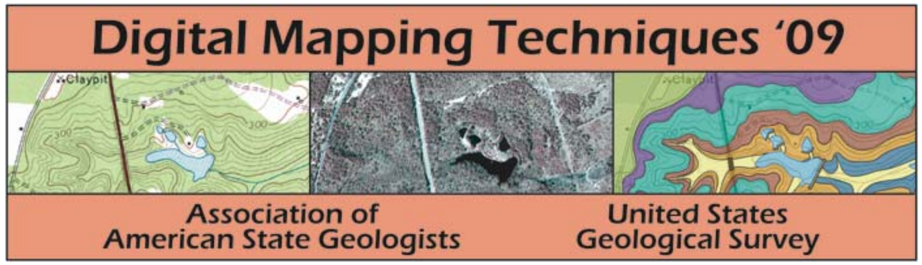

The following was presented at DMT'09 (May 10-13, 2009).

The contents are provisional and will be superseded by a paper in the DMT'09 Proceedings.

See also earlier Proceedings (1997-2008)
http://ngmdb.usgs.gov/info/dmt/

New GIS Tools for Mapping Ohio's Lake Erie Coastal Erosion Areas

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SHORE EROSION ALONG THE COAST OF LAKE ERIE

Erosion along Ohio's Lake Erie shoreline is a major geologic hazard. The coastline undergoes large- and small-scale changes. Figures 1 and 2 highlight some large-scale changes. Figure 1 shows an area near Painesville that has undergone between 34 and 207 feet of recession over a 17-year period, while the Sheldon Marsh barrier island has undergone between 268 and 953 feet of recession during that same period (fig. 2).

More normal coastal erosion rates also erode bluffs and destroy properties. As a bluff recedes, buildings may be either physically moved back from the bluff or torn down before being destroyed or destroyed from the erosion. In Figures 3a, 3b, and 3c, two houses have disappeared and home owners probably have moved into the garages. Geology, lake levels, prevailing winds, and shore protection affect coastal erosion rates. Between 1973 and 1990, average shoreline recession was 1.41 feet per year. Over the 17-year period the shoreline receded nearly 24 feet. In certain areas, recession has occurred at rates up to 56 feet per year (fig. 2). Ohio's Lake Erie coastline erosion significantly affects coastal residents.

FIGURE 1.—Between 1973 and 1990, Ohio's shoreline receded approximately 24 feet. This area near Painesville experienced up to 207 feet of recession. Numerous parcels (black outlines) have been lost to coastal erosion.

