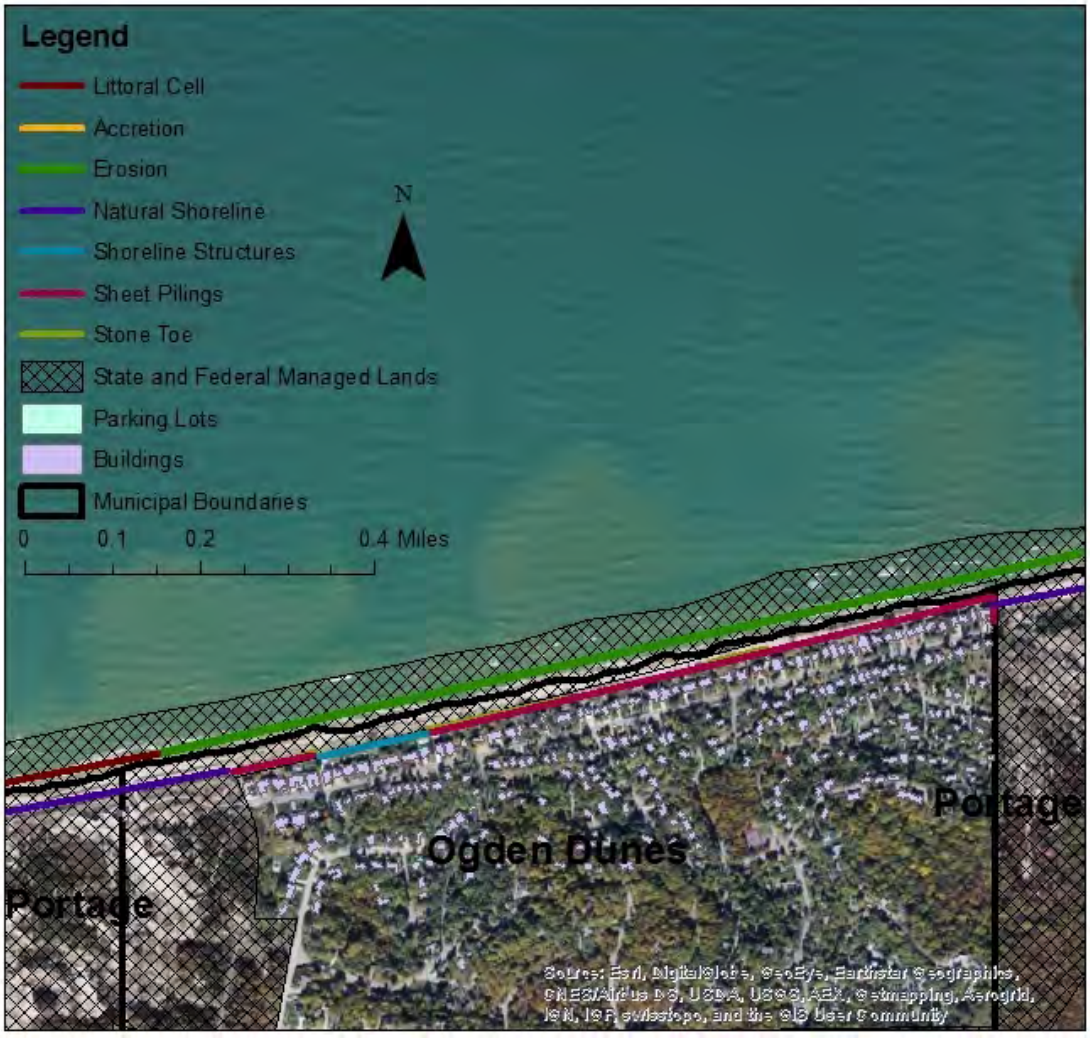


Figure 28: Aerial view of shoreline structures in Ogden Dunes.

The Town of Ogden Dunes is in a high-erosion area and is severely sand-starved. As a result, erosion-prevention structures have been built along the entire length of shoreline, except for the farthest west portion, Indiana Dunes National Lakeshore property, where there are no houses. There is little public parking in Ogden Dunes, but the town has a "walking agreement" with the National Lakeshore that allows visitors to pass through along the shoreline. The residential properties in Ogden Dunes have armored the shoreline with vertical steel sheet-piling walls. Stone toe protection was added on the lakeward side of any seawalls. In 1997, a second steel seawall was built 19 feet north of the existing walls because of concern that the old wall might be undermined from high lake levels, waves and excessive toe scour of the lake bottom in front of these walls. A portion of this newer wall does not have any stone toe protection, which will likely

lead to scouring. Beach nourishment is periodically provided by NIPSCO. Sediment dredged at the Portage-Burns waterway is used to nourish the sand-starved beach. Nevertheless, erosion is a constant issue in Ogden Dunes. No permanent solution has emerged.

