

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

REPORT OF INVESTIGATIONS No. 53

EFFECTS OF LARGE STRUCTURES
on the
OHIO SHORE OF LAKE ERIE

By
Robert P. Hartley

COLUMBUS
1964

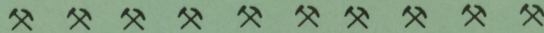


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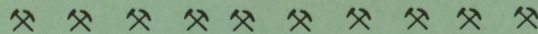
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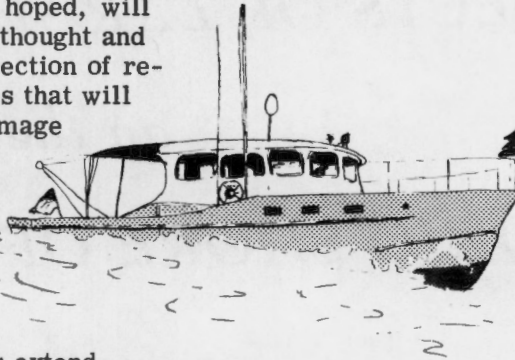
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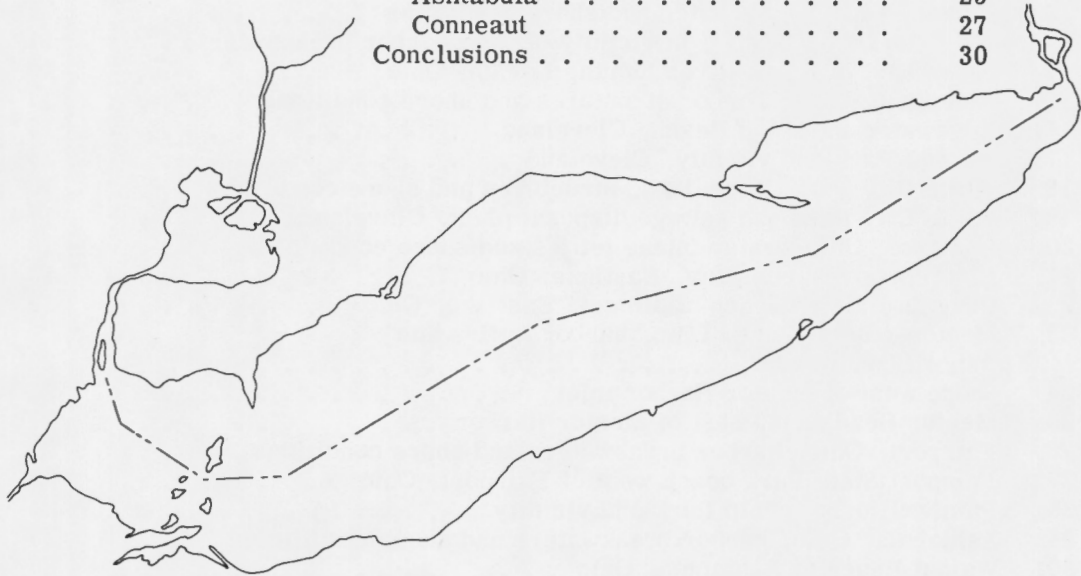
PREFACE

This report, concerned with the Ohio shore of Lake Erie, deals with the effect of such man-made structures as breakwaters and jetties on erosion of the shore. It is not intended in any way as a criticism of these structures, for their need in improvements such as harbor development are at once apparent and appreciated. However, this study, it is hoped, will stimulate some thought and action in the direction of remedial measures that will lessen shore damage from high water and high waves, especially where these factors are coupled with the effects of large structures extending from or along the shore.



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INTRODUCTION

Structures such as breakwaters and jetties, which extend into Lake Erie from the shore, usually affect shore processes. As a general rule, the larger the structure the greater the effect, although this is not always true. This report is restricted to those large structures which have had a measurable effect on half a mile or more of shore.

Massive structures have been built at most of the harbor entrances along the Ohio shore. At shipping ports they are maintained by the Federal government and at small harbors by private interests. The harbor structures have been in existence for many years, most of them since the turn of the century. Since their original construction additions and changes have been made, and now most of them are larger than they were originally. A few other large structures have been built, mainly by industry, for the protection of water supply intakes. These other structures are all of relatively recent construction.

The large structures have been built for the protection of facilities from wave action and sedimentation. They serve these purposes well. However, they have also resulted in changes of great magnitude in the adjacent shore.

The large structures along the Ohio shore of Lake Erie will be described individually in this report, beginning at the western end of the lake. The location of each structure discussed is shown in figure 1. The dimensions and descriptions of the structures, have been obtained largely from co-operative beach erosion control studies¹. Elevations where shown are referred to U. S. Lake Survey 1935 datum of 570.5 feet above mean tide at New York City.

STRUCTURES AND THEIR EFFECTS

PORT CLINTON

The only large structures west of Sandusky which affect shore processes materially are the jetties at the mouth of the Portage River in Port Clinton (fig. 2). They prevent sand from obstructing the harbor entrance.

Both jetties are built of heavy rip-rap up to an elevation of about six feet above datum. The east jetty is 1,243 feet long and extends about 100 feet farther lakeward than the west jetty which is 1,100 feet long.

1. U.S. Army, Corps of Engineers, House Documents 177 (79th Congress), 502 and 596 (81st Congress), 350 and 351 (82nd Congress), 32, 126, 127, 229 and 324 (83rd Congress); 1945 to 1954.

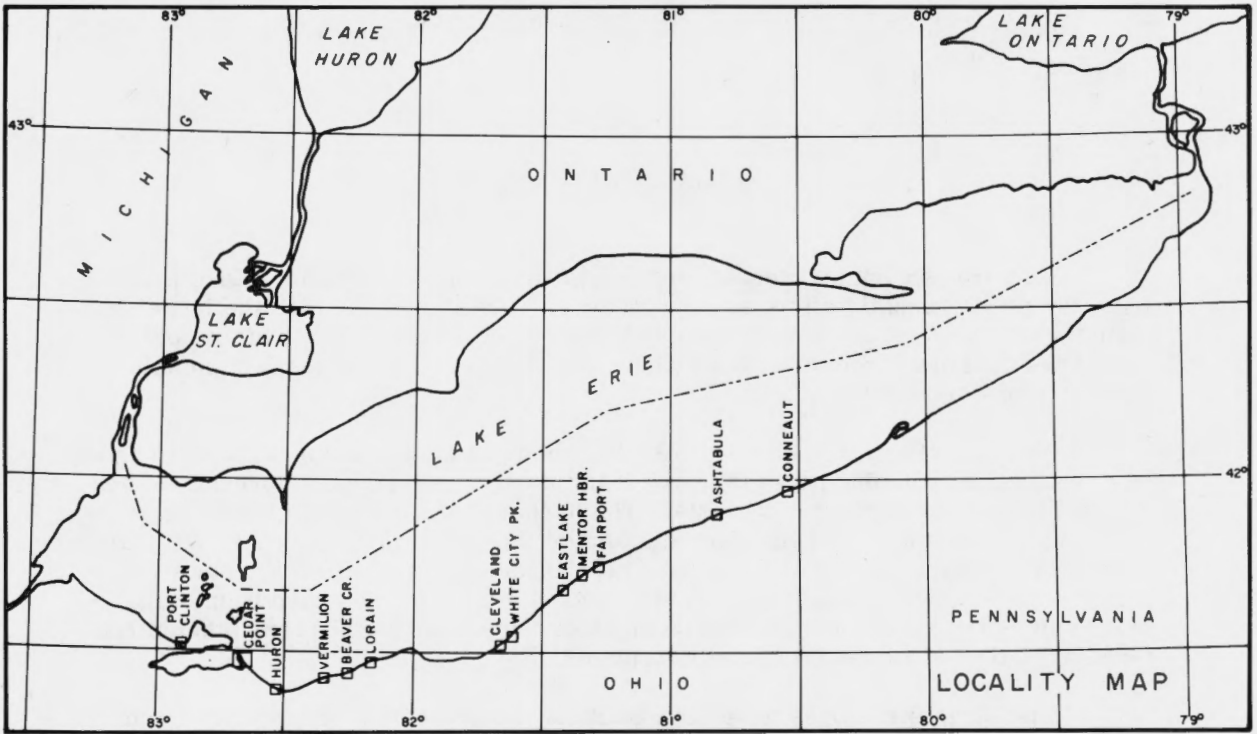


Figure 1.- Locality map.

