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FIRST IMPRESSIONS

Monitoring a Dredged Channel:
Braddock Bay, New York

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New York Sea Grant Institute • 411 State Street • Albany, NY 12246

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MONITORING A DREDGED CHANNEL: BRADDOCK BAY, NEW YORK

A First Impressions Report*

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CONTENTS

FIGURES AND TABLES

FOREWORD

This report concerns the results of the dredging of a channel between Braddock Bay and Lake Ontario in August and September, 1977. Mr. Brian Doyle of the Brockport Office New York Sea Grant Extension Program requested the authors to document changes in sediment distribution which took place with respect to the channel and adjacent bay and lake floors. Project activity took place from October 1, 1977, through July 31, 1978, and was funded by a Sea Grant minigrant.

SUMMARY

The dredged channel and adjacent bay and lake floors were surveyed in October 1977 and July 1978. This project was initiated after the completion of dredging; thus we did not construct a detailed pre-survey map of the area. Sediment samples were taken during the dredging operation, as part of the surveys, and during other site visits. The samples were analysed for size characteristics in order to account for the post-dredging distribution of the dredged materials.

Observations

(1) October 1977 survey

(a) A distinct channel was present with depths to seven feet. A sand bar had formed adjacent to the channel on its southeast margin.

(b) The dredged sediment "bin" on the lake side of the jetty on the east side of the bay entrance was composed of sediment ranging in size from silt to cobbles. Many cobbles displayed angular edges, apparently caused by the dredging operation. The bin was undergoing erosion by waves from the east.

(2) July 1978 survey

(a) The dredged channel between and southwest of the channel markers was filled. The sand bar to the south of the channel had expanded into areas where the channel had been dredged.

(b) The sediment "bin" was reduced to a narrow band of sediment parallel to the shore. Washover bars of sand had formed on the bay side of the jetty between the area of the disposal bin and the channel.

(c) There was no increase in sand or gravel accumulation in the pocket beaches to the west or east of the groin projecting out into

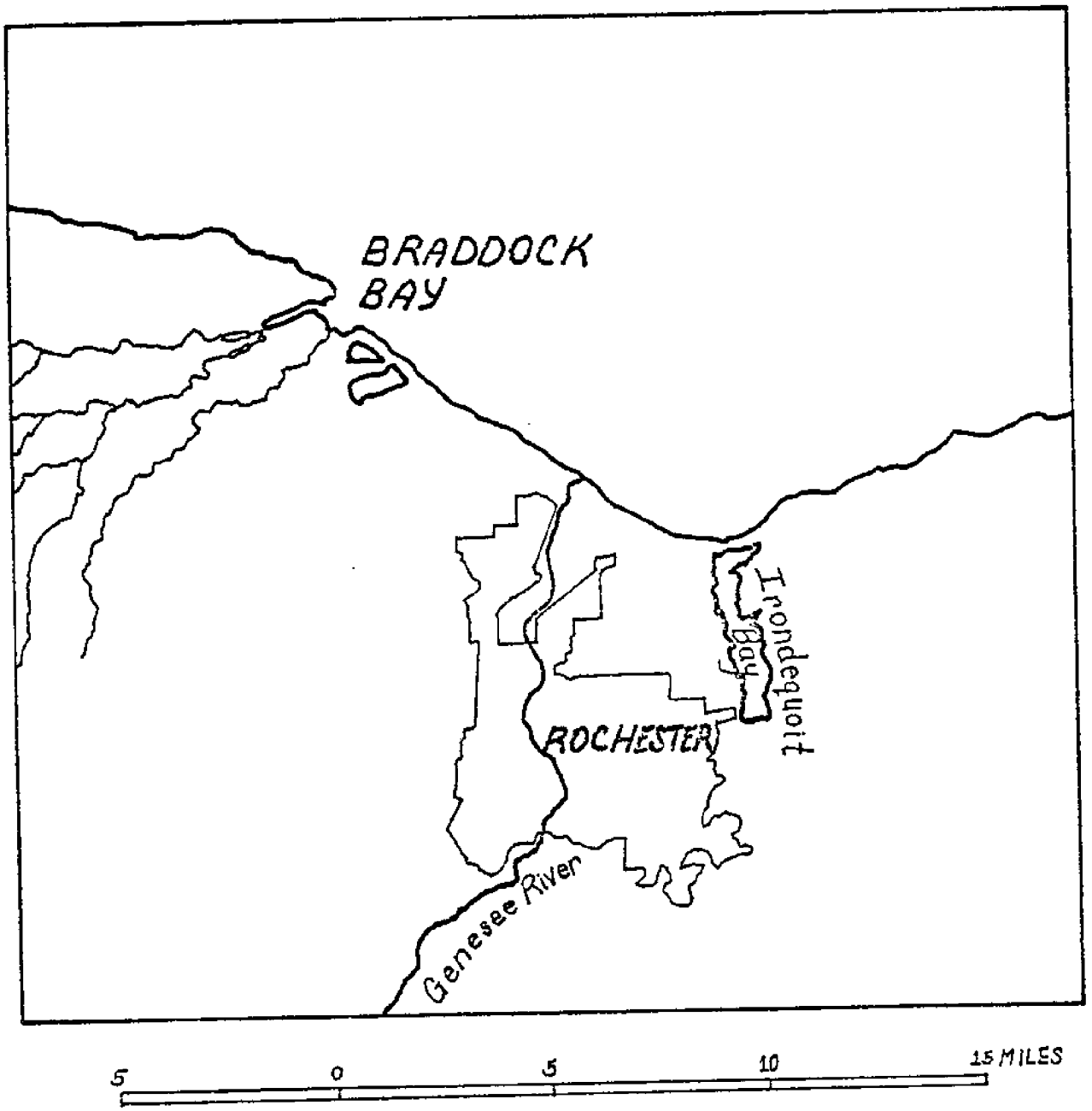


FIGURE 1 Location of Braddock Bay, 7 miles northwest of the mouth of the Genesee River, Rochester, New York

the lake to the east of the disposal bin.

(3) November 1978 reconnaissance

(a) The sediment of the disposal bin had been removed with erosion having exposed marsh sediments in the bin area. Cobbles and pebbles had accumulated in pockets among the boulders of the jetty; no significant beach deposits were present.

Recommendations

(1) The fine grain size of the bay mouth sediment results in its ready movement in water currents. Suspension of the sediment into the water may be caused by wind-generated waves from the lake or bay, or by waves generated by passing boats of any size. Once in suspension, the sediment will move with any wave-induced or other current until deposition takes place in quiet water.

(2) The movement of sediment at the mouth of Braddock Bay should be modeled to predict the stability of any future dredging or other channel opening and maintenance project. Information necessary for a model would include:

a. Movement of wave fronts in the lake and bay.

b. Currents associated with the wave fronts.

c. Currents caused by bay water outflow and storm setup.

d. Irregular currents caused by topography at the bay mouth.

e. Effects of annual and extreme changes in lake level.

f. Stream erosion and deposition interacting with the bay and lake.

(3) The development of alternative solutions to lake access for boaters from bay marinas for consideration if costs or uncertainty preclude maintenance of a deep, stable channel.

