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EcoSphere Technical Report No. 291

Technical Review
Mentor Coastal Habitat Project
KS Associates Report (February 28, 2019)

Prepared by

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Prepared for
City of Mentor
Mentor, Ohio
&
KS Associates
Elyria, Ohio

February 2019

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From: Charles E Herdendorf, Ph.D., EcoSphere Associates
To: Abraham Bruckman, AICP, City of Mentor
Subject: Review of KS Mentor Coastal Habitat Project Report - Submitted Feb 18, 2019

Date: Feb 28, 2019

Thank you for the opportunity to review the subject document. I believe the KS report for Mentor Marsh Coastal Habitat project (Feb 18, 2019) represents a sound, traditional engineering approach to stabilizing the Lake Erie shoreline at the project site. Aside from a few minor typos (such as "tow" for "toe" on page 4), my main concern is it lacks significant incorporation or experimentation of nature-based alternatives to the management of the shoreline—but it serves the essential purpose of protecting critical coastal and nearshore infrastructure. Other than stabilizing the shoreline, a major thrust of the project is to introduce experimental designs and test their effectiveness in managing the shore. In that regard, the KS report offers a baseline approach, which will be useful for further refinement. Of particular value are the tables that offer a variety of options that include expanded use of timber structures that can lend themselves more readily to adoption of "living shoreline" techniques. Also useful in this regard is an outline of cost ranges and the most probable permitting path that will be required to move this project into implementation phases. These items will be extremely helpful as a guide to the City of Mentor and other agencies as they consider project phasing in tandem with natural seasonal cycles and the required assembling of financial and logistical resources for this ambitious initiative.

KS subdivided the project site into four reaches (A-D). Following comments address each of these reaches (areas):

Area A: The estimates of armor stone tonnage appears appropriate for the high-energy wave climate at the site. Also the alternatives to prevent flanking of the revetment are certainly warranted. The report mentions 2 alternatives, but 3 are presented (A,B,C). Alternative C is not an alternative to prevent flanking at the east end, but actually an alternative to the revetment itself. This replacement concept contains several desirable features, especially the retention of a somewhat natural shore.

Area B: The report jumps from using 'A,B,C' labels for alternative to a numbering system (1,2,3). As a modest suggestion for next future steps, the use of a single designation system is preferable, but the intent nonetheless is clear enough. For Area B, the proposed alternatives are the reasonable engineering approaches, but lack the deeper exploration into the more innovative methods or techniques – which will need further, more refined design and technical research. Also, ground water seepage and other surface water-related bluff slumping and stability issues are ignored in the report. This appears to be an important issue at the site and should be addressed with provision for venting ground and surface water to the lake.

Area C: This work appears to be of low priority in the near term but is a proactive measure to ensure shoreline stability of the natural 'wild' beach to the east and, thus, protect the adjacent hike/bike trail to Headlands Beach State Park. The Sawyer Point groins were constructed in 1943 and no recession has been noted at the Point. An intriguing question for future research: Why have the old hardened structures at Sawyer Point endured, hence, the reported shoreline recession there identified as 0.0 feet? (KS Report, page 2).

Area D: Much of the data required for the recommended "metocean analysis" is already available in US Army Corps Engineers, NOAA, and ODNR publications (see summery below). Overall, the general concept of short, wooden groins is consistent with ODNR's 1973 recommendations, especially considering the apparent abundance supply of beach-building sand available in the nearshore area. A ready source of sand for replenishment, along with a documented abundance of fallen timber along this shoreline reach, suggests that this overall approach is appropriate for the project area and could provide a means to test a variety of living shoreline constructions.

Data Sources: The report references the use of ODNR aerial photographs and ODNR recession maps (Attachments B & D). There are several additional data sources that provide useful information and insight concerning the geology, physical limnology, and erosion history of the overall project site, which will have benefits for future refinements of this initial study. Summarized below are these pertinent sources, along with a few suggestions that speak to their future utility for more advanced phases of this initiative:

US Army Corps of Engineers (1950). Shore of Lake Erie in Lake County, Ohio Beach Erosion Control Study.

1. Analysis of samples of bluff material indicate that ~27% of the material is suitable for beach building.

2. The upper strata of bedrock, of which there is no outcrops along the Lake County shore, is Ohio Shale (Upper Devonian age).

3. There are three possible natural sources of sand and gravel for beach building on the study area: (1) erosion of bluffs and beaches on the updrift side of a selected area, (2) material delivered to the lake by streams [very little—current is slowed when streams drop to the level of the lake and any coarse material is generally deposits in the first half mile upstream from the lake], and (3) offshore sand and gravel deposits.

4. From Mentor Harbor eastward to the beach in the vicinity of Painesville Waterworks, there are few beaches of any importance—such beaches as do exist are narrow and vary with wave action. The beaches are coarse sand and gravel that appears to have been derived from erosion of the high glacial till bluffs.

5. Littoral drift—in the study area, winds from the southwest through west to northwest set up alongshore currents in a general west-to-east direction.