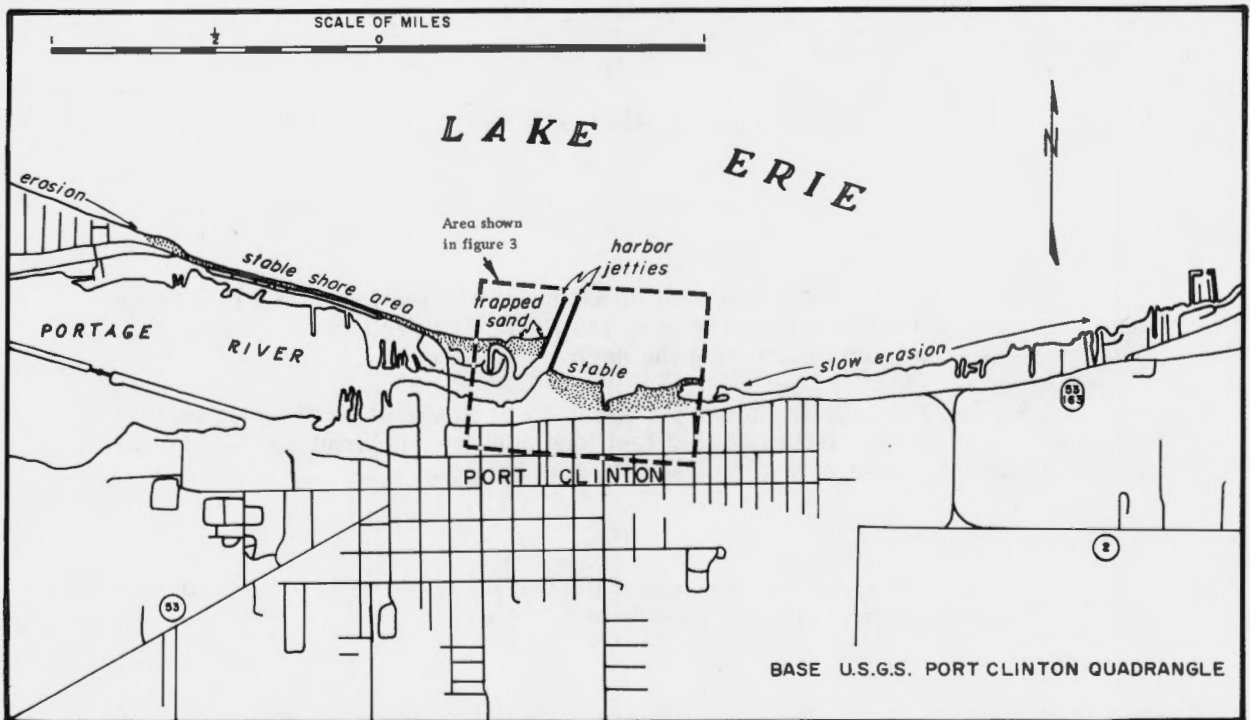


Figure 2.- Port Clinton, Ohio, harbor jetties and beach area.

The beaches both east and west of the jetties are not affected by the jetties as much as might be expected. There is an accumulation of sand just west of the west jetty (fig. 3), but this accumulation does not extend far to the west, even though the jetties have been in existence for 80 years. The beach to the east is not building and the shore is gradually retreating. A fair supply of sand lies just offshore throughout the area but it does not contribute to beach-building. The area appears to be virtually static. The very slow retreat to the east is probably caused by subsidence of the shore and not by a loss of sand.

The area along the shore of Port Clinton is one of converging littoral drifts for sand moving southeastward from Locust Point and southwestward from Catawba Island. Sand which is transported into the area is not removed. The jetties are the only large structures along the entire Ohio shore which do not lie in an area of strong littoral drift. For this reason these jetties have relatively little effect on shore processes.



Figure 3.- Port Clinton harbor entrance and adjacent shores. Dark patches along shore are sand bars. Note position of water line on west side of jetties relative to that on east side, indicating eastward drift. Photo taken 4/15/57. Water level 573.0.

SANDUSKY

The entrance to Sandusky harbor is protected by a rip-rap jetty 6,000 feet long (fig. 4). The jetty is low; its highest part is only about four feet above datum, and during higher water stages it is nearly all submerged. The first part of the jetty was built in 1897 and the last section was completed in 1922. The jetty prevents sand drift from filling the channel on the northwest side. A small amount of sand passes through and over the jetty, however.

The Sandusky harbor jetty has trapped a great amount of sand on its southeast side, to the advantage of the amusement park and residents along the spit to the southeast. The mouth of Sandusky Bay is northwest of the jetty and there have been no detrimental effects. This is the only large structure along the Ohio shore

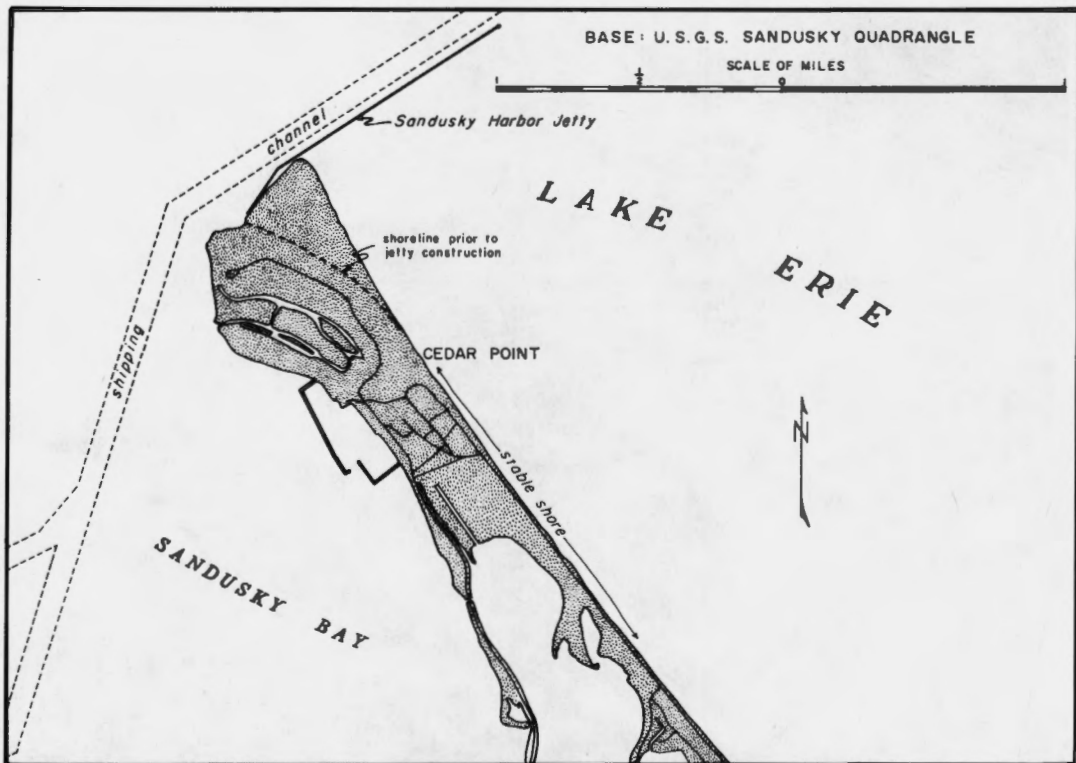


Figure 4.- Sandusky, Ohio, Cedar Point spit and harbor jetty.

which appears to be completely beneficial to the adjoining shore. It has had no measurable effect on the Marblehead shore on the northwest side of the bay mouth. However, it now appears that sand in increasing amounts is being moved around the outer end of the jetty into the mouth of the bay and toward the Marblehead shore. The jetty has also trapped a great amount of sand offshore in addition to that on the shore.

The littoral drift in the area is predominantly northwest and very strong. Most of the sand in the littoral drift originates along the shore between the jetty and

Huron, ten miles to the southeast, although some may come from as far away as Lorain, 30 miles eastward. Other large structures at Huron and Vermilion, however, have nearly stopped the long-distance drift.

HURON

The federally-owned breakwater jetties at Huron (fig. 5) protect the Huron River harbor from storm activity and longshore sediment drift. The west jetty is of stone-filled timber crib and rubble mound construction, totalling almost 3,200 feet in length. Its top elevation varies from 6.5 to 10 feet above datum and the entire structure is impermeable to the passage of sediment. The east jetty is 1,450 feet long and 10 feet above datum. It is of rubble mound construction.

The east jetty has trapped and maintained a wide beach which extends eastward about one mile (fig. 6). Thus this section has been stabilized by a permanent beach derived from erosion of the shore and nearshore bottom to the east.

