CLEAR TECHNICAL REPORT NO. 316-D

ANALYSIS OF SHORE RECESSION RATES AND BEACH PROCESSES AT THE BASE OF CEDAR POINT, LAKE ERIE, ERIE COUNTY, OHIO

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ANALYSIS OF SHORE RECESSION RATES AND BEACH PROCESSES AT THE BASE OF CEDAR POINT, LAKE ERIE, ERIE COUNTY, OHIO

INTRODUCTION

In about 1914, The Cedar Point Company constructed an entrance road to the Cedar Point sand spit approximately 3000 ft west of Sawmill Creek, near the base of the spit. A roadway (Cedar Point Chaussee) was then built along the spit for about six miles to the northwest to provide access to a lakeside resort and amusement park. Within three years, high lake level storms destroyed a large part of the roadway and required the placement of wooden piling along the eastern 4000 ft of the roadway at the base of the spit (Figure 1). In 1918, this section of the roadway was finally destroyed by storms and had to be abandoned (U.S. Army, Corps of Engineers 1947). A New Entrance Road was then constructed about 6500 ft west of the original entrance road. The New Entrance Road was opened in 1920 and remains in service by virtue of massive shore protection works at its eastern end (Frohman 1969).

In 1942, a federal pumping station was constructed at the lakeward end of the Old Entrance Road. Shore recession continued at a rapid pace. Thus, massive shore protection works have been required to preserve the station. The result is that the station, which once stood on a straight beach, now juts out into the lake over 1000 ft beyond the barrier beach to the west (Figure 2).

The purpose of this report is to document the shoreline changes which have occurred at the base of Cedar Point spit since the original surveys, determine the rates of shore recession, and examine the processes which caused these changes. Based on this analysis, prediction for future changes are provided.

METHODS OF INVESTIGATION

Shoreline Changes

The first nearshore bathymetric surveys of the study area were conducted by the U.S. Army, Corps of Engineers in 1877. This agency repeated selected sounding profiles in 1939 and 1949 (U.S. Army, Corps of Engineers 1953). The Ohio Department of Natural Resources (ODNR), Division of Shore Erosion and Division of Geological Survey also conducted nearshore surveys in 1961 and 1971 (Herdendorf 1971, Carter and Guy 1980). A localized study of the bottom depths near the base of Cedar Point was conducted by the Ohio State University, Center for Lake Erie Area Research in 1972 before and after a major November storm (Herdendorf 1972). A report on the effects of this storm was also prepared by the Division of Geological Survey (Carter 1973). The results of all these investigations were analyzed to determine the magnitude of shoreline change and the rates of beach recession.

Because the most recent published report (Carter and Guy 1980) did not consider changes since 1973, a field investigation was conducted on June 7, 1987. The general configuration of the barrier beach west of the Old Entrance Road was mapped, the position of the beach in relationship to the NASA pumping station was measured, and selected depth soundings were made between the pumping station and the eastern end of the Cedar Point Chaussee.

Storm Events

Because the most serious episodes of rapid shore recession or evulsion on Lake Erie area are associated with high-water storm events (Carter 1973, p.3), a documentation of the number and periodicity of these events can be instructive in the analysis of shoreline changes. To develop a chronology of storm events, water level gauging records maintained by the U.S. Army, Corps of Engineers for Toledo, Ohio were analyzed. For the 50-year period, 1936-1986, each storm which produced a water level rise to an elevation of 6.0 ft (or greater) above Low Water Datum was catalogued. The monthly stillwater level for the month in which the storm occurred was then subtracted from the maximum lake elevation during the storm to obtain the maximum height of the storm surge. An analysis of water levels at Marblehead indicated that northeast storms would produce a storm surge height of approximately 50% of that recorded at Toledo for the base of Cedar Point. This relationship was used to project likely water levels for Cedar Point for each storm observed at Toledo.

RESULTS OF INVESTIGATION

Shoreline Changes

The shoreline west of Sawmill Creek is actively receding at an average rate of 10-15 ft/yr as determined by the Ohio Department of Natural Resources, Division of Shore Erosion (Hartley 1961). The Division of Geological Survey attributes most of this loss to the existence of federally-owned breakwaters at Huron which project 3,200 ft into the lake and effectively stop the movement of beach material in the littoral zone (Hartley 1964). As a result, the shore west of Huron is starved of sand which normally moves from east to west along this reach of the Lake Erie shoreline. West of the beach-poor area, the Cedar Point spit begins and sand is somewhat more plentiful on the shore although the beaches are receding at a very rapid rate.

Surveys by the U.S. Army, Corps of Engineers (1953) showed that prior to the construction of the Huron harbor structures the rate of shore loss was slow (1.5 ft/yr, 1877-1939) as compared to the extremely rapid rate (20 ft/yr) for the period 1939-1949 (Table 1 and Figure 3). The final 1200 ft extension of the Huron west jetty was completed in 1935 (Carter and Guy 1980).

The results of an analysis of repetitive aerial photograph surveys of the base of Cedar Point by the Division of Geological Survey for the period 1937-1973, show that the unprotected portions of the shoreline were rapidly receding (Carter and Guy 1980). For 3000 ft east of the Old Entrance Road and 4500 ft to the west, the shore recession rate was 7-11 ft/yr (Table 2 and Figure 4).

Additional studies by the Division of Geological Survey showed that during the period 1961 to 1970, a period of relatively low lake levels, the beach approximately 1000 ft west of Sawmill Creek was receding into the Sandusky Bay marshes at a rate of 7 ft/yr (Herdendorf 1971). High lake levels in 1972 greatly increased this rate. Unpublished studies by the Ohio State University, Center for Lake Erie Area Research showed that in one storm alone (13-14 November 1972) approximately 50 ft of shore was lost between Sawmill Creek and the Old Entrance Road to Cedar Point (Herdendorf 1972).

Storm Events

During high-water storm events lake level can rise to elevations between 4 to 7 ft above Low Water Datum (Chart Depth). Northeast storms are responsible for the greatest water level rise, highest wave heights and thus, the highest shore recession rates. In the past 50 years (Table 3) at least 61 such events have occurred. The Ohio Division of Geological Survey has compiled a list of severe northeast storms on Lake Erie during the period 1861 to 1972 (Carter 1973):

August 1861	April 1882	April 1965
July 1878	May 1903	April 1966
September 1878	July 1943	July 1969
August 1879	May 1946	November 1972
January 1881	March 1952	

No criteria for judging a storm as "severe" was provided in the report, but the author observed that 11 of the 14 damaging storms occurred when the lake was above its long-term average of 570.4 ft (1.8 ft above LWD).

One particular destructive event (13-14 November 1972) has been especially well documented for the base of Cedar Point. In May 1972, three offshore depth profiles were made with a recording fathometer between Sawmill Creek and the Old Entrance Road. These were repeated in November, following the high water storm. Profiles line 0+00 was located near the west bank of Sawmill Creek, profile line 4+00 was located 40 ft to the west at a swimming beach, and profile line 8+00 was located 800 ft west of the creek, within a coastal woodlot.

The results of the three echo sounder profiles from the beach out to 300 ft offshore are shown graphically on Figures 5-7 and are summarized in Table 4. The average area loss (vertical plane) from the shore out to 300 ft was 291 sq ft, which if converted to the volume of loss for the 800 ft stretch of beach equals 8,622 cu yds. If this value is projected for the entire 3200 ft-long beach that then existed between Sawmill Creek and the NASA pumping station, the total volume of loss during the storm was nearly 35,000 cu yds.

The amount of horizontal shore recession was nearly 50 ft near the mouth of Sawmill Creek and 13-15 ft for the more westerly profiles. This yields an average retreat distance of 25.3 ft for the storm. A visual inspection of the retreat near the NASA pumping station indicated that shore moved landward at least as much as the shore closer to the creek mouth. Thus, the 25 ft average horizontal loss appeared to be a reasonable estimate for the entire 3200 ft reach of shore. This would equate to a loss of 1.86 acres of shore.

Carter, et al. (1981) provide an excellent summary of shoreline changes at the base of Cedar Point spit during the period 1972 to 1980. Their account of shore processes following the major breaching event in November 1972 is presented below:

> "The spit has undergone significant changes in the past decade. In November 1972 the spit was breached near the east entrance road about 1.2 miles west of the water intake. Since that time the spit, in contrast to the newly formed barrier island to the west, has receded landward, with the rate of recession increasing toward the tip of the spit. The average rate of recession from 1973 to 1980 has been 85 ft/yr at the tip of the spit and 6.5 ft/yr at the landward end of the spit adjacent to the pump station. At the same time the spit has lengthened and become narrower as sand is both washed over and transported along the spit. The most obvious explanation for the accelerated recession in the 1970s has been the combination of high lake level and northeast storms, however, a likely, more basic underlying reason is a decreased sand supply.

The Huron jetties, by trapping and/or modifying the net longshore transport of sand from east to west, have starved the shore to the west, which includes the Cedar Point spit-barrier. As sand west of the structures has been gradually but inexorably transported west away from the structures, the shore has become subjected to greater wave energy. Manmade structures built to protect the shore have exacerbated the overall problem by acting as local barriers (such as the seawall surrounding the NASA pump station) as well as by protecting the shore and thus reducing the quantity of sand entering the longshore-transport system. Presumably, as sand is transported farther to the west, more and more of Cedar Point will have to be protected to offset the loss of sand.

The Division of Natural Areas and Preserves, which oversees the marsh, has an interesting management question that has both economic and ecologic ramifications. Options include stabilizing the existing spit, rebuilding the spit to its former position in line with the barrier, and leaving the spit alone. We feel that because of the small amount of sand in the littoral system, it is unlikely that the barrier will build lakeward, even during a period of low lake level. Thus the spit could remain in its present position in the short term but over the long term will likely migrate farther landward, reducing the area of marsh behind it and eventually becoming an embayment of the lake. To stabilize the existing spit without manmade structures will probably require at least beach nourishment, possibly with sand trapped by the Cedar Point jetty to the west and/or sand trapped by the Huron jetty to the east."