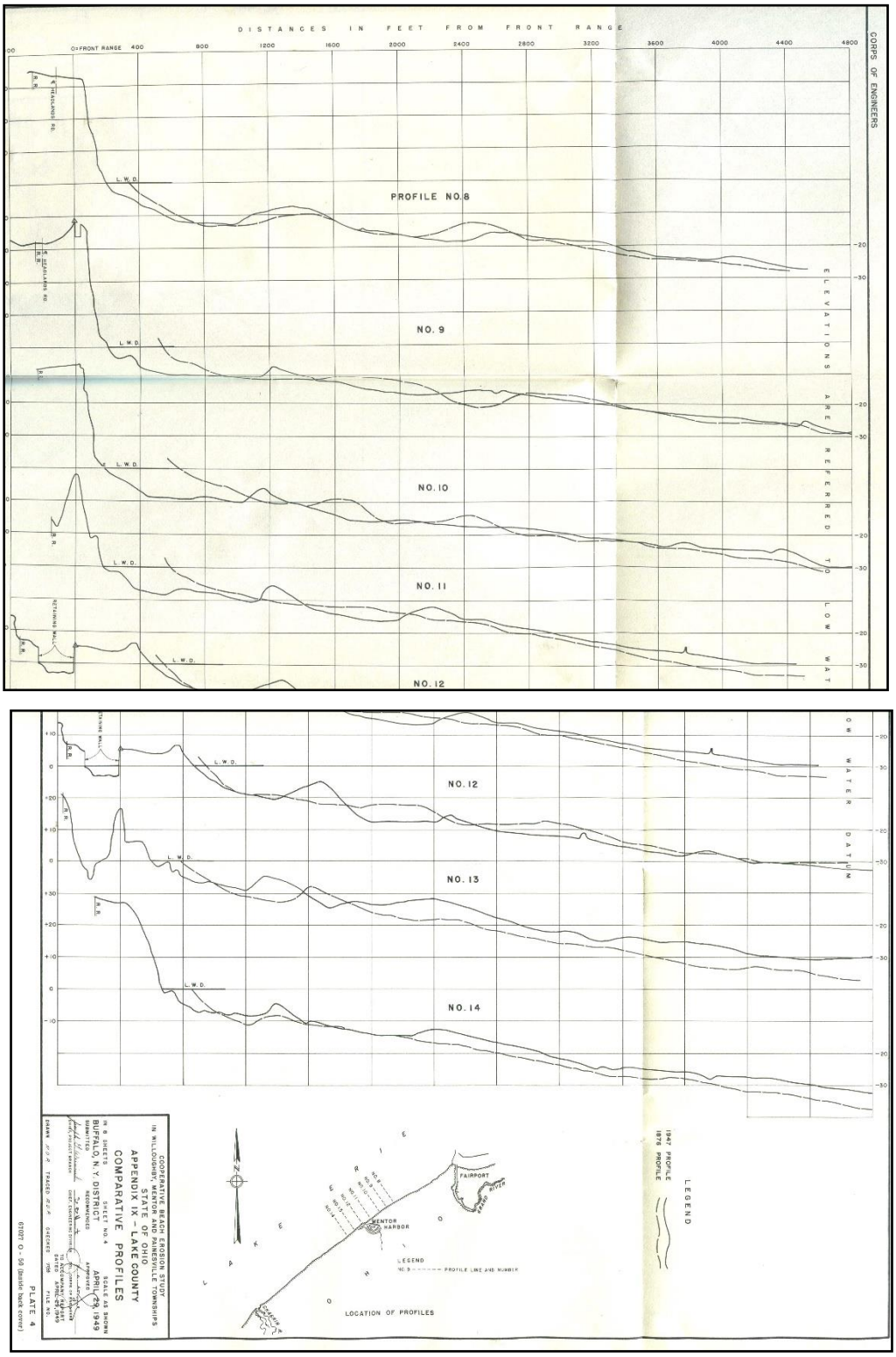
6. The structures at Mentor Harbor, which are designed primarily for navigation, include two sand-filled cellular steel sheet-pile piers, 200 feet apart and 400 feet long. These structures were, which were constructed in 1931, have interrupted the predominant west-to-east littoral drift and caused a beach ~200 feet wide to accumulate west of the west pier. Sand is now being carried around the outer end of the west pier and frequent dredging is required to keep the channel open.

7. A steel sheet pile groin located 1,000 feet easterly of Mentor Harbor has been flanked and is no longer effective.

8. Shore protection approximately 4,200 feet east of Mentor Harbor consists of: (1) a parallel series of four stone groins [semi-permeable, 60 to 150 feet long, 4 feet wide, and 4.9 feet above low water datum (LWD)], (2) a stone breakwater [semi-permeable, submerged at mean lake level, 200 feet long, 4 feet wide, and 1 foot above LWD, and (3) stone shore protection [places at toe of slope when built, 80 feet ling, 4 feet wide and 5.5 feet above LWD]. This work was constructed in 1943 for the protection of property owned by Mr. C. B. Sawyer. The groins have a maximum elevation of ~5 feet above low water datum (LWD). Although these structures capture little sand, they have reduced bluff erosion at this point. Recession of the bluffs east and west of these structures has resulted in the formation of a small headland at this location.

9. Sand and gravel dredging operations, such as have been carried out at Mentor Harbor, is considered <u>bad</u> practice from a standpoint of erosion control. If material removed from between the piers at Mentor Harbor were placed along the shore east of the east pier, it would provide needed protection at the inner end of the east pier where damage has occurred and as carried to the east by predominant drift it would nourish depleted beaches in the Mentor Headlands area.

10. The most economical and practical general plan of protection of the shoreline between the mouth of the Chagrin River and Fairport Harbor is the grading and landscaping the bluffs, revetment of the toe of slope, and maintenance of relatively narrow beaches by means of shore groins. This plan may be used at any point in the area with little, if any, damage to adjoining sections of the shoreline.



Depth Profiles 8-14 in the Vicinity of Mentor Harbor (US Army Corps of Engeneers 1950).

Hartley (1960). Sand Dredging Areas in Lake Erie.