The predominant littoral drift in the Huron area is toward the west. Because the jetties effectively stop the movement of beach materials in the drift, the shore west of the jetties is starved of sand. Beaches are scarce or absent along the shore for $2\frac{1}{2}$ miles west of the jetties (fig. 7). The scarcity of protective beaches has necessitated the construction of bank protection. Protected banks add to the problem by eliminating the only important source of beach supply, for the nearshore bottom

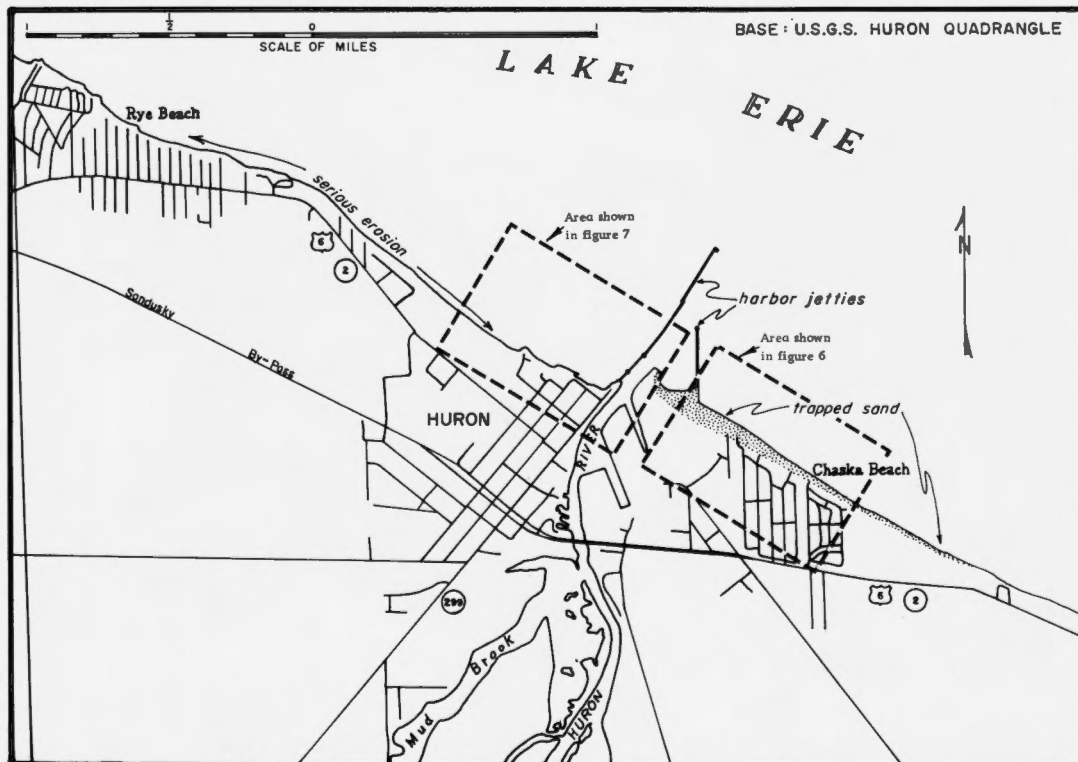


Figure 5.- Huron, Ohio, harbor jetties and shore conditions.



→ Figure 6. - Beach east of Huron River mouth at Huron, Ohio. Base of east harbor breakwater at extreme left of photograph. Note length and width of beach. Photo taken 5/7/56. Water level 573.2.

→ Figure 7. - Shore west of Huron River mouth at Huron, Ohio. Compare condition of shore with that of fig. 6. Shore in eroding condition. West harbor breakwater at right side of photograph. Photo taken 5/7/56. Water level 573.2.

supplies a small amount of sand through the action of wave scour. However, the sand on the bottom is mainly very fine and will not ~~long~~ remain on the shore. In addition, much of the nearshore bottom in the $2\frac{1}{2}$ -mile stretch is bare rock which contributes little or nothing to the beach supply.

West of the beach-poor area, the Cedar Point spit begins and sand is much more plentiful on the shore. However, the shore line is receding rapidly as the beach advances into the marsh at the southeast end of Sandusky Bay. Sand is being slowly lost from the shore by longshore drift toward the northwest. This area supplies most of the sand which is accumulating farther northwestward near the tip of Cedar Point.

The jetties at Huron, in summary, have caused a good, mile-long beach to be built to the east, while adversely affecting, by sand starvation, about five miles of shore to the west. East of the beach, beyond the jetties, the effect has been slight.

VERMILION

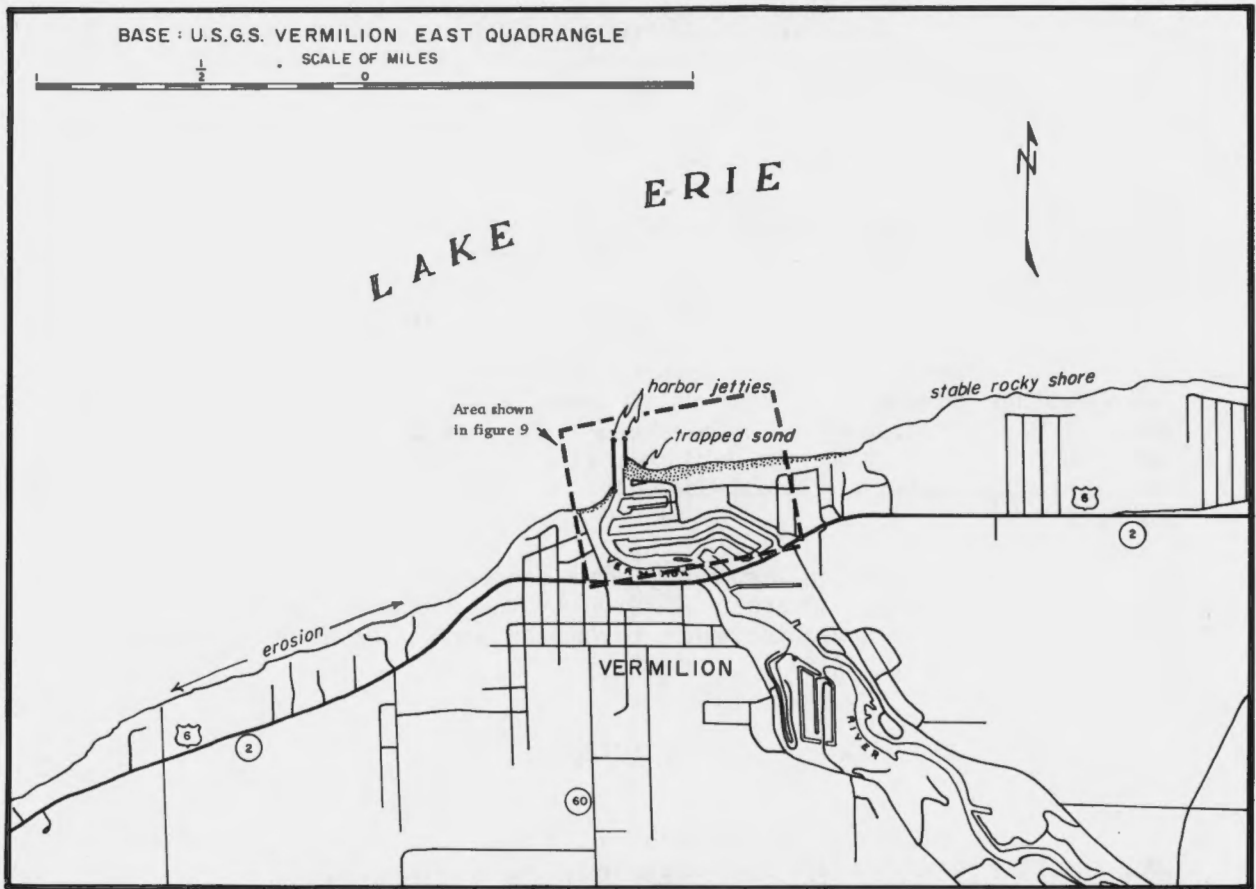
Parallel jetties were built at the mouth of the Vermilion River prior to 1850 (fig. 8). They have been repaired and renovated several times since. The jetties are built of stone blocks with their tops at about 6.5 feet above datum. The west jetty is about 1,000 feet long and the east jetty 460 feet. Both are impermeable to sand drift.