Moseley (1905) is the first investigator to describe the recession processes active at the base of Cedar Point spit. In 1904, he noted the spit was only 30-60 ft wide near Sawmill Creek, and for the next 5000 ft ranged from 50 to 100 ft. He found that in a number of places the lake had washed over the sand spit and in the marsh. As a result the shore of the spit facing the marsh contained numerous projections or alluvial fans and was not an even outline like that of the lake shore. This process of plucking sand (evulsion) from the lake shore and redepositing it in the marsh during storm events appears to be the primary mechanism for shore recession along the base of the spit.

Reconstruction of 1918 Shoreline

The easterly 6000 ft of the Cedar Point roadway was abandoned in 1918 (U.S. Army, Corps of Engineers 1947) due to severe damage from northeast storms. An analysis of early surveys and more recent soundings can permit us to reconstruct the configuration of the 1918 shoreline with reasonable accuracy. During the period 1914 to 1918, high water storms required the placement of wooden piling along the lakeward side of the roadway. Surveys by the Ohio Division of Shore Erosion in 1960-61 (R.P. Hartley and C.E. Herdendorf, unpublished maps and bottom profiles) revealed approximately 4000 ft of submerged piling were still in existence, extending northwesterly from the NASA pumping station (Figure 1). During periods of low water in 1961, the pilings could be seen above the water about 150 ft offshore of the pumping station breakwall and projecting in a line toward the Cedar Point Chaussee at the New Entrance Road.

More recent fathometer profiles by the Ohio Division of Geological Survey confirm the former position of the old Cedar Point roadway between the Old and New Entrance Roads. Carter, et al. (1981) reports that remnants of the old roadbed can be seen on echograms which were run perpendicular to the spit. These lines of evidence allow us to plot the 1918 position of the lakeward shore of the Cedar Point spit as depicted in Figure 1.

The southern or Sandusky Bay shoreline of the spit can also be determined from early surveys. In 1979 the ODNR purchased a 330-acre tract of property known as Sheldon's Marsh. The northeastern boundary of this tract is defined by a 1922 survey which indicated that the property line was positioned 100 ft bayward of the Cedar Point spit. Thus, by plotting the ODNR property line on the same map that showed the wooden piling and measuring 100 ft lakeward of property, a reasonable reconstruction of the Sandusky Bay shore of the Cedar Point Spit can be made.

Figure 1 presents the reconstruction of the 1918-1922 position of the Cedar Point sand spit. Other features contained on this figure include: (1) position of the offshore wooden piling, (2) ODNR property line, (3) 1961 position of sand spit and (4) 1986 position of barrier islands.

Present Condition

The November storm of 1972 was also responsible for breaching the basal portion of the Cedar Point spit about 1200 ft east of the New Entrance Road. By 1973, the open-water breach had widened to 1750 ft (Carter and Guy 1980), effectively creating a second opening into Sandusky Bay. Since that time the beach between the NASA pumping station and the east end of the Chaussee has continued to recede, and migrate landward into Sandusky Bay (Figure 1).

Field studies conducted in June 1987, show that the spit has breached at a number of other locations west of the NASA structure, resulting in an arcuate series of barrier islands rather than the former sand spit which once stretched between the pump station and the Chaussee. The largest opening (about 600 ft) is now located adjacent to the pumping station, while the former 1750 breach at the Chaussee end of this reach of shore has narrowed to about 200 ft. The western end of this reach appears to have now stabilized as evidenced by extensive vegetative cover and the existence of stable inlet features, including sedimentary structure analogous to flood-and ebb-tide deltas. The eastern end of this reach now appears to have the most actively receding shoreline of Cedar Point. The portion of the beach which became detached from the structures protecting the pumping station in 1972 is now approximately 820 ft farther inland. This represents an average recession for this 15 year period of over 50 ft/yr.

CONCLUSIONS

Cedar Point is a 7-mile-long sand spit projecting into Lake Erie from near the mouth of Sawmill Creek and terminating at Moseley Channel, the main entrance to Sandusky Bay. This peninsula forms the northeastern boundary of Sandusky Bay and protects the marshes known as the "east bay" from destruction by direct wave attack.

The basal and eventually the central portions of this spit have experienced severe beach destruction and shoreline recession in the past half century. Evidence from early surveys by the U.S. Army, Corps of Engineers indicated that a marked increase in the rate of recession coincides with the construction of massive harbor structures at Huron. The structures have starved the base of Cedar point of sand needed to replenish the material which is continually being carried to the west by alongshore currents.

In 1964, and again in 1980, the Ohio Geological Survey published reports which documented shore damage in the study area which resulted from the construction of federal breakwaters in Huron (Hartley 1964, Carter and Guy 1980). At the request of the State of Ohio, in 1983, the U.S. Army, Corps of Engineers investigated this situation. In what appears to be a very superficial and self-serving report, the Corps of Engineers (1984) concluded that "although the impoundment of littoral material east of the harbor by the Federal project may have some effect on the westward shore, existing data does not clearly show quantification or definition of an increase in shore erosion due to harbor structures. Only a small portion of the shoreline west of the harbor is not protected by private structures which further negates any impact. Therefore, with no measurable negative impacts of the harbor structures, mitigation is unwarranted." The conclusions in the Corps' report are not supported by the preponderance of data to the contrary.

The recession, and eventual breaching, of the spit west of the NASA pumping station is associated with severe northeast storms, particularly those which occur when the lake stands at high water levels. The past 15 years have been a period of exceptionally high levels. During 1986, nearly every month broke a record for the highest monthly average since gauging of lake levels began in 1860. Correspondingly, the rrecession of the spit base has had the highest rate for this period, over 50 ft/yr. Water level records for the past 15 years show that Cedar Point has experienced at least 42 episodes where storm surges have raised the lake to levels well over 5 ft above Low Water Datum. Rapid, storm induced rises in lake level and the associated wave attack, that reaches much higher on the beach, are the primary agents of destruction which, coupled with sand starvation, have been so devastating to Cedar Point.

REFERENCES

Carter, C.H. 1973. The November 1972 storm on Lake Erie. Ohio Dept. Nat. Resourc., Div. Geological Survey Infor. Circ. 39. 12 pp.

Carter, C.H. and D.E. Guy. 1980. Lake Erie shore erosion and flooding, Erie and Sandusky counties, Ohio: setting, processes, and recession rates from 1877 to 1973. Ohio Dept. Nat. Resourc., Div. Geological Survey Rept. Invest. 115. 130 pp.

Carter, C.H., D.E. Guy and J.A. Fuller. 1981. Coastal geomorphology and geology of the Ohio shore of Lake Erie. Geol. Soc. Am. Annual Meet. Cincinnati, Field Trip Guide No. 7 p. 433-456.

Frohman, C.E. 1969. Cedar Point yesterdays. Ohio Historical Soc. 21 pp.

Hartley, R.P. 1961. Preliminary estimate of erosion or accretion along the Ohio shore of Lake Erie and critical erosion areas. Ohio Dept. Nat. Resourc., Div. Shore Erosion Tech. Rept. 8. 13 pp.

Hartley, R.P. 1964. Effects of large structures on the Ohio shore of Lake Erie. Ohio Dept. Nat. Resourc., Div. Geological Survey Rept. Invest. 53. 30 pp.

Herdendorf, C.E. 1971. Lake Erie shore erosion at the base of Cedar Point, Erie County, Ohio. Ohio Dept. Nat. Res., Div. Geological Survey Research Rept. 10 pp.

Herdendorf, C.E. 1972. Shore erosion at the base of Cedar Point spit resulting from the November 1972 storm. Ohio State Univ., Center for Lake Erie Area Research, Memorandum Rept. 6 pp.

Moseley, E.L. 1905. Formation of Sandusky Bay and Cedar Point. Ohio Acad. Sci. Proc. 4:179-238.

U.S. Army Corps of Engineers. 1947. Inspection of shore lines Lake Erie and Ontario. 4-8 August 1947. Beach Erosion Board, Buffalo District. 39 pp.

U.S. Army Corps of Engineers. 1953. Ohio shore line of lake Erie, Sandusky to Vermilion, Ohio beach erosion control study, Appendix VI. 83rd Congress, 1st Session, House Doc. 32. 61 pp.

U.S. Army Corps of Engineers. 1984. Huron Harbor, Ohio section III study. Termination Rept., Buffalo District. 10 pp.