1. Study area covers the Lake Erie bottom from 5 miles north to 7 miles west of Fairport Harbor, including the area immediately north of Mentor Harbor.

2. The sand along the shore between Mentor Harbor and Fairport has a series of bars with a maximum relief of 10 feet. The sand of these bars and the sand on the beaches is very similar in size and composition to that found through the area. Sand from the designated dredging area is little different from sand found along the beaches.

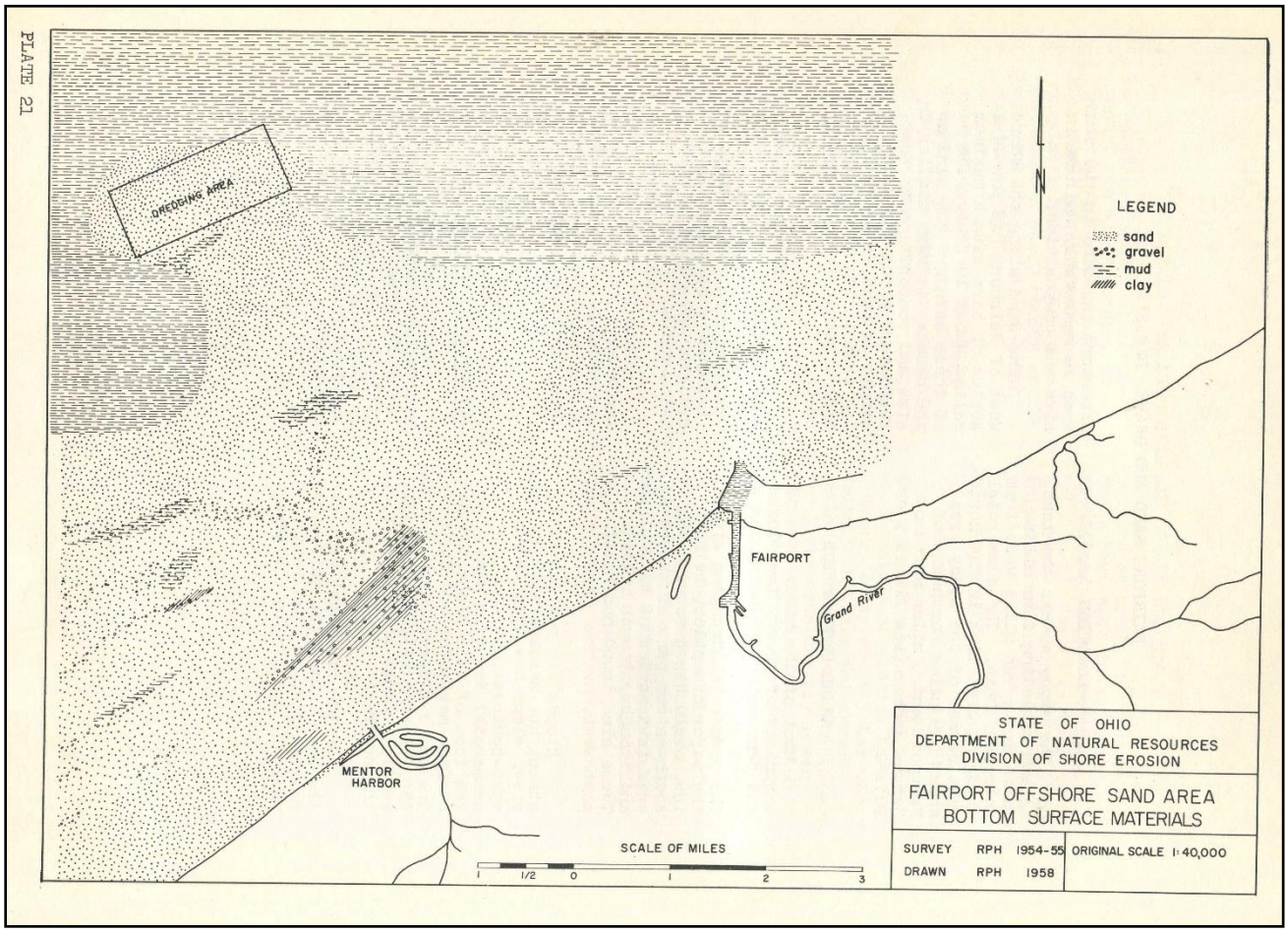
3. The sand is mainly in the medium-size range with most samples containing more than 50% medium sand and none more than 75%.

4. Bedrock lies ~37 feet below LWD at the mouth of the Grand River and over 100 feet below LWD at the dredging area. Glacial till overlies bedrock and underlies the sand deposit, which is over 40 feet thick at the dredging area (see cross-section).

5. Within the limits of the study area the calculated amount of sand exceeds 400,000,000 cubic yards, while within the designated dredging area the amount is ~53,000,000 cubic yards.

