

STATE OF OHIO
John J. Gilligan, Governor
DEPARTMENT OF NATURAL RESOURCES
William B. Nye, Director
DIVISION OF GEOLOGICAL SURVEY
Horace R. Collins, Chief

Information Circular No. 39

THE NOVEMBER 1972 STORM ON LAKE ERIE

by

Charles H. Carter

Columbus
1973



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THE NOVEMBER 1972 STORM ON LAKE ERIE

by

Charles H. Carter

ABSTRACT

The Lake Erie area was hit by a severe storm on the 13th and 14th of November, 1972. A north-northeast wind, which reached a speed of 60 knots, blew for two days directly down the long axis of the lake. This wind generated high (12-foot) waves and at the west end of the lake piled up water more than 6 feet above the lake's average November level (or about 4 feet above the record high lake level set in November 1972). The waves and high water caused damage estimated at 22 million dollars to the Ohio shore. Northern Ohio was declared a major disaster area by the President, and the U.S. Small Business Administration declared Lucas, Ottawa, Sandusky, Erie, Lorain, Cuyahoga, and Lake Counties disaster areas.

INTRODUCTION

The Lake Erie storm of the 13th and 14th of November, 1972, was one of the worst natural disasters to take place along the Ohio shore in historic time. The storm, which took place when the lake was about 2 feet above its long-term November average, forced hundreds of people to evacuate their homes and caused extensive wave and flood damage to residential, agricultural, and recreational interests in the low-lying areas adjacent to the lake (fig. 1). The Ohio damage was estimated at 22 million dollars (Environmental Data Service, 1972). Northern Ohio was declared a major disaster area by the President, and seven Ohio counties, Lucas, Ottawa, Sandusky, Erie, Lorain, Cuyahoga, and Lake, were declared disaster areas by the U.S. Small Business Administration.

This report was prepared because of the tremendous effect that the storm has had on man and his environment in the Lake Erie region. The report has a fourfold purpose: (1) documentation of the storm and storm effects, (2) a historical review of some other Lake Erie storms to show the relationship between lake level and storm damage, (3) a review of natural and man-related factors affecting the water level of Lake Erie, and (4) a Lake Erie forecast considering what measures the people of Ohio can take to reduce damage to the Lake Erie shore.

The following U.S. Coast Guard stations provided wind and sea information for the November 1972 storm: Toledo, Marblehead, Lorain, and Cleveland. The Corps of Engineers gave water-level readings from Toledo (Detroit district) and Buffalo (Buffalo district).

STORM DYNAMICS

Weather front

A low pressure system (cyclone-occluded front) that moved through central Ohio on the 13th and 14th of November, 1972, generated the wind that buffeted Lake Erie.

Wind, water level, and waves

The wind began blowing from the northeast early in the morning of November 13th and continued blowing from this direction until late on November 15th, when it gradually shifted to the northwest. Wind speeds at Lorain and Marblehead were greater than 20 knots for a continuous 28-hour period, and at Toledo wind speeds were greater than 20 knots for a continuous 40-hour period. Maximum wind speed ranged from 35 knots at Cleveland and Lorain to 60 knots at Toledo.

As soon as the wind began to blow it started pushing water from the eastern toward the western end of Lake Erie. The water began to pile up against the southwest shore and at about 0600 hours on the 14th the lake level at Toledo reached its maximum storm height (fig. 2). This height was about 6 feet above the long-term November average of 570.0 feet (Lake Survey Center, 1972). The lake stayed at this level until the wind speed decreased (at 0800 hours on the 14th the wind speed at Toledo was 60 knots and at 1200 hours it was 30 knots). When the force of the wind was unable to hold back the water that had piled up, an inertial surge of water (seiche) from the western to