TABLES

AND

FIGURES

TABLE 1. HISTORIC SHORELINE AND OFFSHORE CHANGES OF CEDAR POINT

Mean Recession for 1877 to 1939 for the Reach from Sawmill Creek to the Amusement Park:

Shoreline		6-ft Depth		12-ft Depth		18-ft Depth	
(62 yrs)	(ft/yr)	(62 yrs)	(ft/yr)	(62 yrs)	(ft/yr)	(62 yrs)	(ft/yr)
95	1.5	153	2.5	78	1.3	86	1.4

Shoreline Changes for 1939 to 1949:

	Recession	
	(10 yrs)	(ft/yr)
1500 ft west of Old Entrance Rd	200	20
2700 ft east of Old Entrance Rd	180	18

Data Source: U.S. Army, Corps of Engineers (1953)

TABLE 2. SHORELINE RECESSION RATE FOR SAWMILL CREEK TO CEDAR PT. CHAUSSEE FOR 1937 - 1973

Distance from Old Entrance Rd		Rate (ft/yr)
west	0- 550	<1 (NASA Pump Sta.)
	550-3350	9-11
	3350-4450	7-9
	4450-6200	breach in barrier beach
	6200-6300	1-3
	6300-6450	<1 (Chaussee)
east	0- 150	7-9
	150- 550	9-11
	550-2050	7-9
	2050-2350	9-11
	2350-2650	7-9
	2650-3000	9-11
	3000-3600	floodplain of Sawmill Ck

Relative Scale	Rate (ft/yr)
very slow	<1
slow	1-3
moderate	3-5
rapid	5-7
very rapid	7-9
extremely rapid	9-11

Data Source: Carter and Guy (1980)

TABLE 3. LAKE ERIE STORM EVENTS (WATER LEVELS GREATER THAN 6.0 FT ABOVE LOW WATER DATUM AT TOLEDO, OHIO) AND PROJECTED WATER LEVELS AT CEDAR POINT, 1936-1986

	Toledo, Ohio			Projections for Cedar Pt	
Date	Max Elev Above LWD	Monthly Mean Stillwater Elev	Storm Surge Ht	Storm Surge Ht	Max Elev Above LWD
			YEAR: 1948		
1 Jan	6.40	1.85	4.55	2.28	4.13
13 Apr	6.10	3.00	3.10	1.55	4.55
			YEAR: 1952		
22 Mar	6.50	3.70	2.80	1.40	5.10
24 Apr	6.10	4.13	1.97	0.99	5.12
30 Jun	6.00	4.18	1.82	0.91	5.09
			YEAR: 1955		
14 May	6.30	2.25	4.05	2.03	4.28
			YEAR: 1961		
14 Jun	6.15	2.87	3.28	1.64	4.51
			YEAR: 1966		
27 Apr	7.07	1.47	5.33	2.67	4.14
			YEAR: 1969		
6 Jul	6.01	4.05	1.96	0.98	5.03
			YEAR: 1972		
6 Apr	6.20	3.45	2.75	1.38	4.83
13-14 Nov	7.40	3.52	3.87	1.94	5.46
			YEAR: 1973		
31 Jan	6.43	3.31	3.12	1.56	4.87
5 Feb	6.00	3.95	2.05	1.03	4.98
17 Mar	6.20	4.31	1.89	0.95	5.26
8-9 Apr	8.07	4.76	3.31	1.66	6.42
27 May	6.13	4.64	1.49	0.75	5.39
29 Oct	6.10	3.50	2.60	1.30	4.80
			YEAR: 1974		
12 Mar	7.10	4.39	2.71	1.36	5.75
28-29 Mar	7.15	4.39	2.76	1.38	5.77
8 Apr	8.27	4.43	3.84	1.92	6.35
8 May	6.59	4.75	1.84	0.92	5.67
19 May	6.10	4.75	1.35	0.68	5.43
23 Jun	6.10	4.65	1.45	0.73	5.38
30 Nov	6.00	2.86	3.14	1.57	4.43
1 Dec	6.90	3.23	3.67	1.84	5.07

TABLE 3. (CONTINUED)

	Toledo, Ohio			Projections for Cedar Pt	
Date	Max Elev Above LWD	Monthly Mean Stillwater Elev	Storm Surge Ht	Storm Surge Ht	Max Elev Above LWD
			YEAR: 1975		
14 Mar	7.92	3.98	3.94	1.97	5.95
2 Apr	6.66	3.95	2.71	1.36	5.31
24-25 Sep	6.64	3.88	2.76	1.38	5.26
17-18 Oct	7.00	3.58	3.42	1.71	5.29
			YEAR: 1976		
1-2 Mar	6.84	4.06	2.78	1.39	5.45
4 Apr	6.20	4.39	1.81	0.91	5.30
24-25 Apr	7.20	4.39	2.81	1.41	5.80
6 May	6.10	4.31	1.79	1.40	5.71
			YEAR: 1977		
29 May	6.40	3.46	2.94	1.47	4.93
5 Dec	6.66	2.22	4.44	2.22	4.44
			YEAR: 1978		
4 May	6.40	3.90	2.50	1.25	5.15
			YEAR: 1980		
14 Apr	8.08	3.87	4.21	2.11	5.98
			YEAR: 1982		
5-6 Apr	7.36	3.65	3.71	1.86	5.51
			YEAR: 1983		
21 Mar	6.75	3.13	3.62	1.81	4.94
28 Jun	6.63	4.09	2.54	1.27	5.36
11 Aug	6.10	3.97	2.13	1.07	5.04
			YEAR: 1984		
27 Feb	6.40	3.09	3.31	1.66	4.75
28 Feb	7.19	3.09	4.10	2.05	5.14
29 Mar	6.20	3.56	2.64	1.32	4.88
28 May	6.99	3.66	3.33	1.67	5.33
			YEAR: 1985		
30-31 Mar	7.90	4.36	3.54	1.77	6.13
1 May	6.20	4.76	1.44	0.72	5.48
2 May	6.20	4.76	1.44	0.72	5.48
11 Jun	6.40	4.63	1.77	0.89	5.52
22-23 Jul	6.00	4.43	1.57	0.79	5.22
31 Jul	6.00	4.43	1.57	0.79	5.22
27-28 Nov	6.83	4.14	2.69	1.35	5.49

TABLE 3. (CONCLUDED)

	Toledo, Ohio			Projections for Cedar Pt	
Date	Max Elev Above LWD	Monthly Mean Stillwater Elev	Storm Surge Ht	Storm Surge Ht	Max Elev Above LWD
			YEAR: 1986		
6-7 Feb	7.64	4.36	3.28	1.64	6.00
11 Mar	6.23	4.52	1.71	0.86	5.38
12 Mar	6.20	4.52	1.68	0.84	5.36
4 Apr	6.16	4.82	1.34	0.67	5.49
14 Apr	6.37	4.87	1.50	0.75	5.62
9 May	6.19	4.91	1.28	0.64	5.55
5 Jun	6.06	5.15	0.91	0.46	5.61
17 Jun	6.29	5.15	1.14	0.57	5.72
20 Jun	6.08	5.15	0.93	0.47	5.62

Explanation

This table shows all storms for the past 50 years which resulted in a water level of 6.0 ft or greater above Low Water Datum (elevation 574.6 IGLD or 576.1 MSL) at Toledo as recorded by the U.S. Army, Corps of Engineers. The storm surge heights and maximum elevations for Cedar Point are projected based on the consideration that a longitudinal storm surge (N67°E) must travel an additional 35 miles to reach Toledo, thereby generating a level approximately 50% higher (average about 1.5 ft) at Toledo. Earlier records indicate that storm events with levels 6.0 ft above LWD may also have occurred in 1913, 1917-1919, 1929 and 1930.

TABLE 4. CHANGES IN SHORELINE AND NEARSHORE BOTTOM AT THE BASE OF CEDAR POINT SPIT BETWEEN MAY AND NOVEMBER 1972

Profile Line		Shoreline Recession (ft)[a]	Cross-sectional Area Loss (ft2)[b]
0+00		48.0	514
4+00		13.0	131
8+00		15.0	228
	Mean	25.3 ft	291 ft2

Notes

a. horizontal shore recesses at 3.0 ft above Low Water Datum (approximate mean lake level for 1971)

b. vertical area loss from shoreline to 300 ft offshore

Data Source: Herdendorf (1972)

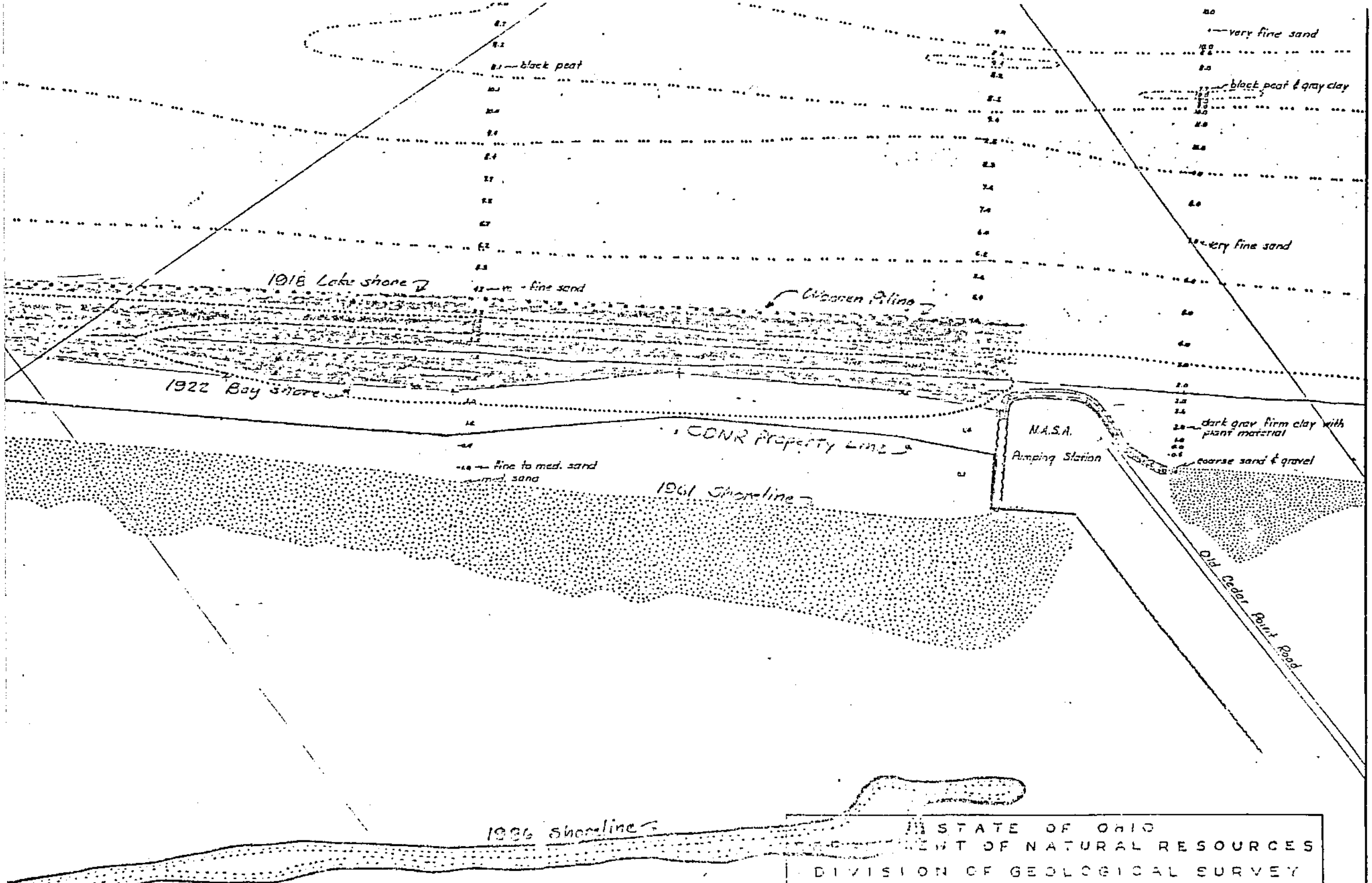


Figure 1. Reconstruction of 1918 shoreline at the base of Cedar Point showing subsequent changes.

