

2.10 COASTAL EROSION

Coastal erosion is the gradual wearing away of the land by the natural forces of wind and water. The constant action of wind, waves, and ice has affected the coastline of Lake Erie. The major causes of erosion along the Ohio Lake Erie coastline are storm-generated waves and gravity or groundwater driven slides and slumps along higher relief areas of the coastline. Wave erosion causes undercutting of the bluff or bank, mass wasting including block falls, rotational slumps, and debris flows, and accelerates down cutting of cohesive lakebed materials. As materials from the bluff or bank slides into the lake, it too is eroded by the waves. As this process continues, the shoreline shifts farther landward. Many natural factors affect erosion of the coastline, including the geology and relief of the coastline, nearshore geology and bathymetry, presence or absence of beaches, shoreline orientation, lake level fluctuations, and a changing climate (increasing storm frequency and magnitude, loss of ice cover, and precipitation).

The current shape of Lake Erie was created by glacial scouring of the earth's surface during the last major glaciation. Prior to the Pleistocene Ice Age (approximately 2 million years ago), the Lake Erie region would be characterized as a low-lying basin or lowland with an east-flowing river, known as the Eriean River. The underlying bedrock geology in the basin included Silurian and Devonian carbonates (more resistant limestone and dolomite) in the western portion of the basin and less resistant Devonian shales in the eastern portion of the basin. The first of the four major glacial advances during the Pleistocene obliterated the existing river drainage system and deepened and enlarged the basin. Succeeding glaciations further deepened and enlarged the basin. Glacial ice was able to erode the less resistant shales to the east to create the central and eastern Lake Erie basins. Glacial erosion to the west was less due to the more resistant limestone and dolomite bedrock thus creating the western Lake Erie basin.

Lake Erie is the southernmost of the Great Lakes and is also the shallowest because the ice was relatively thin (therefore lacking significant erosive power) when the glacier reached its maximum southern extent. As the glaciers advanced, eroded rock and soil were transported by the flowing ice and deposited as glacial till and morainal deposits. Laminated silt and clay were also deposited in proglacial lakes that formed along the margins of the glacier. These geologic materials are now exposed in Lake Erie's coastal bluffs and banks. As the glacier gradually retreated, the proglacial lakes drained westward through the Toledo area into the Mississippi River. Upon final retreat of the glacier (out of Ohio), pro-glacial meltwater started to discharge over the Niagara escarpment (Niagara River) to the east. Over time, glacial isostatic rebound raised the Niagara escarpment and gradually increased Lake Erie water levels to the current mean water level of 571 feet above sea level.

The geology, relief, and erodibility of the shoreline vary along the Ohio Lake Erie coastline. From the Ohio/Pennsylvania border to Huron, Ohio, the shore can be characterized as moderate to high relief bluffs, banks, and slopes composed of glaciolacustrine sands, silts, clay, till, and/or shale. From Huron, Ohio to the Marblehead peninsula (including Sandusky Bay), the shore is a low relief plain composed of glaciolacustrine sediments and till, with limestone/dolomite exposed around the Marblehead peninsula. At the mouth of Sandusky Bay, two barrier beach complexes extend from the east (Cedar Point Chaussee) and from the west (Bay Point) into the Bay. Around Marblehead Peninsula and Catawba Island, low to moderate banks/bluffs are composed of limestone/dolomite bedrock and till. West of Catawba Island, the landscape consists of low-relief lake plain and coastal wetlands (remnants of the Black Swamp). Nearshore slopes are generally gentle and are composed of the same materials in bluff or bank. Natural beaches are typically narrow (less than 50 feet wide) to non-existent along much of the shore. Manmade features have affected the longshore transport of sand trapping sand on the updrift side at harbor jetties, power plant intakes, and shore-perpendicular groins. Shore parallel structures have altered sand transport as well.

Climate affects overall physical setting in the nearshore, beach, and shore zones. Long-term and annual fluctuations in lake level are due to changes in precipitation and evaporative losses in the Great Lakes Basin. Short-term fluctuations (8 to 24 hours) in water level elevations are due to wind-driven storm surges (seiche events). The greatest storm surges occur when the wind blows parallel to the long axis of the lake. Under extreme conditions, lake levels at each end of the lake (Toledo or Buffalo) may rise or fall more than eight feet from pre-storm levels. Passage of storm systems through the Great Lakes can cause lake levels at the ends of the lake to fluctuate over a period of several days as water moves oscillates around the basin. With respect to Ohio, the most significant impacts occur along the shoreline of the western Central Basin and Western Basin shorelines. These seiche events are driven by strong winds out of the northeast resulting in a rapid short-term rise in Lake Erie water levels and large storm-generated waves (and storm surge) in the western portions of Lake Erie.