THE NOVEMBER 1972 STORM ON LAKE ERIE

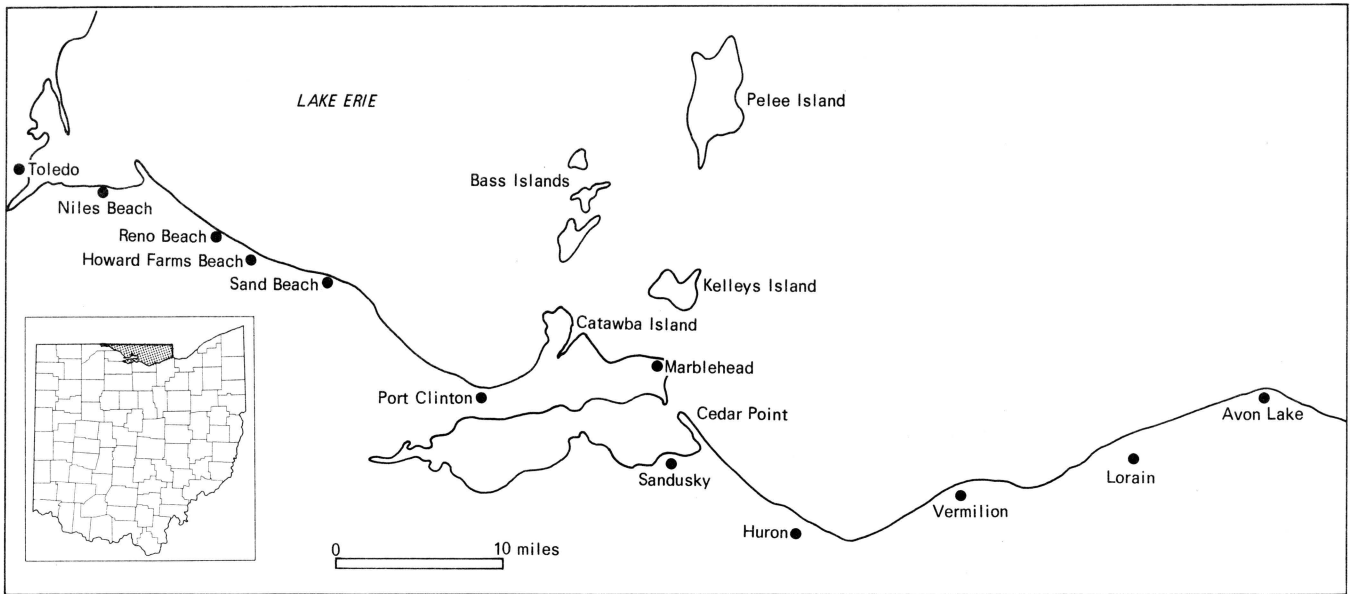


FIGURE 1.—Portion of the south shore of Lake Erie severely damaged by November 1972 storm.

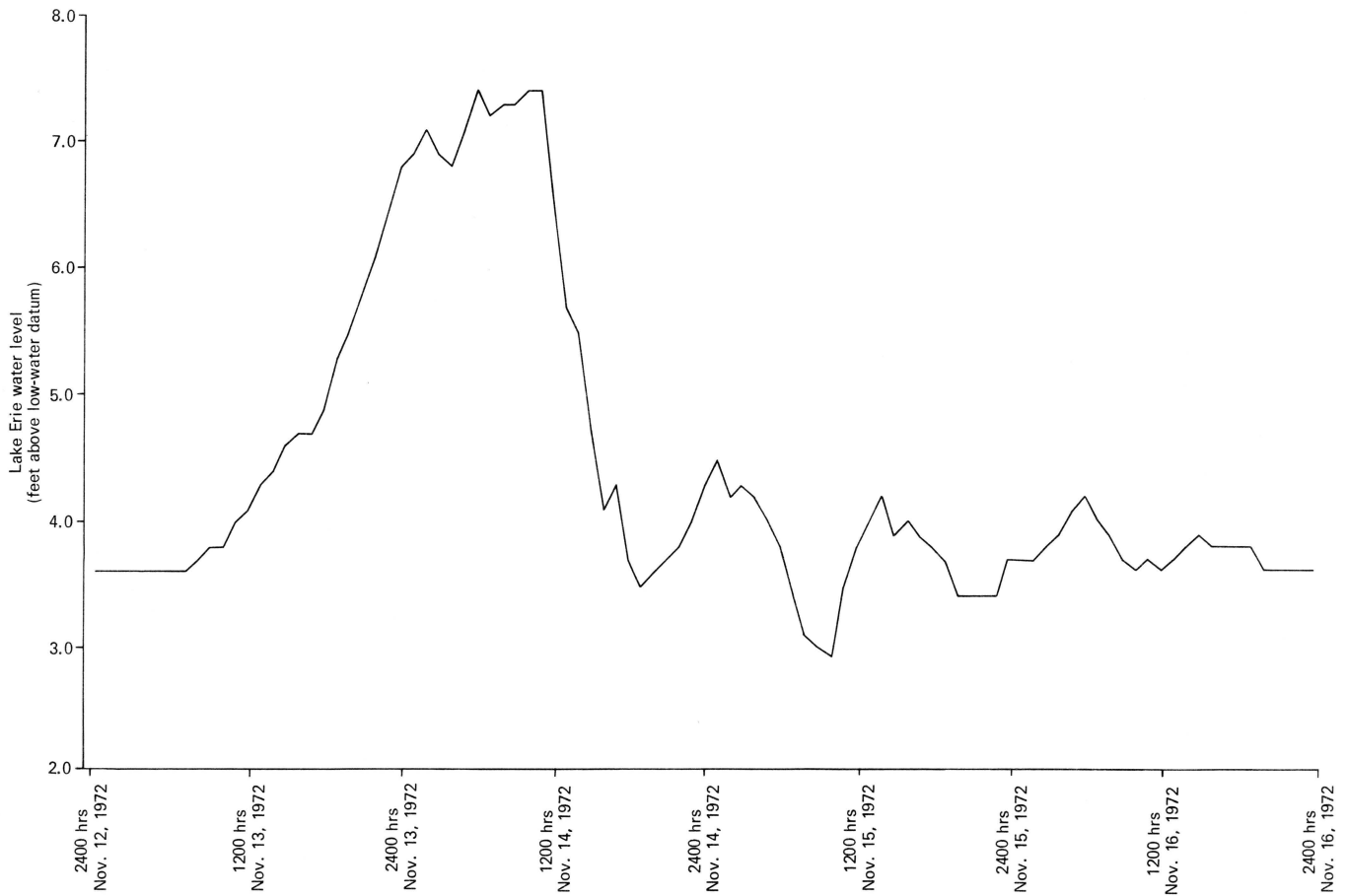


FIGURE 2.—Water-level record during storm at Toledo.

the eastern end of the lake took place. This rapid drop in lake level marked the end of the storm for Lake Erie.

Waves began building on the lake shortly after the wind began to blow. Observations at the Marblehead Coast Guard station show that waves increased in height from 1 foot on the morning of the 13th to 12 feet on the morning of the 14th. Furthermore, wave heights of 4 feet or greater were observed at Marblehead throughout a 34-hour period. Wave direction, in the main, paralleled wind direction. Three principal factors contributed to the high waves: (1) the long fetch (in places over 100 miles), (2) wind duration (more than 2 days), and most importantly (3) wind speed (60 knots).