DISCUSSION

Introduction

Braddock Bay is located 7 miles northwest of Rochester, New York (Fig. 1). Salmon Creek and Buttonwood Creek discharge into the bay and from the bay to Lake

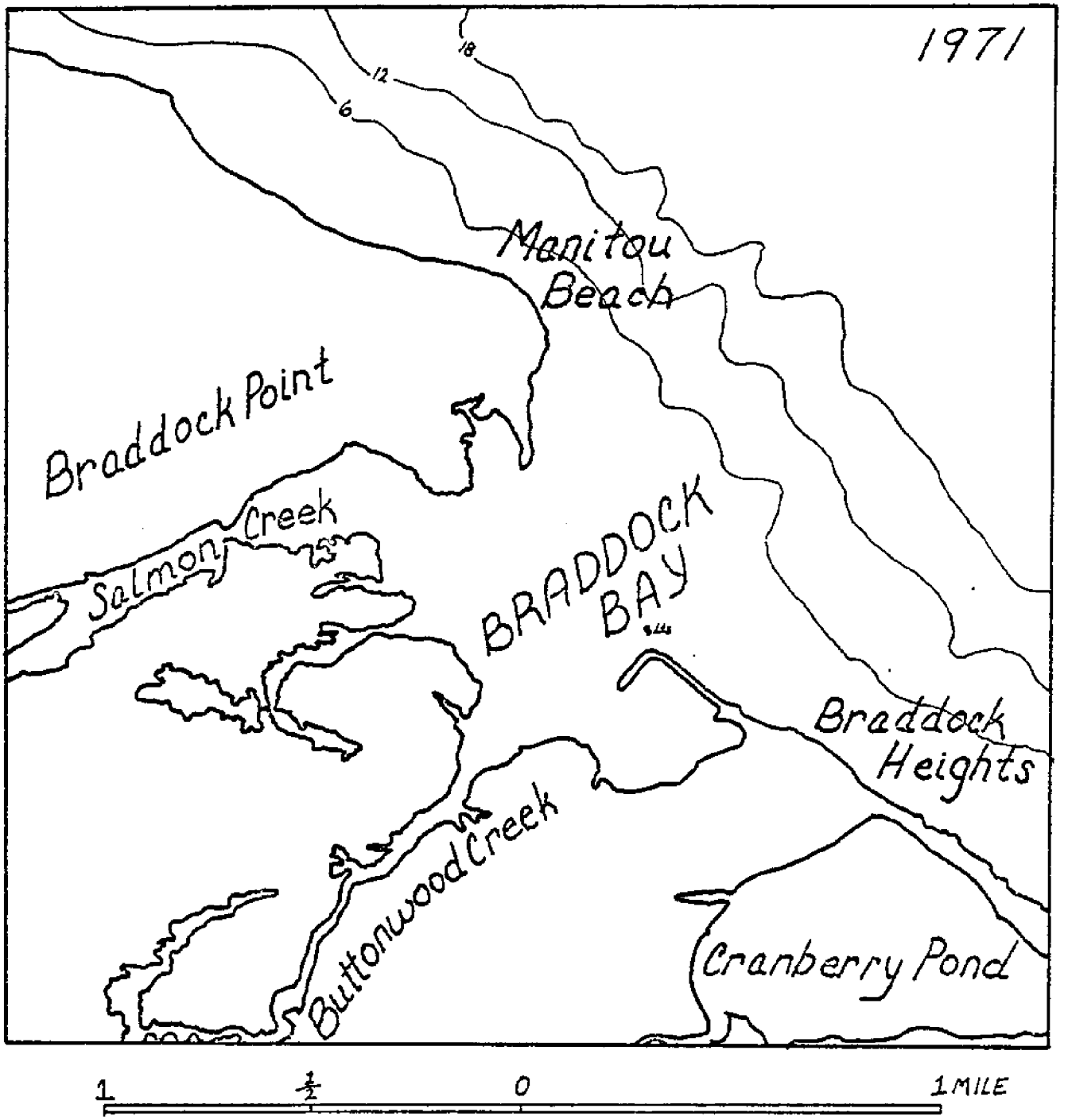


FIGURE 2 Braddock Bay area, 1971. Lights mark the inlet channel northwest of "L"-shaped artificial jetty on the east side of the Bay. Lake depth contours in feet, mean lake level 245 feet.

Ontario (Fig. 2).

Shoaling water at the mouth of Braddock Bay at the inlet area has presented problems to boaters for many years, particularly those using three marinas located in the bay. One of the marinas is franchised by the New York State Parks Commission at Braddock Bay State Park on the southeast edge of the bay.

Groundings have taken place on "sand bars" lakeward of the two permanent channel markers at the bay mouth and on shoal areas within the bay, particularly on the southeast flank of the "marked channel".

The New York State Park and Recreation Commission, in response to demands from users, contracted to have the channel dredged. Proposals for dredging had existed since 1967 and plans for the 1977 dredging had been proposed as early as 1972 (New York State Department of Transportation, 1975). Delays associated with both financial priority and environmental concerns at the state and federal levels occurred before dredging commenced August 27, 1977.

A proposed channel, 1800 feet long and 160 feet wide, was to be excavated. Equipment failure, poor weather, difficult dredging, and the initiation of the fall trout and salmon runs caused the dredging to be stopped September 19, 1977 with partial completion of the proposed program. A channel approximately 1600 feet long and 70 feet wide was dredged; the 7500 cubic yards of sediment removed was pumped through pipes to a "disposal bin" on the north side of the Braddock Bay jetty (Fig. 3).

Initial Survey: October 1977

The survey team established a base map with stations tied to a New York State Parks and Recreation benchmark located in Braddock Heights with elevations recorded based on the International Great Lakes Datum (IGLD). The geometry and sediment characteristics of the "bin", nearshore shallows, and channel area were then measured (Fig. 4).