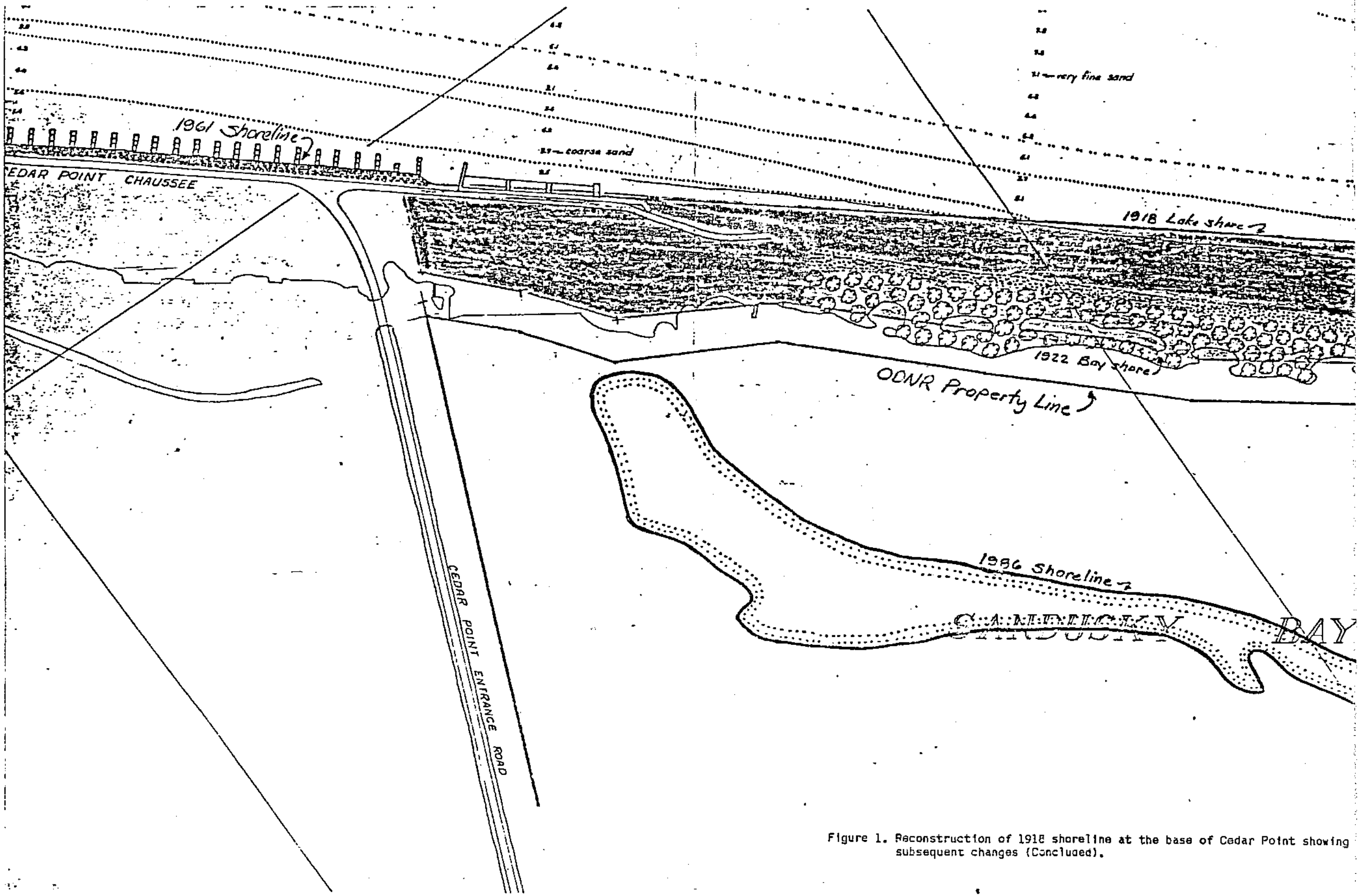


Figure 1. Reconstruction of 1918 shoreline at the base of Cedar Point showing subsequent changes (Concluded).

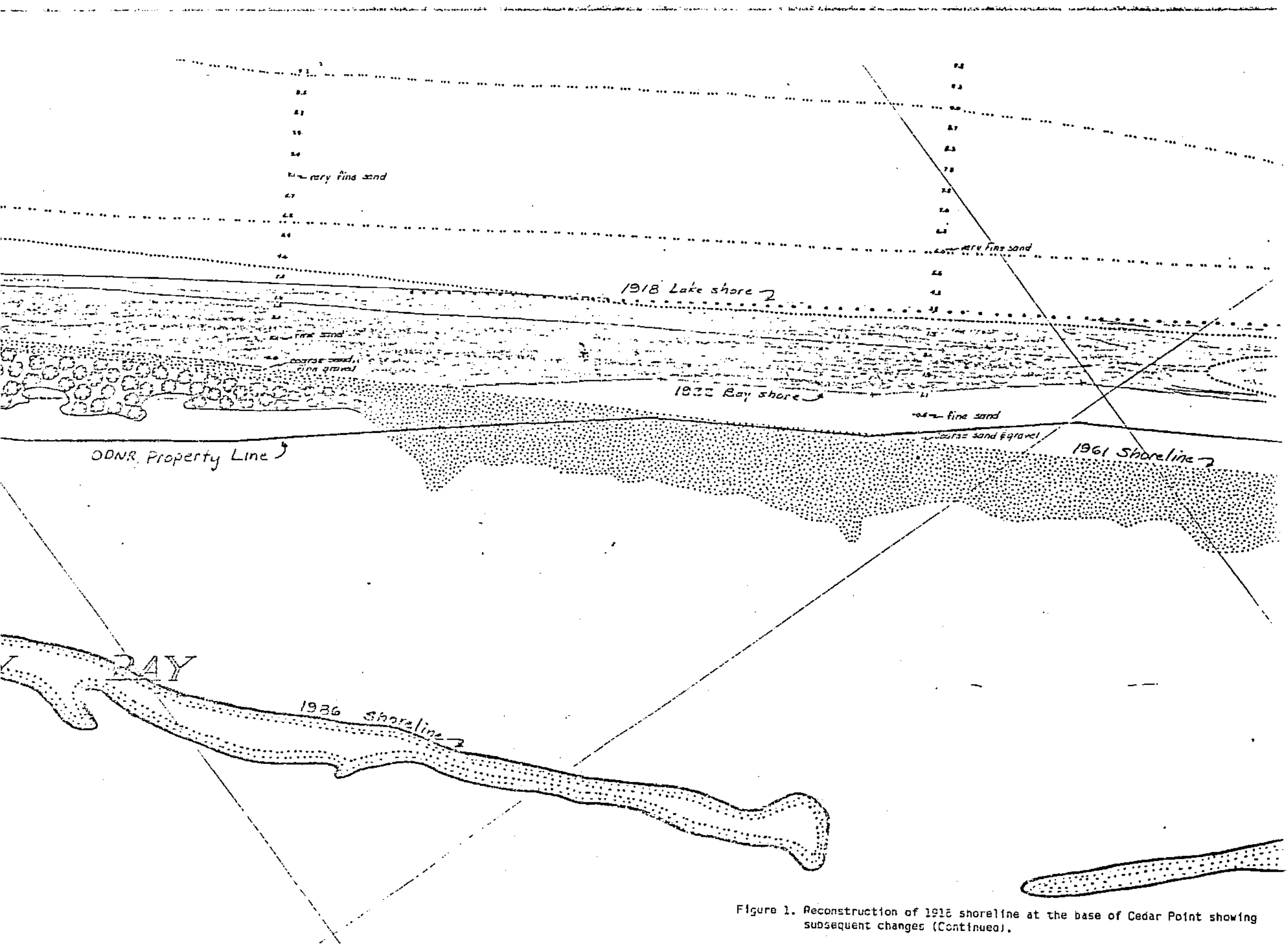


Figure 1. Reconstruction of 1918 shoreline at the base of Cedar Point showing subsequent changes (Continued).