Portage

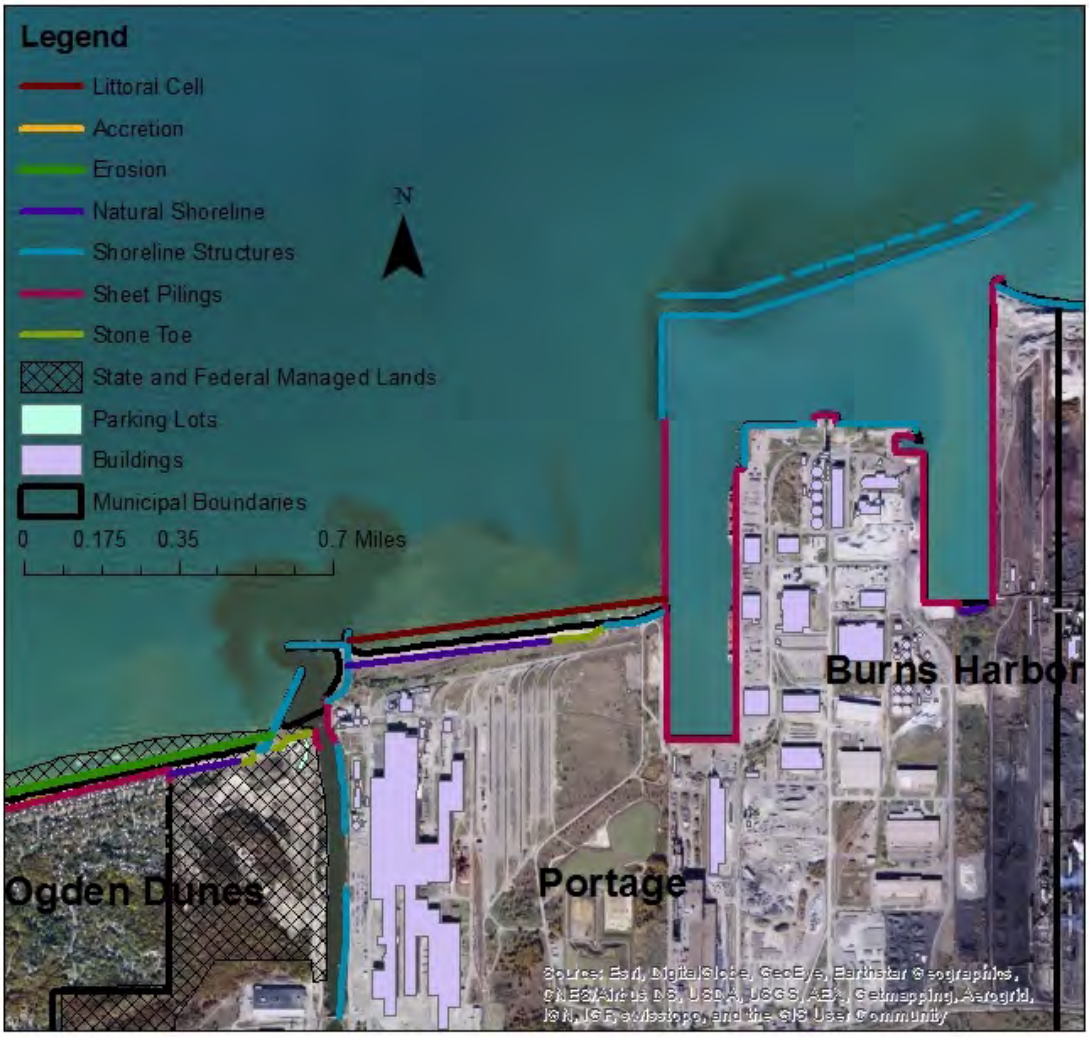


Figure 29: Aerial view of shoreline structures in Portage.

The City of Portage's shoreline is partially natural and partially hardened. The western portion of the city's shoreline is home to the Portage Lakefront and Riverwalk at Indiana Dunes National Lakeshore. A jetty with a pier and a breakwater protect the entrance to the Portage-Burns Waterway. An unprotected beach is located between the jetty and Ogden Dunes' erosion-control structures. This beach suffers from extreme erosion. The eastern portion of Portage's shoreline is a closed littoral cell offshore of the Burns International Harbor complex and U.S. Steel facilities. The port structures extend around 2,000 feet into Lake Michigan and prevent the natural westward movement of sand.

Burns Harbor

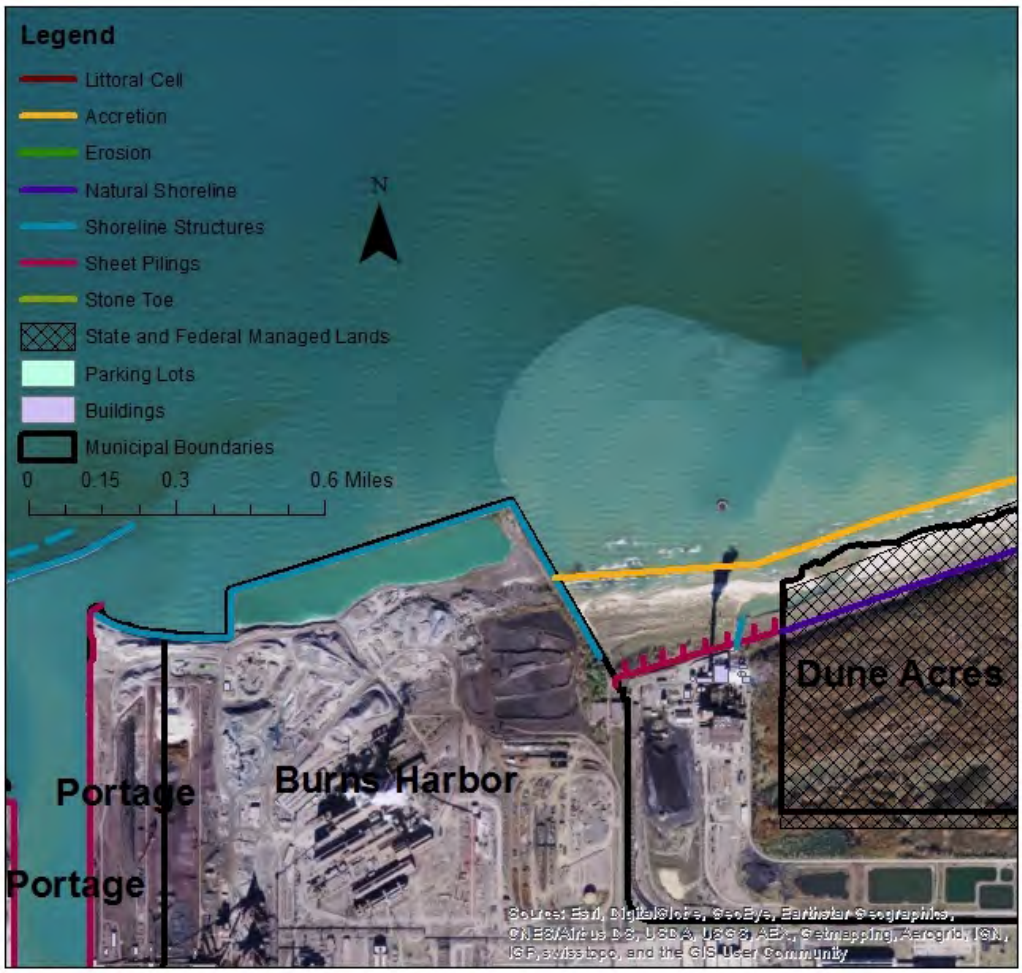


Figure 30: Aerial view of shoreline structures in Portage.

ArcelorMittal and the NIPSCO Bailly Generation Station are located along the Town of Burns Harbor's coast. The eastern breakwater, oriented perpendicularly to the shore, extends 2,000 feet into Lake Michigan. There is a northern breakwater enclosing Lake Michigan waters that previously served as a permitted lakefill disposal site for slag. West of this breakwater is 1,500 feet of man-made shoreline forming the south side of the entrance channel to Burns International Harbor. On the north side of the entrance channel is a federally owned, northern rubble-mound breakwater that protects the harbor basin from north storm waves. A series of submerged breakwaters was completed in 1998 lakeward of this main breakwater to reduce the size of storm waves affecting the harbor structure. The beach lakeward of the NIPSCO facility is an area of accretion because sand being naturally transported west is trapped by the perpendicular breakwater. The lakebed must be periodically dredged, and this sand provides beach nourishment for the Ogden Dunes shoreline.