A beach more than 3,000 feet long has been trapped east of the jetties (fig. 9). The beach exceeds 150 feet in width and offers excellent protection to the landward residential and park areas. The beach is stable and has not changed materially in many years. Apparently the east jetty has trapped its limit of beach sand. Some sand is being added to form small dunes along the back of the beach. East of the beach the jetties have no effect on shore processes.

West of the jetties erosion is active all the way to Huron, ten miles to the west. The erosion throughout this stretch cannot be attributed to the Vermilion jetties, except that they are a contributing factor. However, for $1\frac{1}{2}$ miles west of the Vermilion River the jetties apparently starve the shore of sand. In this stretch groins are not too effective in trapping beaches. From this area west to Ruggles Beach, groins are more or less effective in beach-building, apparently because of a fair amount of sand in the nearshore zone and in eroding banks. Between Ruggles Beach and Huron, the beaches are narrow or nonexistent and bank erosion is generally serious.

Some sand appears to move to the west around the ends of the Vermilion jetties. It is not a significant amount, however, because the sand in littoral drift east of Vermilion is scarce.

The jetties at Vermilion do not greatly affect the shore to the west because of the slight supply of sand and relatively short lengths of the jetties. However, they have kept the sand on the beach to the east out of the littoral supply, with the result that shore conditions on the two sides are not in balance.



→ Figure 8.- Vermilion, Ohio, harbor jetties and shore conditions.

→ Figure 9.- Vermilion, Ohio. Vermilion harbor jetties at upper left. Beach east of jetties trapped by east jetty. Note position of shore west of jetties compared to that east of the jetties. Photo taken 5/7/56. Water level 573.2.

BEAVER CREEK

The jetty along the east side of the mouth of Beaver Creek has been built to prevent sand from damming the mouth (fig. 10). It is 400 feet long and built of dumped rip-rap. The jetty is impermeable to sand and on its eastern side has trapped a good beach more than 2,000 feet long.

The longshore drift in the Beaver Creek area is toward the west, which accounts for the beach build-up to the east (fig. 11). The jetty has apparently trapped as much beach as it can be expected to hold, and sand now passes to the west around the end of the jetty. A beach about 1,500 feet long west of Beaver Creek appears to be maintained by the flow of sand past the jetty. A quantity of sand lies in the near-shore zone off the western beach. A comparable area of sand does not exist off the beach east of the jetty, and the bottom is subject to scour.

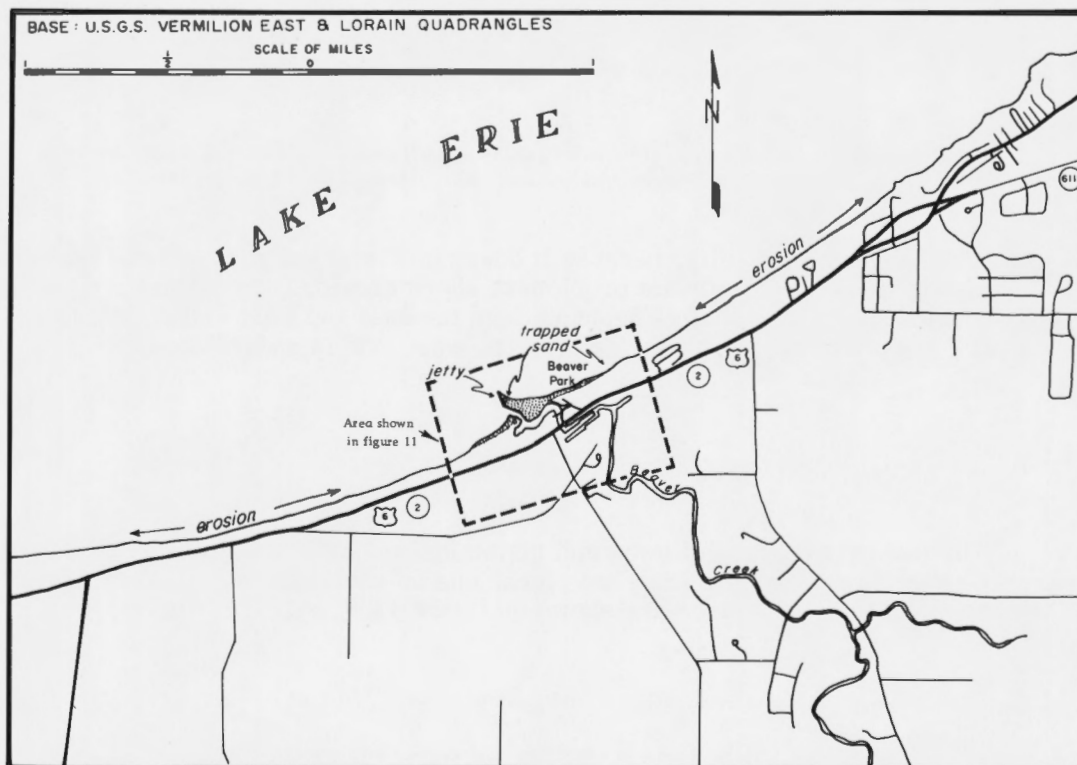


Figure 10.- Mouth of Beaver Creek, jetties and shore conditions.



Figure 11.- Beaver Creek, four miles east of Vermilion, Ohio. Beaches east and west of creek mouth jetty are relatively stable. Jetty retains beach to east. Photo taken 5/7/56. Water level 573.2.

The Beaver Creek jetty, because it does not now greatly impede the longshore flow of sand, creates no important problem of shore erosion. Its effects are beneficial in that it retains a protective beach on both the east and west sides. Residences and a park are protected on the east side. The west side is undeveloped.

LORAIN

The federal government owns and maintains two large breakwaters at the entrance to the Lorain harbor, and two piers, one on each side of the mouth of the Black River. These structures are shown on figure 12.

Figure 12.- Lorain, Ohio, harbor breakwaters and shore conditions. ➔

Figure 13.- Shore of Lorain, Ohio in vicinity of west harbor breakwater. Breakwater at left center of photograph. Note accumulation of sand inside breakwater with a relative scarcity of sand west of breakwater. Photo taken 5/7/56. Water level 573.2. ➔



The west breakwater is shore-connected, 4,050 feet long, and constructed of rubble mound and placed stone to an elevation of 10 feet above datum. The east breakwater is not shore-connected. It lies about 2,100 feet offshore and bears north-westward toward the outer end of the west breakwater. It is of rubble mound construction, 2,300 feet long, and is built to about 10 feet above datum.

The piers at the mouth of the river are timber crib, capped with concrete to an elevation of 8.3 feet above datum. The west pier is about 1,000 feet long and the east pier is 1,875 feet long.

The effects which the large structures at Lorain have had on the adjacent shores are difficult to establish with certainty. Lorain lies at or near the locality where the predominant longshore drift changes direction. West of Lorain the drift is predominantly toward the west, but east of Lorain it is predominantly eastward.

The condition of the shore along the city of Lorain indicates that the structures may have a more or less adverse effect on both the east and west sides. Erosion is very active to the east. A small pebble beach has been built at the base of the east pier. This beach contains little sand and appears to be static in growth. Its composition indicates that it is comprised, in part, of materials dumped over the banks to the east. The orientation of the east pier, at an obtuse angle to the east shore, apparently allows beach material in westerly movement to pass by and into the outer harbor area. This is an offshore movement protected from deflection by the east breakwater.

Very little sand is in transport along the shore west of the west breakwater, as indicated by the relative ineffectiveness of groins in building beaches. However, some sand is in movement because a considerable build-up has occurred at the base of and inside the west breakwater (fig. 13). The base of the breakwater is permeable and allows sand to pass through and over it. Once inside the breakwater, the sand is protected from destructive wave action and only accretion occurs. The deposition is detrimental because it represents a permanent removal of sand from longshore movement. The sand can be brought in by waves from any effective direction, although west and northwest storms probably account for most of it. Northeast storms can also bring material from the nearshore zone into the corner, as indicated by pronounced wave refraction along the wall.

At first glance the build-up of sand at the base of the west breakwater indicates a predominant eastward drift in the area. However this conclusion is not necessarily true. Instead, indications are strong that the area west of the breakwater, in the city park and farther westward, is being starved of sand. Accretion patterns indicate a predominant westward movement.

The extent of the structure effects is not known, but there are very few beaches of any significance for nearly two miles west of the west breakwater. East of the harbor the problem is as great or worse for many miles (fig. 14). Erosion to the east is not related to the structures, except perhaps in the first two miles. Farther to the east bedrock comprises the banks and nearshore bottom, and this, at best, supplies only a meager amount of beach material.