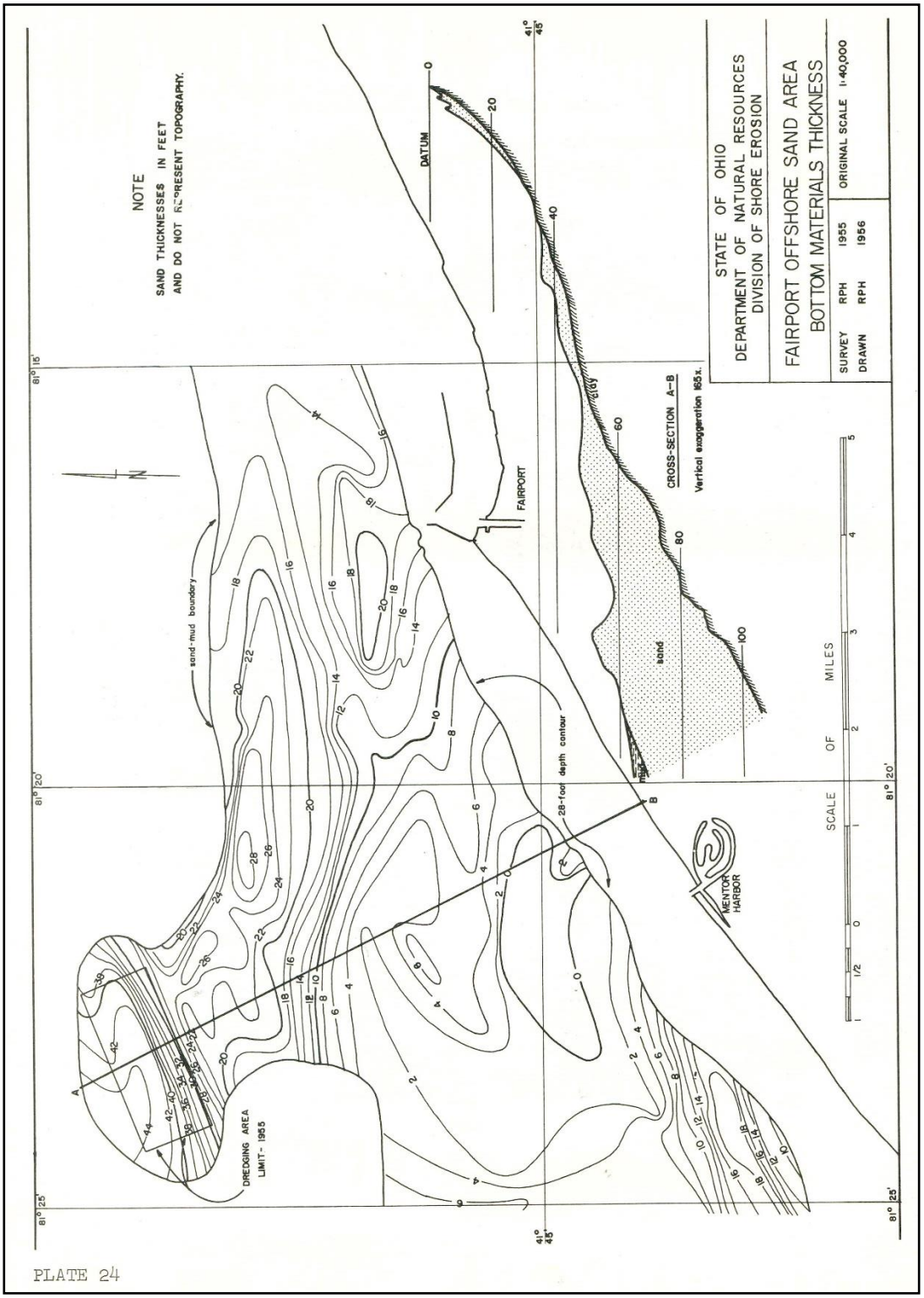
6. Sand for artificial beach building and replenishment is cited as a primary potential use of the sand.

7. Deltaic deposition at the former mouth of the Grand River off Mentor Harbor during a period of lower lake levels is postulated as an origin of the sand deposit.



Fairport Offshore Deposits (Hartley 1960).

Fairport Sand Deposit Cross-Section (Hartley 1960).



Hartley (1964). Effect of Large Structures on the Ohio Shore of Lake Erie.

1. Mentor Harbor structures are demonstrated as have entrapment a massive amount for sand, which has resulted in the serious erosion to the east, in the vicinity of Mentor Headlands.

2. Parallel jetties were built at the entrance to Mentor Harbor in 1931 in an attempt to prevent damming of the entrance by sand in littoral transport. The jetties are ~8 feet above LWD.

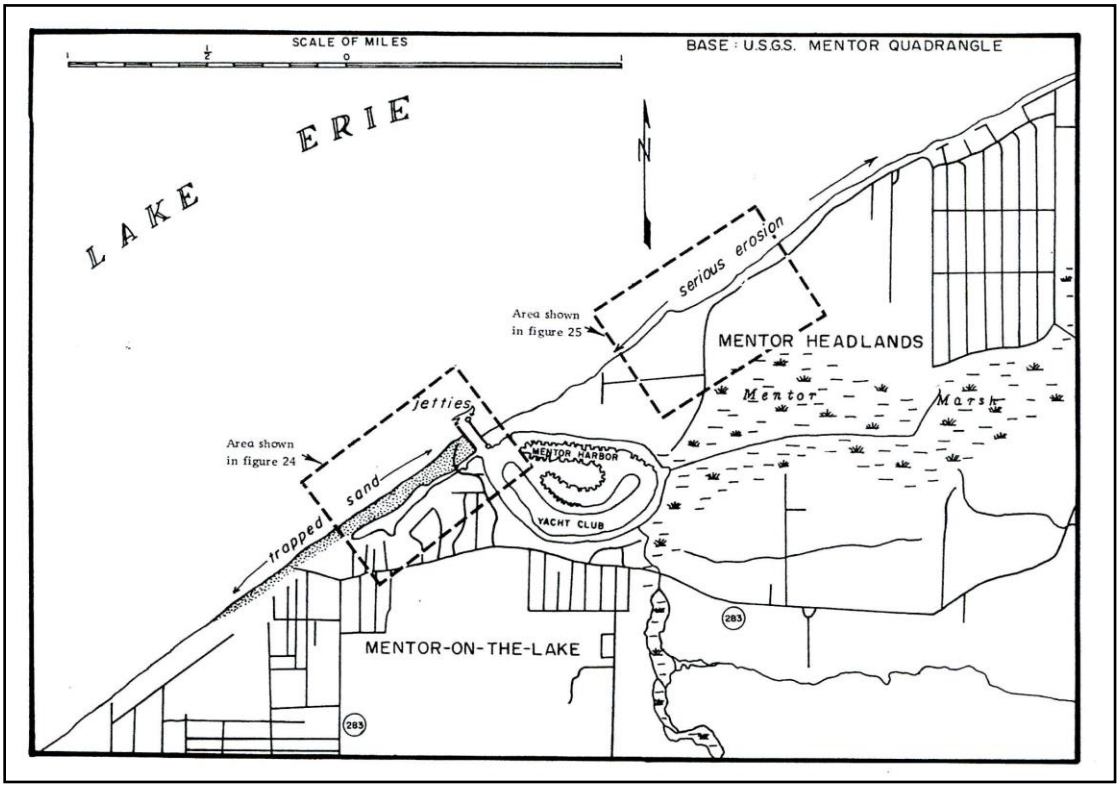
3. The Mentor Harbor jetties have caused an exceptionally large built-up of beach to the west, that is more than 200 feet wide and ~6,000 feet in length. The beach build-up, in itself, may have further interrupted the alongshore drift of material thereby resulting in more accretion.