Dune Acres

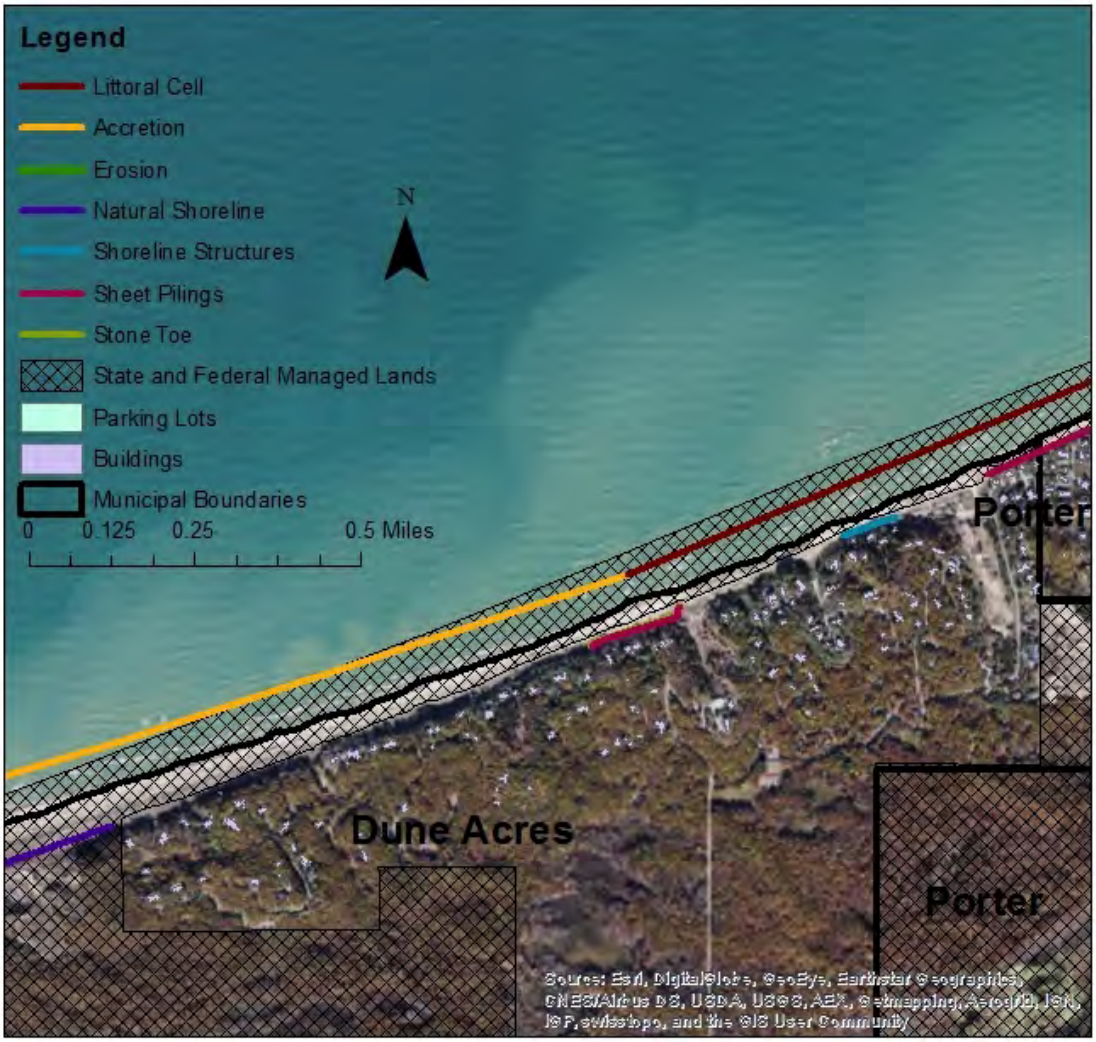


Figure 31: Aerial view of shoreline structures in Dune Acres.

Largely surrounded by Indiana Dunes National Lakeshore, the Town of Dune Acres' land next to the shoreline is entirely residential and recreational. Even though it is located in an area where sand accumulates, it has a combination of vertical sheet-piling walls and rock revetments to stabilize parts of its shoreline. The breakwater at the east side of the Port of Indiana so effectively stops sediment from moving westward along the shoreline that the accumulated sediment has buried a steel sheet-piling wall and a series of perpendicular groins that were constructed at NIPSCO before the Port of Indiana was in place.

Porter

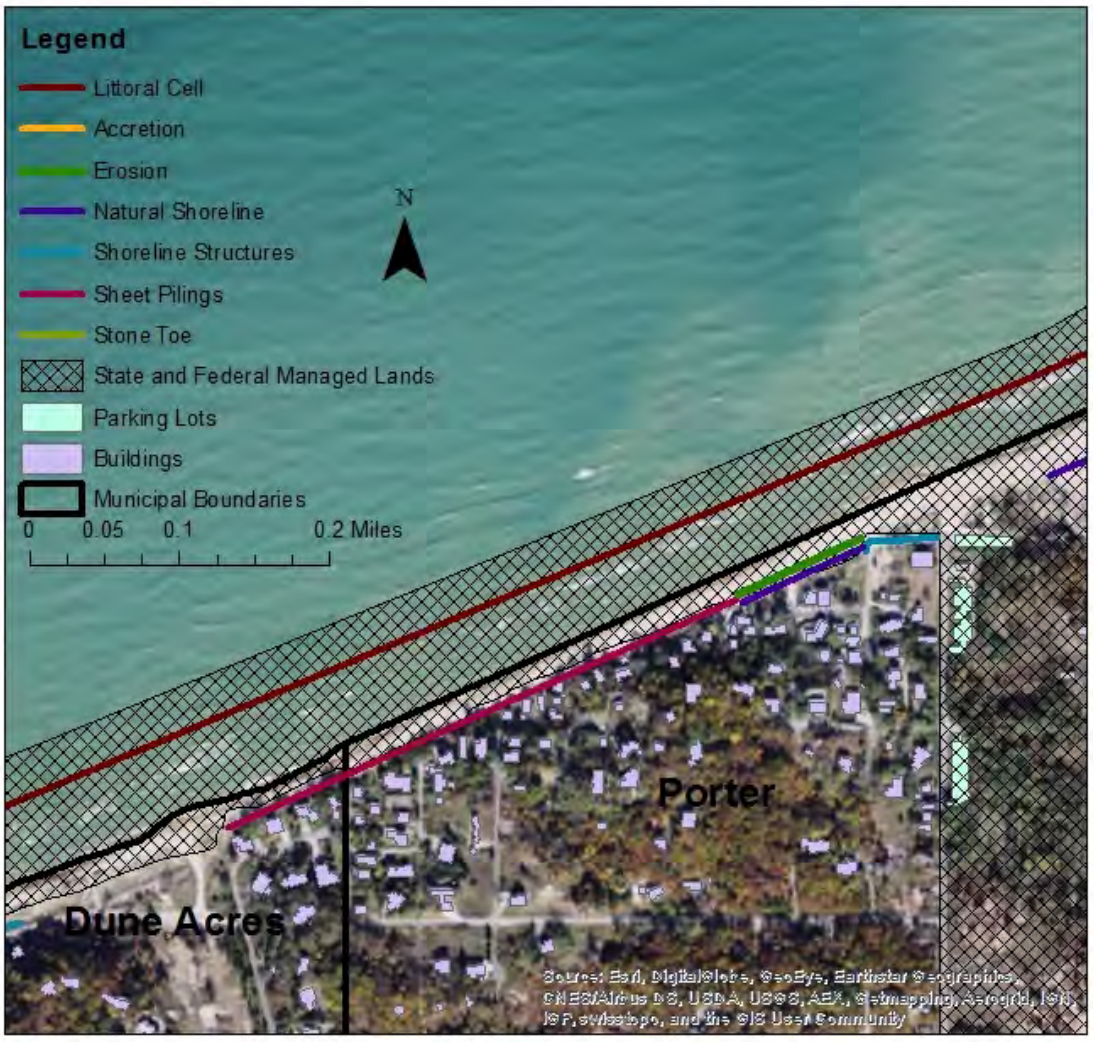


Figure 32: Aerial view of shoreline structures in Porter.

A majority of the Town of Porter's shoreline is protected by sheet piling. Around 700 feet of shoreline is unprotected and is a high-erosion area. Porter's shoreline is located within the littoral cell that extends from Beverly Shores to Dune Acres. The residential area adjacent to Lake Michigan has experienced erosion threats, and the Town of Porter has adopted a beach overlay zone to discourage building that would harm Porter Beach.