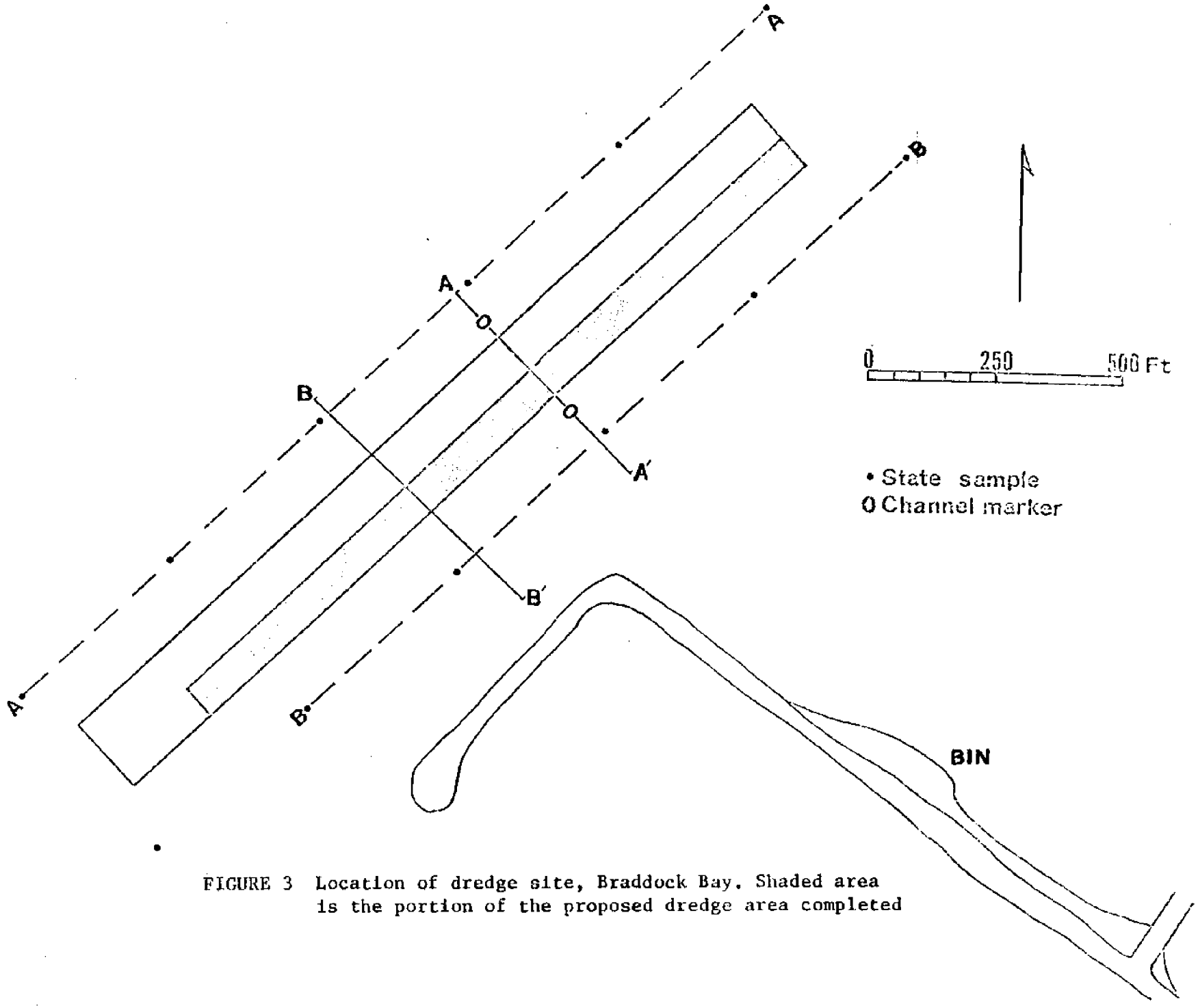


FIGURE 3 Location of dredge site, Braddock Bay. Shaded area is the portion of the proposed dredge area completed