4. The supply for this beach is suspected to be the nearshore bottom, which for some distance lakeward is characterized by sand and some gravel in the form of massive bars.

5. The nearshore deposits may have originated as stream-carried sediment at the former outlet of the Grand River, which the former stream channel is now a lagoonal marsh.

6. Thus, the great quantity of beach material west of the jetties represents a major loss from the littoral drift, which has a predominant northeastward movement. This has tended to starve the shore to the northeast where erosion has been very active. Longshore drift now occurs past the end of the jetties, however significant amounts if this material is deposited in the entrance to Mentor Harbor. This material is dredged annually in large quantities and is used commercially, representing a notable loss to the littoral supply, which also tends to starve the shore to the northeast.

7. As a result, erosion in the next 2.3 miles northeast of Mentor Harbor has been very serious for many years because of the lack of beaches and the action of waves and groundwater seeps on the clay banks.



Shore Conditions in the Vicinity of Mentor Harbor (Hartley 1964)

Carter (1973). Lake Erie Shore Erosion, Lake County, Ohio: Setting, Processes, and Recession Raters from 1876 to 1973.

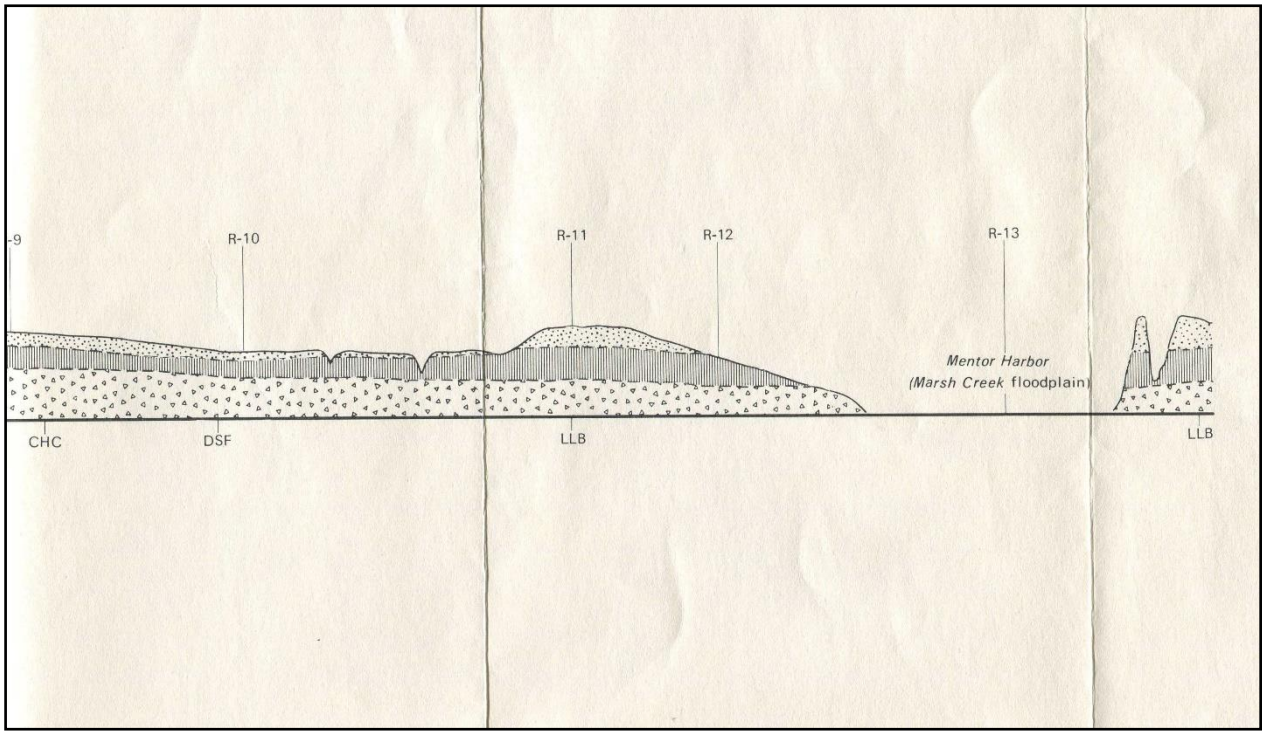
1. Rotational slumps are the most significant result of wave erosion east of Mentor Harbor. The slumps take place along the contact between the glacial till and the laminated clay, with the clay acting as a slip plane for the overlying till. The clay is lubricated by surface water seeping downward along joints in the till and/or by ground water. Erosion of slumped material by waves eliminates the resisting moment at the toe of the bluffs and stimulates new slumps.