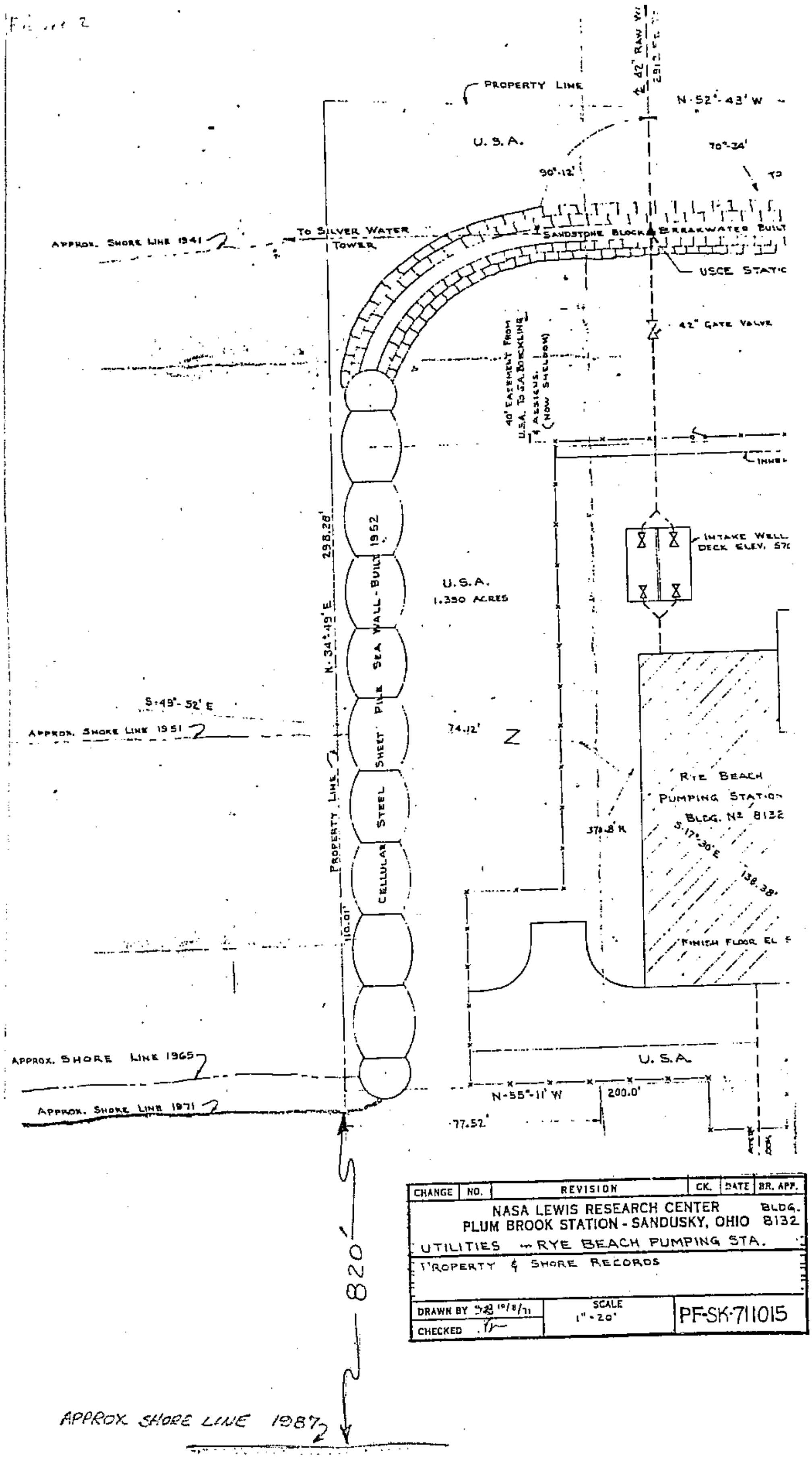


Figure 2. Shoreline changes adjacent to NASA pumping station 1941-1987.

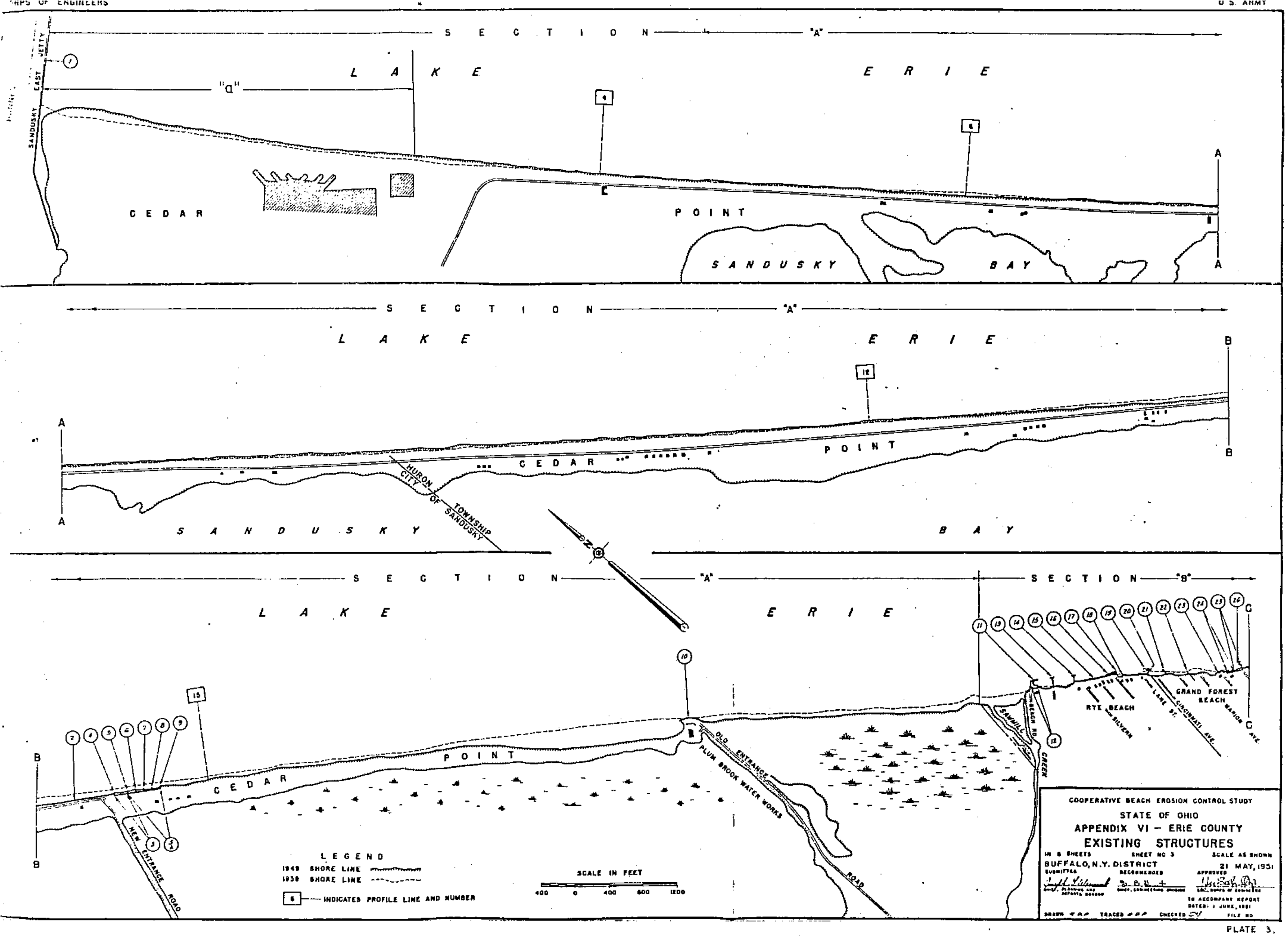


Figure 3. Shoreline changes at the base of Cedar Point spit 1939-1949 (U.S. Army, Corps of Engineers).

