DIVISION OF GEOLOGICAL SURVEY

GUIDEBOOK NO. 1

NATURAL AND MANMADE FEATURES AFFECTING THE OHIO SHORE OF LAKE ERIE

BY

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GEOLOGY SERVES OHIO

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INTRODUCTION

The Ohio shore of Lake Erie is a valuable natural resource. Within this narrow strip of land over 200 miles long live about two million people, who depend to a great extent on such shore-related activities as shipping, commercial fishing, farming, tourism, and power production for their livelihood. In addition, and perhaps most importantly, this zone is vital to our environment and has great potential for recreation.

The shoreline zone, because it is made up of easily erodable surficial deposits, is undergoing constant change. Physical processes are continually modifying the landscape, whether eroding a bluff at Ashtabula or building a sandbar at Cedar Point. Violent Lake Erie storms accelerate these physical processes, and man, as he has done at other places, is beginning to have a pronounced effect on this dynamic system.

Changes in the Lake Erie shoreline were observed early in Ohio history. For example, along most of the shoreline from the Pennsylvania line to Marblehead an average of 130 feet of land was lost to the lake between 1796 and 1838 (Whittlesey, 1838). In those days the shore was affected almost solely by natural processes such as wave action and mass wasting. However, since that time various structures such as groins, jetties, and breakwaters have been built; for the most part these structures have had an influence on the natural shore processes. Other land-based structures such as drainage ditches, sewer outfalls, and dikes have also had effect.

Because of man's continued encroachment upon the shore and with the realization that the lake can be and has been changed by man's activities, it is time that we take a harder look at his influence on the natural processes operating along the lake shore. This guidebook was prepared to point out and to discuss the different types of natural and manmade features and activities that influence shoreline processes along the south shore of Lake Erie.

GEOGRAPHIC AND GEOLOGIC SETTING

The Ohio shore, made up largely of till, clay, and sand except for prominent bedrock exposures at Catawba Island-Marblehead peninsula and at the point near Avon Lake, can be divided into a western and an eastern area on the basis of topography. The area between Toledo and Huron has practically no relief, whereas the area between Huron and Conneaut has marked relief. Shore erosion in the areas of nonresistant surficial deposits is rapid; in some areas records show that the shoreline is retreating as much as several feet a year.

Toledo to Huron

Geography.—The shore between Toledo and Huron, with the exception of Catawba Island-Marblehead peninsula, is characterized by a broad smooth surface which slopes about 2 feet per mile to the northeast and is crisscrossed by an intricate system of dikes, canals, creeks, and streams. Major rivers traversing this area are the Maumee, the Portage, the Sandusky, and the Huron. Vegetation is sparse; it consists largely of oaks and cottonwoods that have been allowed to grow adjacent to the natural and manmade waterways. The area is heavily farmed; offshore the western basin is a productive commercial fishing ground. Toledo, Sandusky, and Huron have major harbors and appropriate associated industries; moreover, a nuclear power plant is being built at Locust Point and another one is planned for the south side of Sandusky Bay. Part of the shore is covered by summer homes and resorts that have easy access to boating, hunting, fishing, and swimming.

Geology.—The shore is made up largely of low front swamps and marshlands. The barrier beaches generally overlie clay deposits; the clay in turn overlies limestone or shale bedrock or till deposits. Nearshore there is generally a narrow band of sand (less than 1,000 feet wide) that merges farther offshore into mud or clay.

On the other hand, the Catawba Island-Marblehead peninsula shore, with the exception of the East Harbor State Park area, is made up of resistant limestones and dolomites that are overlain in places by till. This irregular shoreline has numerous small beaches that are made up of bedrock pebbles and cobbles, whereas the East Harbor reach consists of a long beach made up of well-sorted sand. Offshore from East Harbor the sand merges into mud. Directly off the bedrock shore there is no gradation; the bottoms are generally mud or, where scoured, bedrock.

Modern processes.—The low relief and the location of this area make it very susceptible to flooding because of wind setup during northeast storms. Moreover, because of storm waves, erosion of the surficial deposits can be severe. Net longshore drift along most of the shore is from the southeast to the northwest; the drift direction is indicated by the accumulation of sand and gravel on the windward side of structures extending into the lake, as well as by the shape and orientation of sand bodies such as baymouth bars and compound spits.

Jetties have trapped sand, forming beaches at both Sandusky and Huron. These beaches have helped protect the shoreline on the updrift sides of the structures. Overall, however, there has been a net loss of land to the lake in this area (U.S. Army Corps Engineers, 1961, p. 67). Interestingly enough, in a study on the effects of large structures on the Ohio shoreline, the Sandusky jetty was the only structure considered "... to be completely beneficial to the adjoining shore" (Hartley, 1964, p. 4).

The Catawba-Marblehead shore has been less altered than the rest of the shore between Toledo and Huron. In contrast to the adjoining low-lying areas, the uplands in this area protect the land from flooding, and the bedrock is moderately resistant to erosion. In addition, man has not had too much influence on natural processes along this portion of the shore.

Huron to Conneaut

Geography.—The shore between Huron and Conneaut is characterized by an irregular gently rolling terrain that slopes to the northwest and is crossed by several major rivers: the Vermilion, the Black, the Rocky, the Cuyahoga, the Chagrin, the Grand, the Ashtabula, and the Conneaut. Most of these rivers have major harbors. Six- and seven-hundred-foot freighters bring iron ore from the upper lakes to industrial cities such as Lorain, Cleveland, Fairport Harbor, and Ashtabula at the mouths of these rivers. A large part of the shore is covered by homes and resorts; the shore from Huron to Cleveland is densely populated and is made up largely of suburban and rural communities.

Geology.—Shore deposits, except for the shale headlands near Avon Lake and Vermilion, consist of nonresistant lake clays and sands and till. These deposits, which crop out in bluffs ranging from 10 to 60 feet in height, overlie gray to black shales. Nearshore deposits consist of beach sands or of shale and/or till; mud predominates farther offshore, although there are substantial sand and gravel deposits north and northwest of Lorain and northeast of Cleveland.

The shore near Avon Lake and the local promontories at Vermilion and Lakewood are made up of moderately resistant laminated and thinly bedded shale that is overlain in places by till and/or lake sediments. The shoreline is irregular. A few pocket beaches composed of rounded shale fragments are found in strongly jointed or faulted zones in the shale bluffs. The bedrock is commonly exposed in the nearshore area, but farther offshore the bottom is generally mud.

Modern processes.—Although the shoreline is not faced with a flood problem, as is the low-lying area to the west, there are serious erosion problems. In places the shoreline has lost as much as 20 feet of land a year (Ohio Division Shore Erosion, 1961, p. 13). On the other hand, the beaches, especially the more extensive ones northeast of Mentor, provide the shore with some protection from waves. In the Cleveland vicinity much of the shore is protected by manmade structures. In the stretch from Huron to Conneaut, the point near Avon Lake marks the divide between opposing longshore drift directions. Net longshore drift west of the point is in general to the west, whereas net longshore drift east of the point is to the east.

Many structures have been built between Huron and Conneaut to combat shore erosion. A few of the structures have been successful in preventing or reducing erosion; however, in the main they have not been successful. Perhaps the best examples to consider in this light are large jetties and armored water intakes that extend into the lake for several hundred feet. These structures generally have trapped large quantities of sand on the windward side, thereby protecting the updrift shore. On the lee side, however, a lack of sand and possibly an eddy effect has caused accelerated erosion. Furthermore, the eroded reach is commonly much longer: "... the length of eroding shore is ordinarily five or more times the length of shore which is protected by build-up" (Hartley, 1964, p. 30). This is not to say that all manmade structures have a detrimental effect on the Ohio shore of Lake Erie. However, the only ones that have been beneficial to the shore and surrounding area are those that have been carefully thought out, well designed, and properly built and maintained.

FIELD TRIP STOPS

Field trip stops have been selected to show natural and manmade features characteristic of or of influence upon shore processes. The trip consists of 26 stops; table 1 provides a thumbnail sketch of each location and figure 1 outlines the route. The field trip is designed for two days; however, a one-day trip can be made by visiting stops 2 to 15. The total trip can be shortened by omitting stops 17, 18, 20, 21, and 22. Representative profiles in areas of different shore materials (clay, sand, limestone, shale, and till) are shown in figure 2.

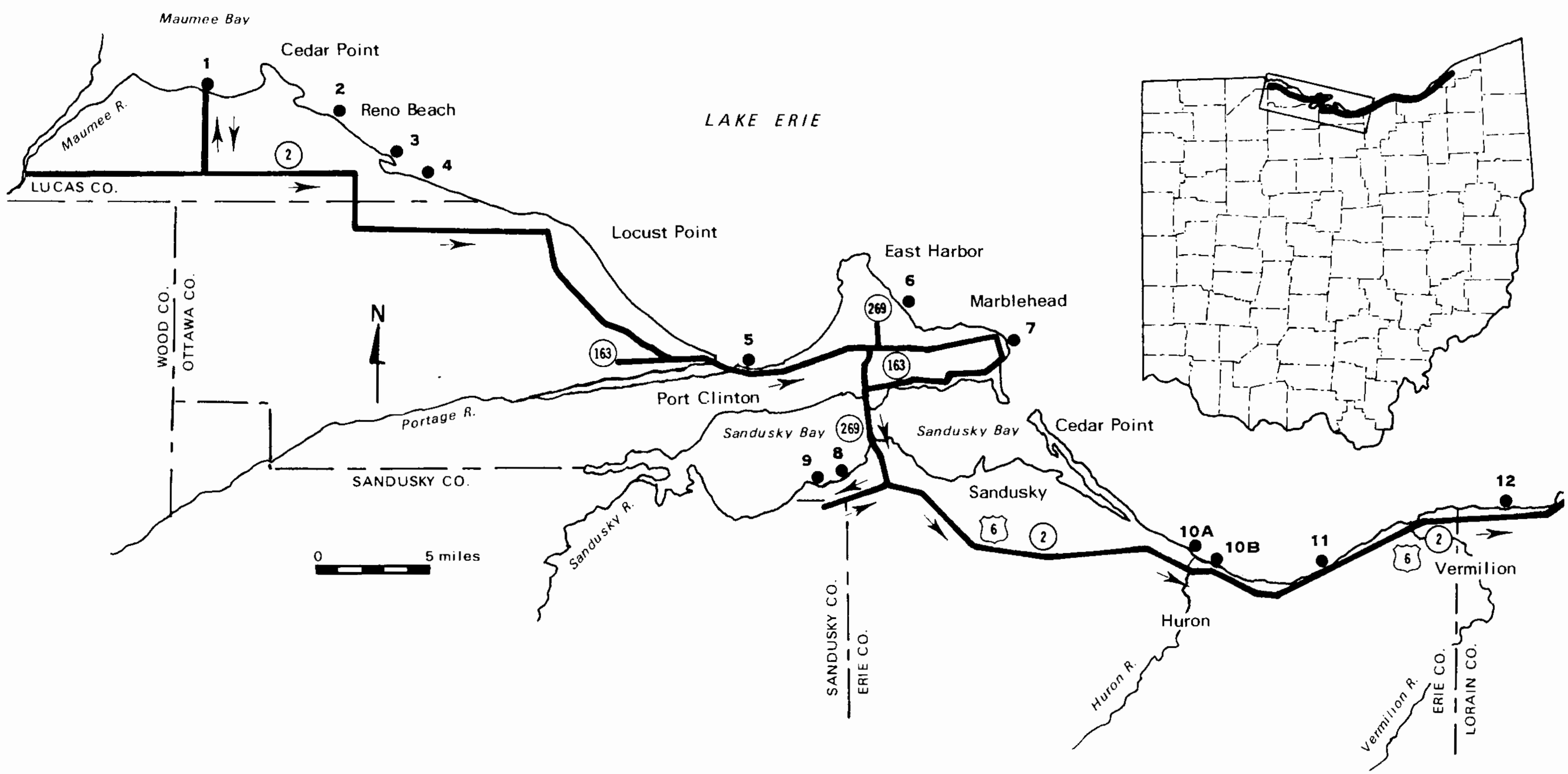
Aerial photographs (figs. 3-28) taken between March 28 and April 1, 1968, illustrate each stop. The mean Lake Erie water level was about 570.9 feet above sea level for the month of March 1968 and about 571.1 feet above sea level for the month of April 1968.