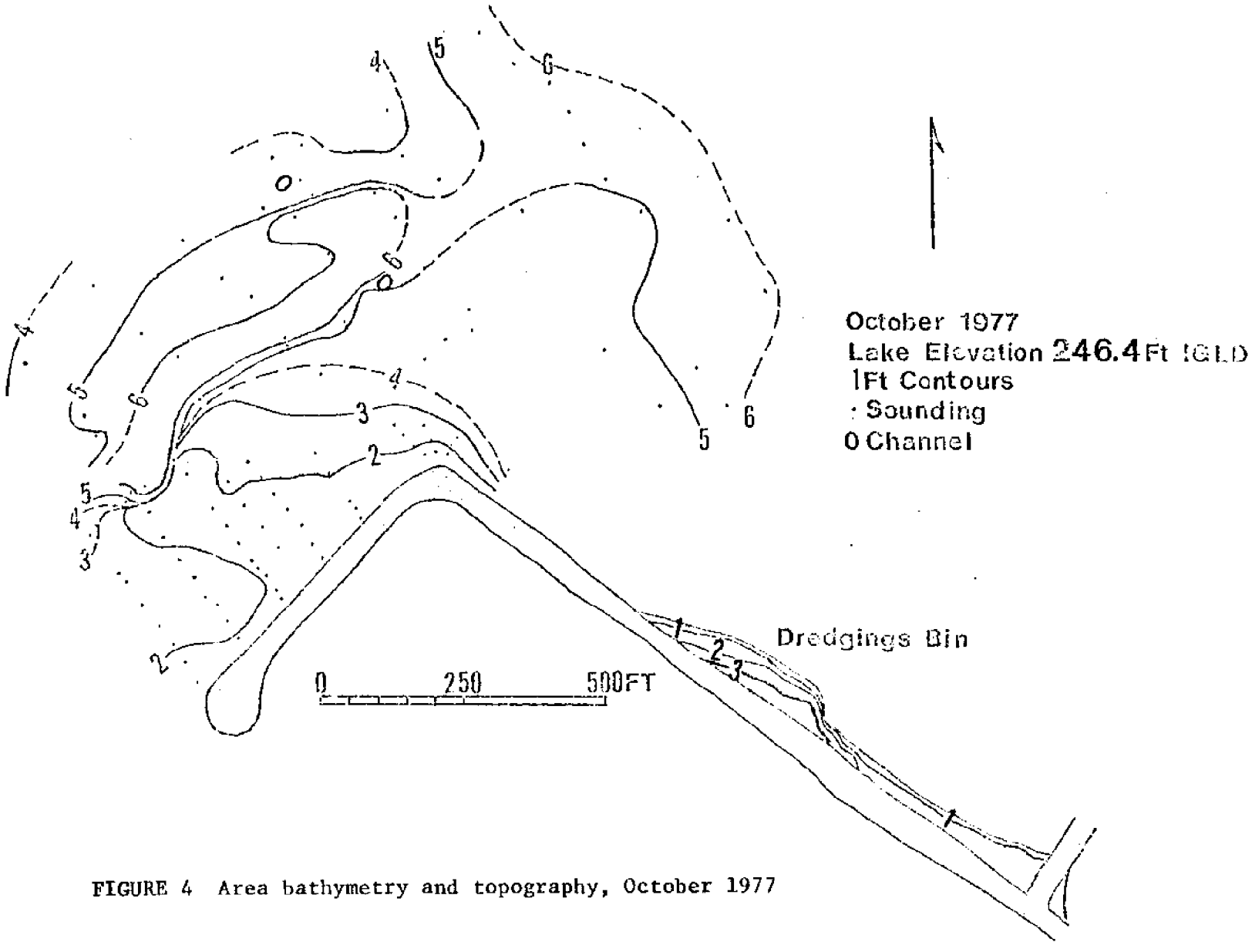


FIGURE 4 Area bathymetry and topography, October 1977

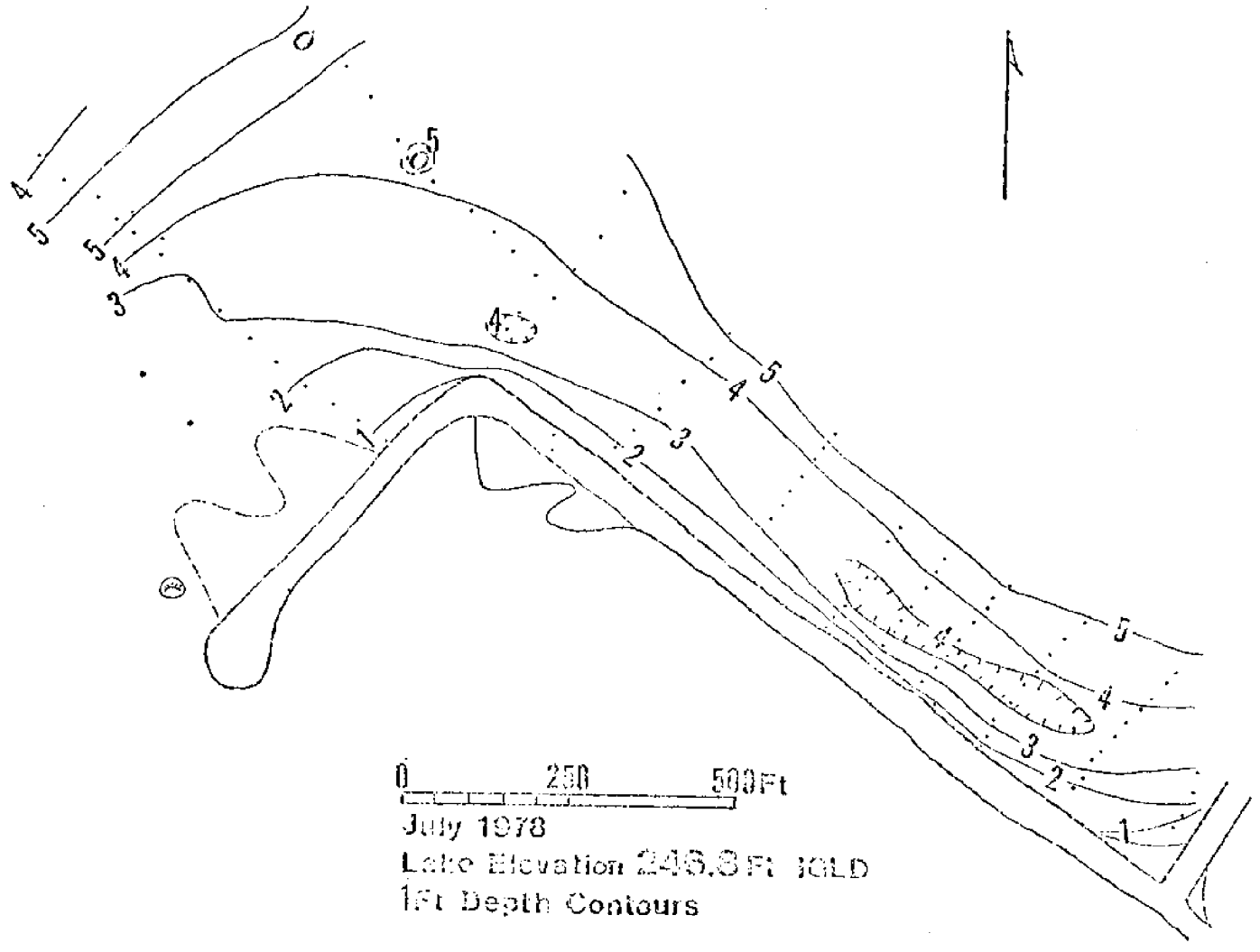


FIGURE 5 Area bathymetry and topography, July 1978

By October 1977 a sand bar had formed at the southeastern edge of the dredged channel. The configuration of the disposal bin edge was irregular and eroded. The highest portion of the bin and the steeper edge near shore was protected by an "armor" of flat pebbles several inches in diameter. These coarser particles, many exhibiting broken edges, had been dredged from the area between the channel markers and may represent an older submerged beach ridge or the foundation of a former trolley bed crossing the bay mouth.

Second Survey: July 1978

Shoreline processes during the winter 1977-1978 and spring 1978 had greatly modified the channel and disposal bin area. A second quantitative survey was taken in July 1978 and the results are shown in figure 5.

The sand bar on the southeast flank of the channel had expanded into the dredged area. Sediments in the bin area had been reduced to a narrow band parallel to the jetty edge. Washover bars of sand had formed on the bayside of the northwestern portion of the jetty.

Depth changes in the channel area are illustrated by the cross-sections of figures 6A and 6B. The channel between the markers had filled in except for local scour at the base of the channel markers and the sand bar at the southeast edge of the channel had migrated farther into the channel. Both cross-sections exhibit approximately 18.5 cubic feet of fill per foot of channel. By late fall (November) the sand bars were exposed on the northwest side of the jetty as Lake Ontario water levels decreased.

Characteristics of the sediments

Size data were obtained by sieve analysis with one-half sieve sizes from 8 to 0.0625 mm (-3 to +4 Ø). Cummulative curves of the percentages by weight of the sieve fractions were plotted on arithmetic probablity paper with size expressed in phi units. The size characteristics of each sample where determined using