The size of wind-generated waves depends upon wind speed and duration, open-water fetch distance, and water depth. The largest waves affecting the Ohio lakeshore are those generated by storm winds from the west through the northeast. Wave energy is highest from late fall through spring; however, lake levels are lower during the winter months and shorefast ice typically forms a natural barrier that absorbs storm waves and prevents shoreline erosion. Most wave erosion occurs during early spring storms when the greatest amount of wave energy is expended on the shore. The largest waves to strike the shore are generated by onshore storms winds from the west to the northeast. Wave erosion causes undercutting of the bluff or bank, mass wasting including block falls, rotational slumps, and debris flows, and accelerates down cutting of cohesive lakebed materials. Bedrock is not as easily eroded as the cohesive glacial sediments. Although erosion of the bluff is necessary to sustain beaches, excessive erosion of the Lake Erie shoreline is considered to be a coastal hazard.

Coastal Erosion Area

A Coastal Erosion Area (CEA) is a designated area of land adjacent to Lake Erie that is anticipated to be lost to erosion in 30 years unless preventive measures are taken. Coastal erosion is measured by determining how far landward the bluff, bank, or dune has receded over time. The landward shift of the bluff, bank, or dune is called recession.

Coastal erosion area designations are a component of the Ohio Coastal Management Law passed by the Ohio Legislature in 1988 in response to the serious hazards and substantial economic losses caused by coastal erosion. The laws and rules that define the Coastal Erosion Area program are found in Ohio Revised Code Section 1506 and Ohio Administrative Code Section 1501-6. The objective of the CEA program is to identify the hazards and mitigate the economic losses of erosion-related damage.

The Ohio Department of Natural Resources (ODNR) developed standards for designating coastal erosion areas with input from geologists, engineers, local officials, and landowners. Coastal Erosion Areas are depicted on maps that are produced by ODNR. To develop coastal erosion maps, rates of recession are calculated using analytical tools, including aerial imagery and LiDAR, mathematical calculations, and field visits to verify observations. The amount of recession that is calculated is used to project recession rates for a 30-year period; areas that are projected to erode greater than a given threshold amount are designated as CEAs and shown on coastal erosion maps. The maps include data tables that show the amount of recession calculated at regular 100-foot intervals along all of Ohio's Lake Erie coast, including the bays and islands.

ODNR has mapped Ohio's Lake Erie coast to identify coastal erosion areas since 1992. Maps showing the first CEA designations were finalized in 1998 and were based on the amount of recession that occurred between 1973 and 1990. Since then, ODNR has updated CEA designations in accordance with the laws and rules that define the CEA program. In 2010, ODNR released maps based on the amount of recession that occurred between 1990 and 2004. The 1998 and 2010 CEA maps now serve only as historical records. In January 2019, ODNR released the 2018 CEA maps, which depict the most current CEA designations based on the amount of recession that occurred between 2004 and 2015. ODNR uses these maps to determine if property is currently located within a CEA. All sets of CEA maps are available to view online at <https://gis.ohiodnr.gov/MapView/?config=cea>.

Property along Ohio's Lake Erie coast that is located within a designated CEA is subject to CEA program requirements, which address property sales and transfers and construction. Landowners selling or transferring property within a designated CEA must disclose that status on the Residential Property Disclosure Form, which is required with all residential real property transactions in Ohio. Construction within a CEA may require a CEA Permit, depending on the type and location of a structure. A permit is required to construct a new building or add 500 square feet or more (as measured at ground level) to an existing structure. This applies to residential, commercial, industrial, institutional, and agricultural buildings, and septic systems. CEA Permits are issued by ODNR through the Office of Coastal Management.

RISK ASSESSMENT

LOCATION AND SELECT HISTORICAL OCCURRENCE

Lake Erie comprises 312 miles of the northern coast of Ohio bordering Lucas, Ottawa, Sandusky (Sandusky Bay), Erie, Lorain, Cuyahoga, Lake, and Ashtabula Counties. Lake Erie, the 12th largest (area) lake in the world, is about 210 miles long, 57 miles wide, and has a shoreline length of 871 miles (including the islands). With the exclusion of government-owned park and reserve areas, the coast is highly prized for commercial and residential development. In many cases, human activity has disrupted the natural function of beach formation and aquatic habitats. According to the Ohio Geological Survey, 95 percent of Ohio's Lake Erie shoreline is subject to gradual erosion over time.