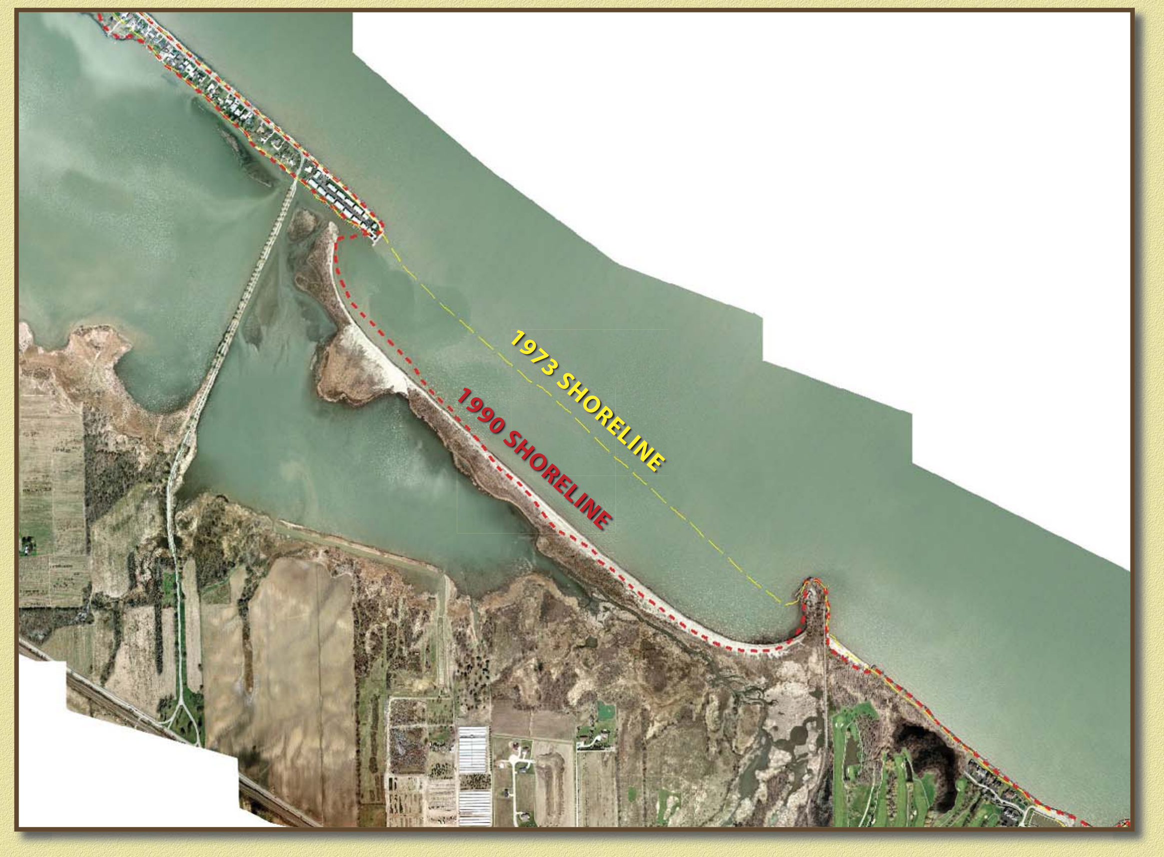

FIGURE 2.—The Sheldon Marsh barrier island has been retreating at a rate between 15 to 56 feet per year.

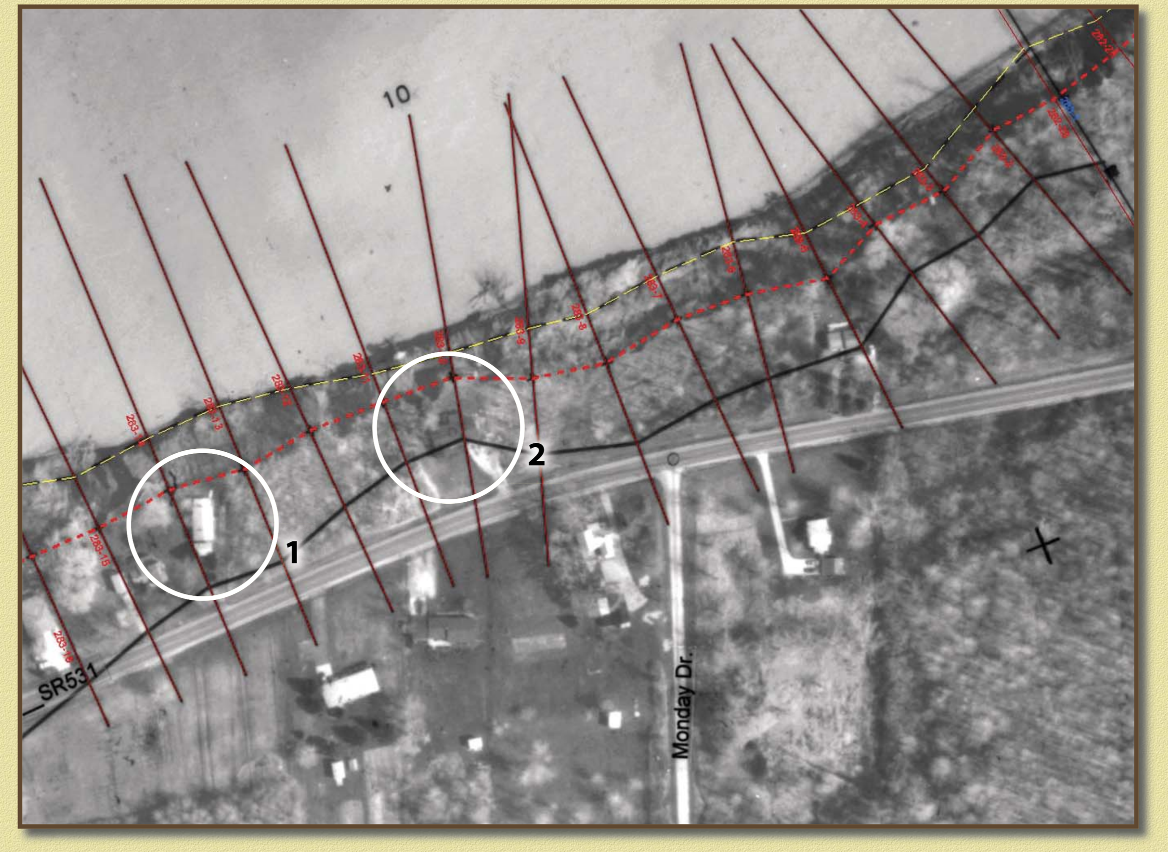

FIGURE 3a.—This aerial image from 1990 shows two houses (circled) threatened by coastal erosion.