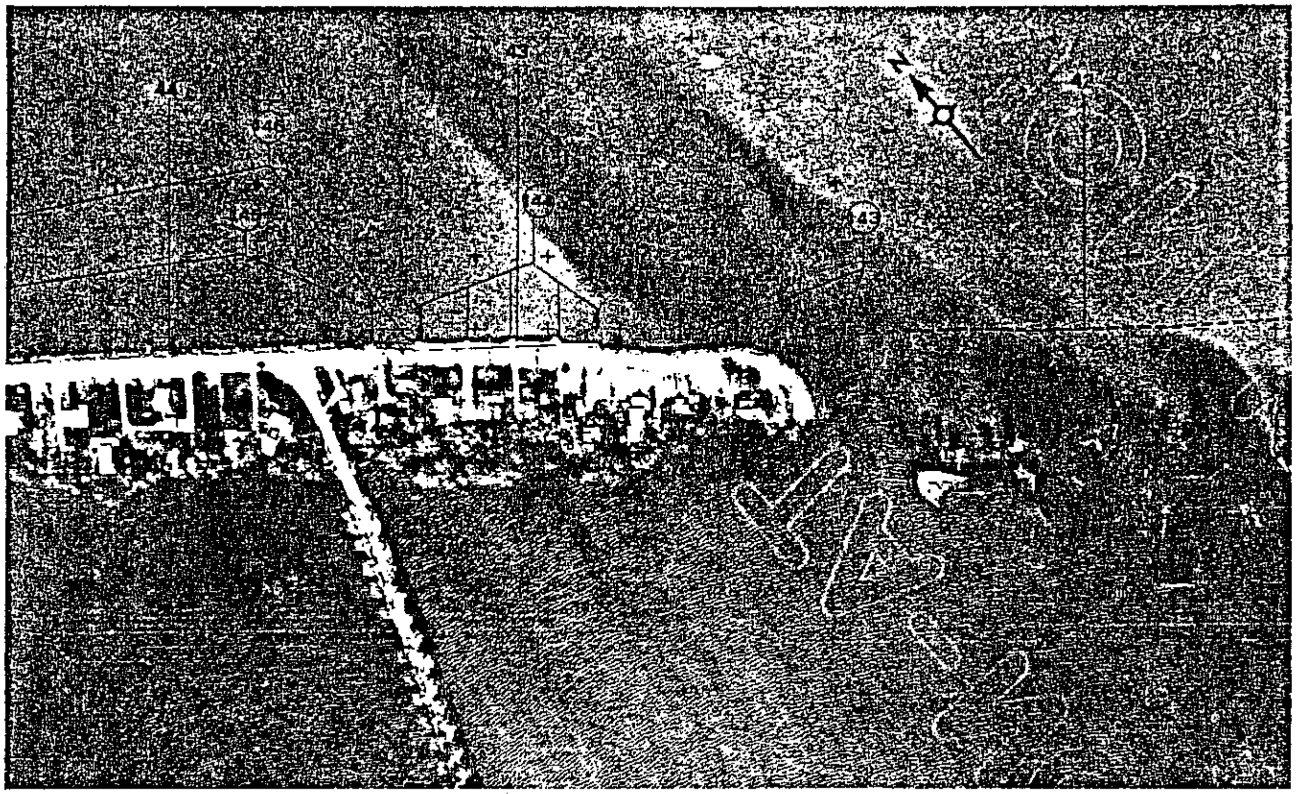


FIGURE 39

AERIAL PHOTOGRAPHS, CEDAR POINT REACH

Aerial photography of the Erie-Sandusky County shore was done in 1973 by the Ohio Department of Transportation. The photographs are reproduced here with superimposed 1937 and projected 2010 recession lines (see Appendix B for photo numbers which correspond to figures). Because of inadequate geographic control, no 1877 recession line could be determined for this reach. The 2010 line is the heavier dashed line farthest landward; the 1937 line is long dashed where the position is moderately defined and short dashed where its position is poorly defined. Recession lines coincide where there has been no change.

Range and structure locations also are shown (see Appendix A for description of the structures). The following symbols are used:

50 — Range location and number

163 — Structure location and number; dashed line indicates structure was missing at the time of the 1975 survey

Scale on all photos: 0 200 400 ft; 0 100 200 m

Scale distorted toward edges of photos

Figure 4. Shoreline changes at the base of Cedar Point spit 1937-1973 (Ohio Dept. Nat. Resour., Div. Geological Survey).

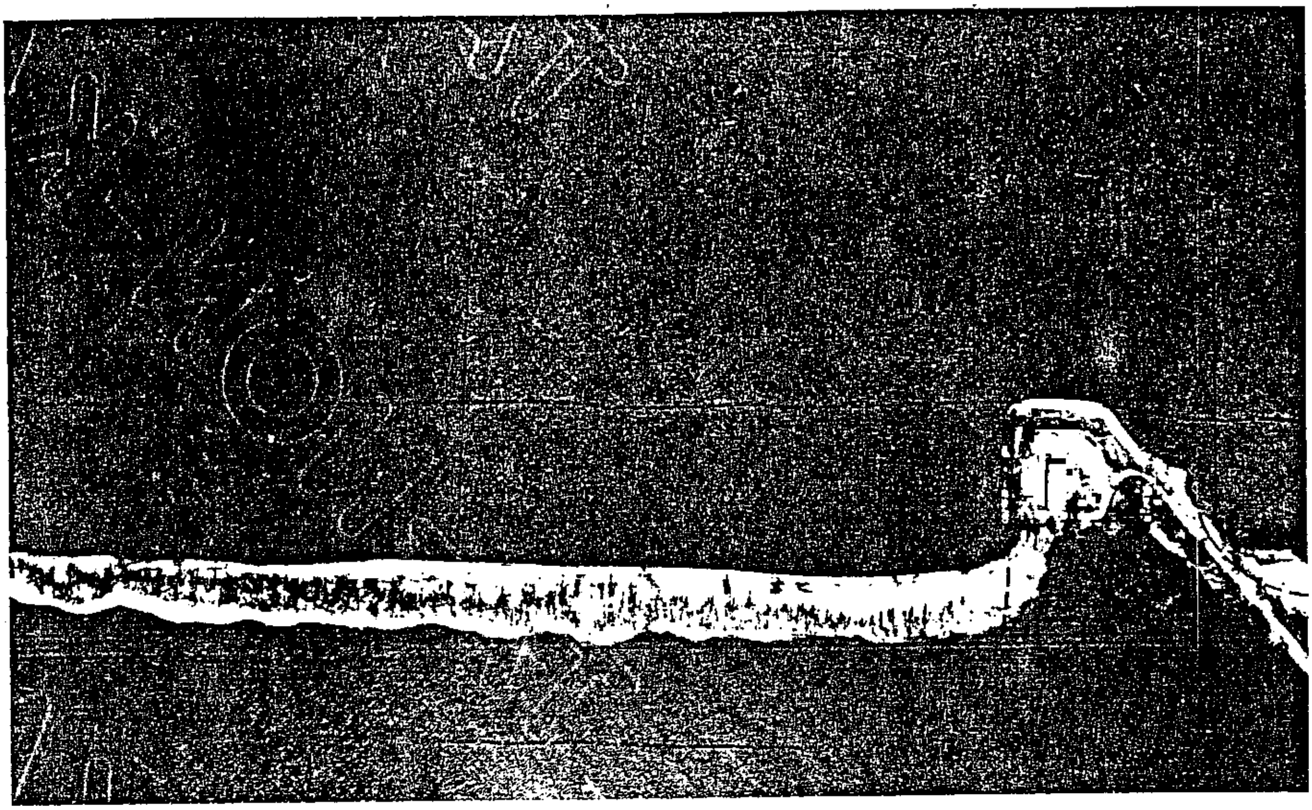


FIGURE 37

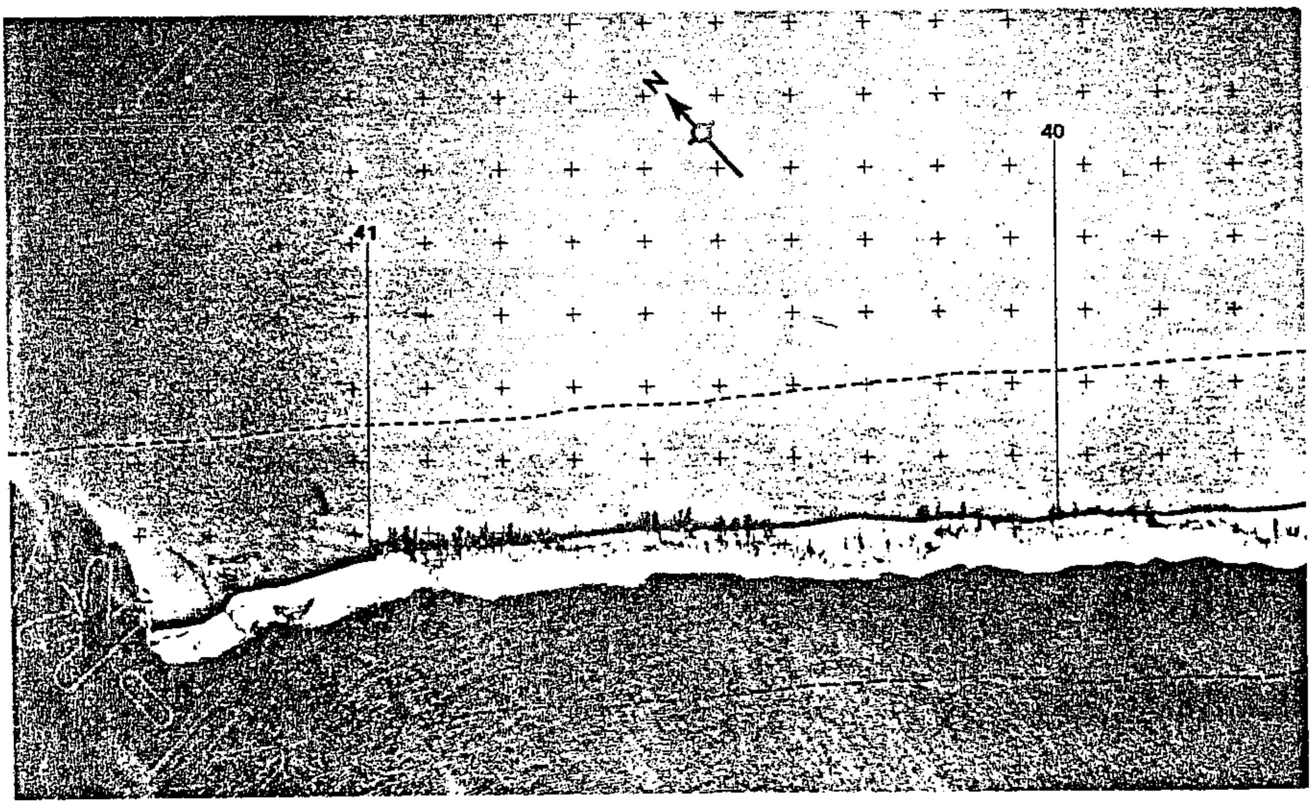


FIGURE 38

Figure 4. Shoreline changes at the base of Cedar Point spit 1937-1973 (Ohio Dept. Nat. Resour., Div. Geological Survey) (Concluded).