2. The recession rate between 1876 and 1937 for ~4,000 feet east of Mentor Harbor was moderate to rapid, largely due to the presence of the Mentor Harbor jetties constructed in 1931. From 1937 to 1973 the reach directly east of Mentor Harbor has undergone a very rapid rate of recession. The reach has undergone accelerated recession because of the Mentor Harbor jetties.

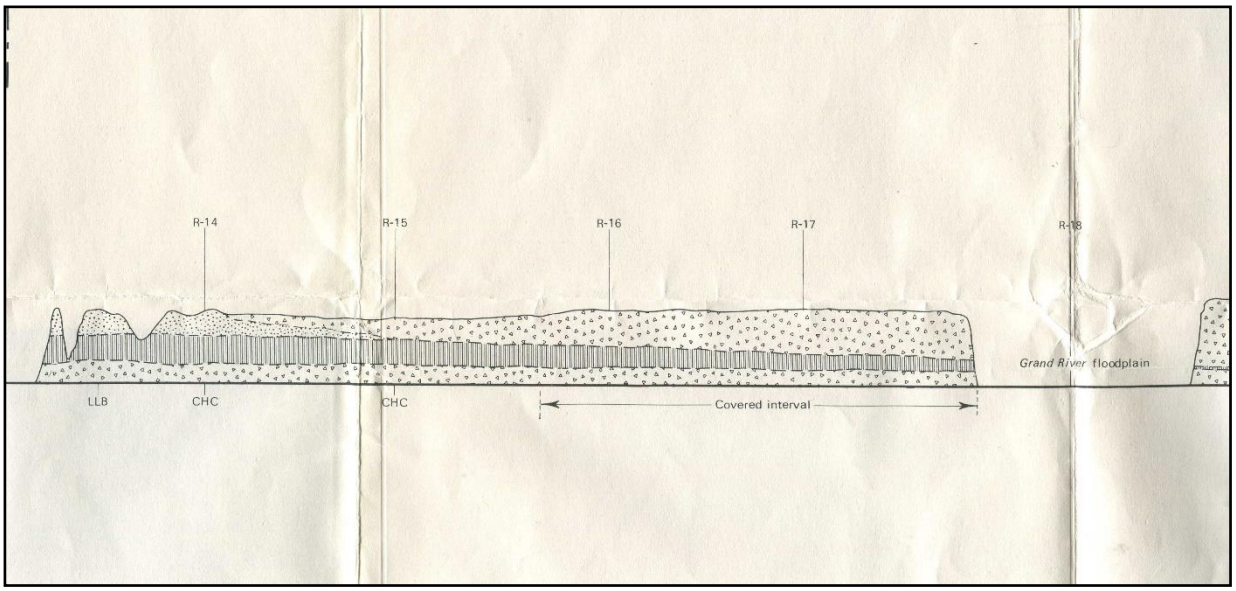
3. Recession rates are classified as follows: very slow=<1 ft/yr; slow=1 to 3 ft/yr; moderate=3 to 5 ft/yr; rapid=5 to 7 ft/yr; very rapid=7 to 9 ft/yr.

4. Because sand dredged from Mentor Harbor is now being put back into the alongshore drift system, the recession rate should decrease along this reach.

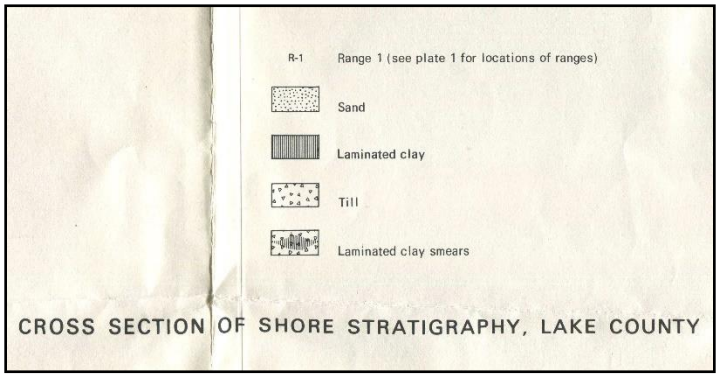
5. Shore protection recommendations: East of Mentor Harbor and in the vicinity of Mentor Headlands standard shore-protection measures can be undertaken to reduce the recession rate. Because of the relatively abundant sand supply along this reach, short (<50 feet) groins can the used to trap sand and help protect the base of the bluffs. Also a combination of landscaping, adequate drainage, and toe protection in the form of seawalls could reduce or eliminate recession along this reach. If water can be kept from the laminated clay there will also be a significant increase in slope stability. This could be accomplished through a system of inexpensive interceptor drains.



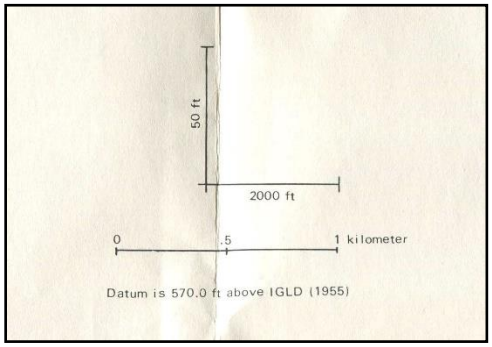
Lake Erie Bluff Profile East of Mentor Harbor (Carter 1973).