FIGURE 3b.—By 2004, the two houses (circled) have been lost to coastal erosion. Property (2) now has a garage.

FIGURE 3c.—The property (2) owners probably have moved into the garage.

THE CEA PROGRAM AND THE 2004 SHORELINE MAPPING

The State of Ohio mandates that Coastal Erosion Areas (CEAs) be designated for the state's 262-mile Lake Erie coastline every 10 years. CEA mapping identifies areas threatened by coastal erosion over a thirty-year period. Once CEAs are designated, the CEA program informs at-risk property owners about how to protect their properties.

The latest remapping of the CEA involved three steps:

1. Converting the 1998 CEA maps to a GIS.
2. Mapping the 2004 toe of the bluff and the shoreline at each shore-normal transect.
3. Calculating new CEA delineation using the 1990 and 2004 shorelines.

Three newly created applications assisted the 2004 shoreline mapping and updated CEA delineation: a shore-normal transect identification number application, a CEA 2004 digitizing application, and a CEA Calculator application. The three applications facilitated the task of remapping the CEA and reduced mapping time from more than one year to less than 3 months.

Unique Shore-Normal Transect Identification Number Application

Before work could be performed for the new CEA delineation, identification numbers had to be assigned to all shore-normal transects. These unique numbers, or TIDs, are contiguous and have a spatially-sequential orientation. TIDs need to have such orientation because a five-point moving average algorithm used smooth CEA delineation lines.

To assign TIDs, staff members took advantage of the fact that the 1990 aerial photography was flown east-to-west along the coast and assigned a sequenced number to each aerial photo. During 1998 CEA mapping, shore-normal transects were drawn on each 1990 aerial photo. These transects were uniquely numbered for each photo; the numbers range from 1 to 72, depending on the width of the photo. Using the aerial-photo sequence number and the sequential-transect numbers on each photo, the application iteratively assigns the unique TIDs for the entire coastal dataset (fig. 4).