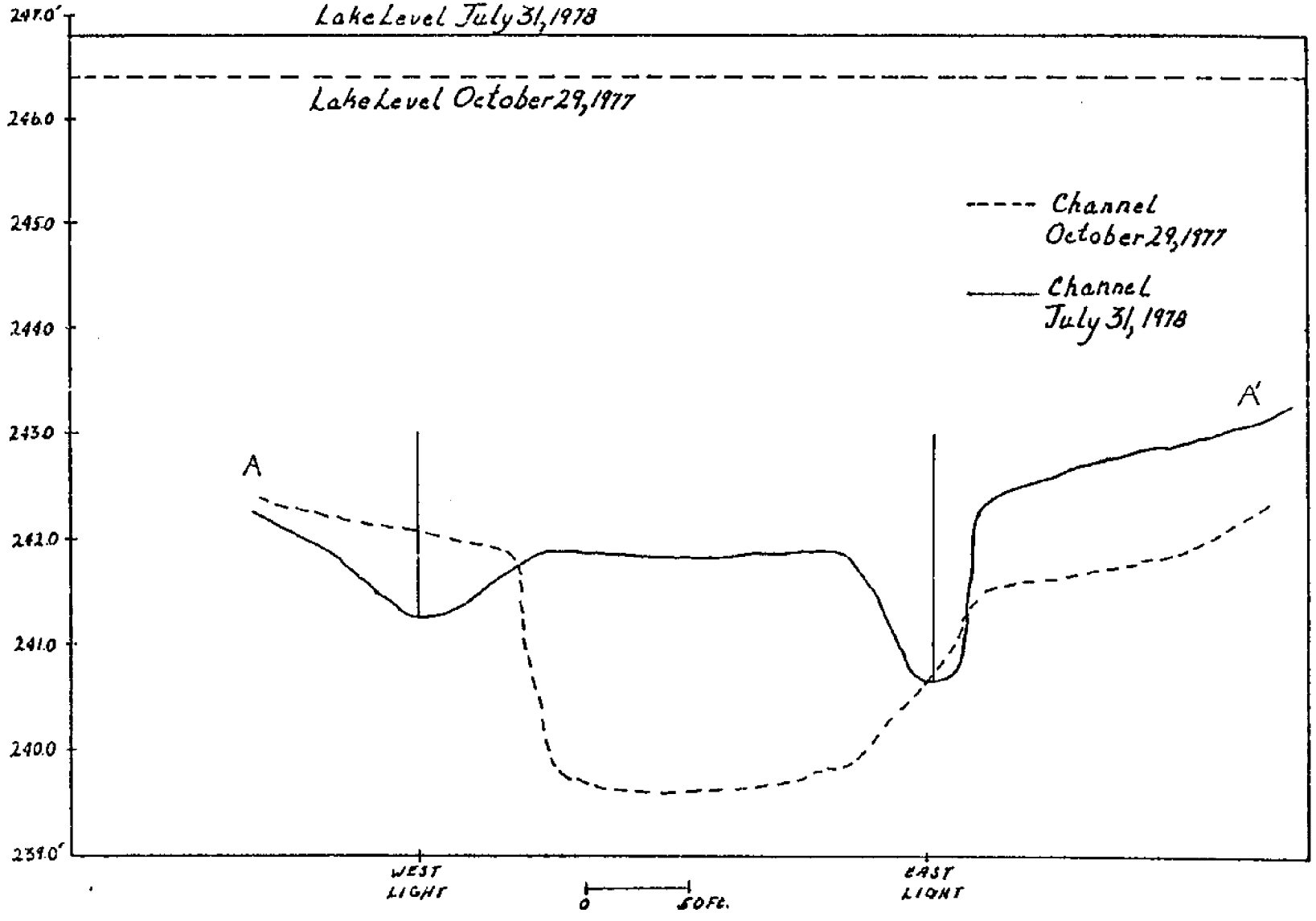


FIGURE 6A Cross-section along line A - A', figure 3

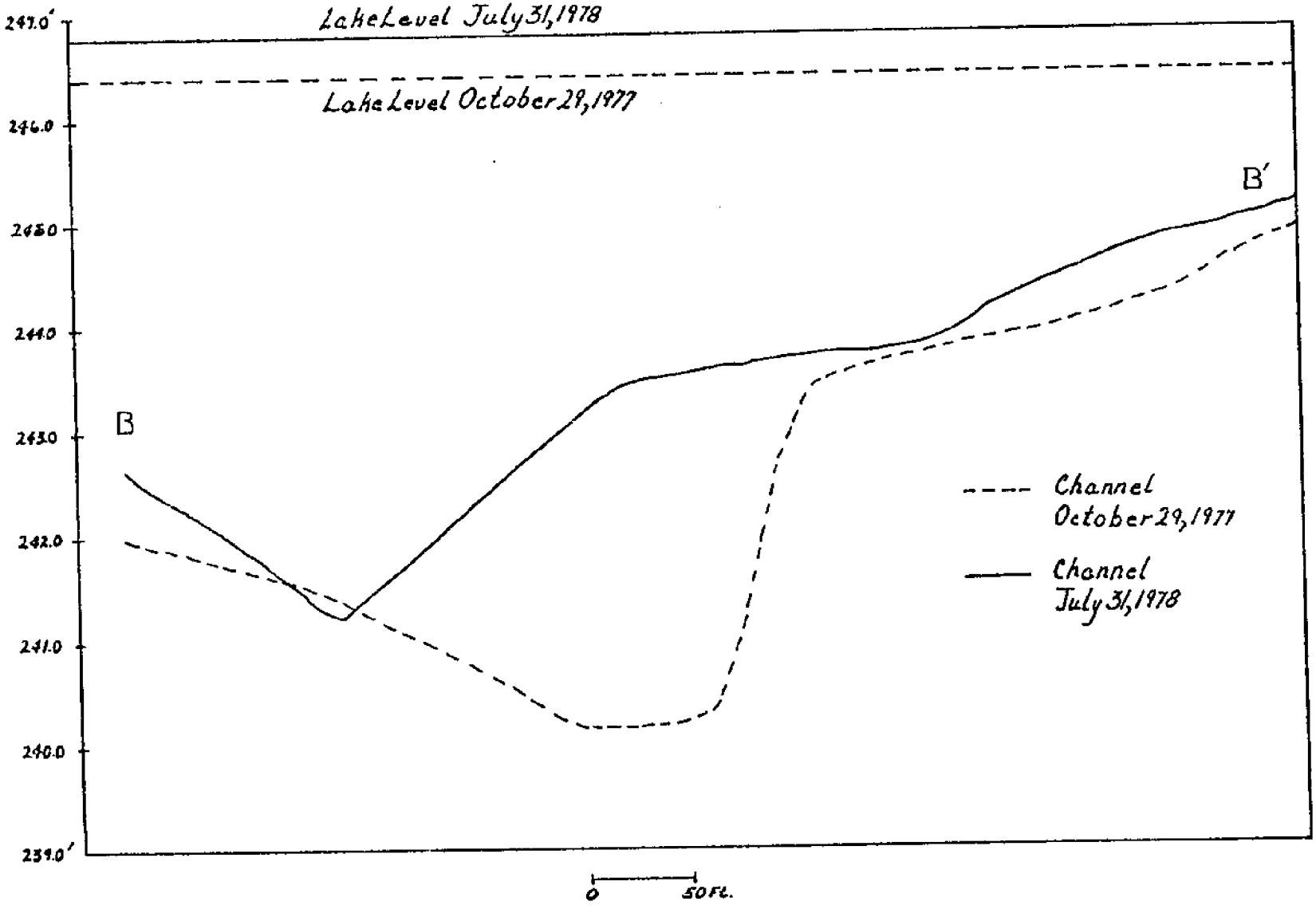


FIGURE 6B Cross-section along line B – B', figure 3

TABLE 1 Mechanical composition of sediments

Sample identification	Median (mm)	Mean (Folk, 1957) (phi)	(mm)
DOT Samples			
DA-13	0.125	3.07	0.118
DA-14	0.082	3.65	0.080
DA-15	0.138	3.23	0.106
DA-16	0.180	2.35	0.195
DA-17	0.180	2.40	0.190
DA-18	0.218	1.58	0.334
DA-19	0.164	2.92	0.129
DA-20	0.175	2.55	0.170
DA-21	0.230	0.48	0.710
DA-23	0.154	2.58	0.166
DA-24	0.146	2.90	0.134
Channel sand bar			
B1	0.177	2.51	0.176
B2	0.151	2.65	0.159
B3	0.167	2.61	0.163
B4	0.196	2.39	0.190
B5	0.200	2.35	0.195
B6	0.190	2.38	0.192
B9	0.230	2.18	0.220
Disposal bin			
B7 lag	0.440	0.81	0.570
B11 lag	0.410	0.52	0.690
B8 lake	0.121	3.04	0.122
BD wind	0.142	2.69	0.155
BS wind	0.140	2.78	0.145
B10 beach	0.140	2.80	0.143
Groin beach			
BG 1	0.200	2.31	0.200
BG 2	0.160	2.56	0.169
Washover bars			
W 1	0.220	2.18	0.220
W 2	0.220	2.17	0.222

the parameters of Folk and Ward (1957). The results of the data collected in our study and that reported in N.Y.S. DOT (1975) are tabulated in table 1. Mean values for sediment size are shown in figure 7.