Lake Erie Bluff Profile East of Mentor Harbor (Carter 1973).

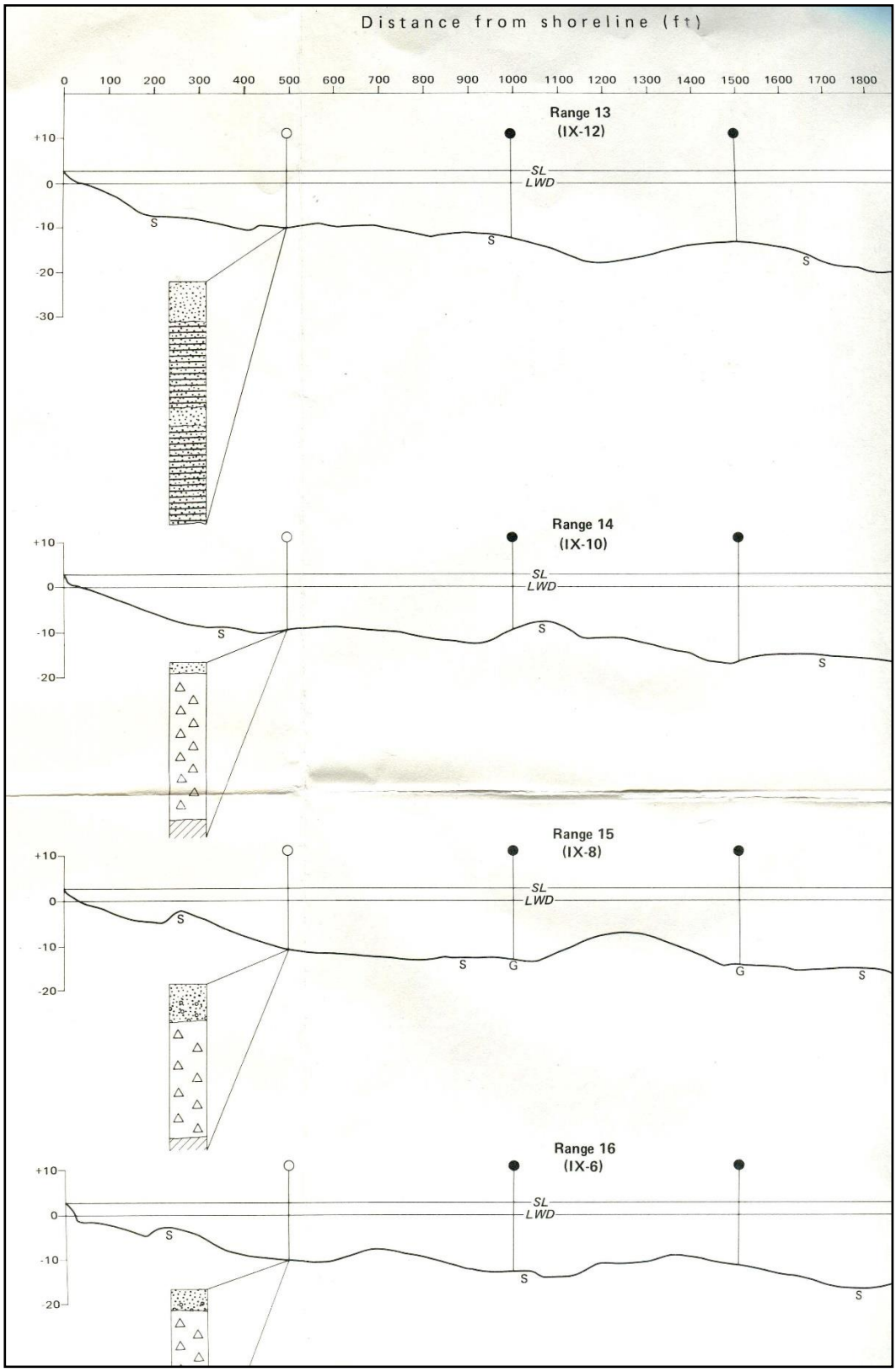


Legend for Lake Erie Bluff Profiles East & West of Mentor Harbor (Carter 1973).