The structures at Lorain, in summary, probably affect shore processes, but definite statements cannot be made except that permanent deposition occurs at the base of the west breakwater, thus removing sand from longshore movement.



Figure 14.- Shore just east of Black River mouth at Lorain, Ohio. A potentially serious erosion problem exists here. Note lack of beaches. Orientation of sea wall at left end of photo allows unimpeded flow of material toward northwest. Photo taken 5/7/56. Water level 573.2.

CLEVELAND

Much of the city of Cleveland is fronted by a massive breakwater (fig. 15), lying between 1,500 and 3,000 feet off the shore and parallel to it. It is shore-connected at the west end. The breakwater is the protection for the shore part of the port of Cleveland and is more than five miles long. It has an opening through it for shipping off the mouth of the Cuyahoga River about 6,000 feet from the west end. West of the opening it is 12.5 feet above datum and east of the opening it is 10.5 feet above datum. It has another opening at the west end for small boat passage.

West of this federally-owned breakwater, the City of Cleveland built another breakwater fronting a yacht basin and a filled park area. This breakwater is 6,000 feet long and 12.5 feet above datum. It is of rubble mound construction and lies about 1,400 feet off the former shore line. It is shore-connected and a wide beach has accumulated west of the shore arm (fig. 16). The beach, a part of a municipal park, is only about 1,400 feet long, but it reaches nearly 400 feet in width.

The city-owned and federally-owned breakwaters protect more than six miles of shore frontage from damaging wave attack. The City of Cleveland has taken advantage of the protection in a program of extensive landfill along the shore.



BASE: U.S.G.S. CLEVELAND NORTH, SOUTH & LAKEWOOD QUADRANGLES

SCALE OF MILES



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WEST BASIN

CLEVELAND

Area shown
in figure 16

eroding

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TACK BUSS

PARK

EDGE WATER

serious erosion

Gordon Park

Bratenahl

Cuyahoga River

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← Figure 15.- Cleveland, Ohio; harbor structures and shore conditions.

The breakwaters have had no adverse effects on the shore throughout their length. However, the shore east of the breakwaters is eroding seriously (fig. 17). The banks are high and comprised of clay and silt. They are easily broken down by wave attack because there are no protective beaches of any consequence for several miles. The breakwaters impede the west-to-east littoral drift which would otherwise be available to the area. Materials which could be useful in beach-building probably move eastward along the lake side of the breakwaters, but they are so far offshore that they cannot be brought ashore after reaching the eastern end. In this way the breakwaters tend to starve the shore to the east for more than two miles.

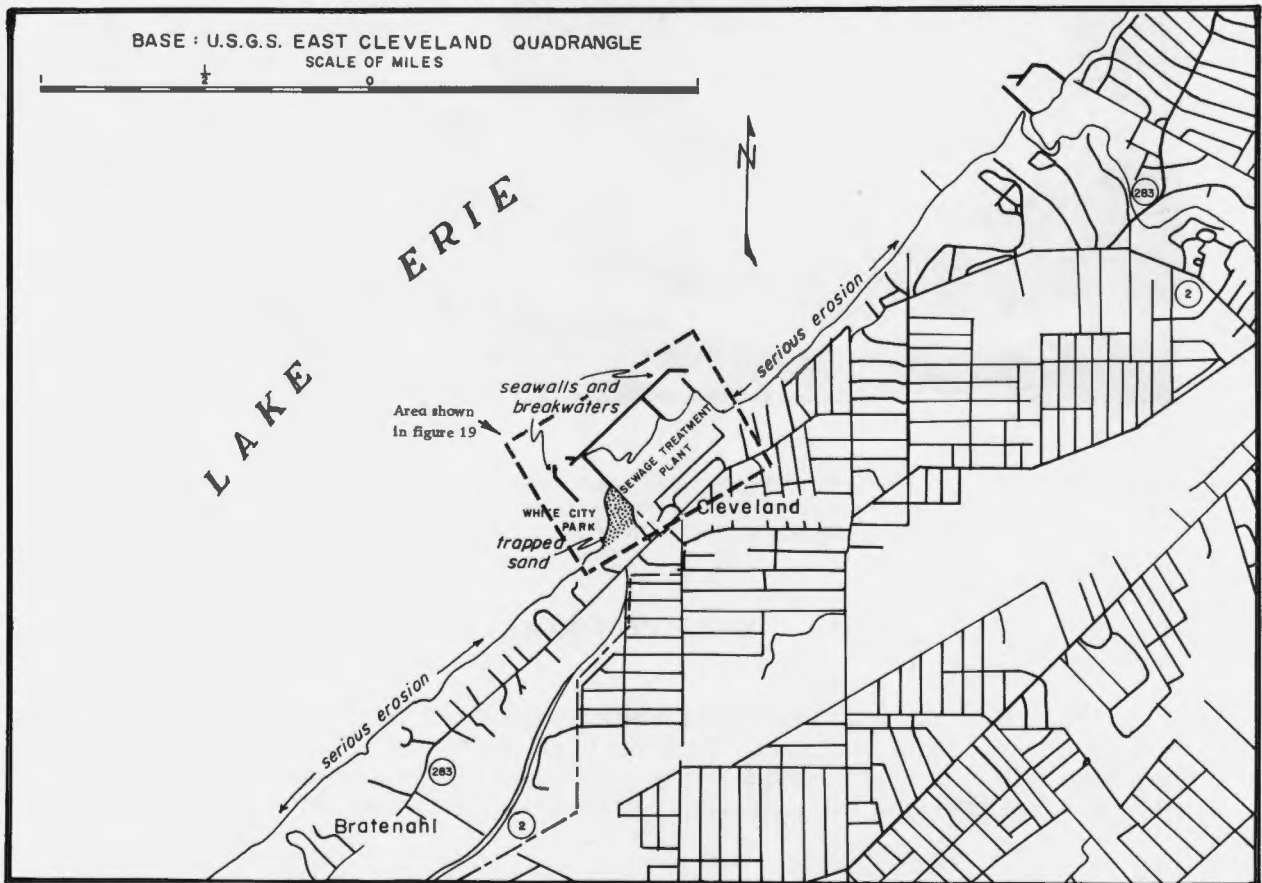
West of the breakwaters, beyond the park beach, the effect of the structures is negligible. The shore in that area is rock-bound and naturally sand-scarce.



Figure 16.- Edgewater Park and Beach on west side of Cleveland harbor structures. Wide beach shown in west half of photograph trapped by sea wall to east. Most of area between sea wall and freeway in east half is artificial fill. Photo taken 5/7/56. Water level 573.2.

WHITE CITY PARK

The City of Cleveland maintains a sewage treatment plant just east of the eastern village limit of Bratenahl. An array of piers, seawalls, and a breakwater have been built to protect the plant and to contain part of its facilities (fig. 18). The structures are mainly of rubble mound construction with top elevations between 7 and



← Figure 17.- Gordon Park and vicinity in east Cleveland. East end of harbor breakwater about one half mile offshore at west end of photograph. Note serious erosion and lack of beaches. Photo taken 5/7/56. Water level 573.2.

← Figure 18.- Cleveland, Ohio, White City Park, structures and shore conditions.

9.5 feet above datum. They extend about 1,200 feet lakeward from the general shore line. The construction was completed in 1933.

The park is just west of the sewage treatment plant. Here the westernmost structures have caused a beach of remarkable proportions to be formed along a stretch of shore characteristically lacking in beaches (fig. 19). Accretion is still taking place rapidly, creating the highly unusual condition of too much sand. Dunes form on the back part of the beach and tend to encroach upon the bordering entrance road. A boat anchorage formed by the walls and the offshore breakwater is filling with sand. Much of this area was dredged in 1961 and thousands of cubic yards of sand were removed to be used for inland construction.

Perhaps the most unusual feature of the beach is that it fronts and protects only about 800 feet of shore and terminates abruptly at the foot of the shore banks on the west. Erosion is serious from here westward, but it is not the result of the structures because the longshore drift is toward the east.



Figure 19.- White City Park and sewage disposal plant, Cleveland, Ohio, just east of eastern village limit of Bratenahl. Sand accumulation here has been very rapid. Note unusual shape of beach, probably due to offshore breakwater in left center of photograph. Erosion serious east and west of this area. Photo taken 5/7/56. Water level 573.2.

The structures tend to hold a small beach at the eastern shore intersection, but they have caused or accentuated the starvation of beaches for the next 3,000 feet, resulting in very serious bank erosion. Farther east the groins at Euclid Beach Park have maintained a long stable beach for many years.