This guidebook was prepared in the spring of 1973 when the Lake Erie water level was at a record high. Because of the high water level there has been a flurry of construction activity that has modified or changed the appearance of the shoreline in many places. These activities as well as natural processes have caused changes at some of the guidebook stops. It is hoped, however, that the overall physical integrity of the shoreline will be preserved for several years.

TABLE 1.—*Thumbnail sketch of stops*

Stop[1]	County	Natural features	Manmade features
1	Lucas	Clay banks	
2 (P)	Lucas	Reclaimed land, sandy reach	Dikes, groins, jetty
3 (R,P)	Lucas	Marsh, sandspit	Jetty
4 (R,P)	Lucas	Sandy reach, clay banks	Groins, seawall
5 (P)	Ottawa	Fill land	Jetties
6 (R,P)	Ottawa	Barrier beach	Seawall
7	Ottawa	Limestone headland	
8	Sandusky	Clay banks	
9	Sandusky	Clay banks	Dike
10a,b (R,P)	Erie	Clay banks, beach	Jetties
11	Erie	Clay and till banks, floodplain	Groins, breakwaters
12 (P)	Lorain	Shale and till, beach	Groin
13 (P)	Lorain	Fill land	Breakwater
14 (R,P)	Lorain	Graded and covered slope	Seawall, groins
15	Lorain	Shale	
16 (R,P)	Cuyahoga	Shale and till, beach	Groins
17 (R,P)	Cuyahoga	Landscaped slope, beach	Groin
18	Cuyahoga	Till and lake-deposits bluff	
19 (R,P)	Cuyahoga	Landscaped slope, beach	Piers
20	Cuyahoga	Landscaped slope	Cylindrical forms
21	Lake	Till bluff	
22	Lake	Till bluff	
23	Lake		Debris
24 (P)	Lake	Till bluff, beach	
25 (R,P)	Lake	Beach, dunes	Jetty
26 (P)	Lake	Till bluff, beach	Groins

[1]P, large parking area, R, restrooms.


Maumee Bay
Cedar Point
1
2
Reno Beach
3
4
Maumee R.
LAKE ERIE
2
LUCAS CO.
WOOD CO.
OTTAWA CO.
Locust Point
East Harbor
6
269
Marblehead
7
N
163
5
163
Port Clinton
Portage R.
Sandusky Bay
269
Sandusky Bay
Cedar Point
9
8
SANDUSKY CO.
Sandusky
Sandusky R.
0
5 miles
6
2
10A
10B
11
12
2
6
Vermilion
Huron
SANDUSKY CO.
ERIE CO.
Huron R.
Vermilion R.
ERIE CO.
LORAIN CO.

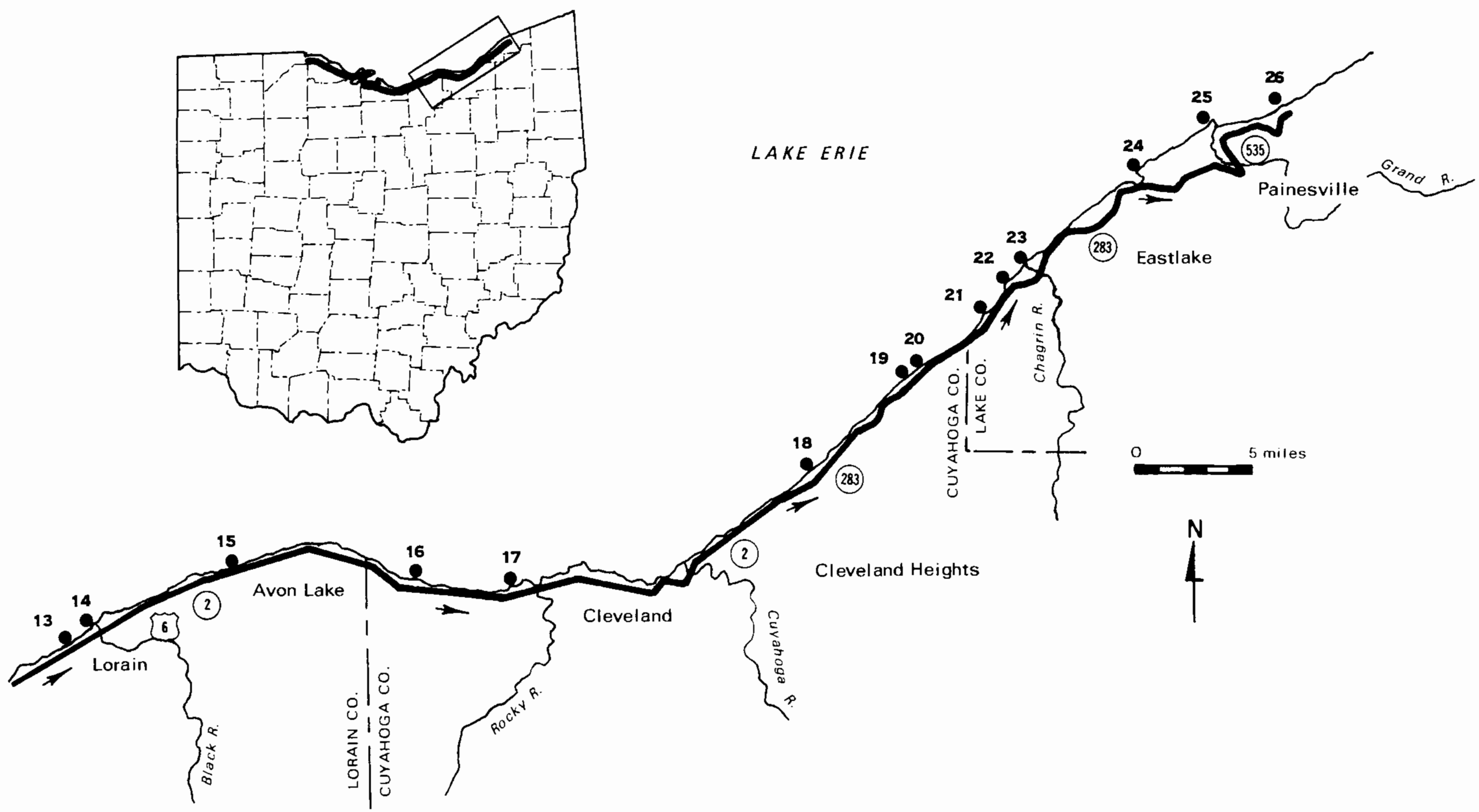


FIGURE 1.–Route of field trip.

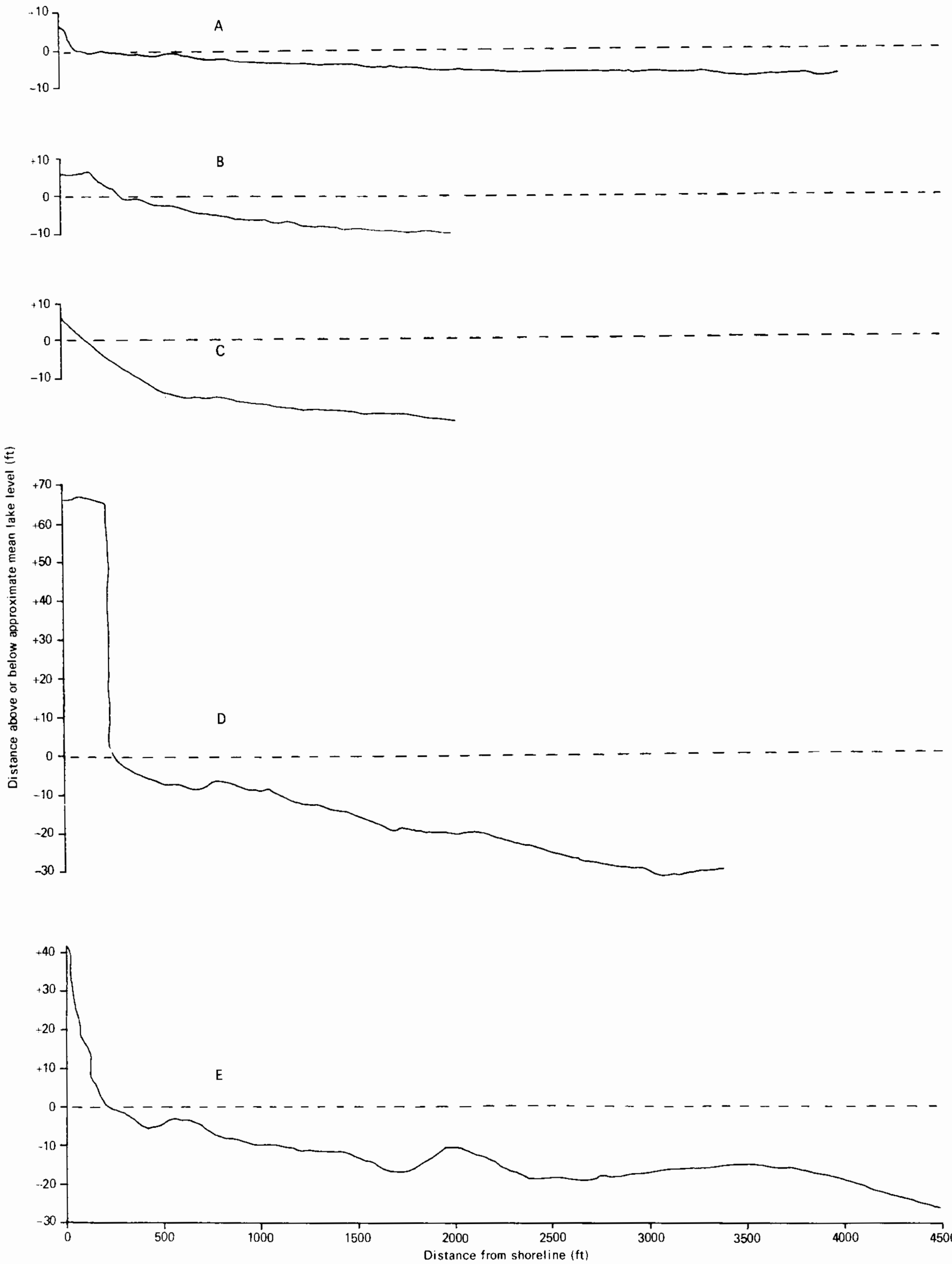


FIGURE 2.—Shore profiles, *A*, from clay bank along the south shore of Maumee Bay (U.S. Army Corps Engineers, 1945, pl. 4, profile 22); *B*, from barrier beach at Metzger Marsh, east of Toledo (pl. 4, profile 75); *C*, from limestone headland on Marblehead peninsula (pl. 4, profile 186); *D*, from shale bluff at Lakewood (1950a, pl. 5, profiles 132 and 97); *E*, from till bluff south of Fairport Harbor (1950b, pl. 3, profile 5).