Beverly Shores

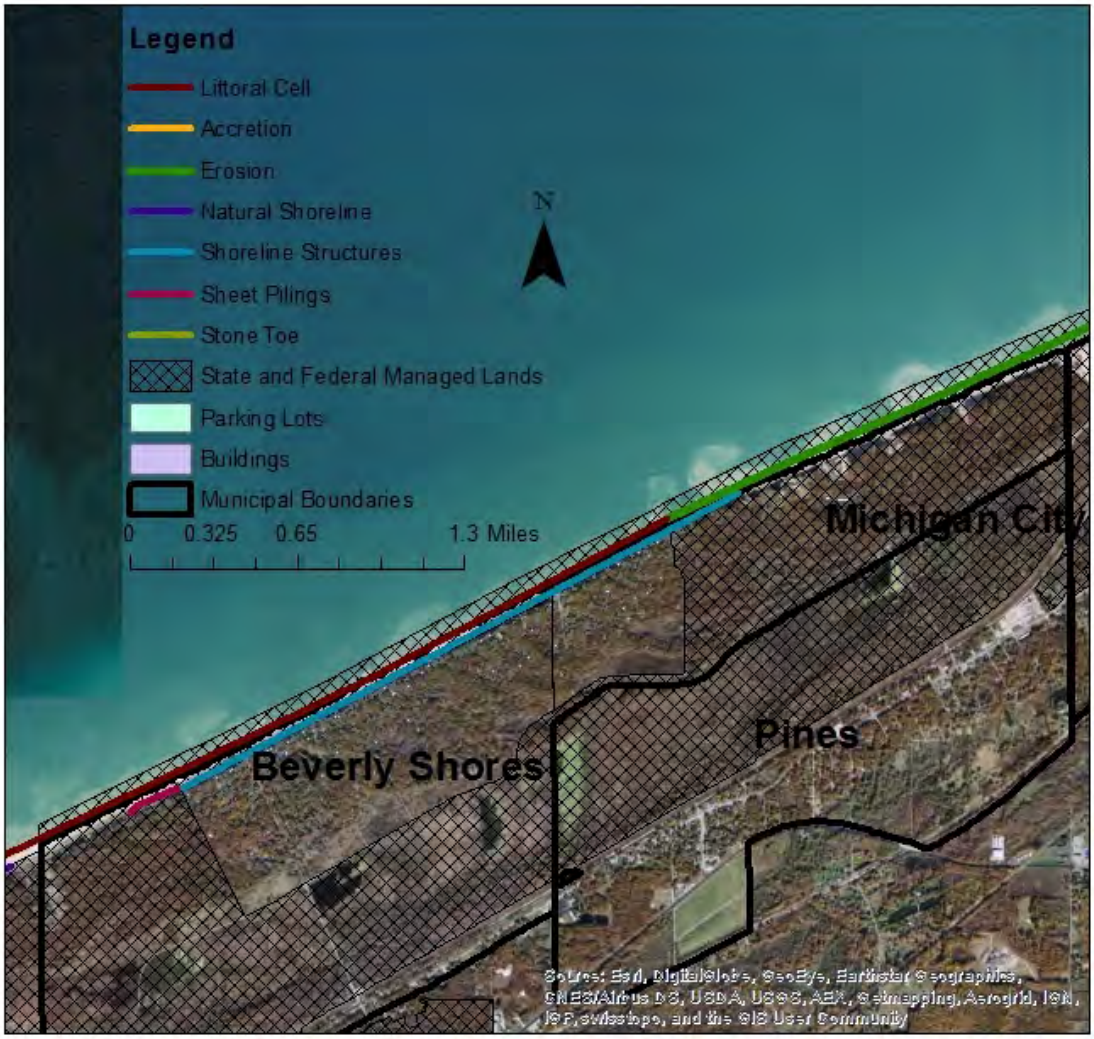


Figure 33: Aerial view of shoreline structures in Beverly Shores.

The Town of Beverly Shores is a small residential community. In 1974, a 13,000-foot-long rock revetment was built along the town's coast to protect Lake Front Drive from erosion. The National Lakeshore property west of Beverly Shore's residential area is unprotected to the east boundary of Indiana Dunes State Park at Kemil Road, except for an isolated area that is protected by rock near the west end of Beverly Shores. The National Park Service closed Central Avenue Beach in July 2015 due to severe erosion and high lake levels that made access to the beach dangerous for the public. Central Avenue Beach, in the eastern portion of Beverly Shores that is part of the National Lakeshore, remains closed at the time of publication. Plans are to reopen the beach after the sand has naturally replenished itself.

Michigan City

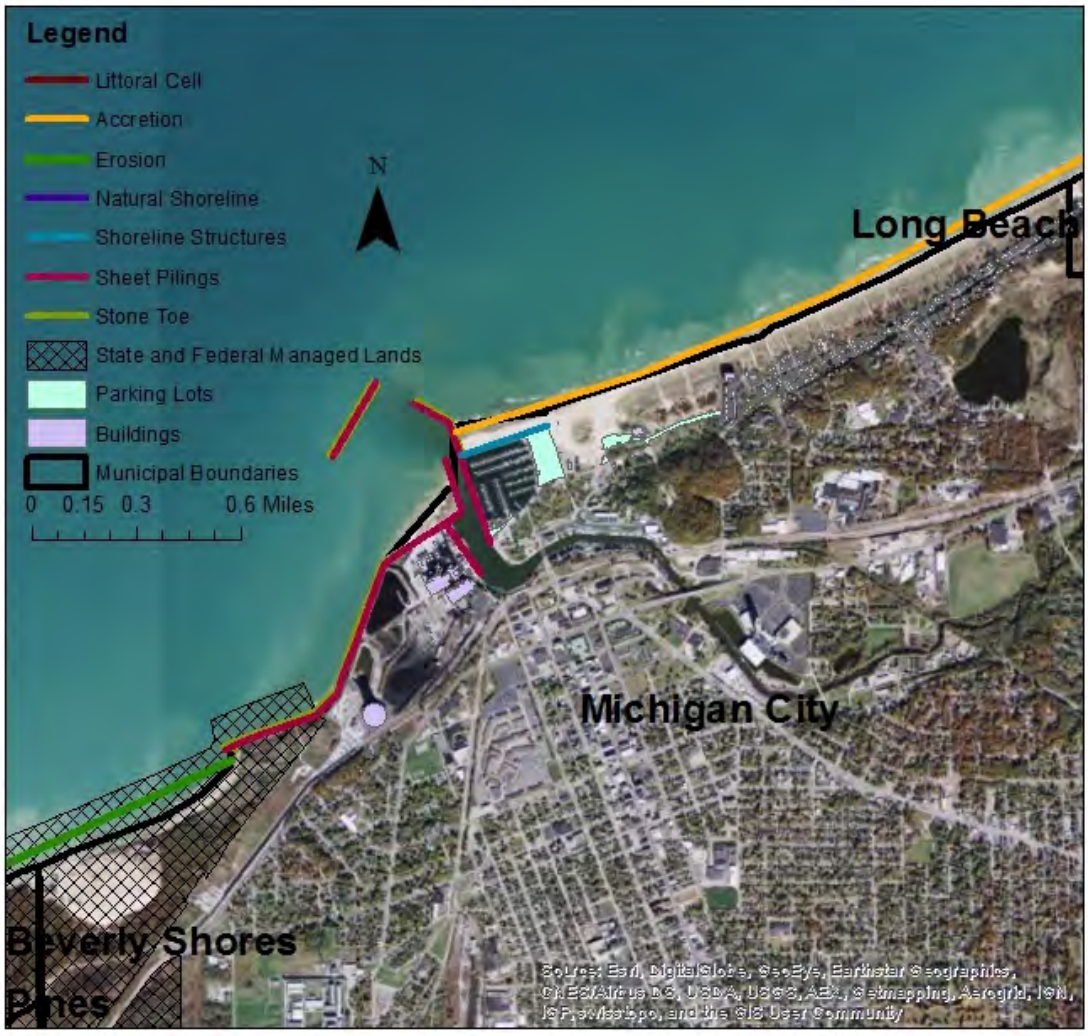


Figure 34: Aerial view of shoreline structures in Michigan City.