While unusual in many respects, the effects of the White City Park structures follow the normal pattern in that the adverse effects cover a much greater length of shore than that which has been protected.

EASTLAKE

Parallel piers have been built normal to the shore at an electric power company in Eastlake. These structures extend about 1,100 feet into the lake and provide protection for a high-volume water intake (fig. 20). They are constructed of filled cellular sheet pile, and concrete-capped, with a top elevation of ten feet above datum.

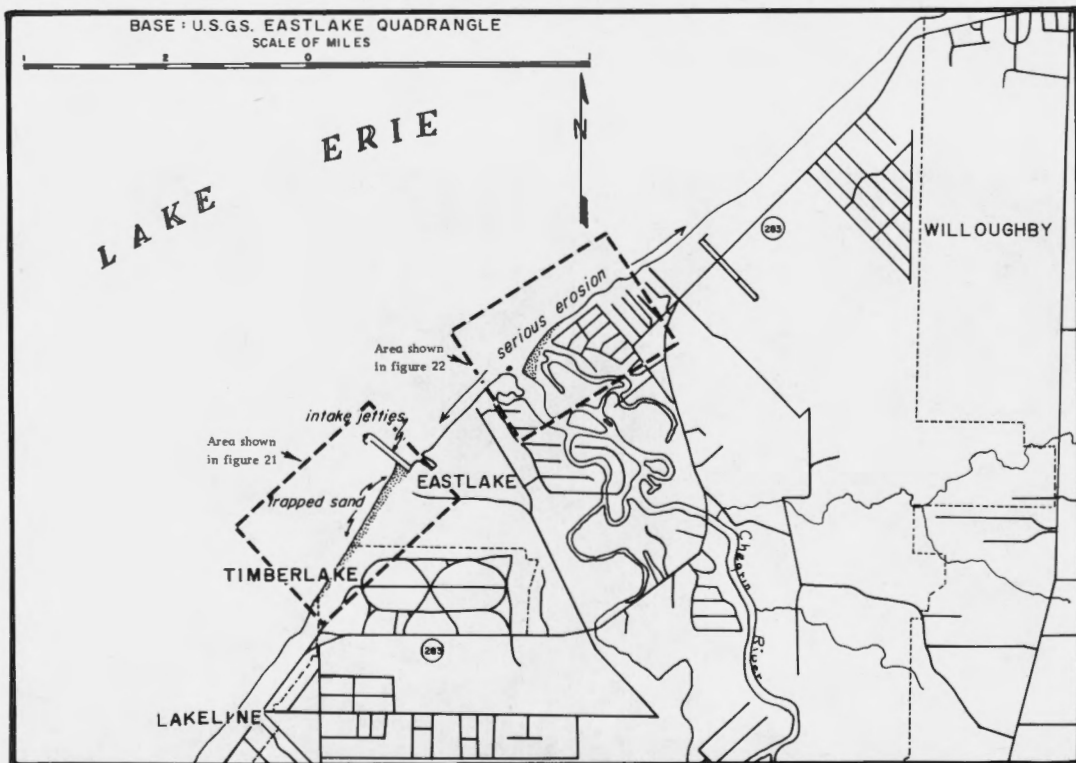


Figure 20.- Eastlake, Ohio, water intake jetties and shore conditions.

Figure 21.- Electric power company at Eastlake, Ohio. Long, wide beach shown west of jetties had accumulated in only four years. Erosion active east of jetties necessitating sea wall construction. Photo taken 5/7/56. Water level 573.2. →

Figure 22.- Chagrin Harbor Beach allotment, Eastlake, Ohio. One half to one mile east of area in fig. 20. Beach eroding, now averaging 50 to 75 feet narrower than at time photograph was taken. Photo taken 5/7/56. Water level 573.2. →



Since their construction in 1952 they have virtually stopped the longshore movement of sand from the southwest and have quickly built a wide beach on the southwest side which now exceeds half a mile in length (fig. 21).

The long piers have probably had more far-reaching and significant effects on shore processes during their short existence than any other structures of comparable size along the Ohio shore. While quickly providing a protective beach to the southwest, they have had an extremely serious effect on the shore to the northeast. Formerly a wide beach some 3,000 feet long fronted the valley of the Chagrin River (fig. 22). This beach is rapidly being lost because of sand starvation. The loss is accelerated by the annual dredging in the mouth of the river. The effect is not as serious farther to the east of the Chagrin valley, but the sand starvation is apparent for at least two miles. Deepening of the nearshore bottom is occurring, and, with higher lake levels, the entire area may become one of very rapid erosion.

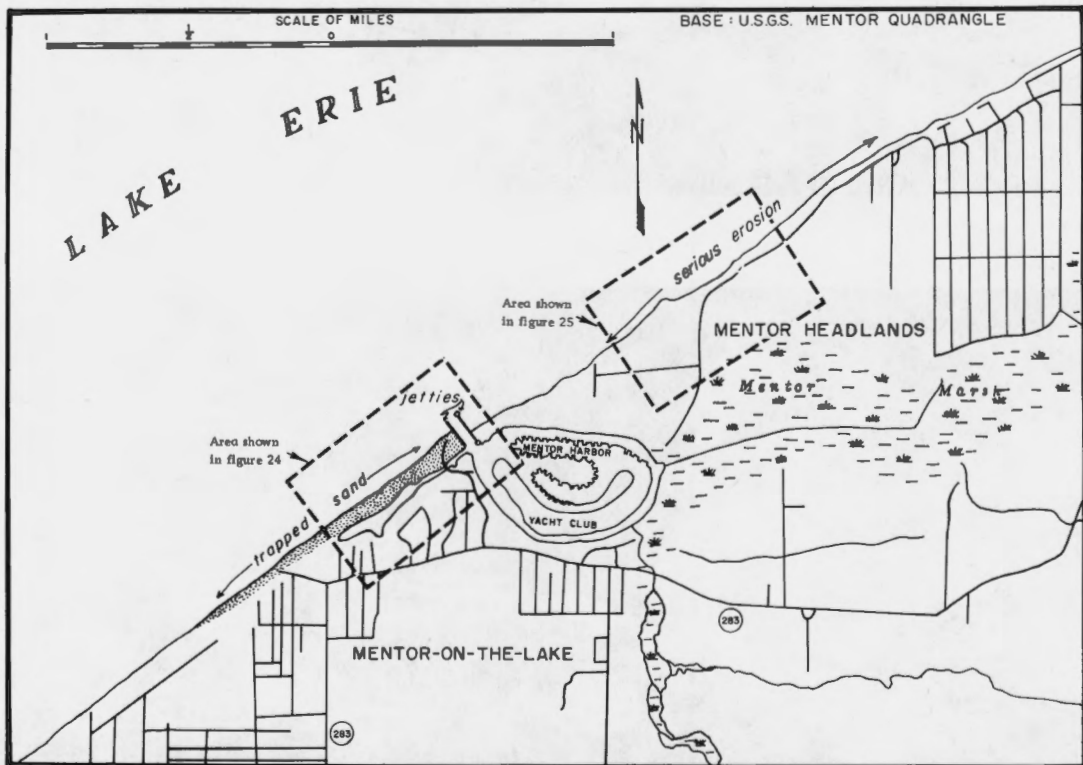


Figure 23.- Mentor-on-the-Lake, Ohio, harbor jetties and shore conditions.

Figure 24.- Shore just west of Mentor Harbor inlet. Entrance jetties at right side of photograph. Note unusual length and width of beach compared to length of jetties. Note sand bars in channel and east jetty, indicating beach drift is not now stopped by jetties. Photo taken 5/1/58. Water level 571.5. ←

Figure 25.- Mentor Headlands area one mile east of Mentor Harbor. Compare shore with that shown in fig. 24. Erosion of 70-foot banks is serious and rapid. Note effectiveness of groins in maintaining promontory even though beach is relatively narrow. Photo taken 5/1/58. Water level 571.5. ←



MENTOR HARBOR

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 (fig. 23). The jetties are about 400 feet long, about 8 feet above datum, and are of cellular steel sheet pile construction filled with sand.

The Mentor Harbor jetties caused an exceptionally large build-up of beach to the west (fig. 24). The beach is more than 200 feet wide and about 6,000 feet long, and is unique along the Ohio shore in that it is retained by structures of such short length. It is probable that the jetties alone are not responsible for the build-up. They may have caused a build-up which, in itself, interrupted the longshore drift of materials, thereby resulting in natural accretion. The supply for this beach probably is mainly the nearshore bottom, which, for some distance lakeward, is characterized by sand and gravel in the form of massive bars. The nearshore deposits may have originated as stream-carried sediments at the former outlet of the Grand River. Much of the beach is backed by the former stream channel, which is now a lagoonal marsh.