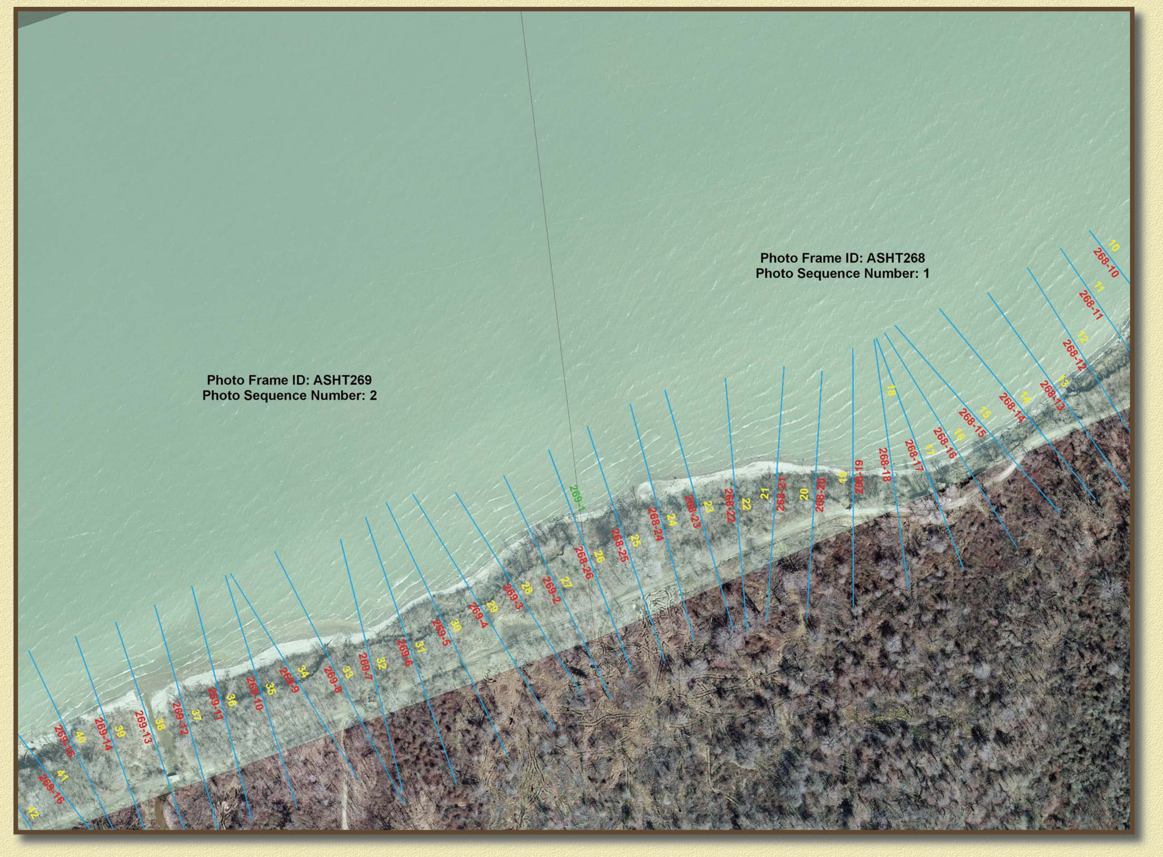

FIGURE 4.—A portion of the coastline near the Pennsylvania border. The outlines of two 1990 aerial photo frames, frame 268 and frame 269, are shown as light green polygons. Also shown are the aerial-photo sequence numbers. The shore-normal transects are labeled in RED with the original frame and transect ID numbers. The last transect in a 1990 aerial photo frame is also the first transect in the next frame. Known as a tie transect, its original frame and transect ID number is labeled in GREEN. The new TID numbers are labeled in YELLOW.

CEA 2004 Digitizing Application

The CEA 2004 Digitizing Tool (fig. 5) can easily digitize the 2004 shoreline and toe of the bluff. Because the application copies all the attributes from the shore-normal transects to the newly digitized 2004 shoreline and toe of the bluff features, attribute errors associated with keyboard entry were almost completely eliminated. The time for GIS quality-control editing reduced from approximately 160 hours to 2 hours.