Michigan City has more than 11,000 feet of unprotected shoreline along its eastern coastal area and a marina at Washington Park with hardened shoreline structures along its western coastal area. Immediately east of the Michigan City Port Authority lighthouse jetty, the shoreline is protected by a federal breakwater at the north wall of the Washington Park Marina. An abandoned federal breakwater protects the adjacent marina parking lot. The unprotected shoreline of Washington Park Beach lies between the east end of the marina parking lot and the west end of the vertical seawall in the Town of Long Beach. This stretch of shoreline suffers high accretion because sand is prevented from moving westward by the marina structures.

The Michigan City Harbor jetties and breakwater complex act as a total sediment barrier. Normally, the highest rate of erosion would occur immediately west of this complex at Trail Creek because the net sand

movement is naturally westward; however, a steel sheet-piling seawall with stone toe protection shields the NIPSCO property and prevents erosion. As a result, the location of severe erosion is transferred westward to Crescent Dune and Mount Baldy in Indiana Dunes National Lakeshore, where the resulting average recession is anywhere from 4-10 feet per year.

Long Beach

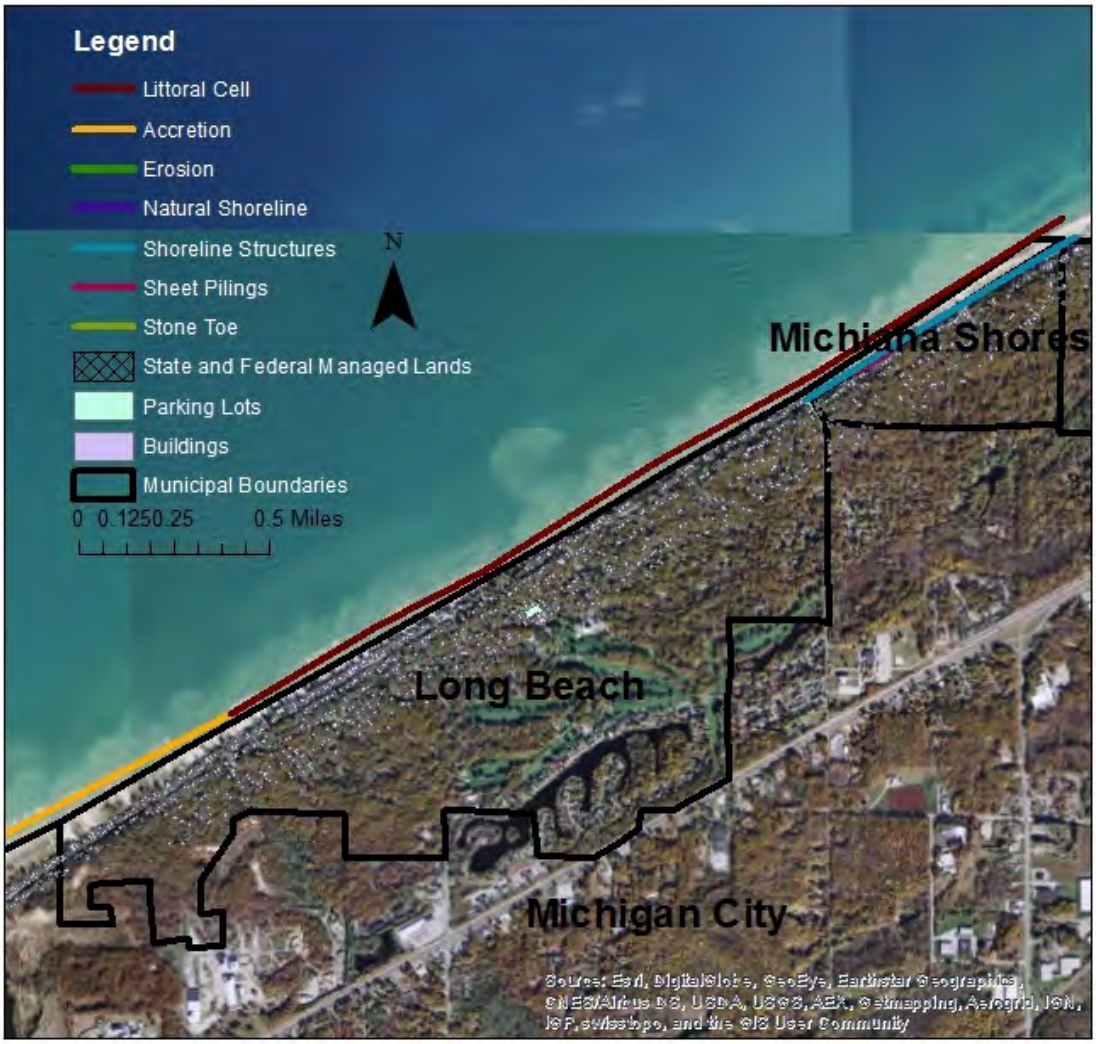


Figure 35: Aerial view of shoreline structures in Long Beach.

The Town of Long Beach is a small residential community with around 3 miles of shoreline. In 1988, LaPorte County placed rock revetment from the Indiana-Michigan state line southwestward to protect a portion of Lake Shore Drive from erosion. In many places, the rock has been buried by sand blowing landward off the beach. The rock revetment abuts a series of continuous vertical walls of various types placed along the shoreline by private homeowners. Nearly every home along the shoreline is protected by one or more seawalls.