The great quantity of beach materials west of the jetties has, of course, been lost 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 (fig. 25). Longshore drift now occurs past the ends of the jetties. However, some of this material is deposited in the entrance channel to Mentor Harbor. This material is dredged annually in large quantities and is used commercially, representing a notable loss to the littoral supply. Thus the dredging also tends to starve the shore to the northeast.

Erosion in the next $2\frac{1}{4}$ miles northeast of Mentor Harbor has been very serious for many years because of the lack of beaches and the action of waves and ground water on the clay banks.

FAIRPORT

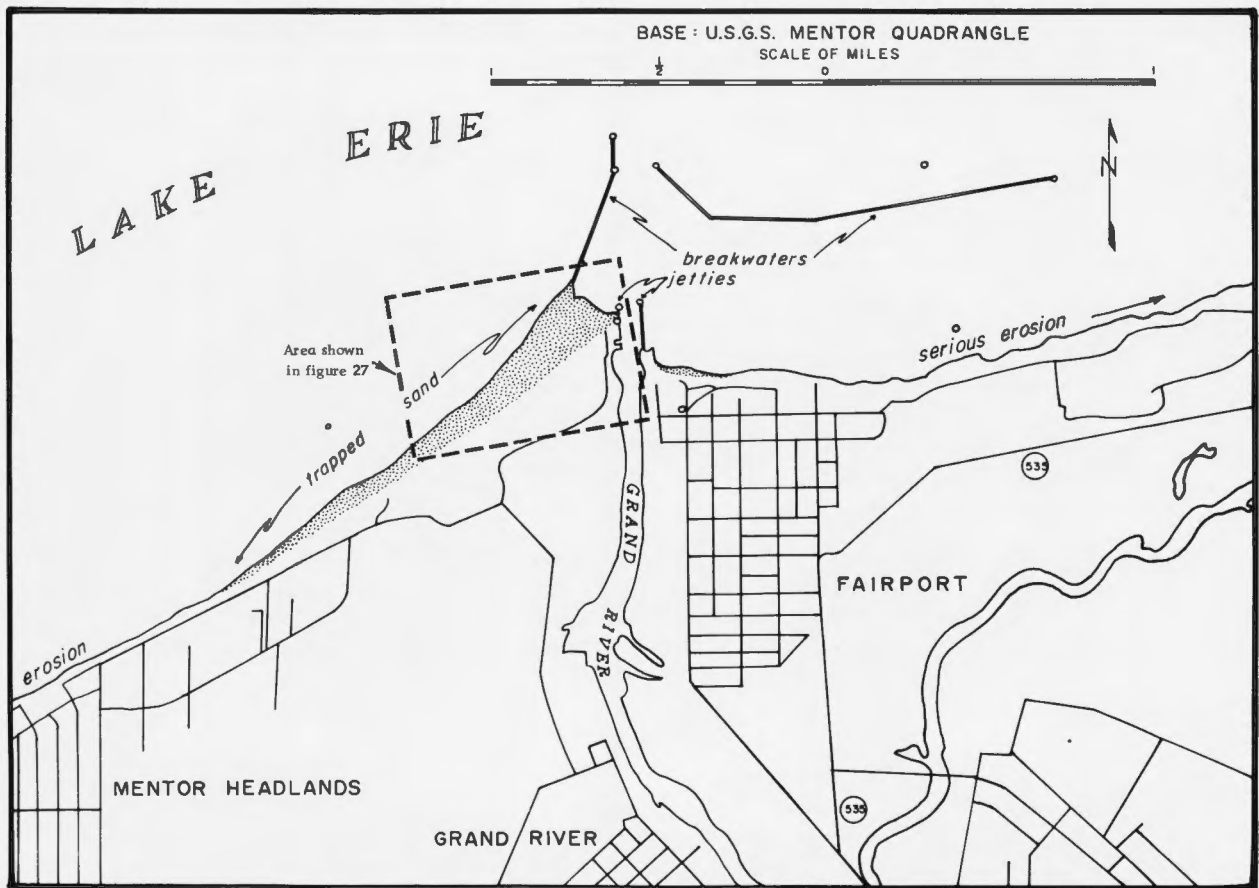
Two large breakwaters were built by the federal government at the mouth of the Grand River shortly after the turn of the century (fig. 26). They protect Fairport Harbor from storm waves and sedimentation.

The west breakwater is about 3,900 feet long and at an obtuse angle to the shore to the west. It is of rubble mound construction except for the outer 500 feet which is cellular steel sheet pile. The east breakwater is of rubble mound construction, 6,750 feet long. It is not shore-connected, but lies about 2,500 feet off and more or less parallel to the shore.

The west breakwater has trapped, on its west side, one of the largest beaches on the Ohio shore (fig. 27). The beach is more than 7,500 feet long, tapering westward from a width of more than 900 feet near the breakwater. Some sand has passed over the breakwater, adding to the beach on the harbor side.

Figure 26.- Fairport, Ohio, harbor breakwaters and shore conditions. →

Figure 27.- Fairport State Park beach west of Fairport, Ohio. Grand River at extreme right of photo. Fairport west harbor breakwater shown at top right. Nearly all of land area in this photo is beach sand trapped by structure. Photo taken 5/1/58. Water level 571.5. →



The long beach and the west breakwater now form a sweeping curve along which sand in northeastward longshore transport moves more or less unimpeded. Strong longshore currents and a good sand supply to the west result in the building of bars off the outer end of the breakwater. This deposition necessitates semi-annual dredging at the harbor entrance. Sand in great quantities is removed and dumped in deep water.

The shore along the village of Fairport, just east of the Grand River, has been more or less protected by both the east and west breakwaters. The predominant easterly longshore currents are deflected lakeward by the west breakwater and are ineffective along the village shore. Southwest, west, and northwest storms are also prevented by both breakwaters from attacking the shore. Northeast storm waves reach the shore, and they bring in materials which cannot be removed. This has resulted in the building of a good beach fronting Fairport. The beach is about 1,600 feet long with a maximum width of about 200 feet. The beach is fairly stable, apparently because there is not a good source of beach supply to the east where rock is near lake level.

East of Fairport the shore again becomes subject to easterly drift and is open to severe wave attack. The nearshore sand supply is meager, rock is near water level, and no beach materials can move in from the west. The result is very serious erosion in a nine-mile stretch extending east from Fairport (fig. 28). A



Figure 28.- Painesville Township Park and vicinity, two and one-half miles east of Fairport, Ohio. Compare condition of shore with that of fig. 27. Erosion in this area very serious. Photo taken 5/1/58. Water level 571.5.

few small areas are relatively stable, some of which have been stabilized artificially. Otherwise the banks are being lost rapidly. The breakwaters at Fairport definitely contribute to the rapid erosion in that they have cut off an excellent supply of sand in longshore movement.

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 Study² 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. This does not mean that such a beach would have been created, but it serves to show the seriousness of the problem created by the breakwater.

ASHTABULA

Breakwaters similar to those at Fairport have been built at the mouth of the Ashtabula River to protect the harbor from waves and sedimentation (fig. 29). The



Figure 29.- Ashtabula, Ohio, harbor breakwaters and shore conditions.

2. U.S. Army, Corps of Engineers, Beach erosion control report on State of Ohio, Appendix IX, Shore of Lake Erie in Lake County, Beach Erosion Control Study, House Doc., No. 596, 81st Congress, 1950.



- Figure 30.- Walnut Beach at Ashtabula, Ohio. West harbor breakwater in upper right center. Note shore arm nearly covered by sand. Large sand deposit east of breakwater built from sand moving over and through wall. Photo taken 5/1/58. Water level 571.5.
- Figure 31.- Vicinity of metallurgical plant three miles east of Ashtabula River. Compare with fig. 30 and note absence of beaches and eroding character of shore banks. Bank east of plant rises to more than 60 feet above lake level. Photo taken 5/1/58. Water level 571.5.

west breakwater is of rubble mound construction, 7,800 feet long, angling northeastward from the shore. The east breakwater is also of rubble mound construction, 4,400 feet long, and is not shore-connected. It angles southeastward, its landward end being about 2,000 feet from shore.

The west breakwater has trapped a beach about 3,500 feet long, tapering westward from a width of nearly 900 feet near the breakwall (fig. 30). The beach continues eastward across the breakwater and a huge amount of sand has accumulated on the east side of the breakwater. This sand is permanently trapped, out of the reach of strong waves and currents. The large beach build-up is the result of strong easterly longshore drift and a fair sand supply to the west.