TOPOGRAPHIC MAPS

The route of this field trip may be followed on U.S. Geological Survey 7½-minute topographic quadrangle maps. Maps on which the stops are located are indicated.

Oregon (STOP 1)
Reno Beach (STOP 2)
Metzger Marsh (STOPS 3, 4)
Genoa (very short stretch)
Oak Harbor
Lacarne
Port Clinton (STOP 5)
Gypsum (STOP 6)
Kelleys Island (STOP 7)
Castalia (STOPS 8, 9)
Sandusky
Huron (STOP 10)
Vermilion West (STOP 11)
Vermilion East (STOP 12)
Lorain (STOPS 13, 14)
Avon (STOP 15)
North Olmsted (STOP 16)
Lakewood (STOP 17)
Cleveland South
Cleveland North
East Cleveland (STOPS 18, 19, 20)
Mayfield Heights (corner only)
Eastlake (STOPS 21, 22, 23)
Mentor (STOPS 24, 25)
Perry (STOP 26)

Quadrangle maps may be obtained from:

Ohio Division of Geological Survey
Building B, Fountain Square
Columbus, Ohio 43224

or

Distribution Section
U.S. Geological Survey
1200 South Eads Street
Arlington, Virginia 22202

A folder describing topographic maps and symbols is available upon request.

STOP 1

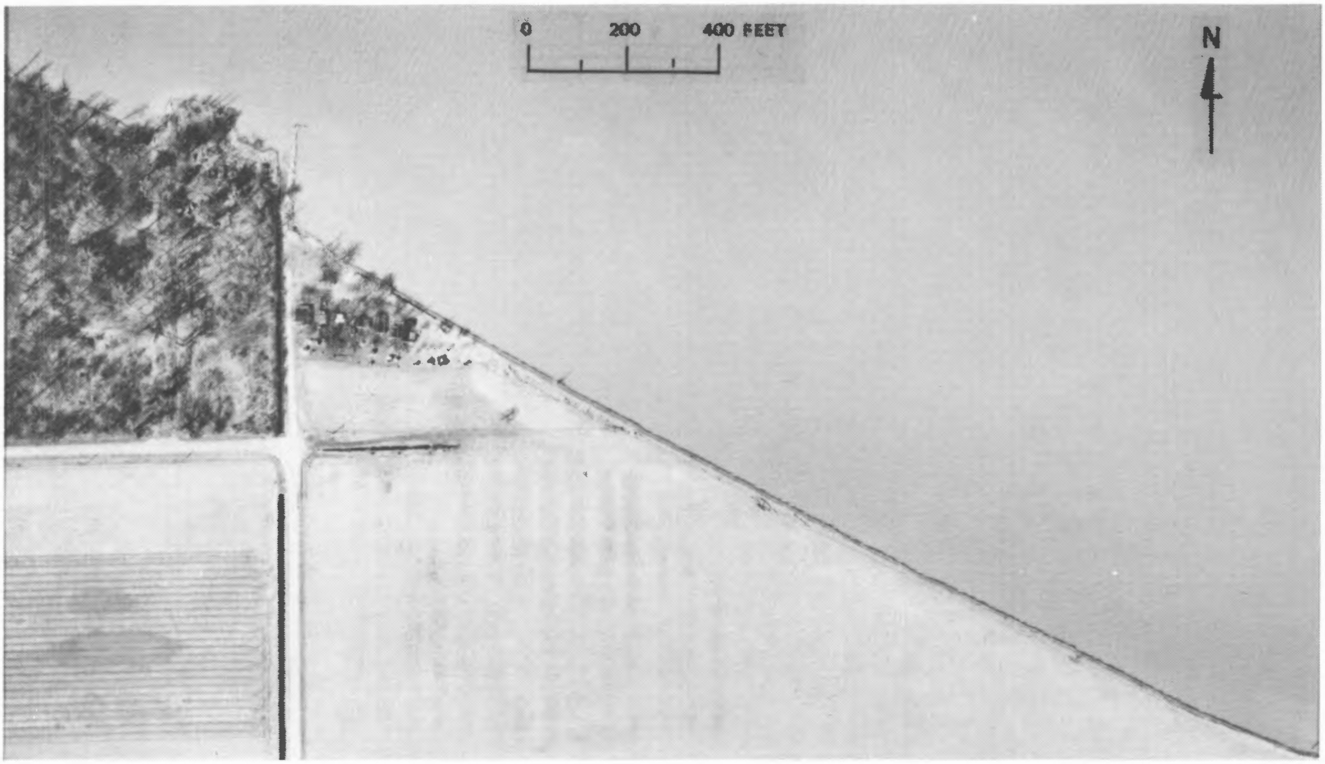


FIGURE 3.—STOP 1, South Shore Park. Low unprotected clay banks.

Mileage

2.0 2.0 From the southeast corner of Pearson Park (Wynn Rd. and Ohio 2) east of Oregon, Ohio, travel east on Ohio 2 to Norden Rd.

5.5 3.5 Turn left (north) on Norden Rd. and travel to the end of the road. Park on the south side of a cluster of summer cottages.

SOUTH SHORE PARK *(Oregon quadrangle).* Low unprotected clay banks on the south shore of Maumee Bay form an irregular shoreline. The beach and near-shore area are covered by a thin layer of sand (less than 1 foot thick). During a severe storm in November 1972 a layer of poorly sorted sand up to 1 foot thick was washed onto the clay banks; this washover fan was as much as 100 feet wide in places.

The unprotected portions of the shore are eroding at a rapid rate. This can be seen easily on an aerial photograph or a topographic map; areas of the shore that are protected by seawalls and other manmade structures project sharply into the bay, whereas the unprotected areas are embayed. This particular stretch of the shoreline receded 600 to 800 feet in the period 1877 to 1943 (U.S. Army Corps Engineers, 1945, pl. 2).

FIGURE 4.—STOP 2, Reno Beach, Lakemont Landing. A good example of a well-protected updrift (southeast) shoreline and an unprotected downdrift (northwest) shoreline.

Mileage		
9.0	3.5	Return to the intersection of Ohio 2 and Norden Rd.
15.1	6.1	Turn left (east) on Ohio 2 and travel to Howard Rd.
16.6	1.5	Turn left (north) on Howard Rd. and travel to Corduroy Rd.
16.9	0.3	Turn left (west) on Corduroy Rd. and travel to Park Colony Blvd.
18.0	1.1	Turn right (north) on Park Colony Blvd., travel to the end of the road, turn left (northwest) at the first dike (Lake St.), and go to the end of the road.

RENO BEACH, LAKEMONT LANDING *(Reno Beach quadrangle).* Southeast of the Lakemont jetty this structure and many groins trap sand from the southeast-to-northwest littoral drift. The sand beaches and two dikes help protect the reclaimed marshland from waves and high water. However, northeast storms have overtopped and breached the dikes; they were damaged by a severe storm in November 1972, but have subsequently been repaired and strengthened.

The Reno Beach shoreline has remained approximately at its present position since the first dike was constructed in 1902 (U.S. Army Corps Engineers, 1946b, p. 23). Just northwest of the Lakemont jetty, however, 7,000 feet of barrier beach which extended on a line from the outer dike to Cedar Point has been eroded, leaving the marsh behind the barrier unprotected. The influence of the jetty and the other structures on the adjacent shoreline is not clearly known; the west pier was built in 1898 (U.S. Army Corps Engineers, 1946b, p. 23), and just west of the jetty the barrier beach had a minimum width of 200 feet as late as 1946 (U.S. Army Corps of Engineers, 1946b, index map). The loss of more than a mile of barrier beach is probably largely the result of storm activity and high water in the early 1950's (a March 1957 aerial photograph of the area does not show the barrier). However, the loss of sand from the littoral drift system to the jetty and groins to the southeast has had a detrimental effect on the downdrift shore.

FIGURE 5.—STOP 3, Metzger Marsh. Jetty and sandspit. Note uprooted trees along the shoreline a few hundred feet southeast of the jetty.

Mileage		
20.9	2.9	Return to the intersection of Howard Rd. and Ohio 2.
21.4	0.5	Turn left (east) onto Ohio 2 and travel to the Bono Rd. turnoff (note Metzger Marsh sign).
21.9	0.5	Continue due east as far as possible.
23.2	1.3	Turn left (north) and travel to the end of the road.

METZGER MARSH *(Metzger Marsh quadrangle)*. A jetty at the mouth of Wards Canal stands between the diked reclaimed marsh of Howard Farms and the unprotected Metzger Marsh Wildlife Area. A tree-covered sandspit that extends a few hundred feet southeast from the jetty into the embayed part of Metzger Marsh is undergoing severe erosion because of lake storms and associated high lake levels.

The 1900 Oak Harbor 15-minute topographic map shows a continuous relatively straight shoreline from the mouth of Crane Creek northwest to Wards Canal. The position of the shoreline remained nearly unchanged through 1946, although between 1900 and 1946 jetties were built at Wards Canal, and a few groins were built along the reach (U.S. Army Corps Engineers, 1946b, index map). These structures trapped sand from the southeast-to-northwest longshore drift. A dike constructed along the shoreline during the high water of 1929 failed and was not repaired (U.S. Army Corps Engineers, 1946b, p. 15).

Since 1946 there has been a profound change in the shoreline for more than a mile southeast of Wards Canal. More than a square mile of marsh has been lost to the lake, and the only sand exposed along the reach is in the spit southeast of Wards Canal. The severe storms and associated high lake levels in the early 1950's, late 1960's, and early 1970's are probably the cause of the erosion. High water levels probably killed some of the marsh vegetation, enabling storm waves to more easily erode the nonresistant marsh shore. The shoreline along this reach receded an average of about 400 feet between 1877 and 1943 (U.S. Army Corps Engineers, 1945, pl. 2).

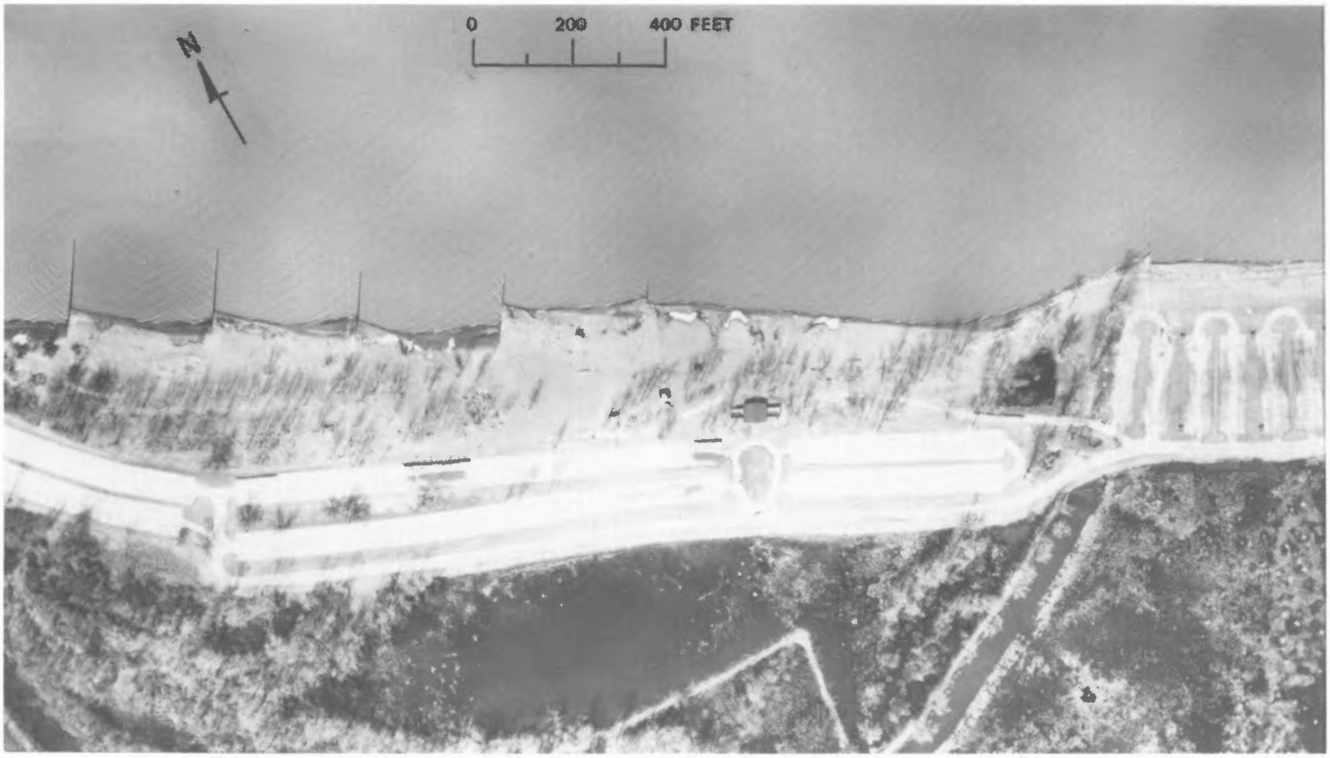


FIGURE 6.—STOP 4, Crane Creek State Park. Barrier beach, groins, and adjoining marsh.