STORM EFFECTS

The waves and high water forced hundreds of people at the western end of the lake to evacuate their homes. Many of the homes which were built directly on the lake suffered severe structural damage from the waves; in places such as Reno Beach and Howard Farms Beach a few homes were completely demolished.

Other manmade works were badly damaged also or were made unusable by the wave activity. For example, cement blocks, some weighing as much as two hundred pounds, were moved several feet from a protective rip-rap seawall at Niles Beach. Roads at Cedar Point, Marblehead, and Port Clinton were undermined in places when waves eroded the protective beaches, and at Cedar Point and Sand Beach waves carried so much sand over protective dikes, dunes, and seawalls that the roads were covered by up to 3 feet of sand. At East Harbor State Park, Catawba Island, waves overtopped the cement seawall and eroded sand from behind and under the structure, causing sections of it to collapse. Shore erosion was greatly accelerated owing to wave action. In areas such as Sand Beach and Cedar Point the waves cut into sand and clay banks for as much as 10 feet, partially destroying the natural barriers and eroding much valuable land.

Widespread flooding took place where waves and high water breached dikes and structures protecting low-lying areas. State Route 2, near the entrance to Sand Beach, was barely passable more than a day after the storm. The elevation there is about 575 feet. Because most of the land bordering the lake at the western end is clay, the water was unable to percolate downward; in areas like Reno Beach and Howard Farms Beach the ground was covered by water to a depth of several feet for many days.

LAKE LEVEL AND STORM DAMAGE

There have been a number of damaging northeast storms on Lake Erie. The more recent ones took place in July 1943, May 1946, March 1952, April 1966, and

July 1969. However, some of the most damaging storms took place in the middle 1800's. E. L. Moseley (1906), for example, wrote that:

The greatest storms of the past century or those which were most effective because occurring at time of highest water were those of 1857-1862.

He then described the August 1861 storm at Sandusky:

Northeast gales may have been more violent at other times, but this one coming when the water was already high and lasting several days was probably in its effect the greatest storm of the century. East of where the water works are now located it lifted the railroad track from its bed and pushed it in places 20 feet away. At the foot of Columbus Avenue the dock was about a foot lower than now and did not extend so far north. A track ran onto the dock from a turn table south of it. In this storm water covered the dock and a great sea struck two empty cars that had been standing there with such force as to move them along the track and cause them to fall into the turn pit.

Other storms in September 1878, July and August 1879, April 1882, and May 1903, caused extensive shoreline damage. One storm, on January 31, 1881, did not cause extensive damage. Moseley wrote:

January 31, 1881, a gale from the northeast began at 7:30 a.m., reaching its height, 64 miles northeast, at 9:35 a.m., February 1, and ending at 5:30 p.m., "The storm was one of the most severe known in these parts, the wind averaging 42 miles per hour for 18 hours: no extensive damage done." The water that winter was too low to be raised to an extraordinary height even by such a gale.

Moseley felt that storm damage is directly related to the lake level. To test this hypothesis average monthly lake levels were plotted for the storms just mentioned (fig. 3). Eleven of the 13 damaging storms occurred when lake level was above its long-term average of 570.4 feet (U.S. Army Engineer Division, 1965, pl. 2). The two most damaging storms of recent vintage (the March 1952 storm and the November 1972 storm) took place when the lake level was 2 to 3 feet above its long-term average, whereas the 1881 storm occurred when the lake was below its long-term average level.

In summary, the most damaging northeast storms on Lake Erie appear to take place during high lake levels. Furthermore, there is a sound physical basis for this: not only is the lake closer to flood stage, but the deeper water allows waves to build to greater heights and to break nearer the shore.

LAKE-LEVEL CHANGES

Man has been fortunate that most of the severe storms on the lake take place during seasonal periods of low water, roughly October to April; however, when lake levels are high during these months, as they were

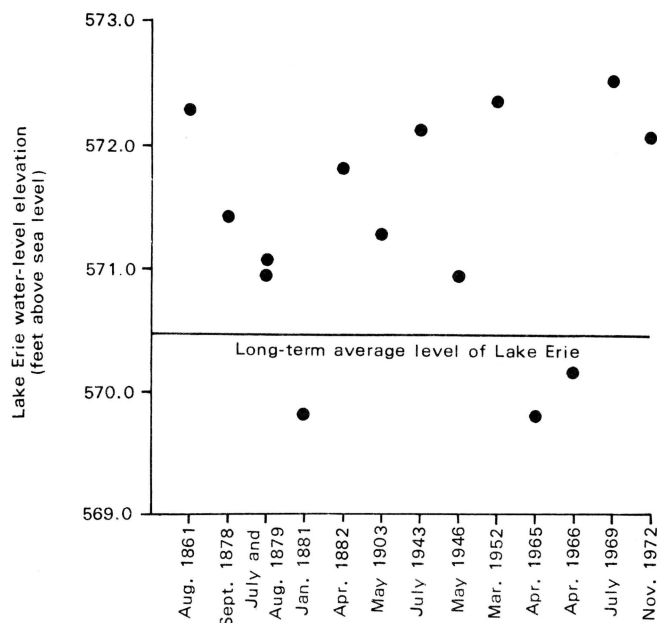


FIGURE 3.—Average monthly lake levels during the months in which severe northeast storms took place on Lake Erie.

this past November, the storms can cause extensive damage. In this section I am going to consider briefly some of the natural and man-related factors that could have an influence on the level of the lake for prolonged periods of time (several years).