The west breakwater completely cuts off the movement of sand past Ashtabula, thereby starving the beaches to the east (fig. 31). Probably more volume is lost annually in this stretch than in any other comparable distance along the Ohio shore. All of the beach materials must originate within this stretch from bank erosion, since the nearshore bottom is bedrock. Much of the bank material is too fine for beaches and is moved offshore.

Although the beach build-up to the west is less than at Fairport, it is a massive deposit, much of which is actually useless. It should be transferred to the east side of Ashtabula where the need for protective sand beaches is urgent.

CONNEAUT

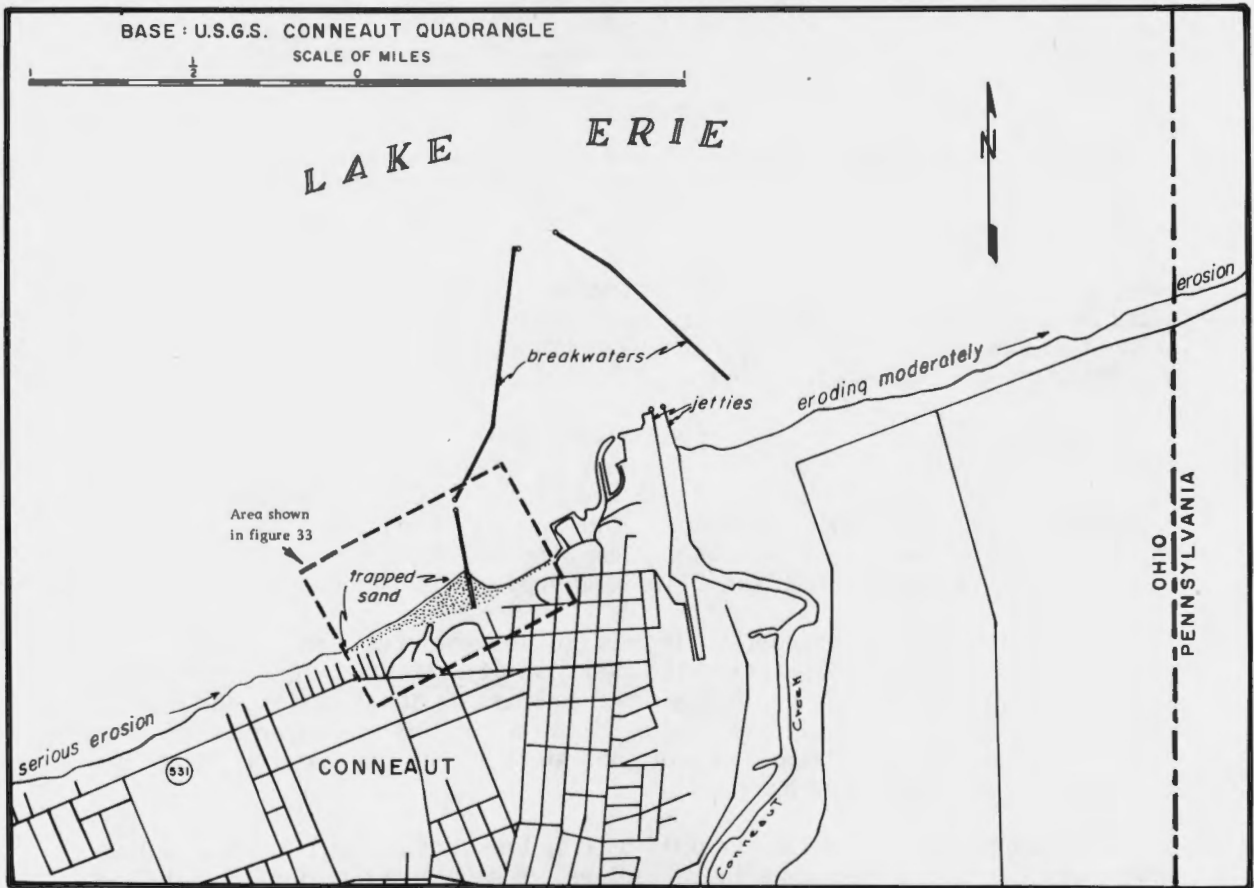
The harbor of Conneaut has breakwaters similar to those at Ashtabula, except they are at a higher angle to the shore (fig. 32).

The west breakwater is almost 5,000 feet long and of rubble mound construction. A gap in the structure about 1,600 feet from shore provides a small boat entrance to the harbor. The top of the breakwater is about 10 feet above datum.

The east breakwater, like the other harbor structures to the west, is not shore-connected. The southeasterly end lies 1,000 feet from the present shore. The top of the structure is 8 to 10 feet above datum. It is about 3,700 feet long and constructed of rubble mound and concrete-capped timber crib.

The west breakwater has trapped a great deal of sand and gravel, creating a beach more than 2,000 feet long (fig. 33). It is about 700 feet wide near the wall and tapers westward to about 50 feet at the west end. A considerable amount of sand has passed over the west breakwater to form a protected beach inside the harbor with shoal water off the beach.

The east breakwater has no great effect on shore processes except to protect a very small beach just east of the Conneaut River mouth.



→ Figure 32.- Conneaut, Ohio, harbor breakwaters and shore conditions.

→ Figure 33.- Conneaut Township Park at Conneaut, Ohio. West harbor breakwater in right half of photo. Note accumulation of sand east of breakwater which has passed over breakwater. Water very shallow east of breakwater, partly a result of sand passing through breakwater opening. Photo taken 5/1/58. Water level 571.5.

Shore erosion is not rapid from Conneaut to the state line although the conditions are those of erosion (fig. 34). Bedrock near water level, covered by pebbles and cobbles, apparently acts as shore protection. The harbor structures do, however, starve the shore to the east of sand. There is no evidence of sand passing the structures. Apparently the west breakwater traps nearly all sand in littoral drift, which is strongly toward the east.

East of the state line erosion is serious and the Conneaut breakwaters undoubtedly contribute to a higher rate of recession.

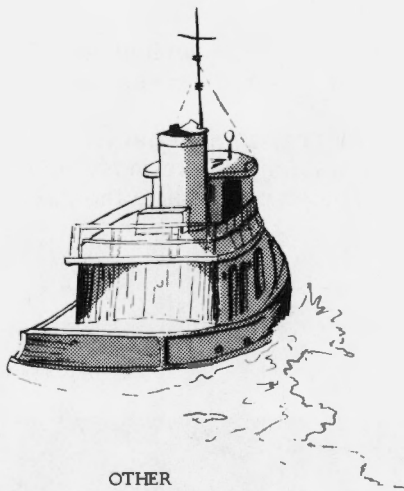
The Conneaut breakwaters, in summary, protect about 2,000 feet of shore to the west of the west breakwater. Unlike most structures of comparable size, they do not create a great erosion problem to the east, at least as far as the state line.



Figure 34.- Shore just east of Conneaut, Ohio. Note relative stability of vegetation-covered banks. Irregular beaches and dark patches near water line are pebbles and cobbles lying on shale. Southeastern end of east breakwater shown in upper left corner of photograph. Photo taken 5/1/58. Water level 571.5.

CONCLUSIONS

Most of the large structures along the Ohio shore have caused build-up of beaches on their updrift sides and accelerated erosion downdrift. The effects are not balancing, in that the length of eroding shore is ordinarily five or more times the length of shore which is protected by build-up. At some places the build-up is even too great, resulting in a waste of beach materials which are in short supply along most of the shore. One possible solution of the problem might be artificial redistribution of the trapped sands by dredging and other methods.



OTHER
PUBLISHED REPORTS
AVAILABLE FROM
THE OHIO DIVISION OF GEOLOGICAL SURVEY

- TR 1. 1950 investigation of Lake Erie sediments, vicinity of Sandusky, Ohio, by H. J. Pincus, M. L. Roseboom, and C. C. Humphris, Jr.
- TR 2. 1951 investigations of Lake Erie shore erosion, edited by H. J. Pincus.
- TR 3. Bibliography of physical limnology, 1781-1954, by James Verber.
- TR 4. Bottom deposits of western Lake Erie, by Division of Shore Erosion staff.
- TR 5. Sand dredging areas in Lake Erie, by R. P. Hartley.
- TR 6. Bottom deposits in Ohio waters of central Lake Erie, by R. P. Hartley.
- TR 7. Engineering geology of the Ohio shore line of Lake Erie, by H. J. Pincus. 7 sheets--sheets A through G.

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