Mileage

25.0	1.8	Return to the intersection of Bono Rd. and Ohio 2.
31.1	6.1	Turn left (southeast) onto Ohio 2 and travel to sign (on the left) for Crane Creek State Park and Magee Marsh Wildlife Area.
32.8	1.7	Turn left (north) and follow the road to the lake.

CRANE CREEK STATE PARK *(Metzger Marsh quadrangle).* The park is essentially a barrier beach complex which lies between Lake Erie to the northwest and Magee Marsh to the southeast. The park shoreline can be divided into three stretches: western, central, and eastern. Along the western portion groins made of interlocking sheet-steel piling trap sand from the net southeast-to-northwest longshore drift; riprap (limestone and concrete) and two badly damaged groins give some protection to the low clay bank in the central stretch; the eastern portion is unprotected. Because of high lake levels and severe storms in the late 1960's and early 1970's a goodly amount of sand trapped by the groins in the western area has been lost. The narrow beach that fronted the shore in the central area is gone, and much of the riprap has been carried by waves onto the top of the bank. Farther east the natural shoreline has undergone severe erosion, and much of the sand barrier fronting the marsh is in danger of being lost.

The park shoreline has had a very erratic history. A comparison of the 1877 and 1915 shorelines, surveyed by the Lake Survey, with the 1943 shoreline, surveyed by the U.S. Army Corps of Engineers, shows that in the western part of the park the shoreline was irregular and there were areas of erosion as well as of accretion (U.S. Army Corps Engineers, 1945, pl. 2). For example, a prominent embayment (about one-quarter square mile in area on the 1900 Oak Harbor 15-minute topographic map) east of the mouth of Crane Creek had been filled by 1943, probably because of a large groin (600 to 800 feet) that trapped a sizable amount of sand from the longshore drift (U.S. Army Corps Engineers, 1945, p. 7). Farther east, in the central and eastern parts of the park, the shoreline receded 100 to 200 feet. The present-day groin field appears to be beneficial in stabilizing part of the Crane Creek reach; moreover, the length of the groins is about 200 feet, allowing sand to bypass the structures and still remain within the littoral drift system. Construction of a few additional groins in the central and eastern areas of the shoreline could help protect those stretches from erosion. According to Pincus (1960, sheet A) ample sand to supply the drift system is located offshore directly east, and there appears to be more than an adequate supply moving along the shore.

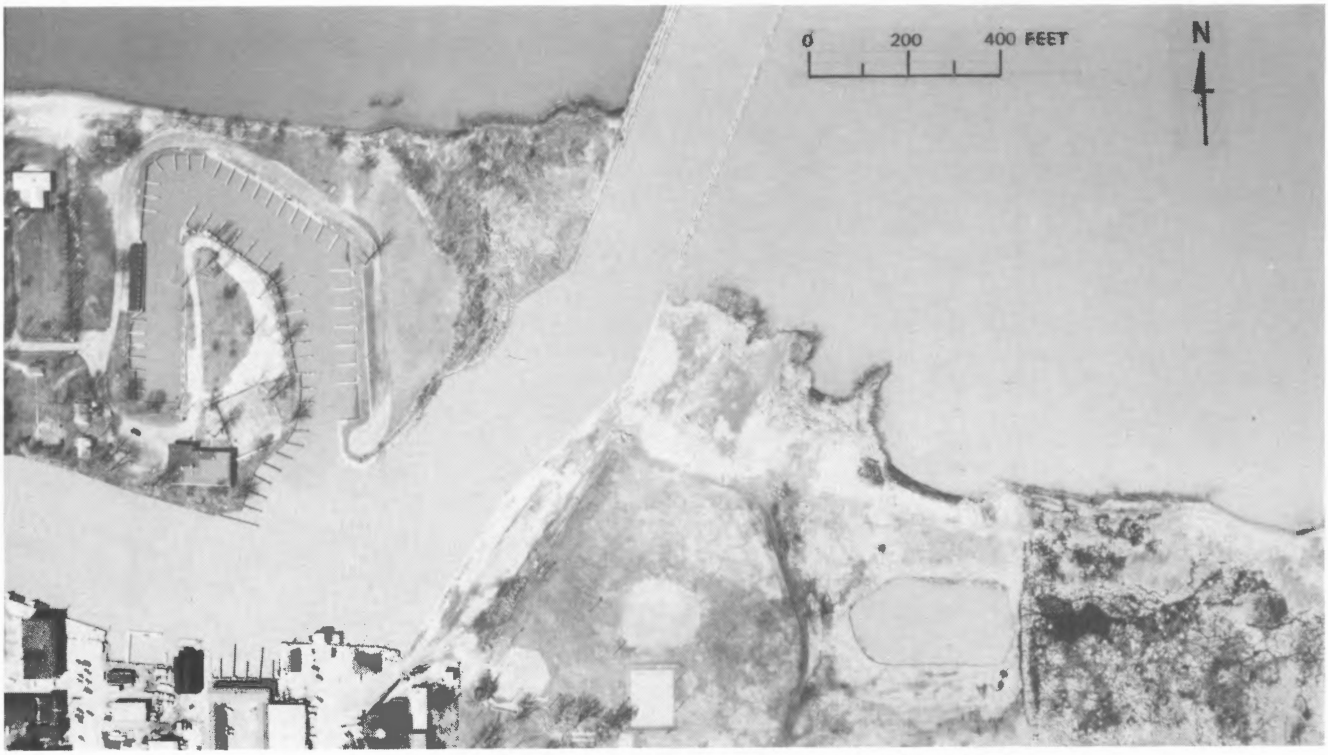


FIGURE 7.—STOP 5, Port Clinton. Riprap jetties and low-lying harbor area.

Mileage		
34.5	1.7	Return to Ohio 2.
46.7	12.2	Turn left (east) on Ohio 2 and travel to Lake Shore Dr.
51.0	4.3	Turn left (east) onto Lake Shore Dr., which becomes Ohio 163, cross the bridge over the Portage River, and go to Jefferson St.
51.1	0.1	Turn left (north) on Jefferson St. and travel out to the jetties.

PORT CLINTON *(Port Clinton quadrangle)*. Two jetties built of heavy riprap protect the entrance to the Portage River. Both jetties have trapped sand because of the convergence of two distinct littoral drift systems near the mouth of the river. Away from the jetties the shoreline is nearly unprotected except for a few narrow beaches (less than 50 feet wide) that front the shore west of the jetties.

The shoreline in the immediate vicinity of the jetties advanced lakeward from 1877 to 1943 because of the sand trapped by the jetties, whereas a few miles west of the jetties the unprotected shoreline receded 200 to 300 feet. East of the jetties the shoreline did not show a distinct erosional or depositional trend between 1877 and 1943 (U.S. Army Corps Engineers, 1945, pl. 3). Overall, the jetties appear to have a favorable effect on the shore, principally because of the atypical littoral drift systems.

FIGURE 8.–STOP 6, East Harbor State Park. Barrier beach and adjoining marsh.

Mileage		
51.2	0.1	Return to Ohio 163.
57.6	6.4	Turn left (east) and travel to Ohio 269 (Buck Rd.).
58.5	0.9	Turn left (north) on Ohio 269 and travel to the park entrance.
59.9	1.4	Enter and follow park signs to the beach.

EAST HARBOR STATE PARK *(Gypsum quadrangle).* A barrier beach complex which extends most of the way from Catawba Island to Marblehead peninsula makes up the East Harbor State Park reach. The 2-mile-long barrier complex has an average width of 400 feet; most of this consists of vegetated dunes. The dune area is protected by a quarry-run stone and concrete-panel seawall which was built along most of the barrier in the mid-1900's; the concrete part of this seawall was badly damaged by a severe storm in November 1972. A minor amount of sand is moved from the northwest to the southeast by littoral drift in this area (U.S. Army Corps Engineers, 1945, p. 14).

Over 200 feet of sand was deposited on the seaward side of the seawall between 1877 and 1943 (U.S. Army Corps Engineers, 1945, pl. 3). This sand was probably derived from offshore: longshore currents in this area have only minor effect, and there is a scarcity of sand along the adjacent bedrock shorelines at Catawba Island and Marblehead peninsula. These bedrock headlands apparently have formed a protective pocket for the beach sand in this area. The seawall has prevented migration of the barrier and, because of the location and minor effect of littoral drift, the structure apparently has not had a significant influence on shore processes.

STOP 7

FIGURE 9.—STOP 7, Marblehead Lighthouse. Lighthouse near end of angular headland.

Mileage

62.2 2.3 Return to the intersection of Ohio 163 and Ohio 269.

68.2 6.0 Turn left (east) onto Ohio 163 and travel through the town of Marblehead to Lighthouse Lane, an obscure dirt road on the left.

68.3 0.1 Follow this road as far as possible (a few hundred feet). Park and walk to the lighthouse.

MARBLEHEAD LIGHTHOUSE *(Kelleys Island quadrangle).* This point is a limestone headland made up of low ledges (less than 10 feet high in February 1973) of thin-bedded fossiliferous limestone. The adjacent shoreline is largely bedrock, although there are a few small pocket deposits of till. The point is exposed directly to northeast storms, during which waves 10 to 15 feet high batter the Marblehead shore.

The shoreline from this point west to Marblehead remained in the same position from 1877 to 1943, although the offshore depth profile steepened slightly (U.S. Army Corps Engineers, 1945, pl. 3). Manmade structures, primarily L-shaped groins that form protective harbors, do not appear to have had any effect on the shoreline in this area, primarily because of the resistant bedrock.

FIGURE 10.—STOP 8, Crystal Rock. Unprotected clay banks; waves breaking on nearly demolished manmade structure just offshore.

