PROTECTING SHORELINE INVESTMENTS FROM RISING LAKE LEVELS

It's not news to any shoreline owner that Great Lake's water levels in recent years have risen to match and exceed historic highs, resulting in widespread advances in erosion. There's also potential for further rise throughout all of 2020, as predicted by the US Army Corps of Engineers. If the duration of many past "peaks" is an indicator of what may occur, higher than average levels are likely to persist through 2021 or 2022. This presents a challenge to owners whose homes are already uncomfortably close to the erosion advance. In contrast, wherever a home has yet to be built, or existing homes still have more than adequate setback, this time may present an opportunity to improve owner access to the beach in a manner that benefits natural shore dynamics. In order to make informed decisions in either case, it's helpful to understand how dynamic our shorelines are.

Our Naturally Dynamic Shoreline

Lake Michigan's calm water line changes drastically with rising lake levels.

The water levels of all the Great Lakes downstream of Lake Superior have varied throughout a range of about six feet between historic highs and lows. With the typically gentle slope of the near-shore lake bottom, this difference in lake levels results in large variations in the position of the calm water line. Wide swaths of grassy dunes typically develop along sandy shores during low water periods. As water levels rise, the dunes erode, and their sand helps form near-shore sand bars that are critical in causing storm waves to break and dissipate most of their energy before they reach the beach. This transfer of beach sand to the near shore bottom during high water levels helps to reduce erosion.

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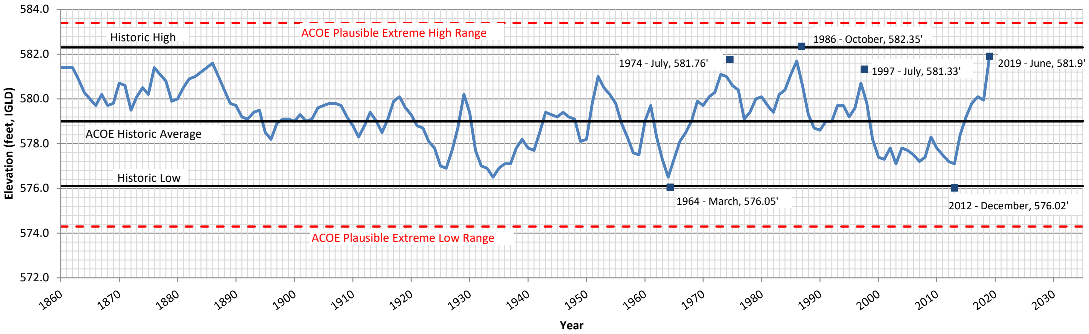
Where the shoreline is comprised of bluffs, the beaches are not as wide as the low lying sandy reaches of shoreline, even during low water periods. During high water periods, storm waves erode the toe of these bluffs, initiating a new cycle of slope failures propagating upward. These slope failures are typically relatively shallow, and continue for a decade or more before vegetation is re-established. By that time, the next high water level may be initiating a new cycle of sliding.

Historic Water Levels and the O.H.W.M.

Annual Average Water Levels
**Water level temporarily rises about one foot during storm surges.*



Average recorded water levels in Lake Michigan have fluctuated by about 6 feet throughout the last 4,000 years. Although 4,000 years sounds like a long time, our present shorelines are actually very young in terms of geomorphologic development. In fact, all but the rocky segments of our shoreline have been recessing (eroding) at average rates typically ranging from 50 to 200 feet per century, depending on location. However, this usually occurs in sudden increments of 10 to 20 feet during on-shore storms when water levels are high.

Long term rates of shoreline recession are the reason that local ordinances require minimum "setbacks" from the Ordinary High Water Mark (O.H.W.M.) for new construction. The O.H.W.M. as described in State Administrative Codes is the upper limit of evidence of high water levels. For inland lakes, the minimum required setback is at least 75 feet. In the 1980's most states around the Great Lakes established a 100-foot minimum setback model ordinance due to the Great Lakes shoreline's long term erosion rates (which don't occur on inland lakes and rivers).