Natural causes

Precipitation (and associated climatic conditions), in both the Lake Erie drainage basin and the upper lakes (Superior, Michigan, Huron) drainage basin, appears to be the principal cause of natural water-level fluctuations in Lake Erie. Processes contributing to a rise in lake level include direct precipitation on the lake surface, runoff from adjacent land surfaces and tributaries, and inflow from the Detroit River; processes contributing to a lowering of lake level include evaporation and outflow through the Niagara River. The influence of ground water on the lake level is not well documented. However, the direct relationship between precipitation and ground-water level (Gilluly and others, 1958, p. 254) suggests that the influence of ground water on the lake level is related directly to precipitation.

The relationship between lake level and precipitation during the period 1959 through 1972 can be seen by comparing table 1 and figure 4; the data were supplied by the Lake Survey Center, NOAA, U.S. Department of Commerce. Note that even though the differences in rainfall are only on the order of a few inches the two periods of rising lake level coincide with above-average precipitation, and the period of falling lake level coincides with below-average precipitation.

Another natural cause, although an irreversible one, contributing to a change in the level of Lake Erie is crustal movement. In certain parts of North America, such as the Great Lakes region, the earth is still rebounding from the tremendous pressure exerted by the glaciers. This movement, which has raised the north side of Lake Erie relative to its south side, has caused the lake level on the south side to rise an estimated 0.37 foot/century (U.S. Army Engineer Division, 1965, Appendix A, p. A-19).

Man-related causes

There are several manmade projects that have modified the inflow and outflow of the Great Lakes. The most significant include the following (U.S. Army Engineer Division, 1965, Appendix A, p. A-23):

- (1) Long Lake and Ogoki diversions into Lake Superior, in Canada.
- (2) Regulatory works in the St. Marys River.
- (3) Diversion out of the Lake Michigan Basin at Chicago.
- (4) Channel changes in the St. Clair-Detroit River system.
- (5) Diversion via the Welland Canal, bypassing the Niagara River.
- (6) The Gut Dam and Channel changes in the St. Lawrence River.
- (7) Regulatory works in the St. Lawrence River.

Projects 1 to 5 could affect the level of Lake Erie; whereas projects 6 and 7 cannot. Effects of projects 1, 3, and 5 on Lake Michigan-Huron and Lake Erie were evaluated by the Lake Survey (U.S. Army Engineer District, Lake Survey, 1964):

Lake	Rise(+) or fall(-) effect (inches)		
	Long Lake-Ogoki diversion	Chicago diversion	Welland Canal diversion
Michigan-Huron	+4½	-2¾	-1¼
Erie	+2¾	-1⅝	-3⅞

These calculations suggest that Lake Erie could be lowered 2¾ inches by the combined effects of the diversions (projects 1, 3, and 5).

There have been several channel changes in the St. Clair-Detroit River system (project 4). The Michigan-Huron lake level was lowered about 0.6 foot by channel changes prior to 1927 (U.S. Army Engineer Division, 1965, Appendix A, p. A-24). Subsequent dredging for 25- and 27-foot navigation projects has lowered the level of Lake Michigan-Huron farther yet:

Recent studies indicate that by the end of 1968, Lake Michigan-Huron had nearly reached equilibrium and the net effect of the 25 and 27-foot projects was that the level of Lake Michigan-Huron was lowered by 0.59 foot. To date this value has not been coordinated with the responsible Federal Canadian agency and may be subject to revision (Ernest Graves, March 1973, written communication).

TABLE 1.—Average annual precipitation in inches

Basin	1900-1971	1959-1961	1962-1964	1965-1972
Great Lakes	31.50	33.13	28.60	33.62
Lake Erie	33.75	34.38	28.61	35.07

Therefore Lake Michigan-Huron has been lowered an estimated 1.19 feet by the St. Clair-Detroit River channel changes; this increased discharge from the St. Clair-Detroit River system has probably caused the level of Lake Erie to rise at least several inches. Even excluding a discussion of the regulatory works in the St. Marys River (project 2), it is obvious that manmade projects have affected the level of Lake Erie.

LAKE ERIE FORECAST

Storms, especially during periods of high lake level, will continue to damage the Ohio shore. Even between storms, the lake shore is undergoing continuous erosion; valuable irreplaceable land is being lost to the lake. And this is not a new problem: as early as 1838, from 165 to 330 feet of land had been lost to the lake east of Cleveland within a 32-year period (Whittlesey, 1838, p. 53). Shore erosion of this magnitude is common today (Ohio Division of Shore Erosion, 1961).

What can be done to help correct the present situation? There are at least three possible courses of action: (1) lake-level regulation, (2) shore erosion and flood-control measures, and (3) shore zoning.

Lake-level regulation

Since the November storm lake-level regulation has been the most publicized solution for Lake Erie's

problems. This idea was also in vogue following the storms in the spring of 1952 and was one of the primary purposes of a comprehensive report published by the U.S. Army Engineer Division (1965). Because regulation of the level of Lake Erie would reduce storm damage and reduce the rate of erosion (and the rate of lake sedimentation), why hasn't it been attempted? There are at least two reasons. First, regulation of Lake Erie would be costly. For example, a preliminary cost estimate for regulatory works in the upper Niagara River was over 100 million dollars (U.S. Army Engineer Division, 1965, Appendix F, p. F-24). Second, lake regulation is a complex engineering problem. Planning and design, for example, are complicated by the variability of Great Lakes weather and the intimate hydraulic relationships among Lakes Michigan-Huron, Erie, and Ontario. Moreover, many political and economic concerns have an interest in the water levels of the Great Lakes.