Mileage		
68.4	0.1	Return to Ohio 163 (Bay Shore Rd.).
76.5	8.1	Turn left (south) onto Ohio 163 and travel to Ohio 269 on the south shore of Marblehead peninsula.
79.1	2.6	Turn left (south) on Ohio 269 and cross Sandusky Bay, turning right (southwest) to continue on Ohio 269.
81.0	1.9	Continue on Ohio 269 to the intersection of U.S. 6.
82.9	1.9	Turn right (west) on U.S. 6 and travel to Northwest Rd.
83.4	0.5	Turn right (north) onto Northwest Rd. and travel to Wahl Rd.
83.6	0.2	Turn left (west) onto Wahl Rd. and travel to Brunner Rd.
84.1	0.5	Turn right (north) onto Brunner Rd. and continue due north to the bay.

CRYSTAL ROCK *(Castalia quadrangle).* Low clay banks (6 to 8 feet high) make up the shore southwest of Crystal Rock. The clay is easily eroded and this unprotected reach is deeply embayed in comparison to the shore at Crystal Rock, where seawalls have prevented erosion.

Comparison of 1937 and 1968 aerial photos shows that the shoreline at this location receded about 150 feet in those 31 years. This loss is consistent with data from areas farther west where the annual rate of erosion has been 5 to 8 feet per year for a 125-year period (U.S. Army Corps Engineers, 1953a, p. 10). However, "Individual property surveys made during the period of record show that the rate of loss has not been constant, but varies greatly from year to year, being more rapid during times of high water stages" (p. 10).

FIGURE 11.–STOP 9, Willow Point. Quarry-run stone dike adjacent to unprotected embayed shoreline.

Mileage

84.6	0.5	Return to the intersection of Brunner Rd. and Wahl Rd.
85.4	0.8	Turn right (west) onto Wahl Rd. and travel to a gravel road on the right (north) side of the road next to (east of) a small white house.
85.6	0.2	Turn right (north), go to the end of the road. Park and walk along the eastern edge of the dike to the bay.

WILLOW POINT *(Castalia quadrangle).* The quarry-run stone dike fronting Sandusky Bay was constructed in 1948 (U.S. Army Corps Engineers, 1953a, p. 12). The dike has held up well and has protected the easily erodable clay banks from erosion; even during a severe storm in November 1972 only a few pieces of stone were removed from the dike.

In contrast to this protected reach, a nearly unprotected stretch of shoreline immediately east of the Willow Point dike has been eroded. The eroded area is now a shallow embayment; the shoreline surrounding the embayment has receded at least 40 feet since 1948. The dike has probably helped to protect this reach by shielding the shoreline from west winds; this probably accounts for the unusually low erosion rate (in general, the erosion rate in Sandusky Bay is 5 to 8 feet per year, U.S. Army Corps Engineers, 1953a, p. 10) in spite of high lake levels and severe storms in the past 25 years.

HURON JETTIES *(Huron quadrangle).* Two jetties, the west one of rubble-mound and stone-filled timber crib and the east one of rubble-mound construction, protect the entrance to the Huron River. The jetty system was begun in 1827; the jetties have subsequently been reinforced, repaired, and extended several times (U.S. Army Corps Engineers, 1946a, p. 11). The shore along the Huron reach is composed largely of lake clay, although there are a few exposures of till and/or shale. A sizable beach has accumulated on the east side of the jetties, whereas beaches are small or lacking on the west side, prompting construction of numerous structures to prevent or impede erosion.

Shore studies between 1847 and 1939 show that on the east side of the jetty system the shoreline is slightly erosional, whereas west of the jetty system the shoreline is markedly erosional (U.S. Army Corps Engineers, 1946a, pl. 3). More specifically, within 1,000 feet of the east jetty, the position of the shoreline remained nearly unchanged, whereas within 2,000 feet of the west jetty the shoreline had retreated about 400 feet (U.S. Army Corps Engineers, 1946a, pl. 4). The combination of a predominantly southeast-to-northwest longshore drift and the jetty system has created this situation; the jetty system has trapped or forced sand far offshore on the east side, thereby depriving the west side of protective sand. Because of the jetty system erosion has been retarded on the east side and has been accelerated on the west side.

FIGURE 12.—STOP 10A, Huron jetties. West side of jetties; riprap seawall fronting Huron City Park.

FIGURE 13.—STOP 10B, Huron jetties. Wide beach on east side of jetties.

Mileage		
87.3	1.7	Return to U.S. 6.
90.9	3.6	Turn left (northeast) and travel to Ohio 2.
103.8	12.9	Turn right (east) onto Ohio 2 and travel to Center St. in Huron (first traffic light).
104.3	0.5	Turn left (northeast) onto Center St. and go to Huron City Park at the edge of the lake. This is the west side of the west jetty.
104.8	0.5	Return to Ohio 2.
105.6	0.8	Turn left (east) and cross the Huron River to Tiffin Ave.
106.1	0.5	Turn left (north) onto Tiffin Ave. and follow the road and signs to Norfolk and Western Park.

FIGURE 14.—STOP 11, Beulah Beach. Chappel Creek floodplain between steep till bluffs.

Mileage		
106.6	0.5	Return to Ohio 2.
112.4	5.8	Turn left (east) and travel to the Beulah Beach Christian & Missionary Alliance sign on the left (north) side of the road.
112.6	0.2	Turn left (north) here, take the first road to the right and travel to the end of the road. Walk to the beach and Chappel Creek.

BEULAH BEACH *(Vermilion West quadrangle).* Several stone-filled timber crib groins and stone-filled crib bulkheads were built along this reach in the early 1900's. The groins have trapped some sand from the northeast-to-southwest longshore drift; this sand has helped protect the base of the steep 20- to 30-foot till and clay bluff. However, there has been a goodly amount of erosion along the reach. Erosion is due largely to ground-water saturation and resultant slumping of the clay and till bluff; in addition, wave action, especially during high-water periods, directly undercuts the bluff. The 600-foot topographically low reach directly at the mouth of Chappel Creek is the Chappel Creek floodplain; this reach is easily eroded by wave action.

A comparison of the 1877 U.S. Lake Survey study with the 1939 U.S. Army Corps of Engineers study shows that the bluff receded 200 to 250 feet in the Chappel Creek area in that period of time (U.S. Army Corps Engineers, 1946a, pl. V). This recession rate is comparable to the recession rate of 130 feet as determined from aerial photographs for the period between 1937 and 1968. The groins and bulkheads, by protecting the base of the bluff, have had a beneficial effect on the shore in this area. Furthermore these structures are small enough so that sand can bypass them and be distributed farther downdrift. The major erosion problem here is slope stability. The fine-grained surficial deposits need to be adequately drained, and the steep unstable bluff faces need to be sloped and protected by some kind of cover.

FIGURE 15.—STOP 12, Vermilion-on-the-Lake. Vertical shale bluff west of the groin and less resistant till bluff east of the groin.

Mileage		
112.8	0.2	Return to Ohio 2.
120.3	7.5	Turn left (east) onto Ohio 2 (U.S. 6) and travel to Woodside Rd. at Sunnyside.
120.6	0.3	Turn left (north) onto Woodside Rd. and travel to Edgewater Dr.
120.8	0.2	Turn left (west) onto Edgewater Dr. and go to turnout on the right (north) side of the road.

VERMILION-ON-THE-LAKE *(Vermilion East quadrangle).* A concrete groin about 150 feet long traps sand from the east-to-west longshore drift along this 400-foot reach. The sand trapped by the groin helps protect the toe of the bluff from wave action. The bluff is made up of shale and till; the shale dips to the southeast so that the eastern one-fourth of the reach is entirely till. The shale bluff is moderately resistant to erosion; however, on the updrift side of the groin there is sapping at the till-shale contact, and farther east the till bluff in places is slumped severely.

Comparison of an 1876 shoreline study with a 1948 study showed that the shoreline along this reach receded about 40 feet during that period (U.S. Army Corps Engineers, 1953c, p. 22). This is a small loss compared to the amount of recession that has taken place at many of the previous stops; the shale is relatively resistant in comparison to the surficial deposits of clay, sand, and till. The groin does not appear to have had an adverse effect on the downdrift (west) side because of the shale bluff; moreover, sand can probably bypass the groin and remain in the longshore drift system.

FIGURE 16.--STOP 13, Elyria waterworks. Rubble-mound seawall fronting the waterworks complex.

Mileage		
121.3	0.5	Return to U.S. 6 (Ohio 2).
126.7	5.4	Turn left (east) onto U.S. 6. Be careful to bypass the Ohio 2 turnoff west of the Ford plant. Travel to the waterworks entrance on the left (north) side of the road.
126.8	0.1	Turn in and park on the west side of the building nearest the lake.

ELYRIA WATERWORKS *(Lorain quadrangle).* A rubble-mound seawall, which was built as a breakwater because of severe erosion problems in 1945 and has since been backfilled, protects the waterworks along this eroding reach. The shore is made up of till and/or till overlain by lake clay. Manmade structures (groins and seawalls) are common along the shore on both sides of the waterworks. The groins trap some sand from a predominantly northeast-to-southwest longshore drift; the sand forms narrow beaches, which help protect the base of the till bluffs.

Comparison of an 1876 shoreline study with a 1948 study showed that "The average landward movement in this area has been about 115 feet with a maximum movement of 180 feet about three-fourths mile west of Lorain Harbor" (U.S. Army Corps Engineers, 1953c, p. 22). To the east the jetty and breakwater system at the mouth of the Black River in Lorain has trapped some sand, especially inside the west breakwater; however, there is not a sizable buildup of sand on either side of the artificial structures as at Huron. The scarcity of sand is probably due in part to the resistance to erosion of the shale bluffs farther east at the point near Avon Lake as well as to the scarcity of sand-size sediment in the shale. Because of this scarcity this structure does not appear to have much influence on the sedimentary processes along the reach.

FIGURE 17.—STOP 14, Lakeview Park. Groins and associated beaches along the park shoreline.

Mileage		
126.9	0.1	Return to U.S. 6.
127.9	1.0	Turn left (east) and travel to the western entrance of Lakeview Park on the left (north) side of the road.
128.0	0.1	Enter and park.

LAKEVIEW PARK *(Lorain quadrangle)*. A concrete seawall and six groins protect the till shore along this reach. There are three multiple-row stone-block groins, two concrete-capped sheet-steel pile groins, and one pre-cast concrete groin (U.S. Army Corps Engineers, 1953c, pl. 11). These structures have trapped sand from the localized northeast-to-southwest longshore drift, thus providing a bathing beach and helping to protect the shore. The seawall has protected the toe of the gentle grass-and-tree-covered slope; however, after a severe storm in November 1972 a few of the concrete slabs forming the walkway inside the seawall were undermined and collapsed near the center of the park shore. Minor erosion has taken place also along the toe of the slope at the top of the seawall. Net longshore drift along the Lorain-Vermilion shore appears to be from east to west; however, the Lorain harbor jetty and breakwater system, northeast of the park, has apparently diverted offshore the sand coming from the northeast, at the same time creating, in the lee of the west jetty, an eddy that has caused sand on the west side of the harbor to move northeast. The Lakeview Park groins have trapped sand that otherwise would have accumulated inside the Lorain harbor west breakwater.

The reach between the Elyria waterworks and Lorain harbor receded an average of 115 feet from 1876 to 1948. Since 1948, recession of this part of the shore has been greatly reduced because of the large number of artificial structures, primarily groins and seawalls, that have been constructed; a 1968 aerial photograph shows that nearly all of the shoreline between the Elyria waterworks and Lorain harbor is protected in some way or another. The park groins especially appear to have a beneficial effect on the shoreline because the sand, if not trapped by the groins, would accumulate inside the breakwater and for all practical purposes be completely removed from the lake system.

FIGURE 18.—STOP 15, Shellcove Park. Vertical shale bluff fronting the shoreline.