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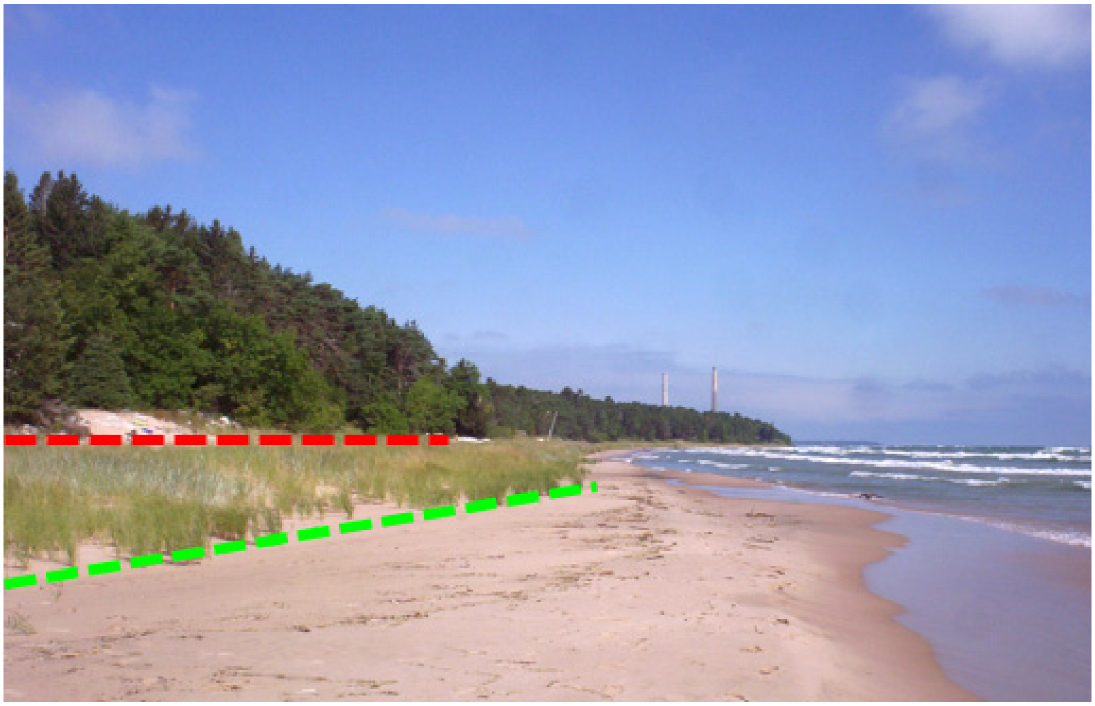
The O.H.W.M. is often easy to identify from the limit of vegetation along the shores of inland lakes and rivers, which regularly experience similar seasonal highs. However, that limit varies drastically with the large range in water levels on the Great Lakes, creating confusion when trying to determine safe setbacks.



The Ordinary High Water Mark (O.H.W.M.) varies greatly, sometimes up to 200 feet, between low and high water periods along the Lake Michigan shoreline.

When water levels have been relatively low for a number of years, the O.H.W.M. along a sandy beach might be the lakeward limit of the dune grass (as shown with the green line in the above photo). During high water periods, the erosion advance may cut beyond the historic high water erosion line and may cause mature trees to fall into the lake (as represented by the red line above). Because the distance between these two positions commonly ranges from 100 to 200 feet at many locations, a house built to the minimum setback requirements during low water levels may be in danger as lake levels rise. For this reason, it makes more sense for setbacks around the Great Lakes to be measured from the historic erosion mark, which is a more consistent position long-term, and is more relevant to the service life of a structure.

Ordinance minima are seldom optimum, all things considered. We strongly recommend that any owner plan new construction at least 100 feet from evidence of the historic erosion limit as opposed to the O.H.W.M. This will minimize the need to install costly shoreline protection in the future.

Objectives and Methods for Shoreline Preservation

The goal for shoreline protection along the Great Lakes should be to allow the lakes to reach their natural shoreline equilibrium over the longest period of time possible. This can be accomplished by building capital investments far enough inland to allow for natural long-term shoreline recession. Periodic grading of any steep erosion scarp that develops is an economical way to provide safe access without the use of hard structures. Hard structures built into the lake starve the natural shoreline system of the sand that is needed to sustain a shallow near-shore lake bottom. Because of this, revetments and seawalls should be avoided unless absolutely necessary since it's this shallow near-shore profile that minimizes wave energy before it reaches the shore.

Wherever homes and structures cannot be built or moved a safe distance from the active shoreline, a protective revetment may be needed. Revetments should always be designed and constructed at or inland of the historic erosion limit. This leaves as much room as possible for natural beach dynamics. Not only will the revetment last much longer because it's exposed to wave action the least amount of time, it will allow the exchange of sand required to reduce wave energy, and result in maximum beach area during periods of low and average water levels. Revetments placed any farther lakeward (in order to regain some land recently lost) will result in higher wave energy and little or no beach during all but the lowest water levels.

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An effective revetment requires careful thought and design to effectively absorb wave energy. Revetments should consist of large enough stones to avoid displacement, but not so large that the revetment becomes wave-reflective. This reflection will cause scour at the base of the revetment, significantly shortening its useful life. The bottom of the revetment should be placed low enough to avoid being undermined during lower water levels, and the top of the revetment should be high enough to accommodate water levels from storm surges and wave run-up.

As water levels drop and the beaches widen, blowing sand naturally covers revetments, provided they have been tucked in along the historic erosion scarp. This sand cover provides an opportunity to plant dune grass to re-naturalize the shore dynamics by rebuilding dunes. Dunes are an important part of the natural shoreline because they supply sand to the near shore system during the next high water period, which is otherwise deprived by revetments that have been built out in the water. Without this source of sand, the near shore bottom profile of the lake begins to deepen and allow progressively larger waves to reach the shore over time. This greater wave energy speeds up scour at the base of a revetment structure, shortening its useful life and increasing its likelihood of failure and/or collapse into the lake over time.

Make sure your revetment has been designed by a licensed and experienced Professional Engineer who understands the dynamics of the Great Lakes. Improperly designed revetments can be overtopped by waves, leading to erosion landward of the revetment. Revetments can become undermined and fail due to under-cutting and scour. Displaced revetment stones cause gaps in the structure, resulting in gaps in your protection.

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For more information on the dynamics of the Great Lakes, naturalized shoreline design, or appropriate revetment design, please contact the experts at Miller Engineers & Scientists. We've been working with residential, commercial, and municipal shoreline owners on appropriate and effective shoreline protection design for over 30 years.

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