Shore erosion and flood-control measures

The best protection against shore erosion caused by storm waves is a broad beach and/or a rocky shore. A beach causes the waves to break lakeward of the shoreline, whereas a rocky shore, like that at Marblehead Peninsula or the point at Avon Lake, is resistant to erosion caused by storm waves. Along other shores severe wave erosion will take place during storms unless preventive measures are taken. Two basic types of structures for preventing and/or limiting shore erosion caused by storm waves are: (1) structures such as seawalls and breakwaters that protect the shore by blocking the waves, and (2) structures such as groins and jetties that protect the shore by trapping sand on the updrift side of the structure, causing the buildup of a beach. These structures are expensive to con-

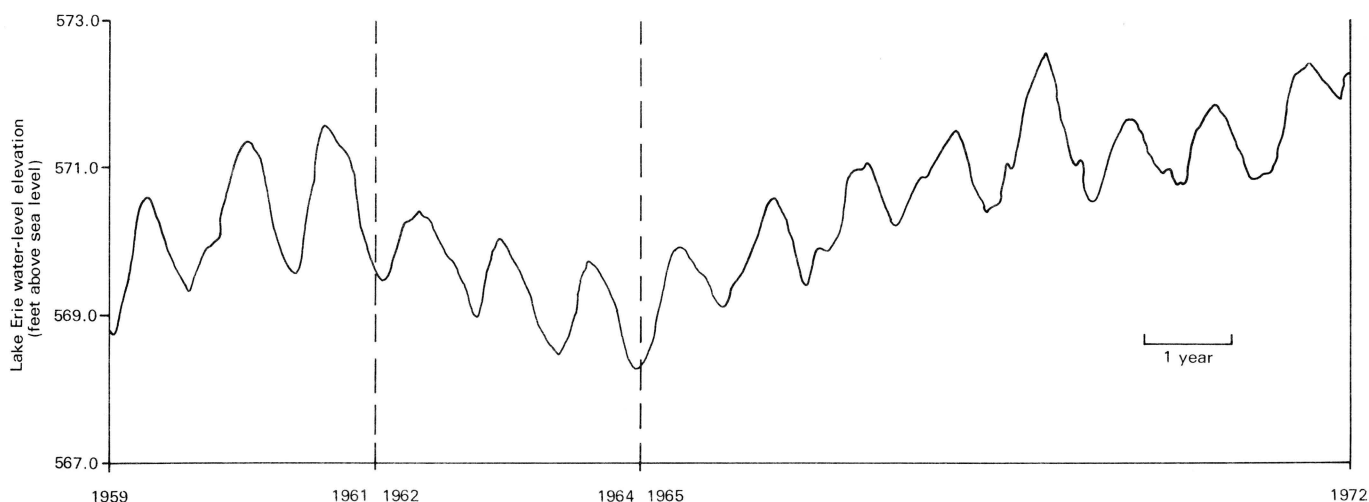


FIGURE 4.—Plot of Lake Erie water-level elevation vs. time for the period 1959 through 1972.

struct and maintain, and their effects on the adjacent shore are not well known. The jetties, for example, trap sand that would normally be transported farther along the shore, thereby depriving other areas of sand and in places causing accelerated erosion (Hartley, 1964). Seawalls and breakwaters, on the other hand, commonly cause changes in the offshore profile; moreover, seawalls, in preventing erosion, keep sediment from entering the littoral drift system.

Dikes such as those in the Reno Beach-Howard Farms Beach area have been relatively successful in preventing the flooding of low-lying areas. However, dikes built directly on the shoreline must be sturdy enough to withstand the impact of storm waves. For example, the substantial outer dike at the Reno Beach-Howard Farms Beach area was breached during the November storm; this dike has subsequently been re-

paired and strengthened by the U.S. Army Corps of Engineers, Detroit.

Shore zoning

New zoning regulations to restrict or prohibit construction along the Ohio shore of Lake Erie would greatly reduce the amount of storm damage to property and roads. The shore, however, would still be subject to erosion, especially during high-water periods.

Discussion

In conclusion, all of the listed corrective measures have some merit. What is needed now is a comprehensive and coordinated plan of action so that we can begin to remedy the shore erosion and flooding problems along the Ohio shore of Lake Erie.

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APPENDIX A - WEATHER

U.S. Coast Guard Station
Cleveland HarborU.S. Coast Guard Station
Lorain

Date and time (hrs)	Wind direction	Wind speed (knots)	Barometric pressure (in)	Wave height (ft)
11/12/72				
0100	WSW	06		
0300	SSW	04		
0500	SSW	05		
0700	SSW	06		
0900	S	06		
1100	S	03		
1300	SSW	03		
1500	N	05		
1700	NW	04		
1900	NNW	07		
2100	NNE	07		
2300	NNE	08		
11/13/72				
0100	S	05		
0300	SE	06		
0500	S	05		
0700	N	04		
0900	ENE	07		
1100	ENE	10		
1300	NE	10		
1500	E	10		
1700	NE	08		
1900	ENE	12		
2100	ENE	09		
2300	ENE	11		
11/14/72				
0100	ENE	20		
0300	ENE	15		
0500	ENE	25		
0700	E	15		
0900	ENE	18		
1100	ENE	18		
1300	ENE	20		
1500	NE	30		
1700	NNE	25-35		
1900	ENE	25		
2100	NNE	26		
2300	NNE	25		
11/15/72				
0100	NNE	20		
0300	N	18		
0500	N	17		
0700	N	20		
0900	NNE	20		
1100	N	20		
1300	N	16		
1500	N	11		
1700	NNE	09		
1900	NNE	08		
2100	NNE	07		
2300	NNE	05		