Mileage		
128.1	0.1	Return to U.S. 6.
134.2	6.1	Turn left (east) onto U.S. 6 and travel to Shellcove Park. The park is small and on the left (north) side of the road.

SHELLCOVE PARK *(Avon quadrangle)*. An unprotected shale bluff, commonly capped by till, and pocket beaches make up the shore. A comparison of the 1901 Oberlin 15-minute topographic map with the 1963 Avon 7.5-minute topographic map indicates that the shoreline receded about 90 feet between 1901 and 1963. This is consistent with erosion rates of shale east of Vermilion (STOP 12). In general, the shoreline in this area is moderately stable except for a few topographic lows that are filled with more easily erodable till.

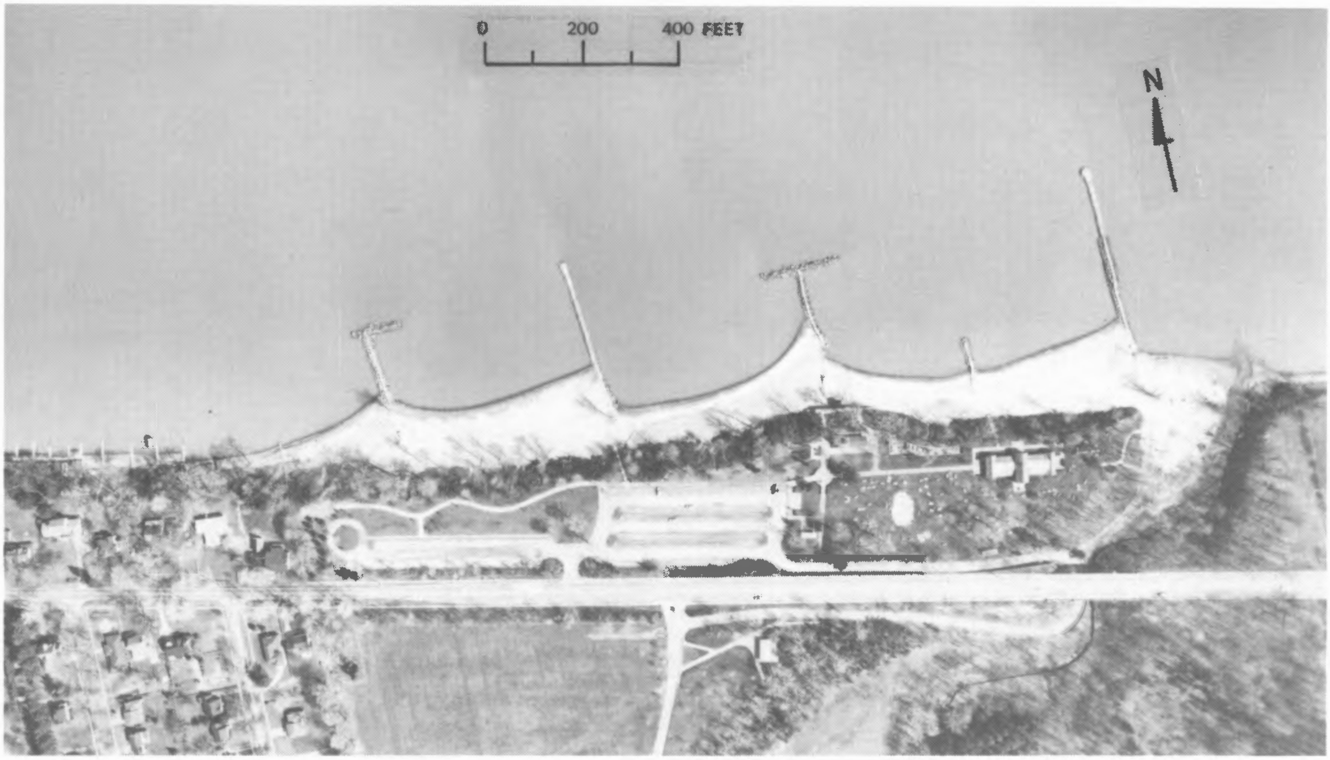


FIGURE 19.—STOP 16, Huntington Park. Groins, associated beaches, and shale bluff.

Mileage		
142.7	8.5	Return to U.S. 6, which becomes Ohio 2 again, and travel east to Huntington Park.
142.8	0.1	Turn left (north) into the park.

HUNTINGTON PARK *(North Olmsted quadrangle).* Four large sandstone-block multiple-row groins (several hundred feet long) and three smaller sandstone-block multiple-row groins have trapped sand from the predominantly west-to-east longshore drift. The sand forms beaches about 25 feet wide (April 1973); these help protect the base of the 35-foot-high bluff. The bluff is sloped and is made up of shale capped by till and lake sediments. At the base of the bluff, sand deposits that have been partially cut away to form low banks (2 to 6 feet high) are covered by reeds and other vegetation, whereas farther up, the slopes composed of till and lake sediments are covered with cottonwoods, willows, and brush. There has been slumping in places along the upper part of the bluff; this is indicated by an irregular hummocky slope, by displaced trees, and by open scars at the heads of a few of the slumps.

Comparison of an 1876 shoreline study and a 1947 study shows that the Huntington Park shoreline has remained in nearly the same position, although there are local areas of erosion or deposition (U.S. Army Corps Engineers, 1950a, pl. 2). This is in contrast to the shoreline both east and west of the park, where the loss has been about 100 feet. Stabilization of the shoreline is probably due largely to the groins, which were constructed in 1933, although Porter Creek at the east end of the park has probably caused some disruption of the longshore drift, thus contributing to sand deposition. The broad beach has protected the bluff from waves; however, the unusually heavy precipitation in 1972 and 1973 has caused some of the more poorly drained areas to slump. Better drainage could have prevented the slumping because there is a more than adequate beach to dissipate wave energy, as well as protection in the form of sand deposits along most of the toe of the bluff. The groins do not appear to have had a significant effect on the downdrift (east) shore, which is largely a steep shale bluff.

FIGURE 20.—STOP 17, Rocky River Park. Landscaped slope, beach, and V-shaped groin.

Mileage		
142.9	0.1	Return to Ohio 2 (U.S. 6).
146.7	3.8	Turn left (east) onto Ohio 2 and travel to Avalon Dr.
147.4	0.7	Turn left (northeast) onto Avalon Dr. and travel to Beach Cliff Blvd.
147.7	0.3	Turn left (north) onto Beach Cliff Blvd. and travel to the entrance of Rocky River Park.
147.8	0.1	Enter and park.

ROCKY RIVER PARK *(Lakewood quadrangle).* A concrete-block groin about 200 feet long traps sand from the net southwest-to-northeast longshore drift. The sand forms a 20-foot wide (April 1973) beach. A partly submerged groin forms the western boundary of the park, and there is a partially submerged riprap breakwater at the base of the 40-foot slope. The slope has been terraced and landscaped; it is composed of shale capped by till and lake sediments. Minor slumping has occurred along the toe of the lowest terrace (April 1973) because of inadequate drainage.

Comparison of an 1876 shoreline survey with a 1947 survey shows that the position of the Rocky River Park shoreline, like that of the Huntington Park shoreline, did not change, whereas both east and west of the park the shore receded as much as 150 feet (U.S. Army Corps Engineers, 1950a, pl. 2). The present park reach appears relatively stable, although there is a drainage problem along the base of the lowest slope. The concrete-block groin has a beneficial effect on the updrift shore because of the sand it traps; the downdrift shore is protected by manmade structures and/or shale except for a few hundred feet of shoreline adjacent to the park.

FIGURE 21.—STOP 18, Bratenahl Road. Severely slumped till bluff.

Mileage		
148.9	1.1	Return to the intersection of Avalon Dr. and Ohio 2.
164.4	15.5	Turn left (east) onto Ohio 2, which joins I 90 in downtown Cleveland, and travel to the Bratenahl exit.
164.6	0.2	Take the exit, turn left (north) onto Eddy Rd. and cross the overpass to Lake Shore Blvd.
165.3	0.7	Turn left (west) onto Lake Shore Blvd. and travel to Bratenahl Rd.
165.5	0.2	Turn right (north) onto Bratenahl Rd. and travel to the end of the road. Park and walk west along the top of the bluff.

BRATENAHL ROAD *(East Cleveland quadrangle).* A 35- to 40-foot bluff composed of till overlain by glaciolacustrine sediments makes up the shore. There are severe drainage problems and associated slumps (April 1973) in this material, particularly near the contact between the sandy lake sediments and the till. A partially submerged sandstone-block breakwater (formerly a seawall?) in poor condition lies just offshore from the foot of the bluff; there are also several randomly positioned concrete blocks that help shield the bluff from waves.

Comparison of an 1876 shoreline survey with a 1947 survey shows that the shoreline in this immediate area receded about 100 feet in that period (U.S. Army Corps Engineers, 1950a, pl. 2). This amount of erosion has been consistent along the unprotected areas of the Bratenahl reach. The major erosion problem here also is probably inadequate drainage, although during high-water periods the toe of the bluff is easily eroded by storm waves.

FIGURE 22.–STOP 19, Euclid Park. Landscaped slope, beach, and parallel piers.

Mileage		
166.4	0.9	Return to the intersection of Lake Shore Blvd. and Eddy Rd.
172.3	5.9	Continue east on Lake Shore Blvd., which becomes Ohio 283, to the Euclid Park entrance on the left (north) side of the road.
172.5	0.2	Enter and park.

EUCLID PARK *(East Cleveland quadrangle).* Two sandstone rubble-mound piers, each one about 200 feet long, form a water-treatment outfall at the east end of the park. The west pier has trapped sand and gravel from the predominantly southwest-to-northeast longshore drift. Adjacent to the beach, which is about 200 feet wide next to the pier (April 1973), the park frontage is sloped and grass covered. The slope is stable, although at the west end of the park, where the slope is steepest, there is some slumping. West of the park a 20-foot-high bank made up of 5 to 10 feet of fissile shale overlain by till appears moderately stable, although the till is slumped in places.

The stable slope and substantial beach are protecting the park shore well. In addition several small groins (less than 50 feet long) on either side of the outfall have trapped sand to help protect the base of the bluff; however, in most places the bluff has not been sloped, and there is slumping in the till. The shoreline in this area is estimated to have receded as much as 100 feet between 1876 and 1953 (U.S. Army Corps Engineers, 1954, p. 39). Presumably the beach and stable slope will prevent erosion at Euclid Park. Furthermore, the beaches fronting the bluff both east and west of the park will help reduce the rate of erosion, although the need for adequate drainage to prevent slumping will still exist.

FIGURE 23.—STOP 20, Horizon House Apartments. Landscaped slope and narrow beach.

Mileage		
172.7	0.2	Return to Ohio 283 (Lake Shore Blvd.).
173.4	0.7	Turn left (east) and travel to the apartment complex on the left (north) side of the road.
173.5	0.1	Enter and park on the west side of the complex.

HORIZON HOUSE APARTMENTS *(East Cleveland quadrangle)*. Several sections of concrete storm drain (5 feet in diameter by 9 feet long) placed along the toe of a landscaped grass-covered slope and a narrow sand and gravel beach (20 feet wide, April 1973) on the lake side of the sections help protect this location from erosion. However, because of extremely wet ground (April 1973), there have been a few small slumps on the 20- to 30-degree slope. Erosion is serious along the unprotected reach to the west; there have been large slumps in the saturated till bluff (April 1973).