Michiana Shores

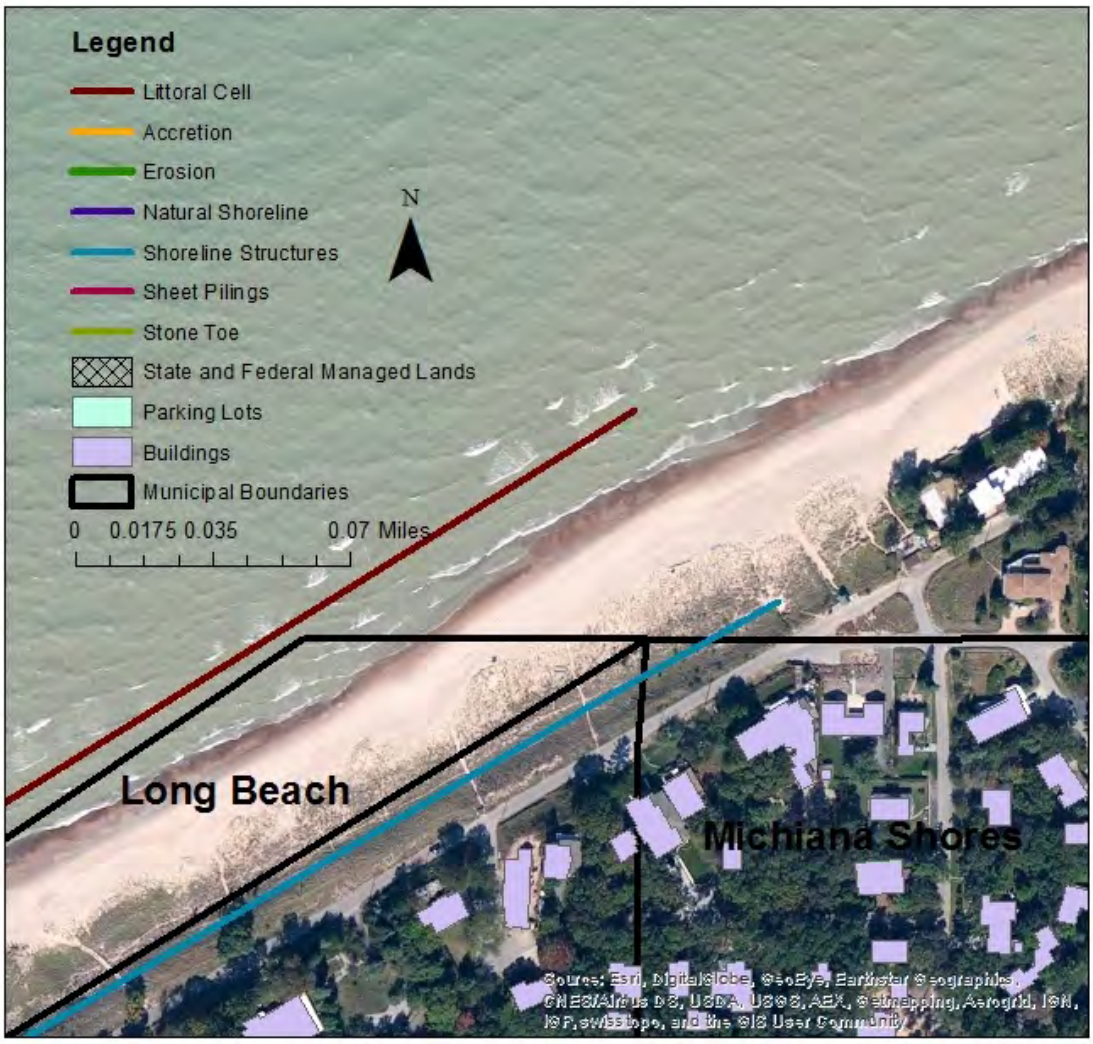


Figure 36: Aerial view of shoreline structures in Michiana Shores

The Town of Michiana Shores has only 350 feet of shoreline within the State of Indiana. In 1988, LaPorte County placed a rock revetment from the Indiana-Michigan state line southwestward to protect a portion of Lake Shore Drive from erosion. Unlike in neighboring Long Beach, no homes are built lakeward of Lake Shore Drive.

Section IV: Suggested Hazards Ordinances

This section contains model ordinances that can be adopted by municipalities to address some of the risk and impacts associated with coastal hazards. These ordinances should serve as a starting point for decision-makers. Each community has unique needs, and the language of ordinances should reflect those individual characteristics and desires. Considerations when tailoring a model ordinance include goals of the municipal comprehensive plan; existing ordinances; local coastal characteristics and resources; and input from citizens, organizations, and other units of government. These model ordinances are just a sample of policies that can be adopted to address coastal hazards. None of these ordinances is required to be adopted for any particular jurisdiction. It should be noted that before a municipality can adopt a zoning ordinance, it must have a comprehensive plan in place that has been approved by the municipal plan commission (see Indiana Code 36-7-4 Section 500-600).[40]

Essential Components

The Purpose and Intent, Applicability, and Definitions sections are important in every ordinance. These three sections should come at the beginning of the ordinance or be amended if adding coastal hazard provisions to existing ordinances. There are several options for where to include coastal hazard ordinances: in existing zoning ordinances as a special provision for shoreline areas, in a newly created coastal protection overlay zone, or in an existing subdivision ordinance.

Purpose and Intent

The purpose and intent of the ordinance should explain its importance and the reason the plan commission is adopting the requirements.

Sample Ordinance Language

Purpose and Intent

The [city/town] of […] is committed to protecting life and property, reducing costs to the public, and minimizing damage to the natural resources of the coastal zone that might result from inappropriate development in environmentally hazardous areas. The purpose of the coastal area regulations is based upon the recognition that:

- *The economic and environmental well-being of [city/town] of […] is connected with the protection of its Lake Michigan shoreline areas.*
- *The Lake Michigan shoreline has unique physical, biological, economic, and cultural attributes.*
- *Future land development and redevelopment should not be conducted at the expense of these attributes.*
- *Pollution, impairment, and/or destruction of the shoreline areas should be minimized.*

The provisions of this coastal-area ordinance are established with the following intent:

- *To protect the integrity of the coastal area that is a distinctive and valuable feature of the community and region*
- *To recognize the potential for coastal hazards to affect life and property*
- *To protect the stability of the Lake Michigan shoreline and thereby reduce the risk of coastal erosion*

Applicability

The applicability section of the ordinance should clearly explain to whom or what the requirements will apply. This section can stand alone or be embedded within the different provisions of the ordinance.

Sample Ordinance Language

Stand alone

Applicability

This ordinance shall apply to the Lake Michigan Coastal Overlay Zone, all land lying within […] feet of the Ordinary High Watermark. This boundary extends across all underlying zoning districts.

Or embedded

General Regulations …

…The minimum setback for all structures within […] feet of the Ordinary High Watermark, excluding piers, bridges, dams, patios, walkways and stairways that are necessary for providing pedestrian access to the shoreline shall be […] feet from the Ordinary High Watermark.

Definitions

The definitions section of the ordinance should clearly define terms used within the ordinance. It is better to over-explain terms and concepts than to leave them vague and open to interpretation. The sample language below provides an idea of the types of terms and level of detail one can expect from an ordinance. The actual terms used will depend upon the provisions included in the ordinance.

Sample Ordinance Language

Definitions

"Accessory structure or use" means a detached subordinate structure or a use that is clearly incidental to, and customarily found in connection with, the principal structure or use to which it is related, and that is located on the same lot as the principal structure or use. Including but not limited to patios, gazebos, garages, workshops, sheds, carports.

"Department" means the Department of […].

"Development" means any man-made change to improved or unimproved real estate, including, but not limited to the construction of buildings, structures, or accessory structures; the construction of additions or substantial alterations to buildings, structures, or accessory structures; the placement of mobile homes; ditching, dredging, filling, grading, paving, excavation, or drilling operations, and the deposition or extraction of earthen materials.