The following size terms are used in this report:

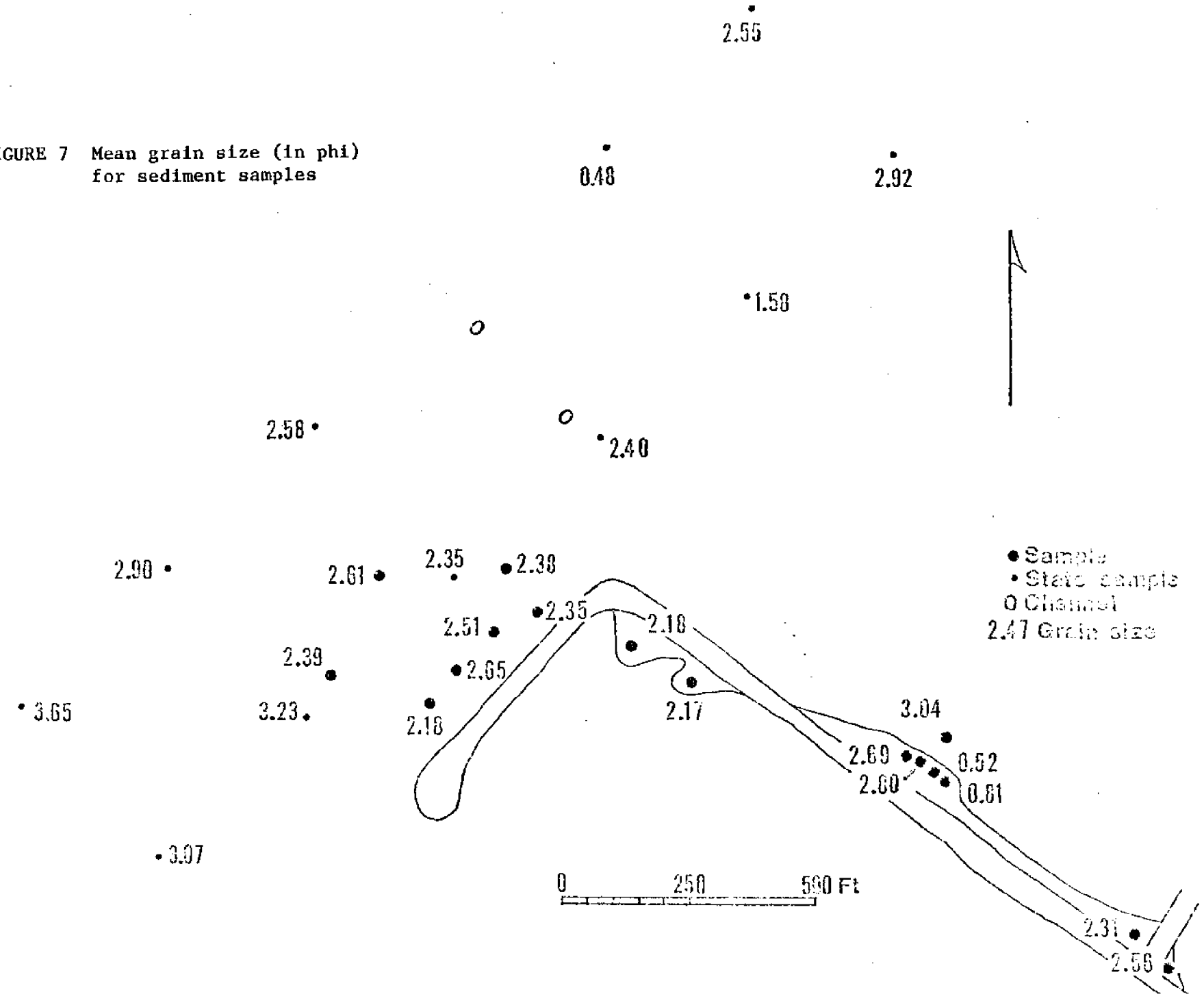
term	size range (mm)	size range (phi)
very fine sand	0.0625 - 0.125	4 - 3
fine sand	0.125 - 0.25	3 - 2
medium sand	0.25 - 0.5	2 - 1
coarse sand	0.5 - 1.0	1 - 0

The coarsest sediment in the area was the coarse sand found as a lag deposit on the disposal bin. This material represents a deposit left after finer material was washed out or blown off the surface of the bin sediments. Medium and coarse sand is present at two of the DOT sample sites lakeward of the channel markers and in areas not dredged. The origin of coarser sand was either the coarse component of the general dredged material or it may have been associated with the gravel encountered by the dredge near the channel markers.

Most of the material in the area is fine to very fine sand. It constitutes the material found in the channel area and is characteristic of the sediment comprising the sand bars, washover bars, windblown accumulations, and beaches. Sutton et al. (1965) found that such fine sediment extends lakeward from Braddock Bay to depths greater than 25 feet. Sedimentologists consider that material of this grain size is capable of being eroded and transported more easily than any other grain size, including clay and silt (Fig. 8).

The source for the sediment at the mouth of Braddock Bay is considered by Sutton et al. (1974) to be subaqueous glacial till undergoing erosion during a rise in lake level over the last 5000 years. Erosion of the bluffs at Braddock Heights and Manitou Beach may have been important in the past. Their present "armoring" by property owners precludes additional contributions of sediment

FIGURE 7 Mean grain size (in phi) for sediment samples



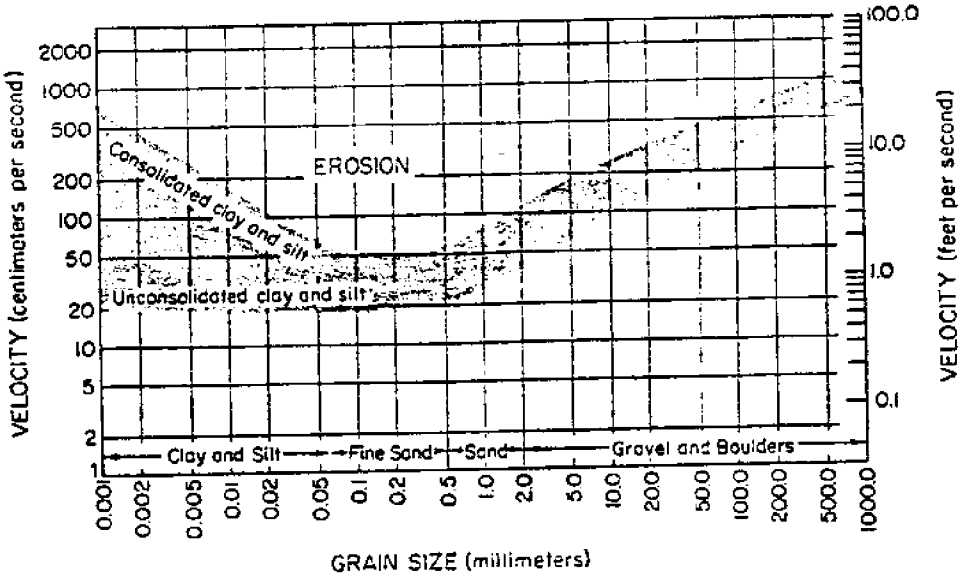


FIGURE 8 Hjulstrom's diagram showing critical velocity for movement of quartz grains. The shaded area indicates the scatter of experimental error. From Blatt et al., 1972