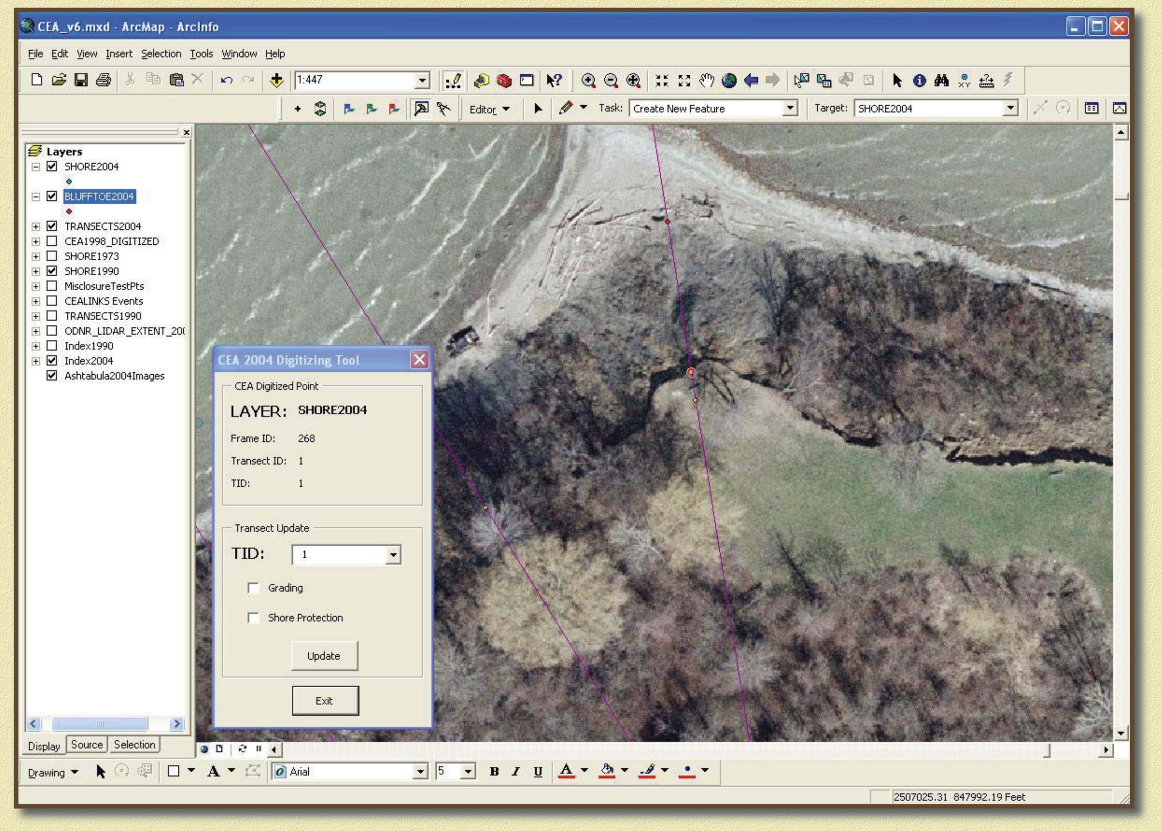

FIGURE 5.—CEA 2004 digitizing application. Transects can be attributed according to whether man-made grading has occurred and whether a transect encounters shore protection.

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CEA Calculator Application

The CEA Calculator application (fig. 6) can calculate the recession distance and recession rate between two different shorelines, along with the 30-year average recession distance. Originally written in FORTRAN 77 for the 1998 CEA mapping project, the application was converted to VBA using ArcObjects for the latest remapping of the CEA. CEA calculations are a three step process. First, the operator creates the calculated accuracy limit (CAL) line. Then, the operator calculates the recession distance, recession rate, and the 30-year average recession distance and writes these values to the attribute table of the shore-normal transects. Finally, the operator plots the CEA lines using the application. The final output can be assembled into traditional mapbook pages (fig. 7) or can be distributed to the public using an ArcIMS service. The calculator output can also be integrated with a county auditor's GIS parcel data. Such integration will allow us to determine which property owners will be affected by upcoming remapping of the CEA, along with notifying property owners who will be dropped from the 1998 CEA areas.