Unlike many of the other hazards affecting Ohio, the Ohio Lake Erie coastline is subject to continuous coastal erosion. Although a combination of high Lake Erie water levels and severe storm events may increase periods of (local) short-term catastrophic erosion, generally the shore continues erodes gradually (imperceptibly) every day due to the impact of continuous wave activity.

**Table 2.10.a – 2004 to 2015
Ohio Lake Erie Erosion Statistics**

County	Distance	Feet/year
Ashtabula	2.8	0.26
Lake	5.4	0.49
Cuyahoga	0.8	0.07
Lorain	0.3	0.02
Erie (lake)	0.3	0.03
Ottawa (lake)	0.5	0.04
Lucas	0.2	0.01
Erie (bay)	0.6	0.05
Ottawa (bay)	9.1	0.54

To monitor erosion, the net landward movement of the shore over a specific time is calculated. The position of characteristic shore features such as bluff lines can be determined from maps and aerial photographs. By analyzing the position of these features (recession lines) through time, the amount of recession can be determined, and rates of recession can be calculated. Long-term and short-term recession data have been developed for each county (see table 2.10.a).

During 1929-30, the mid-1940s, 1952, the fall of 1972, the spring of 1973, 1985, 1998 and 2012 storms and high lake levels caused property damage along the low-lying areas, such as low glacial till bluffs, low glaciolacustrine banks, and barrier beaches and eroded high glacial till or glaciolacustrine bluffs inducing mass wasting in Erie, Lake, Cuyahoga, and Ashtabula counties. The short-term and long-term rates indicate that the low-lying areas have been extremely affected.

More recently, Lake Erie experienced a gradual rise in water levels that began in 2015 and resulted in record-high water levels in 2019 and in 2020. Record-high water levels and associated storms resulted in significant erosion along both protected and unprotected reaches of the Ohio Lake Erie coastline. Record-high water levels also resulted in severe persistent flooding in low-lying coastal areas along the Ohio Lake Erie coastline. More recently, Lake Erie water levels have declined since 2020 and are now about a foot above the long-term mean (2023). The ODNR Division of Geological Survey and the ODNR Office of Coastal Management are collecting new aerial imagery and elevation (LIDAR) data to assess the impacts of the recent record-high water levels in 2019 and 2020 on the Ohio Lake Erie coastline. GeoSurvey and the Office of Coastal Management also continue to monitor ongoing coastal erosion and flooding and provide technical assistance to municipalities and coastal property owners in response to local erosion or flooding events.

LHMP DATA

The LHMPs for counties that border Lake Erie (Ashtabula, Cuyahoga, Erie, Lake, Lorain, Lucas, Ottawa, and Sandusky) indicate that coastal erosion is a recognized hazard and ranked them either fourth or fifth for their county. Most of the plans reference the same data (Figure 2.10.a) provided by the Ohio Geological Survey. Erie County's LHMP indicated that they had completed a structural inventory in the late 1990's; but those data were not available to them at the time of writing their plan.

Ashtabula County. The HIRA of the Ashtabula County Countywide All Natural Hazards Mitigation Plan of August 2012 describes the 28 miles of Lake Erie coastline from the northern border of the County. The HIRA also explains that factors such as high lake levels, long shore currents, high winds, water runoff over cliffs, bluff recession and seasonal fluctuations are driving forces that lead to coastal erosion. The risk is classified as having a Moderate Probability and Moderate Impact. The plan's vulnerability analysis determined 2,619 structures would be affected with a loss estimate of \$78,295,582.

Lake County. As part of the Lake County Planning Commission's coastal management plan, breakwalls have been constructed in Mentor and North Perry. Further, individual jurisdictions have been compiling agreements with appropriate contractors, state agencies, and local partners to ensure that response measures (such as shoring up structures and filling in eroded areas) can be implemented quickly. These jurisdictions include Fairport Harbor, Painesville Township, and North Perry. While coastal erosion is likely to remain a hazard for the foreseeable future (due to the county's proximity to Lake Erie), potential losses have been lessened since previous adoptions of this plan.

Erie County. Factors that cause shoreline erosion include bluff recession, high lake levels, high winds, and human activities. These factors may cause many problems in the coastal communities of Bay View, Sandusky, Huron, Vermilion, and Kelley's Island. Manmade shoreline structures that lie within a designated CEA along Lake Erie's coastline are susceptible to property damage over a 30-year period. Because of the large number of residential properties located within a CEA along the shoreline, property damages are expected to be high.

Based on the property damage expected from stream bank and lake erosion, the impact on the local economy and local government expenditures is considered to be high. Manmade shoreline structures built along the Lake Erie shoreline, trap sand supply, causing beachless shores. Lack of beaches may have an adverse effect upon tourism in Erie County. County roadways may be affected and in need of repair, but this repair does not typically have an adverse effect on the economy, as motorists will find an alternate route.