The concrete drain sections help protect the toe of the slope from direct wave attack as well as help support the slope. These sections, however, may not be massive enough to stand up under a severe storm. The gentle slope reduces the probability of slope failure, one of the primary causes of erosion in this area.

STOP 21

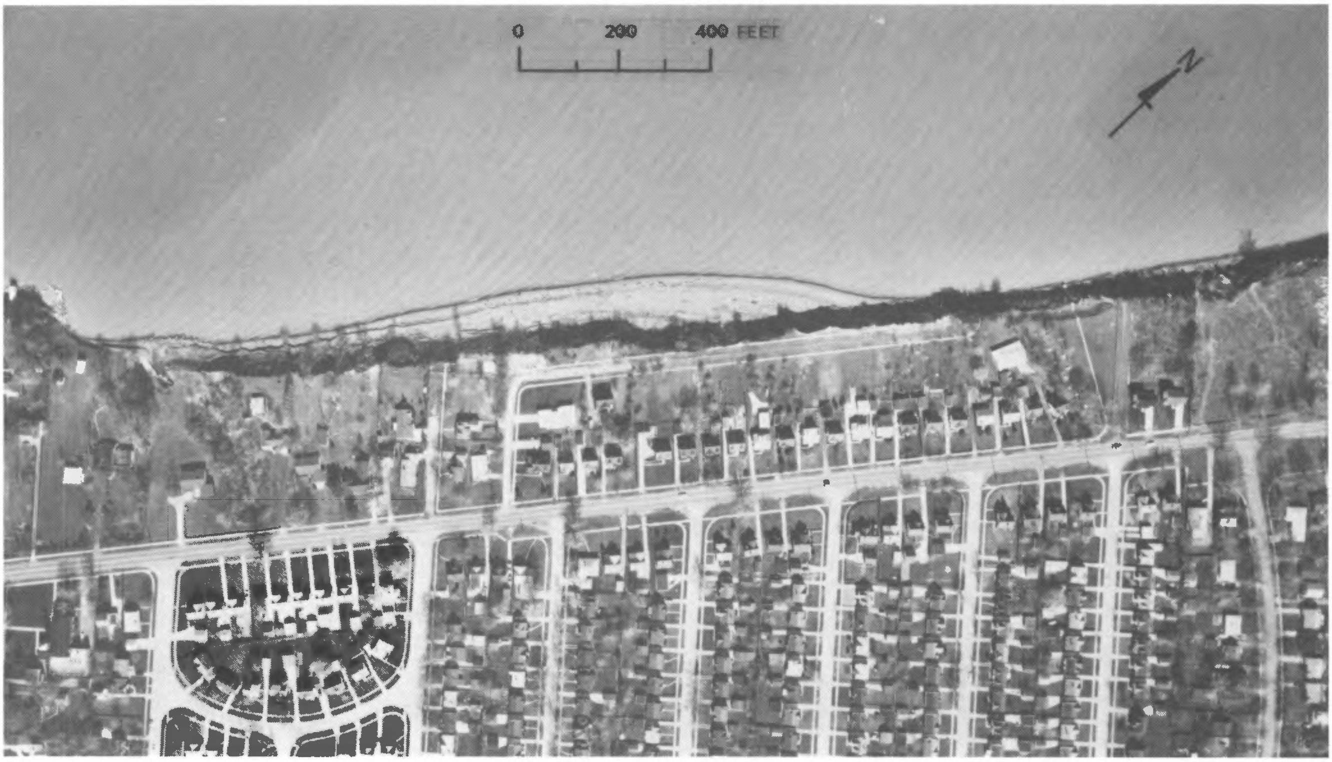


FIGURE 24.—STOP 21, East 325th Street. Steep till bluff and moderate beach.

Mileage		
173.6	0.1	Return to Ohio 283 (Lake Shore Blvd.).
177.2	3.6	Turn left (east) and travel to East 325th St. on the left (north) side of the road.
177.3	0.1	Turn left (north) and travel to the end of the road.

EAST 325TH STREET *(Eastlake quadrangle).* A 30- to 40-foot till bluff is partially protected here by a 50-foot-wide beach (April 1973). There are large slumps in the upper half of the bluff, and in places the till has been undermined by small springs.

Erosion has been fairly rapid in this area because of inadequate drainage and the scarcity of protective structures. A comparison of profiles from an 1876 survey and a 1948 survey "... show[s] a landward movement of the shoreline of up to 200 feet; however, it is estimated that the movement of the bluffs has been somewhat less" (U.S. Army Corps Engineers, 1954, p. 21-22). Between 1938 and 1948 the bluff receded about 30 feet (U.S. Army Corps Engineers, 1954, p. 23).

FIGURE 25.—STOP 22, Timberlake Village Park. Steep till bluff and moderate beach.

Mileage		
177.4	0.1	Return to Ohio 283 (Lake Shore Blvd.).
178.6	1.2	Turn left (east) and travel to East Shore Blvd.
178.8	0.2	Turn left (northeast) at curve onto East Shore Blvd. and travel to Timberlake Village Park, which is adjacent to the village hall. Park and follow path to the edge of the bluff.

TIMBERLAKE VILLAGE PARK *(Eastlake quadrangle).* A 30- to 40-foot till bluff is partially protected by a 50-foot beach (April 1973). Sand has been trapped in places from the southwest-to-northeast longshore drift by sheet-steel piling and concrete-block groins.

This stop is very similar in erosional history to the East 325th Street stop. However, farther east, the Cleveland Electric Illuminating Company's intake jetties, which were built in 1952, have trapped a sizable amount of sand as well as having "virtually stopped the longshore movement of sand from the southwest" (Hartley, 1964, p. 20).

FIGURE 26.—STOP 23, Chagrin River. Homes adjacent to lake.

Mileage		
179.0	0.2	Return to Ohio 283 (Lake Shore Blvd.).
181.0	2.0	Turn left (east) and travel, crossing the Chagrin River, to Forest Rd.
181.2	0.2	Turn left (north) onto Forest Rd. and travel to Portage Rd.
181.3	0.1	Turn left (southwest) on Portage Rd. and travel to Hiawatha Rd.
181.4	0.1	Turn right (northwest) and travel on Hiawatha-Hillside Rd. to Wanaka Rd.
181.4	(<0.1)	Turn left (southwest) on Wanaka Rd. and travel to River Rd.
181.5	0.1	Turn right (northwest) and travel to the lake (intersection of Galilina and River Rds.).

CHAGRIN RIVER *(Eastlake quadrangle).* The shoreline (April 1973) is adjacent to homes on the north side of Galilina Road. Most of the homes have suffered severe structural damage during storms.

This stretch of shoreline receded about 170 feet between 1876 and 1947; in 1947 a wide sand beach, low sand banks, and dunes fronted 3,000 feet of shoreline east of the Chagrin River (U.S. Army Corps Engineers, 1950b, p. 19). However, since construction of the Cleveland Electric Illuminating Company's intake jetties just to the southwest the beach has been eroding, probably largely because of sand removed from the littoral drift system by the western jetty (Hartley, 1964, p. 20). Beach nourishment and construction of a groin field to hold the sand should stabilize the shore in this area.

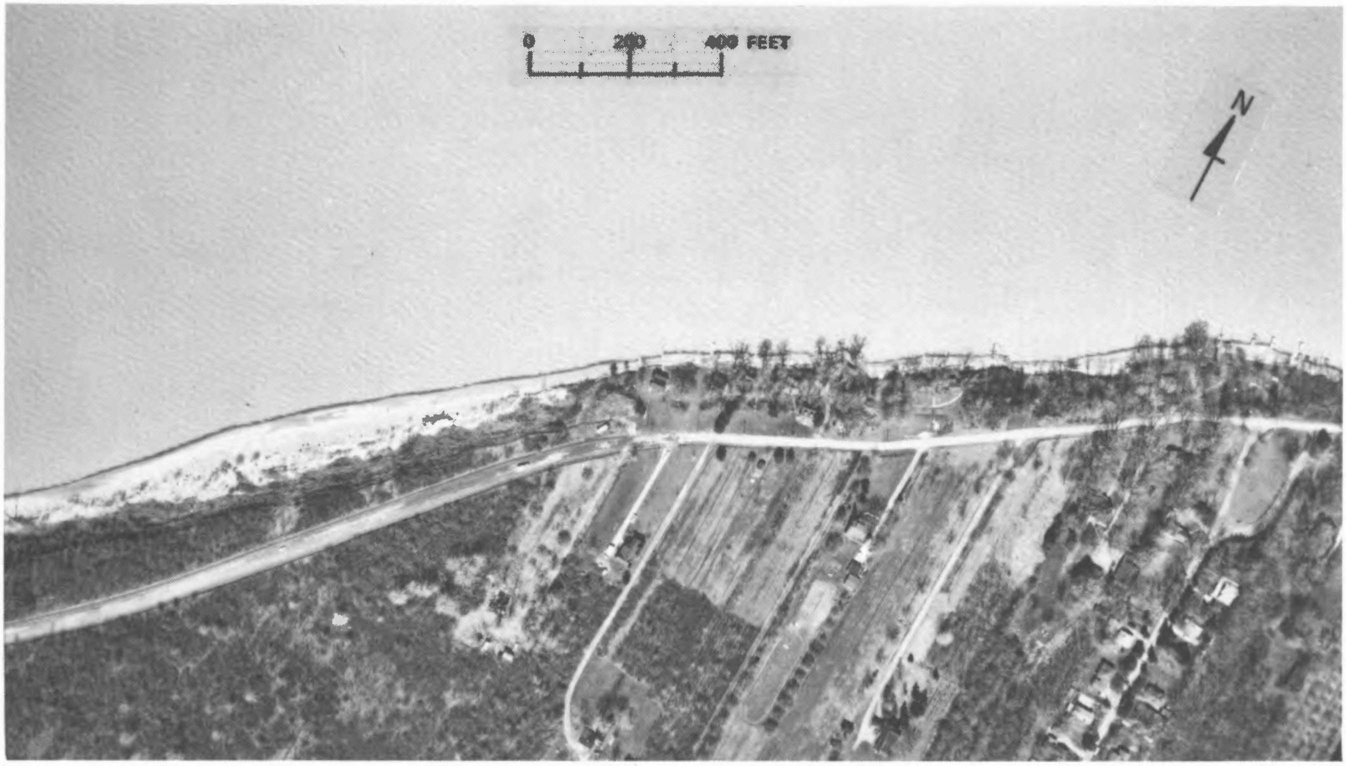


FIGURE 27.--STOP 24, Headlands Road. Badly slumped laminated clay and till bluff and narrow beach.

Mileage		
181.7	0.2	From the intersection of Galilina and River Rds. travel northeast on Galilina Rd. to Forest Rd.
181.9	0.2	Turn right (southeast) on Forest Rd. and go to Portage Rd.
182.1	0.2	Turn left (northeast) on Portage Rd. and travel to Ohio 283 (Lake Shore Blvd.).
186.1	4.0	Turn left (northeast) on Ohio 283 to Andrews Rd.
187.1	1.0	Turn left (north) on Andrews Rd. and travel to the Ohio 283 continuation (Lake Shore Blvd.).
190.2	3.1	Turn right (east) and travel to Corduroy Rd.
191.5	1.3	Turn left (north) on Corduroy Rd. and go to Lake Overlook Dr.
192.4	0.9	Turn left (west) on Lake Overlook Dr. and travel to where the road is blocked.