Date and time (hrs)	Wind direction ¹	Wind speed ¹ (knots)	Barometric pressure (in)	Wave height (ft)
11/12/72				
0100	SSW	7	30.19	
0300	SSW	5	30.20	
0500	S	6	30.19	
0700	SSW	5	30.20	
0900	S	7	30.22	
1100	S	7	30.52	
1300	W	8	30.20	
1500	NNW	9	30.19	
1700	NW	5	30.20	
1900	NNW	8	30.20	
2100	NNW	7	30.20	
2300	NNE	7	30.20	
11/13/72				
0100	ESE	4	30.20	
0300	ESE	2	30.20	
0500	S	5	30.20	
0700	N	4	30.17	
0900	ENE	10	30.19	
1100	NE	14	30.19	
1300	NE	14	30.13	
1500	ENE	17	30.09	
1700	ENE	16	30.06	
1900	ENE	19	29.99	
2100	ENE	17	29.98	
2300	ENE	25	29.86	
11/14/72				
0100	ENE	30	29.29	
0300	NE	28	29.72	
0500	NE	28	29.70	
0700	NE	35	29.64	
0900	NE	24	29.64	
1100	NE	26	29.65	
1300	NNE	24	29.63	
1500	N	30	29.68	
1700	NNW	26	29.79	
1900	N	29	29.82	
2100	N	25	29.89	
2300	N	21	29.93	
11/15/72				
0100	Variable	23	29.96	
0300	Variable	19	30.01	
0500	Variable	21	30.04	
0700	Variable	19	30.05	
0900	N	12	30.01	
1100	NW	16	30.19	
1300	N	12	30.16	
1500	NNE	9	30.18	
1700	N	9	30.18	
1900	N	10	30.20	
2100	NW	8	30.20	
2300	NE	8	30.21	
11/16/72				
0100	NE	7	30.20	
0300	NNW	7	30.24	
0500	SSE	6	30.20	
0700	E	3	30.20	
0900	SE	7	30.20	
1100	SE	9	30.19	
1300	ESE	9	30.14	
1500	NE	7	30.11	
1700	ENE	10	30.06	
1900	ENE	6	30.06	
2100	SE	9	30.04	
2300	ENE	7	30.02	

¹Measurements obtained from the Lorain sewage and treatment plant anemometer.

THE NOVEMBER 1972 STORM ON LAKE ERIE

U.S. Coast Guard Station
Marblehead

Date and time (hrs)	Wind direction	Wind speed (knots)	Barometric pressure (in)	Wave height (ft)
11/12/72				
0100	SW	5	30.22	Calm
0300	SW	5	30.24	Calm
0500	SW	4	30.24	Calm
0700	SSW	6	30.24	Calm
0900	SW	7	30.24	Calm
1100	SW	8	30.26	Calm
1300	SW	6	30.26	Calm
1500	WNW	6	30.24	Calm
1700	NW	8	30.24	Calm
1900	NW	4	30.24	Calm
2100	N	4	30.23	Calm
2300	NNE	5	30.23	Calm
11/13/72				
0100	NNW	3	30.22	Calm
0300	NNE	7	30.21	Calm
0500	N	6	30.26	Calm
0700	NNE	10	30.22	Calm
0900	NE	12	30.23	1
1100	NE	16	30.23	2
1300	NE	17	30.17	2
1500	ENE	17	30.13	3
1700	NE	15	30.11	3
1900	NE	25	30.07	3
2100	NE	28	30.00	4
2300	ENE	30	29.86	8
11/14/72				
0100	ENE	30	29.80	8
0300	ENE	30	29.80	9
0500	NE	38	29.76	9
0700	NE	35	29.72	9
0900	NE	30	29.72	9
1100	NNE	30	29.66	12NE
1300	NNE	27	29.66	8
1500	N	27	29.78	4-6
1700	N	27	29.80	4-6
1900	N	27	29.80	4-6
2100	NNE	25	29.90	6
2300	NNE	20	29.90	5
11/15/72				
0100	N	18	29.90	5NNE
0300	N	20	29.90	5NNE
0500	N	20	29.90	5NNE
0700	NNW	25	30.10	5N
0900	N	15	30.10	1-2
1100	N	12	30.10	1-2
1300	N	12	30.10	2
1500	N	8	30.10	1-2
1700	N	9	30.22	1
1900	NW	8	30.24	1
2100	NW	8	30.25	Calm
2300	N	5	30.24	Calm
11/16/72				
0100	NE	5	30.23	Calm
0300	W	5	30.23	Calm
0500	SW	5	30.23	Calm
0700	SW	3	30.22	Calm
0900	SW	3	30.22	Calm
1100	SSE	10	30.19	Calm
1300	E	7	30.16	Calm
1500	E	7	30.12	Calm
1700	E	8	30.10	Calm
1900	E	8	30.08	Calm
2100	E	6	30.08	Calm
2300	E	6	30.06	Calm