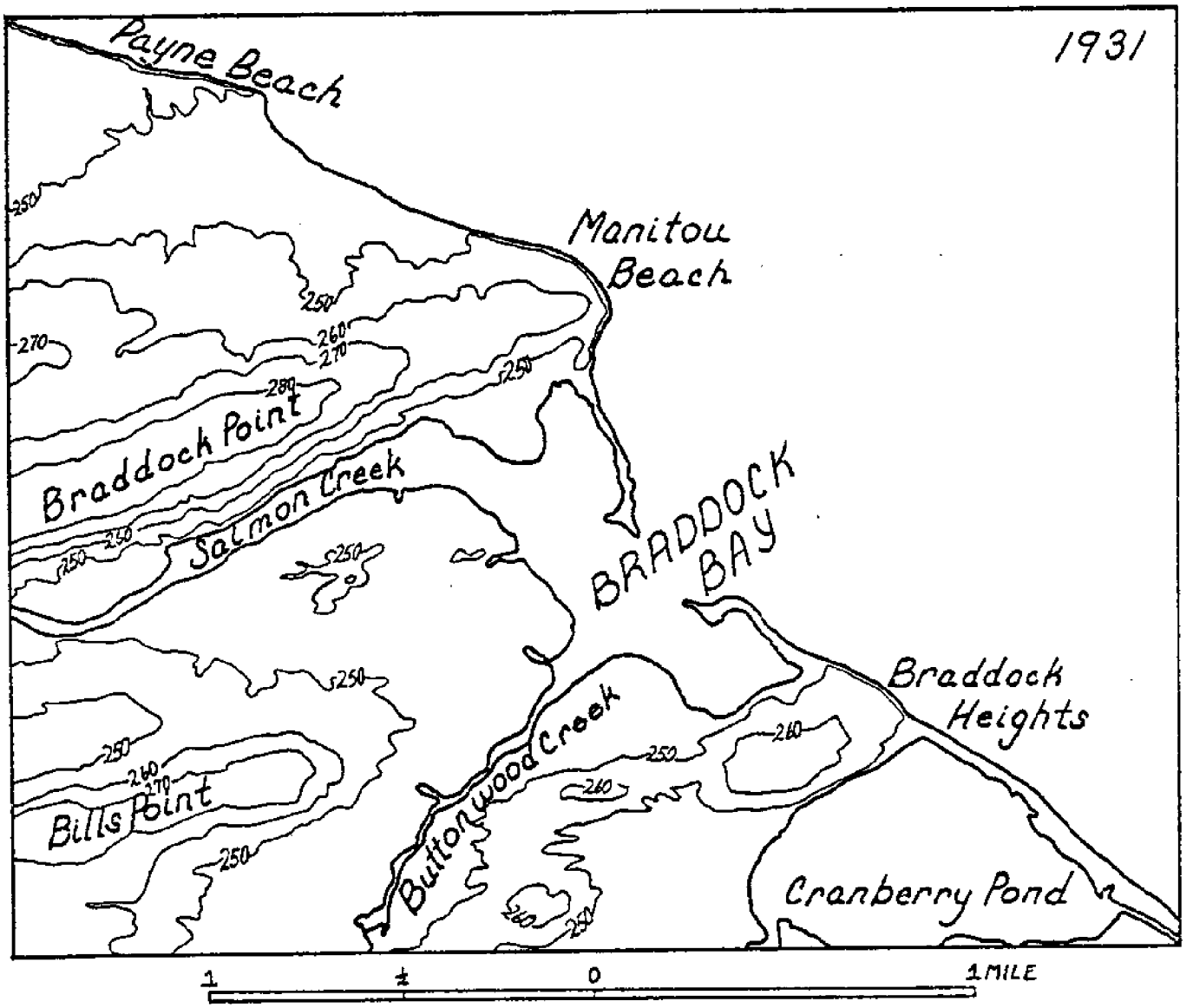


FIGURE 9 Topographic map of the Braddock Bay area, 1931. Note extensive spit development at the east and west margins of the bay mouth.

Movement of the fine sediment at the mouth of Braddock Bay was considered in the "Beach Erosion Control Report on Cooperative Study of the New York State Parks, Lake Ontario - Braddock Bay State Park" prepared by the U.S. Corps of Engineers, 1954:

> " Sand which has accumulated at the mouth of Braddock Bay over a period of many years is subject to reversals of drift and no apparent change in its amount has occurred in recent years. The lack of accretion on either side of the old structures just west of the bay mouth or adjacent to the two new groins on the easterly spit in the two years following their construction indicates the absence of a large amount of drift in the area".

In his evaluation of the sediment distribution within Braddock Bay, Peter Buttner, Director of the Environmental Management Bureau, N.Y.S. Department of the Office of Parks and Recreation, concluded that the sand present represents a wedge of sediment originating from the lake (Buttner, 1978).

Sediment dispersal

The movement of the sand-sized sediment at the mouth of Braddock Bay has been considered to be in and out of the bay with sediment originating from the lake. There is no documentation of movement parallel to the lake shore. Evidence for such transport is available on the U.S.G.S. Topographic Map of the area for 1931 (Fig. 9). The general form of the spits at the bay mouth may have resulted from the abandoned trolley track bed across the mouth, however, the terminal curvature at the tips of the east and west spits attest to movement toward the west and east respectively. Material in these spits may have originated in part from the bluffs at the northeast end of Braddock Heights and Braddock Point and in part from the lake. Subsequent protection of the shorefront property may have reduced sediment supply from the east and west and by 1954 (Corps of Engineer's report) no major sediment movement was apparent.

TABLE 2 Combined discharge of Buttonwood and Salmon Creeks into Braddock Bay during IFYGL 1972-73: Relative frequency.

100	% of flows greater than	19 cfs
80	%	30
60	%	40
50	%	70
40	%	150
30	%	200
20	%	350
10	%	400
5	%	565

(After U.S. Geological Survey Open File Report on Lake Plain Hydrology for the International Field Year on the Great Lakes 1972-73, Albany, New York)