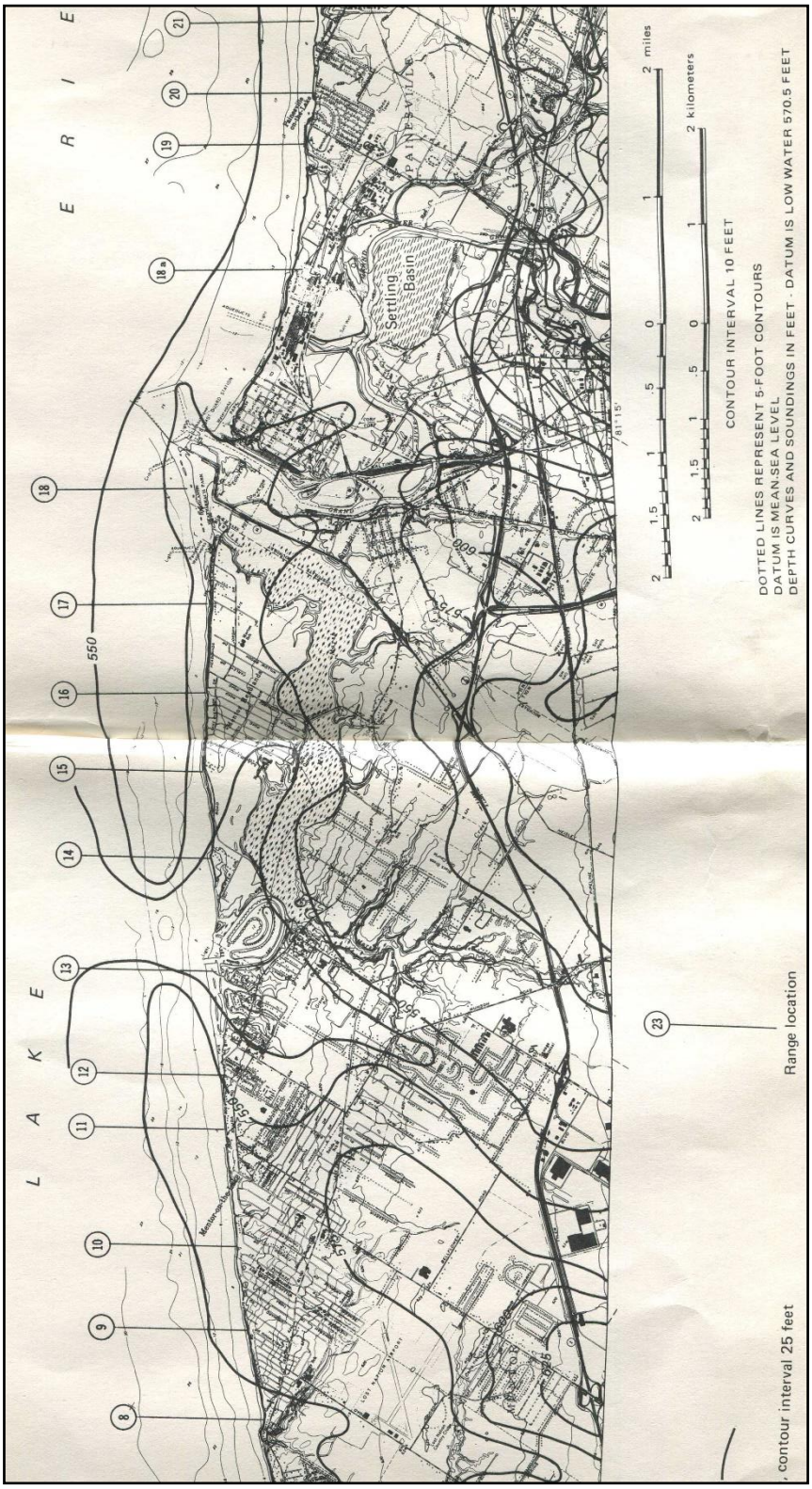


Scale for Lake Erie Bluff Profiles East & West of Mentor Harbor (Carter 1973). Not to scale with profile diagrams.

Depth Profiles for Ranges in the vicinity of Mentor Harbor (Carter 1973).



Location of Profile Ranges & Bedrock Elevation the vicinity of Mentor Harbor (Carter 1973).



Literature citations

Carter, Charles H. [1970 Field Surveys conducted by Charles E. Herdendorf]. 1973. Lake Erie Shore Erosion, Lake County, Ohio: Setting, Processes, and Recession Raters from 1876 to 1973. ODNR, Division of Geological Survey, Report of Investigation No. 99. 105 pp.

Hartley, Robert P. 1960. Sand Dredging Areas in Lake Erie. ODNR, Division of Shore Erosion, Technical Report No. 5. Columbus, Ohio. 79 pp.

Hartley, Robert P. 1964. Effect of Large Structures on the Ohio Shore of Lake Erie. ODNR, Division of Geological Survey, Report of Investigation No. 53. Columbus, Ohio.

US Army Corps of Engineers. 1950. Shore of Lake Erie in Lake County, Ohio Beach Erosion Control Study. Appendix IX. 81st Congress, 2nd Session, House of Representatives Document N. 596, Washington, DC.

Conclusions

KS Associates has done an admirable job in assessing the erosion problems at the project site and recommending sound engineers solutions to stabilizing the shoreline. As a start to a living shorelines approach, the most innovative approach is found in Area B, in that short, wooden groins are proposed.

I would caution that, as shown in these preliminary study designs, these wooden structures may not be long enough or durable enough to establish the desired effect. Continual nourishment of these structures may be required – another factor that requires further technical study and design refinements to better determine. Also, to serve the purpose of introducing and establishing a series of nature-based, living shorelines concepts along this extended reach of Lake Erie, stone-based revetments and breakwater structures, such as those indicated diagrammatically in the KS portion of this study / report, could be designed so that, approximately along and above the typical waterline, that these structures could be designed to look rugged and jagged, more like rocky natural reefs at various distances, and in a somewhat irregular fashion. The stone structures themselves could then also serve to support living shoreline concepts to some extent. As sturdy and substantial as these structures have to be to withstand the rigors of Lake Erie waves and weather, they could also be used to help establish / re-establish near shore and shoreline habitat along these reaches – which would be appropriate for a municipal lakeside nature preserve that is contiguous to a state nature preserve.

The proposed range of shoreline stabilization techniques along the identified strategic sites can serve to support a more expansive range of new or innovative nature-based approaches, to be tested at this high-energy reach of Lake Erie shoreline. A more detailed and sophisticated analysis and set of design concepts will be required to do so. This certainly would not be an easy task, but here is an opportunity that should not be missed.

Charles E. Herdendorf
Geological Scientist

February 28, 2019