"Ordinary High Watermark" means the following as defined by Title 312-Article 1-Rule 1-Section 26 of the Indiana Administrative Code:

1. *The line on the shore of a waterway established by the fluctuations of water and indicated by physical characteristics. Examples of these physical characteristics include:*
    a. *A clear and natural line impressed on the bank*
    b. *Shelving*
    c. *Changes in character of the soil*
    d. *The destruction of terrestrial vegetation*
    e. *The presence of litter or debris*
2. *Notwithstanding subdivision (1), the shore of Lake Michigan at five hundred eighty-one and five-tenths (581.5) feet I.G.L.D., 1985 (five hundred eighty-two and two hundred fifty-two thousandths (582.252) feet N.G.V.D., 1929).*

"Principal structure or use" means any primary living quarters, main commercial buildings, and functionally necessary appurtenances to those structures such as septic systems and infrastructure. Not included area: roads, utilities, and accessory structures.

Ordinance Provisions

Overlay Zone

An overlay zone is a zoning district that is applied over previously established zoning districts and adds new standards to the standards required of the underlying zoning districts. Overlay zones are used to protect cultural or natural resources or promote a specific type of development, such as mixed-use or affordable housing.[41] In regard to coastal hazards, a municipality can adopt an overlay zone to enact more strict development standards in sensitive coastal areas. Overlay zones should be explicitly defined in the ordinance. Many communities choose to include on the official municipal zoning map a clear depiction of

the location and coordinates of overlay zones. An overlay zone may take the place of the Applicability provision, depending upon how the municipality structures the ordinance.

Sample Ordinance Language

Lake Michigan Coastal Overlay Zone

The purpose of the Lake Michigan Coastal Overlay Zone is to regulate uses and activities in the affected areas in order to:

- *Ensure that development is consistent with the natural limitations of the coastal ecosystem;*
- *Ensure that public access, areas of cultural significance to the region, wildlife and natural habitat and other resources are not negatively affected by inappropriate development for the area;*
- *Conserve, protect, develop, or restore natural resources and ecosystem services of the beach and dune ecosystems; and*
- *Reduce the risk of damage to life and property resulting from coastal hazards.*

Boundaries of the Lake Michigan Coastal Overlay Zone shall apply to all land lying within […] feet of the Ordinary High Watermark. This boundary extends across all underlying zoning districts. All new development within this overlay district shall be subject to the requirements of the Coastal Hazard requirements.

Coastal Hazard Setback

The Great Lakes Levels Board has concluded that the most promising measures for minimizing future damages to coastal property and life are strict local zoning and structural setback requirements.[42] Setback requirements protect development and redevelopment from potential hazards by establishing an area a certain distance from the edge of the lake, commonly from the Ordinary High Watermark, within which development is not allowed. The generally accepted rule of thumb is that a setback minimum should not be less than 75 feet from the Ordinary High Watermark; however, this standard is likely not enough for areas of the shoreline with high erosion rates. For example, in an area with a recession rate of 2 feet per year, a 75-foot setback ordinance means that a structure could be within 55 feet of the Ordinary High Watermark within 10 years. A structure like this would be out of compliance with the ordinance and, more seriously, in danger of suffering damage from coastal hazards like erosion and storms.

A setback that takes the average long-term recession rate and useful life of structures into account is recommended because there is always a level of uncertainty presented by fluctuating lake levels, varying erosion rates and climate change. The structural life expectancy can be determined from the general character of the neighborhood. Commonly, structures stay in good condition with regular repair and maintenance for at least 75 years after construction. Long-term average recession rates can be determined

by looking at historical records. The safety factor used in the setback calculation should be based upon expert recommendations. For example, an area that has a long-term recession rate of 2 feet per year and a 75-year structural life expectancy using a safety factor of 1.2 would require a setback of 180 feet rather than the traditionally used standard of 75 feet (2 feet/year * 75 years * 1.2 = 180 feet).

Additionally, a setback ordinance should specify which structures are subject to the requirements and which structures are exempt. Permanent structures should be subject to the requirement, but many municipalities make exceptions for temporary or movable structures. Requirements for shoreline protection structures like seawalls are usually contained in a separate ordinance provision.

Sample Ordinance Language

Setback Requirements within Lake Michigan Coastal Overlay Zone

- *Unless otherwise specified, all principal structures and accessory structures shall be set back at least […feet] from all points along the Ordinary High Watermark of Lake Michigan. The lowest floor level of all structures shall be elevated at least 2 feet above the Ordinary High Watermark.*
- *Exceptions:*
    - *Decks, provided they do not extend waterward more than 20 percent of the remaining setback*
    - *Stairways, elevated walkways, ramps, lifts, fences, flagpoles, piers, wharves, boat hoists*
    - *Utility poles, lines, and related equipment without permanent foundations*
    - *Structures, not buildings, as defined in Definitions section*
    - *Signs as permitted*
- *No person shall encroach on Lake Michigan waters with a dock or pier without first obtaining a permit from […] and*
    - *No permit shall be granted if the encroachment adversely affects the public good.*
    - *Existing encroachments shall not be enlarged, extended, or added to without first obtaining a permit from […].*
- *Parking lots shall be set back at least […feet] from all points along the Ordinary High Watermark. However, the Plan Commission may, with a conditional-use permit, grant modifications for parking lots only.*

Noncomplying Development within Lake Michigan Coastal Overlay Zone

- *Privately owned development within the Lake Michigan Coastal Overlay Zone constructed before the effective date*

of and in nonconformity to the Coastal Hazard regulations shall be abated immediately by the person or persons who constructed, now use, and/or maintain such development; unless permission from […] has been obtained establishing an amortization period of such development.

- *The following privately owned development within the Lake Michigan Coastal Overlay Zone shall constitute a public nuisance. In addition to other remedies provided by law, all direct and indirect costs, including legal expenses, incurred in abating such nuisance shall become a lien on the property and a personal obligation of the person or persons who constructed, now use, and/or maintain such development, and shall be a special assessment against said property to be collected as ordinary municipal taxes.*
    - *Privately owned development that was constructed before the effective date of and in noncompliance with the Coastal Hazard regulations and thereafter is maintained either without or contrary to the terms set forth between the private person or persons and […].*
    - *Privately owned development that is constructed and maintained after the effective date of and in noncompliance with the Coastal Hazard regulations.*
- *Notwithstanding the provisions of the Coastal Hazard regulations and recognizing the limited suitability of these areas for development, a onetime expansion is permitted for structures defined as noncomplying in [Definitions section], provided*
    - *Expansion is limited to no more than a 10 percent increase in the total square footage of the existing building footprint, and*
    - *Expansion will result in the new structure being no farther lakeward than the existing structure.*

Shoreline Protection Structures

Local governments may choose to include a provision that discourages the construction of hard, man-made shoreline protection structures. As described in the Coastal Hazards Concepts section, these types of structures negatively affect the natural transport of sand along the shoreline and, while intended to minimize erosion, actually increase erosion in the long run. Living shoreline concepts are the preferred option for property owners experiencing erosion issues; however, these techniques are not always feasible in areas with intense wave action. No ordinance should prohibit these types of structures outright, but should instead allow these structures as an option of last resort with proper design and implementation.