U.S. Coast Guard Station
Toledo

Date and time (hrs)	Wind direction	Wind speed (knots)	Barometric pressure (in)	Wave height (ft)
11/12/72				
0000	SSW	8	29.4	
0400	SW	8	29.4	
0800	SW	8	29.4	
1200	SSW	3	29.4	
1600	SSW	4	29.3	
2000	SSW	2	29.3	
11/13/72				
0000	Calm	Calm	29.4	
0400	N	8	29.4	
0800	NNE	13	29.4	
1200	NE	23	29.3	
1600	NE	23	29.4	
2000	NE	40	29.3	
11/14/72				
0000	NE	30	29.0	
0400	NE	25	28.9	
0800	N	60	29.9	
1200	NNW	30	29.0	
1600	N	23	29.1	
2000	N	25	29.2	
11/15/72				
0000	NNE	22	29.1	
0400	NNE	20	29.6	
0800	N	13	29.4	
1200	NE	6	29.5	
1600	W	5	29.5	
2000	WNW	5	29.4	
11/16/72				
0000	NW	5	29.4	
0400	S	5	29.4	
0800	NNW	4	29.4	
1200	SE	5	29.3	
1600	N	6	29.3	
2000	NE	7	29.3	

APPENDIX B - LAKE ERIE WATER-LEVEL RECORDS

Corps of Engineers Gage
Buffalo Harbor, Buffalo, N. Y.

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0100	3.48	3.30	1.67	2.60	3.42
0200	3.45	3.30	1.34	2.87	3.45
0300	3.43	3.40	0.80	2.86	3.33
0400	3.29	3.41	0.78	3.10	3.28
0500	3.31	3.36	0.28	3.51	3.22
0600	3.29	3.37	0.08	3.25	3.31
0700	3.26	3.40	0.10	3.43	3.38
0800	3.32	3.30	0.21	3.57	3.43
0900	3.35	3.25	0.00	3.79	3.45
1000	3.30	3.27	-0.91	3.53	3.46
1100	3.32	3.22	0.42	3.50	3.51
1200	3.32	3.10	0.17	3.48	3.48
1300	3.37	3.10	0.61	3.40	3.50
1400	3.26	2.98	0.58	3.32	3.46
1500	3.40	2.86	1.52	3.28	3.50
1600	3.31	2.88	1.84	3.37	3.31
1700	3.32	3.04	2.03	3.37	3.26
1800	3.40	2.80	2.28	3.32	3.17
1900	3.40	2.42	2.90	3.43	3.14
2000	3.49	2.40	2.69	3.68	3.20
2100	3.32	2.43	3.01	3.80	3.21
2200	3.35	2.48	2.98	3.72	3.20
2300	3.28	2.27	2.70	3.76	3.15
2400	3.33	1.93	2.40	3.56	3.23

Corps of Engineers Gage
Bayview Station, Toledo

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0100	3.4	3.6	6.9	4.5	3.7
0200	3.4	3.6	7.1	4.2	3.7
0300	3.5	3.6	6.9	4.3	3.8
0400	3.5	3.6	6.8	4.2	3.9
0500	3.5	3.6	7.1	4.0	4.1
0600	3.5	3.6	7.4	3.8	4.2
0700	3.5	3.6	7.2	3.4	4.0
0800	3.5	3.7	7.3	3.1	3.9
0900	3.5	3.8	7.3	3.0	3.7
1000	3.5	3.8	7.4	2.9	3.6
1100	3.5	3.9	7.4	3.5	3.7
1200	3.6	4.1	6.6	3.8	3.6
1300	3.6	4.3	5.7	4.0	3.7
1400	3.5	4.4	5.5	4.2	3.8
1500	3.5	4.6	4.7	3.9	3.9
1600	3.5	4.7	4.1	4.0	3.8
1700	3.5	4.7	4.3	3.9	3.8
1800	3.5	4.9	3.7	3.8	3.8
1900	3.5	5.3	3.5	3.7	3.8
2000	3.5	5.5	3.6	3.4	3.6
2100	3.5	5.8	3.7	3.4	3.6
2200	3.6	6.1	3.8	3.4	3.6
2300	3.6	6.5	4.0	3.4	3.6
2400	3.6	6.8	4.3	3.7	3.6

THE NOVEMBER 1972 STORM ON LAKE ERIE

Ohio Division of Geological Survey Gage
Lorain

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0000	3.41	3.46	4.22	4.00	3.47
0100	3.41	3.48	4.38	4.06	3.42
0200	3.42	3.47	4.58	4.07	3.54
0300	3.46	3.49	4.80	4.13	3.62
0400	3.47	3.49	NR ¹	4.10	3.73
0500	3.44	3.47	NR	4.05	3.77
0600	3.44	3.46	NR	3.92	3.72
0700	3.45	3.47	NR	3.70	3.65
0800	3.46	3.48	NR	3.68	3.75
0900	3.47	3.51	NR	3.69	3.72
1000	3.45	3.52	NR	3.68	3.66
1100	3.44	3.58	NR	3.74	3.62
1200	3.43	3.59	NR	3.65	3.54
1300	3.44	3.63	NR	3.56	3.53
1400	3.46	3.65	NR	3.68	3.59
1500	3.47	3.64	NR	3.75	3.63
1600	3.47	3.71	4.77	3.86	3.62
1700	3.46	3.77	4.65	3.89	3.77
1800	3.44	3.76	4.28	3.76	3.69
1900	3.45	3.86	4.31	3.72	3.78
2000	3.44	3.89	3.98	3.65	3.82
2100	3.43	3.86	3.87	3.62	3.83
2200	3.46	3.91	3.93	3.57	3.77
2300	3.46	4.02	4.12	3.54	3.79
2400	3.46	4.22	4.00	3.47	3.71