HEADLANDS ROAD *(Mentor quadrangle)*. A narrow sand and gravel beach (50 feet wide, April 1973) fronts a badly slumped laminated till and clay bluff at this location. The bluff is about 30 feet high. At the top, where it is composed of till, the bluff is hard and dry, but about 15 feet down, near the clay-till contact, the bluff is soft and sticky because of ground-water saturation (April 1973). Several periods of slumping are indicated by the steplike bluff profile. A house at the eastern end of the reach is partly protected by sheet piling and concrete forms; these manmade structures have trapped sand from the net southwest-to-northeast longshore drift.

This reach is rapidly eroding. Between 1876 and 1947 the shoreline retreated about 330 feet (U.S. Army Corps Engineers, 1950b, p. 20, 21). The major cause of erosion appears (April 1973) to be inadequate drainage. Ground water lubricates and weakens the clay, which acts as a slip plane for the overlying till. Slumping takes place, and the bluff recedes. Storm waves carry away the slumped debris as well as attack the toe of the bluff, causing greater instability. Toe support, better drainage, and a landscape slope are corrective measures that would work here.

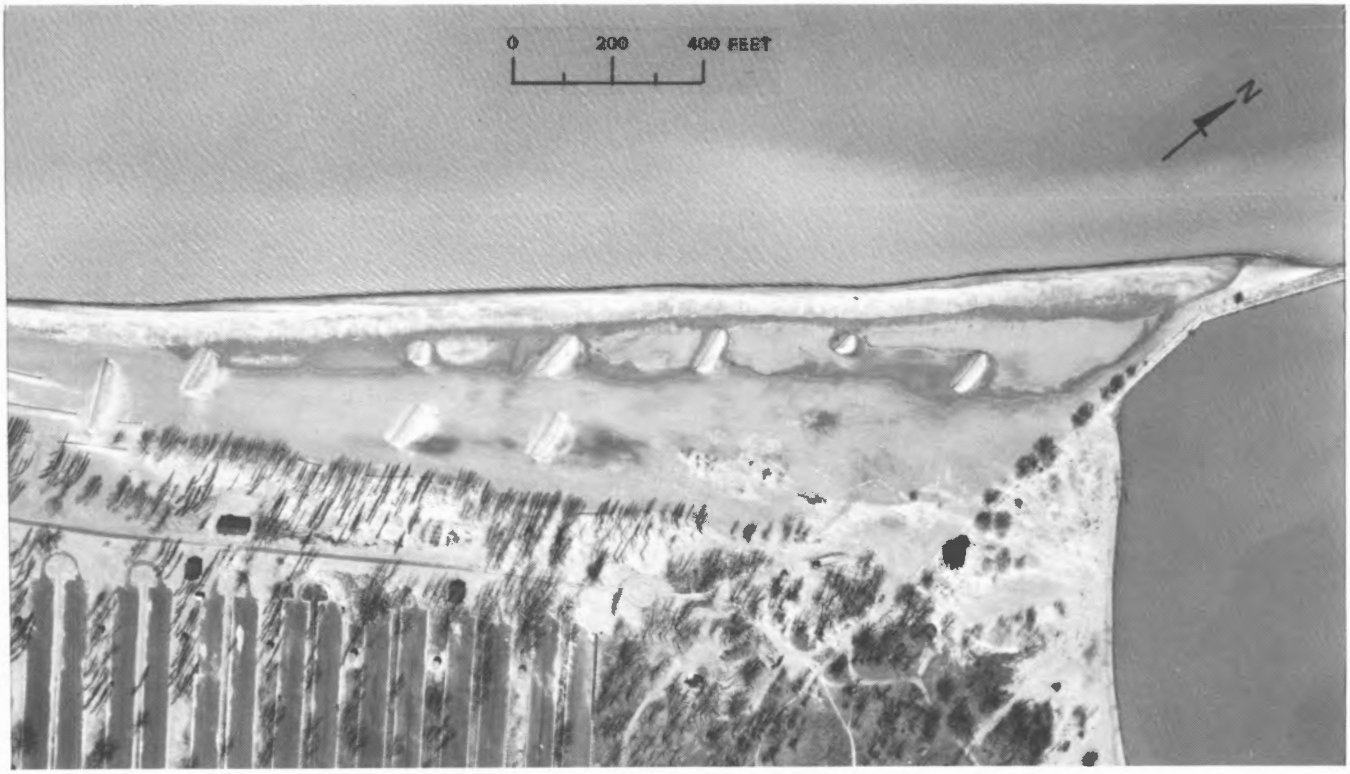


FIGURE 28.–STOP 25, Headlands Beach State Park. Rubble-mound jetty and extensive beach with well-developed dunes.

Mileage		
193.3	0.9	Return to the intersection of Lake Overlook Dr. and Corduroy Rd.
193.3	(<0.1)	Turn right (south) and travel to Jordan Dr.
194.4	1.0	Turn left (east) on Jordan Dr. and travel to Headlands Rd.
194.8	0.4	Turn right (east) on Headlands Rd. and travel to Headlands Beach State Park.
195.5	0.7	Enter and bear to the right in order to get as near the jetty as possible.

HEADLANDS BEACH STATE PARK *(Mentor quadrangle).* The west Fairport Harbor jetty, which is about 4,000 feet long and is largely of rubble-mound construction (heavy sandstone riprap), has trapped a sizable quantity of sand on its west side from the net southwest-to-northeast longshore drift. This sand forms a large beach several hundred feet wide by about one mile long (April 1973). Well-developed dunes, stabilized by cottonwoods and willows, form the landward margin of the beach; the dunes have encroached upon and in places cover the west side of the jetty. The beach is a superb recreational resource and protects a long reach of shore from wave attack.

Comparison of an 1876 survey with a 1948 survey showed that the shoreline west of the jetty had advanced lakeward a maximum distance of about 850 feet (U.S. Corps Engineers, 1950b, p. 20). The reach appears very stable, although one must consider, as did Hartley (1964, p. 25), the possible effect of any structure on its downdrift side:

"The Fairport west breakwater has probably had a greater effect on a greater length of shore than any other structure on Lake Erie. The effect is also probably the most serious because it interferes with sand movement from one of the largest source areas along the lake shore. According to the U.S.-Ohio Beach Erosion Control Study of the area, more than 700,000 cubic yards of sand were removed by dredging from the outer Fairport harbor between 1932 and 1947. All of this material came from longshore drift from the west. If this material could have been placed on the shore to the east, it presumably could have created a beach 75 feet wide, throughout the nine-mile eroding stretch."

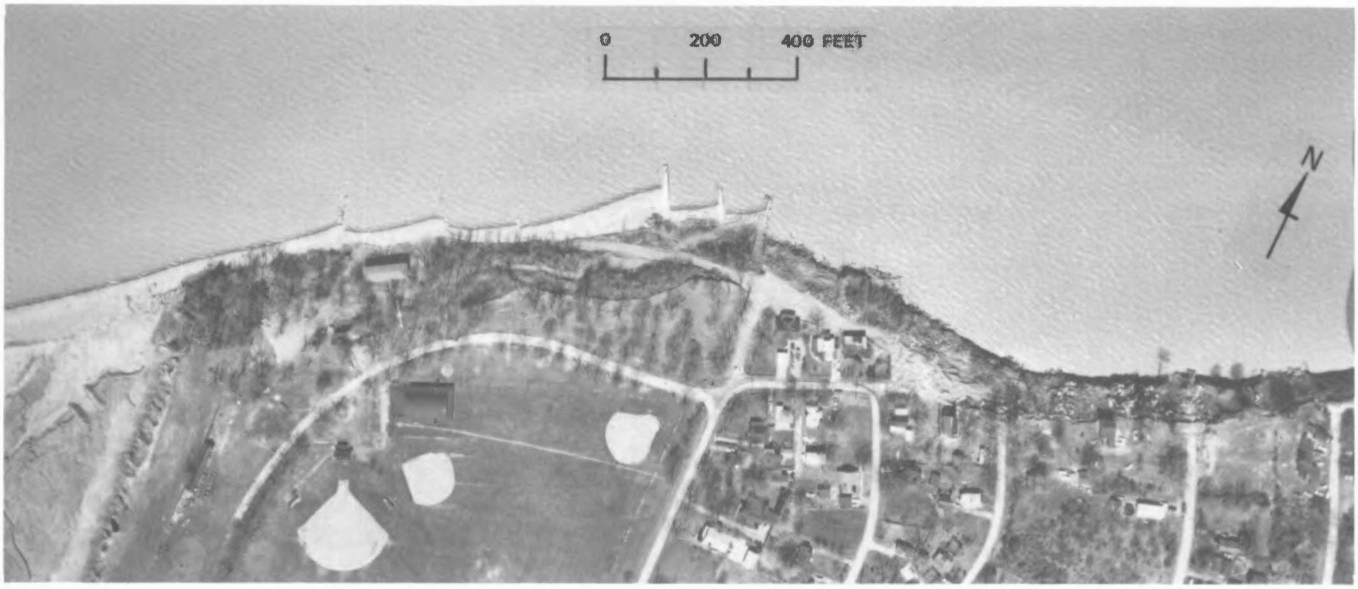


FIGURE 29.—STOP 26, Painesville Township Park. Groins and badly slumped till bluff.

Mileage		
196.2	0.7	Return to the park entrance.
197.1	0.9	Turn left (east) on Williams Rd. and go to Olive Rd.
197.2	0.1	Turn left (east) on Olive Rd. and travel to River Rd.
198.5	1.3	Turn right (south) on River Rd., which joins Ohio 283, and travel south-southeast to the intersection with Ohio 535.
202.2	3.7	Turn left (north) onto Ohio 535 and follow a circuitous route to Hardy Rd.
203.1	0.9	Turn left (north) onto Hardy Rd. and go to the end of the road. Turn left (west) on John Bailey Rd. to Painesville Township Park, and park. Walk along the east margin of the park to a path and follow this to the lake.

PAINESVILLE TOWNSHIP PARK *(Perry quadrangle).* Three medium-sized concrete-block groins (up to 150 feet long) in fair to good condition have trapped some sand from the net southwest-to-northeast littoral drift. The sand makes up a narrow beach (less than 20 feet wide) west of the westernmost groin, whereas the other groins are partially submerged, and the shoreline is at the base of the slope (April 1973). The brush-covered slope is made up of boulder till capped by glaciolacustrine sands and clays. Near the base of the bluff is a poorly defined laminated clay zone 1 to 2 feet thick. The till has slumped in several places and there are many small debris flows (on the order of a few feet). The slope surface is very irregular and hummocky, and there is a prominent seep at what is probably the contact between the till and the glaciolacustrine deposits. This evidence, in addition to tension cracks parallel to the shoreline, indicates severe slumping.

The groins, by trapping sand, have had a stabilizing influence on the park shoreline; however, as is the case in many similar areas along the shore, inadequate drainage during periods of above-average precipitation appears to have caused severe erosion problems. Ground water is held at the till-glaciolacustrine contact, and the overlying sediment becomes saturated and eventually slumps. Possibly the most significant cause of shoreline recession here, however, is the laminated clay near the base of the bluff. As at Stop 24, this clay may act as a slip plane for the overlying materials. Erosion along this reach has been estimated at 1 to 2 feet a year (Ohio Division Shore Erosion, 1961, p. 7).

The area immediately to the east, on the other hand, has undergone more rapid erosion. Between 1876 and 1948 a maximum landward movement of about 340 feet took place (U.S. Army Corps Engineers, 1952, p. 24). Along this reach there is no shoreline protection and the shoreline has retreated rapidly. This can be seen by walking back to John Bailey Road and walking east a few hundred feet to where the bluff has retreated, taking the road with it. This reach may be somewhat affected by the park groins but the major reason for the scarcity of sand is the Fairport Harbor jetty farther west.

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