Lucas County. According to the Lucas County Countywide All Natural Hazards Mitigation Plan of March 2013, lake surges (also referred to as storm surges) are associated with extreme weather events and are responsible for coastal flooding and erosion along Lake Erie within Lucas County. The storms that generate the large waves of lake surges can develop year-round, however within Lucas County, these events have typically occurred in the early spring and late fall months. Storm surges inundate coastal floodplains, the rise in water levels in inland bays and harbors, and backwater flooding through river mouths. Coastal erosion is generally associated with storm surges, windstorms, and flooding hazards, and may be exacerbated by human activities such as boat wakes, shoreline hardening, and dredging. Conversely, actions to supplement natural coastal processes, such as beach nourishment, dune stabilization, and construction of shore protection structures can greatly modify and reduce erosion trends within an area.

Ottawa County. Within Ottawa County, the risk for coastal erosion varies by jurisdiction. The lakeshore jurisdictions in the western portion of the county have a higher coastal erosion risk than those to the east. The coastal areas in Carroll, Erie, and Bay Township are primarily beach and marsh areas with low elevations. Structures in these coastal areas are primarily residential and include a large percentage of summer homes and seasonal cottages. Some of these areas are protected by breakwalls that reduce the impact of waves as they wash onshore.

The eastern municipalities of Marblehead, Port Clinton and Put-In-Bay and Catawba Island, Danbury, Portage, and Put-In-Bay Townships are susceptible to coastal erosion but, given their high elevation and rocky surface and sub-surface, erosion is less likely to impact structures than in other areas of the county. The high cliffs and rock ledges protect the homes, businesses, and infrastructure along the lakeshore from wind and water damage. In the city of Port Clinton, the highway and homes are several hundred feet from the coastline and not significantly susceptible to coastal erosion damage. While the county is significantly lakefront, there is not a large amount of beach across the shoreline. A large percentage of the coastal area is either marsh and wetland, or rocky ledge.

Mitigation Information Portal (MIP). See Section 4.3 for an analysis of coastal erosion data in local hazard mitigation plans.

Coastal Barrier Resources System

The Coastal Barrier Resources Act (CBRA) of 1982 and subsequent amendments established the John H. Chafee Coastal Barrier Resources System (CBRS). The CBRS consists of relatively undeveloped coastal barriers and other areas located the Atlantic, Gulf of Mexico, Great Lakes, U.S. Virgin Islands, and Puerto Rico coasts. The CBRS currently includes 585 System Units, which comprise nearly 1.4 million acres of land and associated aquatic habitat. There are also 277 "Otherwise Protected Areas," a category of coastal barriers that are mostly already held for conservation and/or recreation purposes that include an additional 2.1 million acres of land and associated aquatic habitat. The CBRS units are identified and depicted on a series of maps entitled "John H. Chafee Coastal Barrier Resources System." These maps are controlling and indicate which lands are affected by the CBRA. The maps are maintained by the Department of the Interior through the U.S. Fish and Wildlife Service and can be viewed at: <https://www.fws.gov/cbra/Maps/Mapper.html>. The Coastal Barrier Resources Act and its amendments

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prohibit most new federal expenditures that tend to encourage development or modification of coastal barriers. The laws do not restrict activities carried out with private or other non-federal funds and only apply to the areas that are within the defined CBRS. The main prohibition affecting property owners is the prohibition on federal flood insurance.

Examples of prohibited federal assistance within System units include subsidies for road construction, channel dredging, and other coastal engineering projects. Federal flood insurance through the National Flood Insurance Program is available in a CBRS unit if the subject building was constructed (or permitted and under construction) before the CBRS unit's effective date. If an existing insured structure is substantially improved or damaged, the federal flood insurance policy will not be renewed.

PROBABILITY OF FUTURE EVENTS

With shore structures increasing along the coastline, the shoreline becomes increasingly modified. Reports and studies suggest that wave erosion and mass wasting caused by Lake Erie will continue to erode the Ohio shore for the foreseeable future. Damage to the built environment is inevitable without intervention and will warrant the full understanding of coastal processes within each stretch to rehabilitate the shoreline.

STATE-OWNED AND STATE-LEASED CRITICAL FACILITIES VULNERABILITY ANALYSIS & LOSS ESTIMATION

Previous versions of this plan indicated that coastal erosion had limited potential to affect any state-owned structures or critical facilities. All state facilities near the Lake Erie Coast were evaluated for their proximity to coastal erosion areas using the DAS data within a GIS. No state-owned or state-leased facilities are located within the coastal erosion areas, which represents no change since the last plan update.