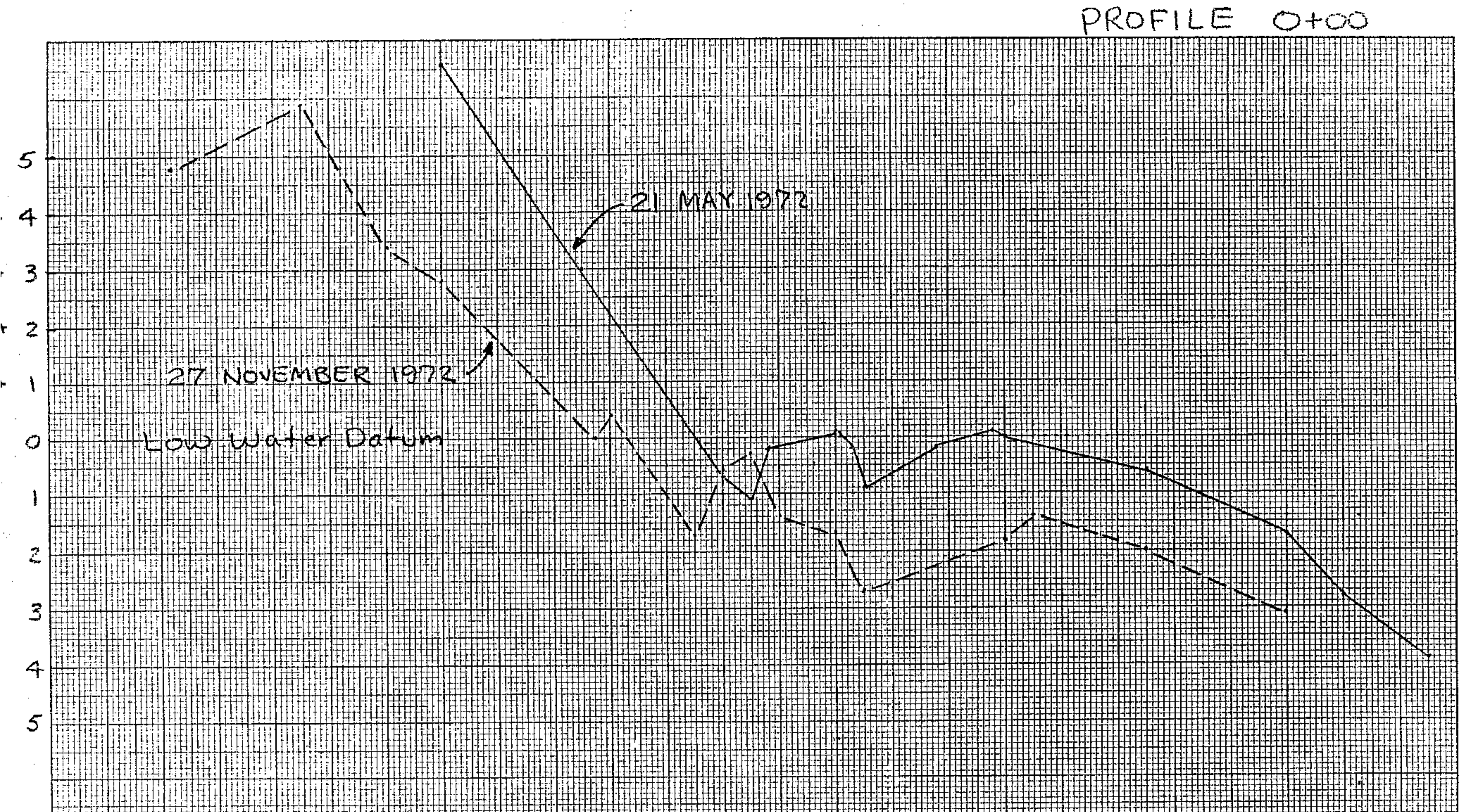


Figure 5. Comparative nearshore bottom profiles of station 0+00, base of Cedar Point spit, 1972.

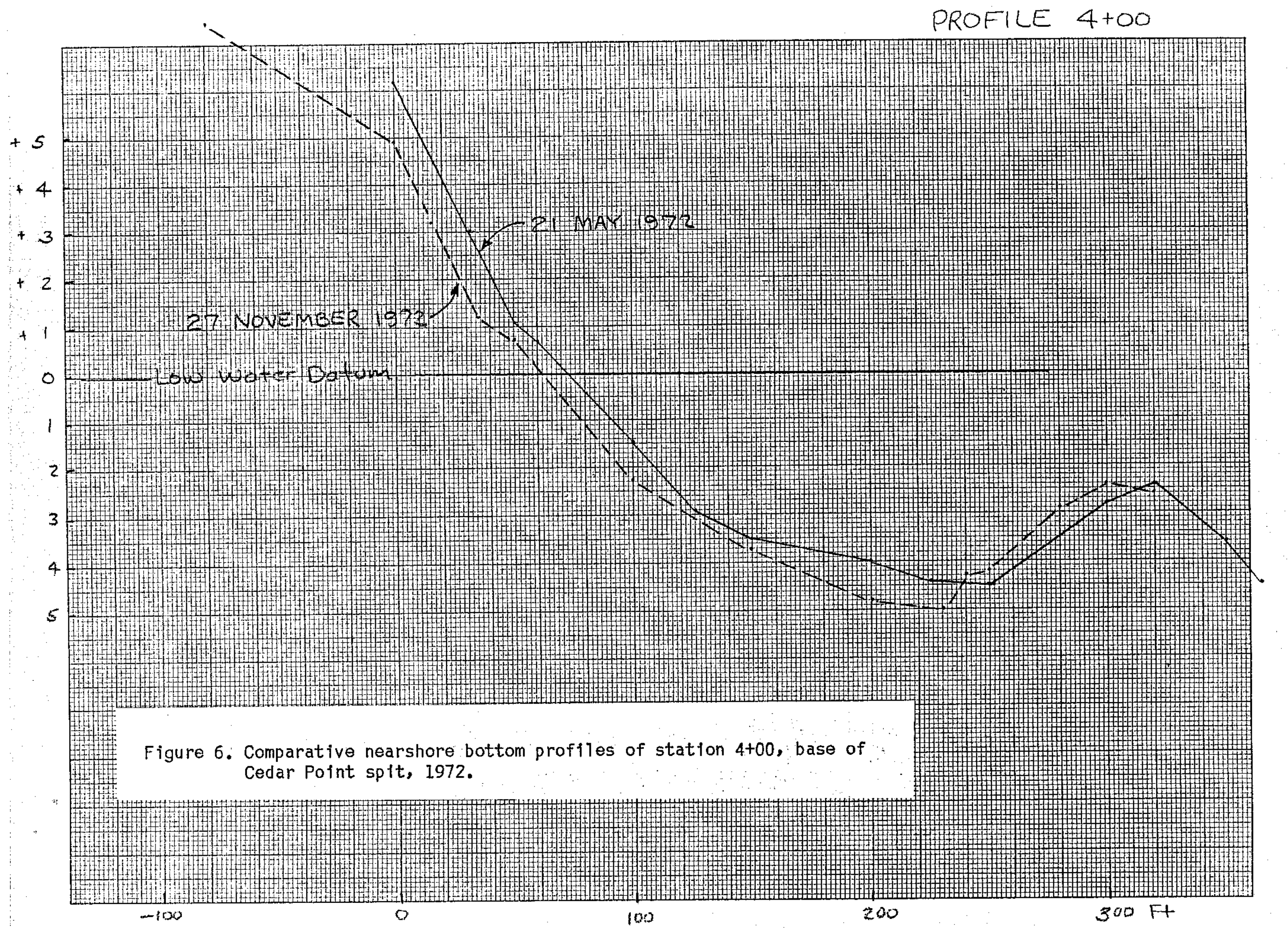


Figure 6. Comparative nearshore bottom profiles of station 4+00, base of Cedar Point spit, 1972.