¹No record.Ohio Division of Geological Survey Gage
Port Clinton

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)			
	11/13/72	11/14/72	11/15/72	11/16/72
0000	NR ¹	5.74	4.86	3.91
0100	NR	5.97	5.02	3.99
0200	NR	6.02	4.98	4.04
0300	NR	6.17	4.92	4.16
0400	NR	6.14	4.86	4.24
0500	NR	6.14	4.66	4.22
0600	NR	6.24	4.60	4.27
0700	NR	6.38	4.36	4.29
0800	3.72	6.45	4.09	4.10
0900	3.87	6.45	3.99	4.09
1000	3.92	6.45	4.00	3.98
1100	3.97	6.48 ²	3.97	3.88
1200	4.06	6.48	4.20	3.96
1300	4.11	6.40	4.29	3.94
1400	4.25	6.08	4.28	4.00
1500	4.38	5.75	4.44	4.12
1600	4.39	5.24	4.36	4.18
1700	4.50	5.21	4.28	4.23
1800	4.51	5.07	4.23	4.28
1900	4.54	4.95	4.10	4.24
2000	4.57	4.80	4.00	4.23
2100	4.72	4.75	3.92	4.22
2200	5.03	4.81	3.88	4.19
2300	5.28	4.92	3.93	4.16
2400	5.74	4.86	3.91	4.14

¹No record.²Upper recording limit.

Ohio Division of Geological Survey Gage
Put-in-Bay, South Bass Island.

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)		
	11/12/72	11/13/72	11/14/72
0000	3.47	3.54	5.90
0100	3.48	3.55	5.95
0200	3.52	3.54	6.03 ¹
0300	3.51	3.55	5.95
0400	3.52	3.55	5.77
0500	3.52	3.54	5.95
0600	3.48	3.56	NR ²
0700	3.48	3.55	NR
0800	3.51	3.63	NR
0900	3.52	3.70	NR
1000	3.53	3.73	NR
1100	3.54	3.83	NR
1200	3.52	3.87	NR
1300	3.50	3.98	NR
1400	3.47	4.13	NR
1500	3.44	4.12	NR
1600	3.45	4.13	NR
1700	3.46	4.21	NR
1800	3.47	4.22	NR
1900	3.50	4.35	NR
2000	3.52	4.45	NR
2100	3.53	4.80	NR
2200	3.55	5.04	NR
2300	3.54	5.42	NR
2400	3.54	5.90	NR

Ohio Division of Geological Survey Gage
Rossford

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0000	3.40	3.67	6.50	4.22	3.87
0100	3.45	3.65	7.07	4.42	3.92
0200	3.54	3.64	7.36	4.92	4.06
0300	3.58	3.64	7.58	4.84	4.12
0400	3.57	3.63	7.33	4.57	4.16
0500	3.57	3.65	7.11	4.58	4.25
0600	3.62	3.69	7.12	4.54	4.44
0700	3.64	3.72	7.70	4.31	4.58
0800	3.62	3.73	7.75	4.12	4.57
0900	3.56	3.75	7.67	3.67	4.49
1000	3.55	3.85	7.66	3.54	4.33
1100	3.57	3.95	7.68	3.38	4.13
1200	3.65	4.03	7.67	3.47	4.12
1300	3.69	4.17	7.30	3.85	4.14
1400	3.68	4.47	6.44	4.15	4.11
1500	3.58	4.99	5.69	4.37	4.15
1600	3.52	4.90	5.22	4.03	4.24
1700	3.50	4.83	4.78	4.43	4.38
1800	3.50	4.90	4.44	4.40	4.57
1900	3.56	5.17	4.35	4.38	4.64
2000	3.60	5.59	4.06	4.26	4.63
2100	3.61	5.88	3.78	4.09	4.63
2200	3.62	5.95	3.97	3.90	4.53
2300	3.66	6.10	4.08	3.86	4.46
2400	3.67	6.50	4.22	3.87	4.48

¹Upper recording limit.²No record.

THE NOVEMBER 1972 STORM ON LAKE ERIE

Ohio Division of Geological Survey Gage
Sandusky

Time (hrs)	Water level (ft above low-water datum of 568.6 ft)				
	11/12/72	11/13/72	11/14/72	11/15/72	11/16/72
0000	3.49	3.62	5.38	4.46	3.62
0100	3.51	3.65	5.54	4.56	3.65
0200	3.60	3.63	5.63	4.51	3.80
0300	3.60	3.65	5.75	4.55	3.92
0400	3.56	3.64	5.77	4.36	3.93
0500	3.58	3.59	5.78	4.17	3.93
0600	3.58	3.68	5.79	4.08	3.93
0700	3.58	3.70	5.80	3.89	3.96
0800	3.58	3.68	NR ¹	3.83	3.92
0900	3.59	3.72	NR	3.82	3.84
1000	3.56	3.79	NR	3.80	3.78
1100	3.57	3.85	NR	3.76	3.69
1200	3.57	3.87	NR	3.79	3.66
1300	3.57	3.97	NR	3.87	3.77
1400	3.59	4.05	5.76	4.01	3.79
1500	3.57	4.13	5.52	4.03	3.84
1600	3.57	4.16	5.05	4.13	3.94
1700	3.57	4.14	4.90	3.97	3.97
1800	3.56	4.20	4.80	3.88	4.02
1900	3.57	4.35	4.78	3.87	4.07
2000	3.57	4.40	4.61	3.78	4.05
2100	3.57	4.40	4.56	3.69	4.04
2200	3.63	4.82	4.72	3.67	4.00
2300	3.62	5.13	4.55	3.60	3.93
2400	3.62	5.38	4.46	3.62	3.87

¹No record. The water level peaked between 0900 and 1200 hrs at 6.75 ft above low-water datum.