Sample Ordinance Language

Shoreline Protection Structures

[Town/City/County] acknowledges that seawalls, revetments, retaining walls, groins, and other such structural or "hard"

methods designed with the intention of forestalling erosion also alter natural shoreline processes that result in a variety of negative effects on coastal resources, including but not limited to effects on sand supply, public access, coastal views, natural landforms, and overall beach dynamics. Therefore, the priorities of shoreline protection, from highest to lowest, are:

A. Proper maintenance of existing vegetation

B. Planting or restoration of riparian vegetation

C. Hybrid of "green" and "gray" methods

D. Riprap

E. Vertical structures such as revetment or seawall

Protective structures as defined in […] may be developed on private property landward of the Ordinary High Watermark, irrespective of any otherwise applicable setback requirements imposed by the Municipal Zoning Code after the proposal is granted a proper permit by [Planning Commission/Planning Department]. The following requirements apply to construction or modification proposals for items C, D, E:

- *The applicant must first establish that there is no feasible and prudent non-structural alternative to construction of the proposed shoreline structure, including the inability to relocate any principal structure threatened because of coastal erosion on the applicant's lot of record.*
- *The proposed structure is the minimum necessary to provide for the level of protection that has been identified and is placed as far landward as is practical.*
- *Potential adverse impacts on adjacent property and/or public beach access are minimized.*
- *A long-term maintenance plan with specifications regarding how to maintain the integrity of the structure must be included with the permit application.*
- *All necessary permits have been received from [Indiana Department of Natural Resources, U.S. Army Corps of Engineers, etc.]*
- *Before approving any shore protection structure, the [Town/City/County] shall hold a public hearing on the proposed structure. Notice shall be sent to all property owners within […] feet of the proposed shore protection structure.*

Disclosure of Coastal Hazards

Local governments may choose to require that coastal hazards be disclosed to inform current and prospective property owners. A disclosure and liability ordinance provision helps ensure that current property owners and buyers understand the risks associated with building in or making changes to coastal land. A waiver should

make clear that property owners are proceeding at their own risk and adequately convey what those risks are.

Sample Ordinance Language

Coastal Hazard Disclosure and Liability Waiver

Prior to the issuance of required permits for development permitted in the Lake Michigan Coastal Overlay Zone, the applicant shall provide a copy of a Coastal Hazard Disclosure and Liability Waiver, a form provided by the [zoning administrator/planning department/clerk], that has been signed by the subject property owner and recorded in the deed records of [County/City/Town] and that sets forth the following:

- *A statement that the property is subject to chronic natural hazards and that development thereon is subject to risk of damage from such hazards;*
- *A statement acknowledging that the property owner assumes all risks of damage from natural hazards associated with the development of the subject property; and*
- *A statement releasing the jurisdiction, its agents, and its employees from any and all claims that may arise as a result of damages, losses, or injuries sustained by the property owner and his/her heirs, successors and assigns, from natural hazards.*

Upon any transfer of real property by sale, exchange, or lease, including condominium unit and timeshare property, the transferor shall deliver to the prospective transferee a Coastal Hazard Disclosure and Liability Waiver, a form provided by the [zoning administrator/planning department/clerk], signed by the transferee and recorded in the deed records of [County/City/Town].

Shoreline Vegetation Buffer

Where natural or moderately altered shoreline exists, local governments may opt to require that some type of natural vegetation remain or be restored along the shoreline to protect the ecology and aesthetic of the duneland ecosystem. Landscaping-ordinance provisions are often difficult to enforce over time, so many communities partner with local nonprofit or homeowners associations to develop educational campaigns about the benefits of natural vegetation and appropriate maintenance techniques.

Sample Ordinance Language

Vegetative Buffer Strips within the Coastal Zone

Vegetative buffers protect water quality and shoreline habitat, preserve scenic and aesthetic character, and control coastal erosion and flooding. To preserve the fragile coastal ecosystem, vegetative standards will apply within the Lake Michigan Coastal Overlay Zone Setback. The following standards apply to the Lake Michigan Coastal Overlay Zone Setback:

- *Vegetation removal will be limited to the amount necessary for the development of the site. Protection of tree crowns*

and root zones shall be required for all trees planned for retention. Removal of trees, shrubs, ground cover and other native vegetation shall require review and approval by […] to ensure that impacts to the coastal ecosystem are minimized. To stabilize the soil with root structures, stumps of trees cleared or harvested must remain undisturbed in the ground.

- *Vegetation shall be restored in areas affected by construction activities. Temporary vegetation may be required on disturbed areas as needed to prevent erosion. New vegetation must be native to the Lake Michigan shoreline. Consult [local native planting guidance] for acceptable vegetation.*
- *After construction, only minimal alteration of vegetation using selective pruning or thinning techniques necessary to obtain a filtered view of the water shall be acceptable. Tree removal shall be limited to removal of fallen, dead, or dangerous trees and shall require review and approval by […].*
- *In cases where native vegetation does not exist within the Lake Michigan Coastal Overlay Zone Setback, the landowner is encouraged to replant the buffer zone with native vegetation.*

Site Planning

Having strong coastal hazard-ordinance provisions in place cannot guarantee that problematic development will not take place along the shoreline. Conditions on the coast can vary widely between areas only a short distance apart. Therefore, the inclusion of a site-planning provision provides an avenue to detect potential problems on a particular site. Site planning requires landowners and local officials to discuss the details of each development before construction starts. The community decides the required details of site plans. Some municipalities require detailed descriptions. Others require only the elements necessary for basic understanding of the property and the proposed activities. More strict requirements can be required of development in the coastal zone than is required of development away from the coast.

Sample Ordinance Language

Site Plan Approval Standards[43]

Any development on property within the Lake Michigan Coastal Overlay Zone will require the approval of […], contingent on the submission of a site plan that meets these standards:

- *The site plan shall demonstrate that the impact to fish, birds, wildlife, and native vegetation is minimized by preserving natural habitat.*
- *The site plan shall demonstrate that erosion and sedimentation shall be prevented, and that the risk of structural loss due to future changes in lake levels is minimized.*

- *The site plan shall demonstrate that the natural character and aesthetic values of the coast are maintained by minimizing the visual impact of development from neighboring properties.*
- *Site development shall be fitted to the topography and soil so as to create the least potential for vegetation loss and site disturbance.*
- *All structures shall be located to maintain an open and unobstructed view to the waterfront from adjacent properties, roadways, and pedestrian ways, to the maximum extent possible.*

All applicants shall submit site plans prepared by a licensed architect that contain the following information:

- *The location of the property and nearest public road intersection, a north arrow, and a map scale;*
- *The name, address, professional status, license number, and phone number of the person who prepared the plan;*
- *Construction staging and progress schedule;*
- *Two complete sets of site plans that show the placement of any principal or accessory structures and, if applicable, delineate the Lake Michigan Coastal Overlay Zone boundary;*
- *All existing roads, driveways, structures, and other pertinent features within 100 feet of the area of site disturbance;*
- *All proposed disturbance activities on the site, including but not limited to the installation of sanitary sewage disposal systems, stormwater management systems, power lines, and communication installations;*
- *Location and description of all shoreline types and natural costal resources, including but not limited to wetland boundaries, streams, soil type, dune crests, Ordinary High Watermark, tree line (as defined by trees with a minimum 4" dbh), and first landward boundary of native grasses;*
- *An inventory of all existing vegetation and individual trees greater than 4" dbh proposed to be disturbed or removed and a description of proposed native vegetation restoration*
- *Detailed drawings and descriptions of all temporary and permanent erosion-control and bank-stabilization measures*

Section V: Endnotes

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