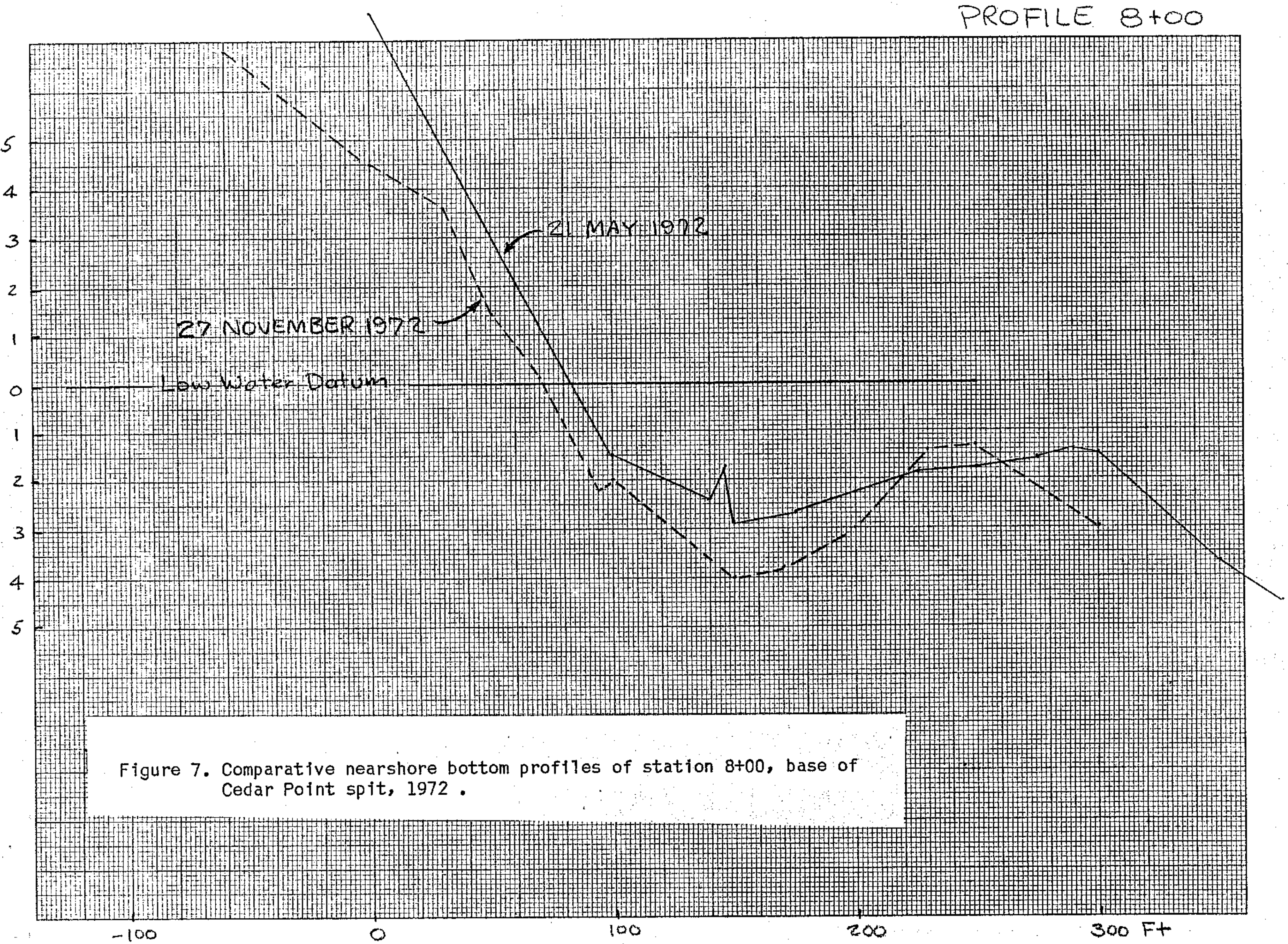


Figure 7. Comparative nearshore bottom profiles of station 8+00, base of Cedar Point spit, 1972 .

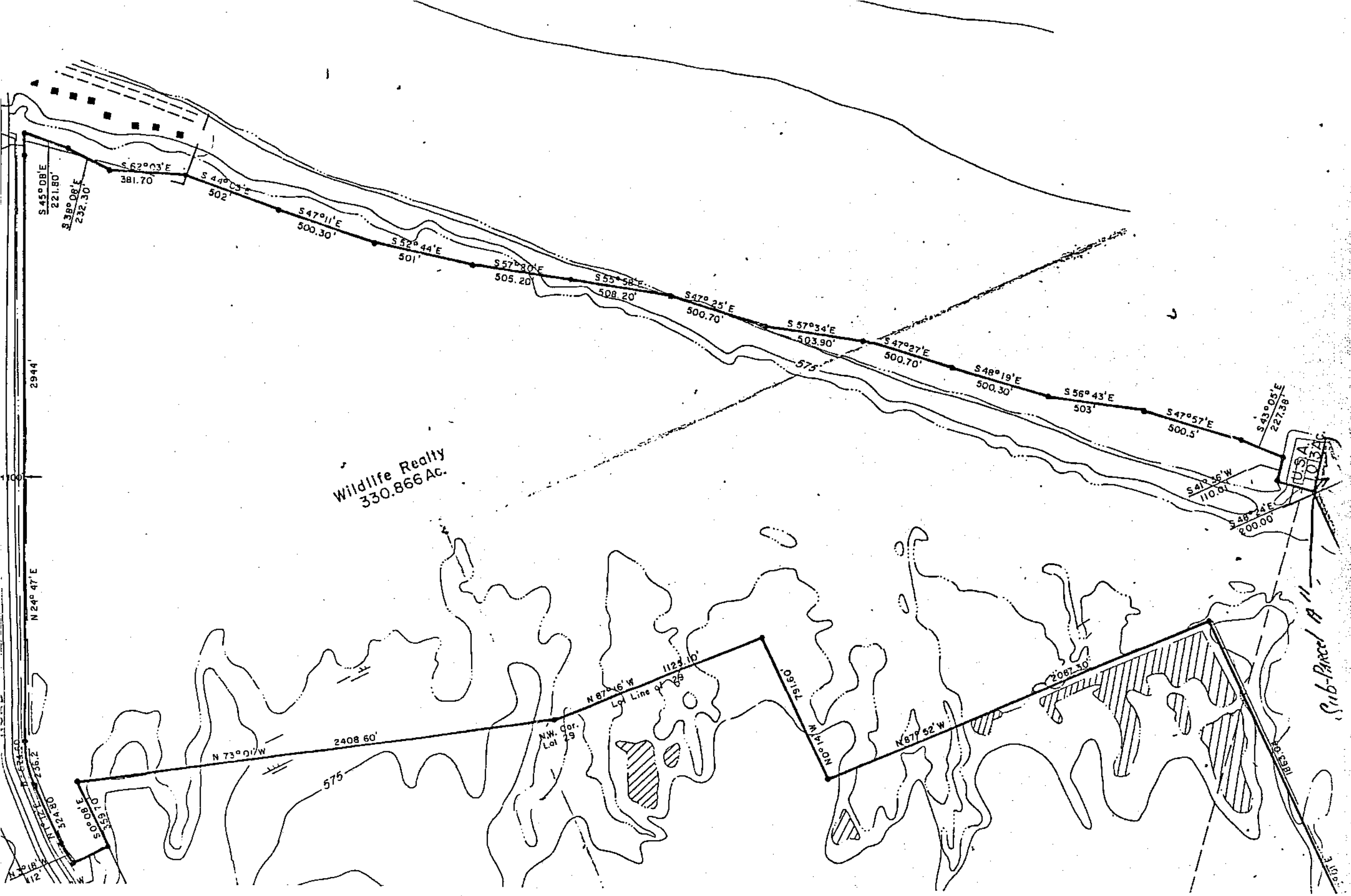
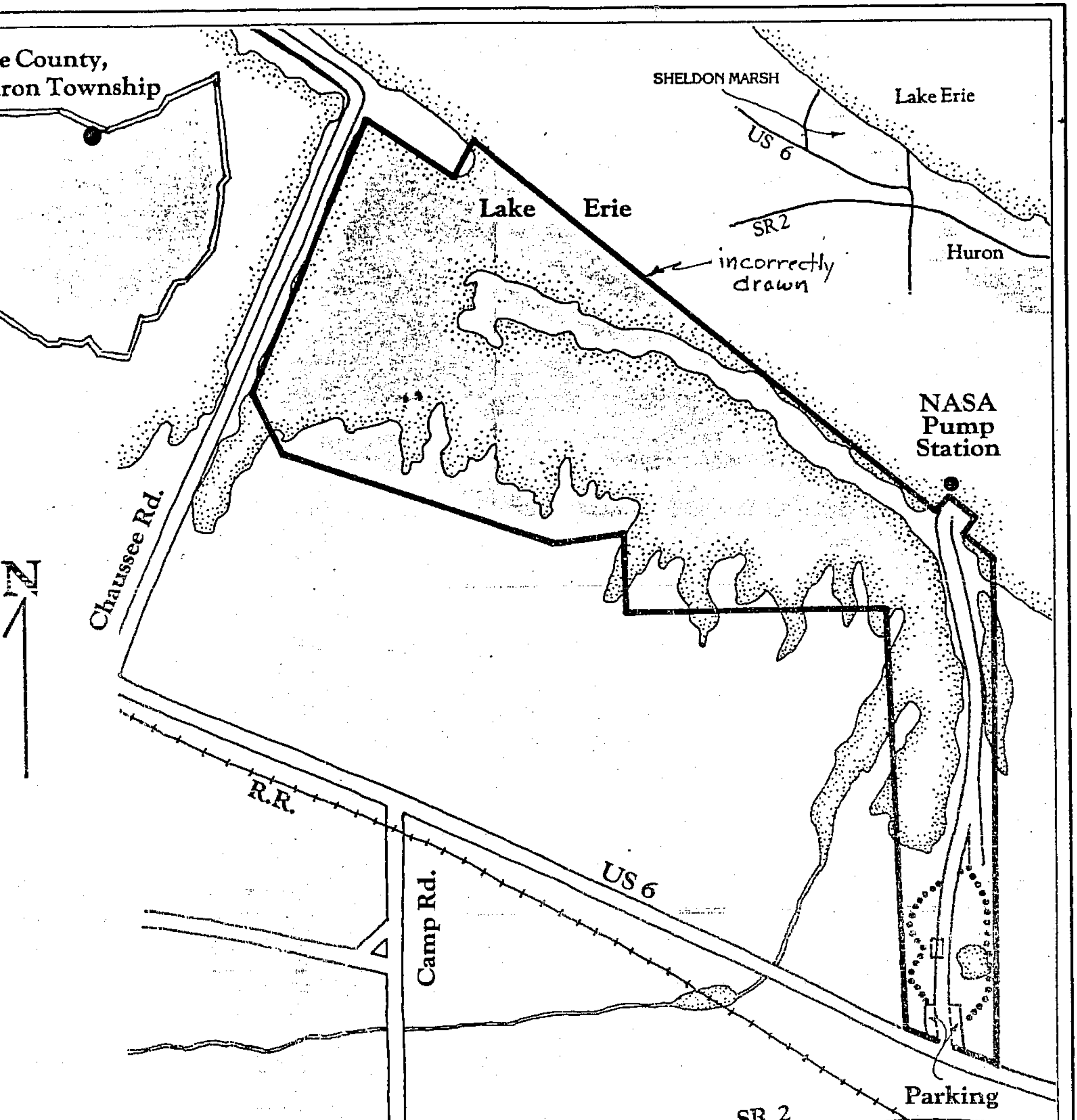


Figure 8. Sheldon's Marsh State Nature Preserve (Ohio Dept. Nat. Resour., Div. Natural Areas & Preserves).



xt: Gene Wright
ustrations: W. Scott Hoffman, cover; Jim Glover

Open daily April-October
Dawn to Dusk

Jovember-March, Access by Permit Only

Sheldon Marsh
State Nature Preserve

Figure 8. Sheldon's Marsh State Nature Preserve (Ohio Dept. Nat. Resour., Div. Natural Areas & Preserves) (Concluded).