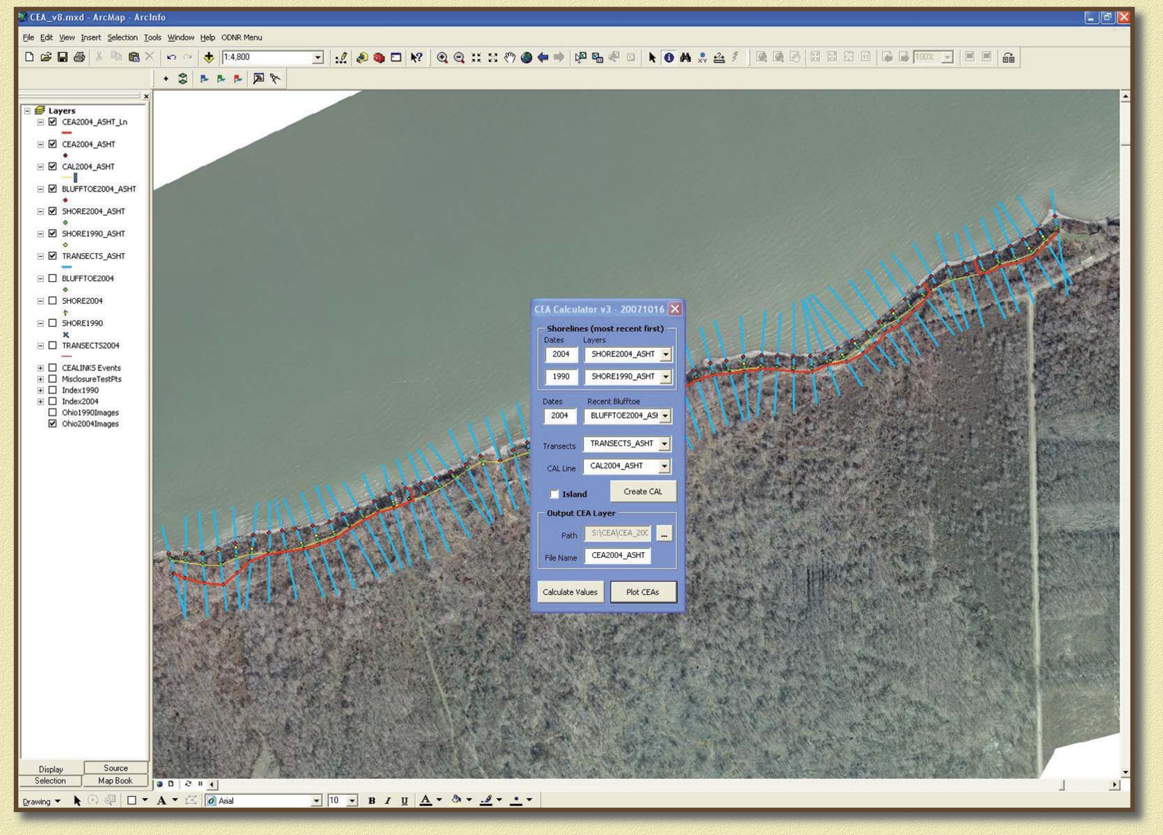

FIGURE 6.—The CEA Calculator tool. CEA calculation requires four different layers: the two shorelines, the toe of the bluff for the most recent epoch, and the shore-normal transects.

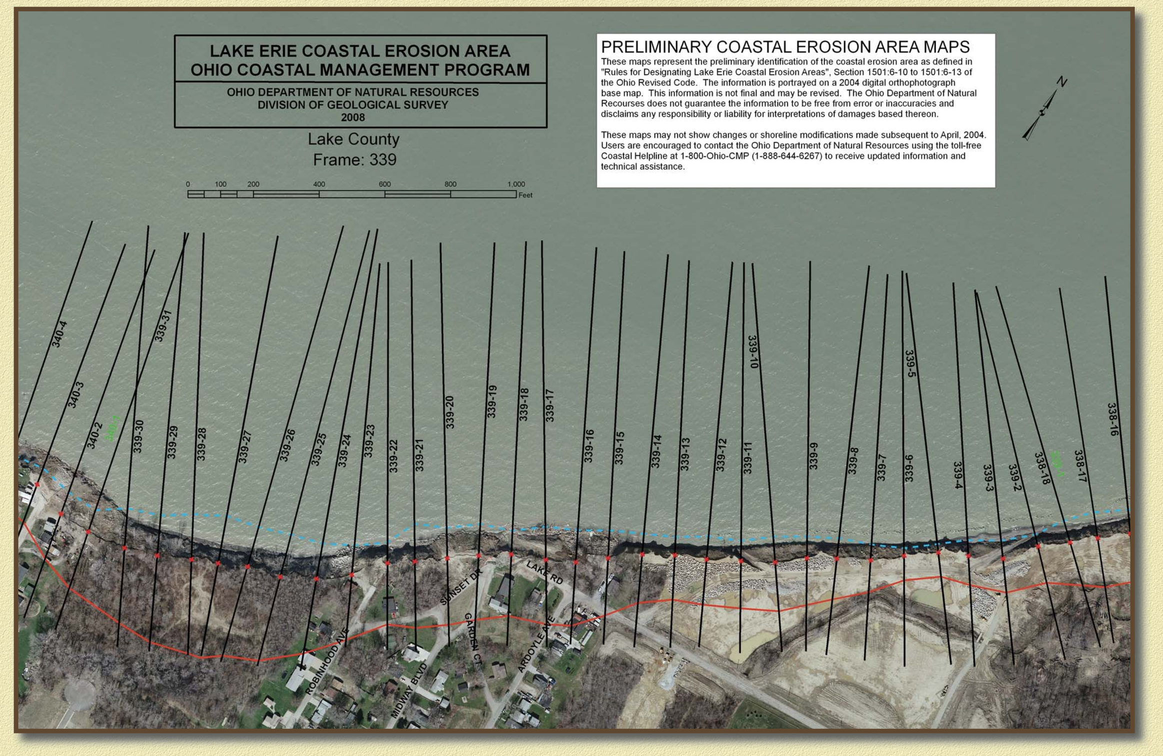

FIGURE 7.—Example output of a mapbook page for a CEA in Painesville, Ohio.