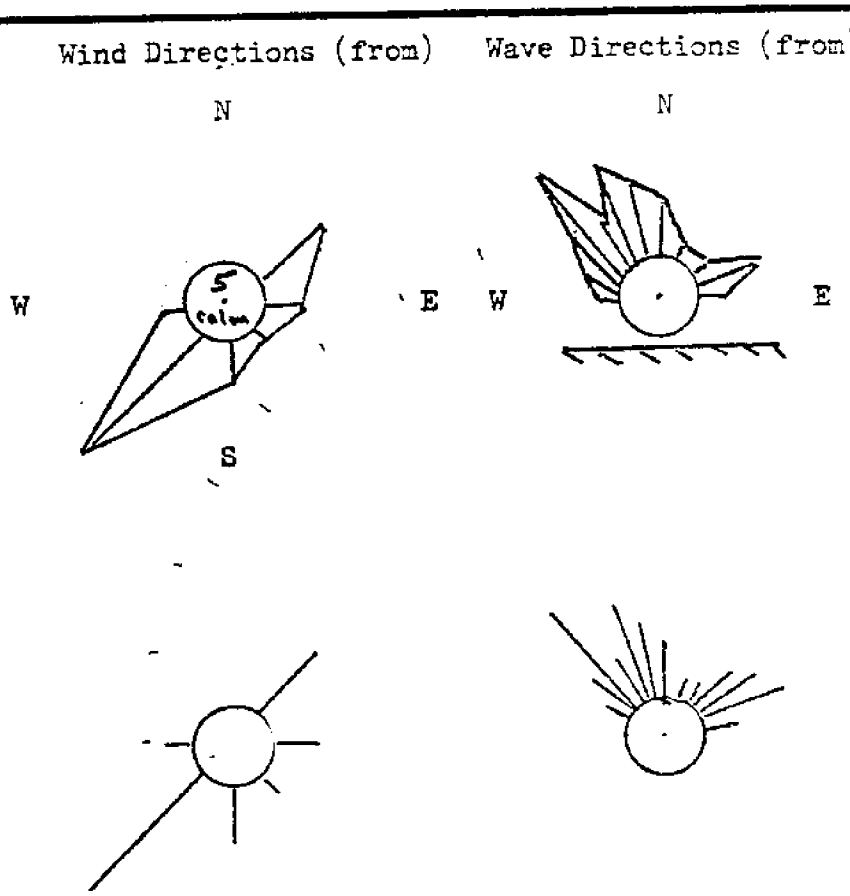


FIGURE 10 Winds and wave directions on the Lake Ontario shore. In September and October 1976 wind and wave observations were made at the Brockport Water Plant. A wind rose and wave rose indicating relative frequency of observations during that time.

Dispersal of the dredged sediments from the 1977 operation seems to have paralleled the inferred movement in 1931. The sand bar at the western end of the jetty, washover sand masses to the south of the jetty, and the lack of significant accumulation adjacent to the groin to the east suggest an east to west movement of much of the material. This lateral movement, in conjunction with a normal input from the lake, served to produce the present conditions at the mouth of the bay.

Supplementary information

The depositional and scouring activity of streams entering the bay was considered. The 100 square mile Salmon Creek - Buttonwood Creek watersheds have discharges indicated in table 2. No extensive study was made on stream velocities or water and sediment transport.

Maximum discharges and associated high velocities after spring snowmelt have excavated natural channels through the bay when the lake level (stream base level) was lower according to local residents. However, current measurements by Buttner (1978) indicated little erosion or deposition of sand-sized material from the streams.

Currents associated with storms and wind-wave interaction appear to be largely associated with sediment transport and deposition. Transport associated with waves driven by northeast winds was observed on several occasions. This is complicated by refraction of shallowing waves, surges, and currents within the bay.

Relative frequencies of wave directions observed at the lake shore 7 miles west of Braddock Bay are indicated by figure 10. The most frequent west-to-east component generally produces an eastward moving long shore current transporting sediments (Casey, et al., 1965). However, refraction alters direction of transport (Fig. 11), and eddy currents in the Rochester embayment were observed to carry suspended matter westward from the Genesee River plume during the

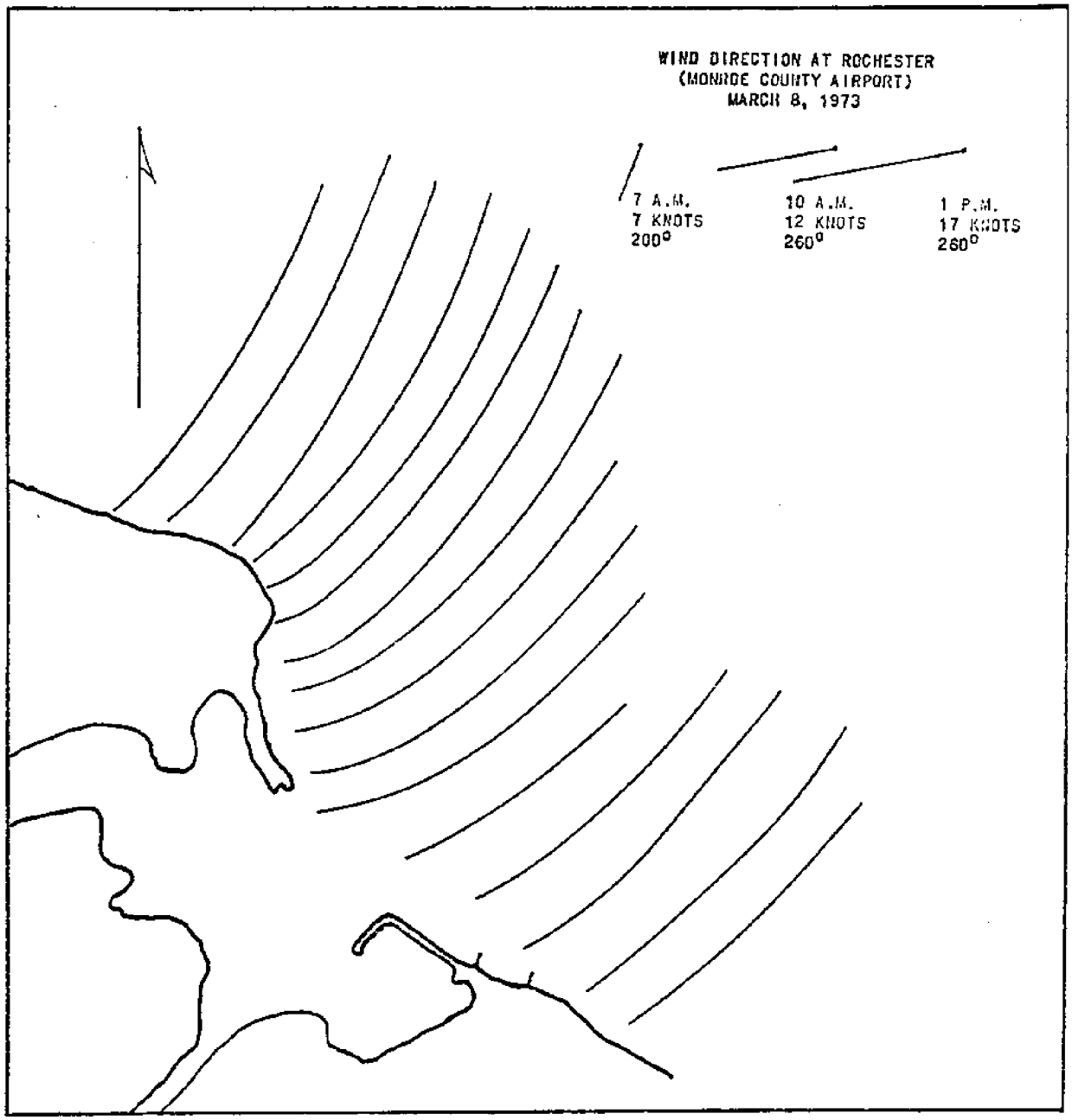


FIGURE 11 Wave fronts approaching Braddock Bay. Tracing from an aerial photograph March 8, 1973. Insert shows winds recorded at the Monroe Count airport for the same day (winds from direction shown).

International Field Year (1972-73) (J. Scott, personal communication). Thus current movement and sediment transport in the general region are very complex.

Suggestions for further research

To predict the consequences of dredging it will be necessary to obtain information on the effect of waves, currents, and changing lake levels on sediment movement. It appears that sediment movement is related to the currents formed by refracting wave fronts at the bay mouth interacting with the topography of the bay and lake floors. Relating these processes to seasonal wind patterns and changing lake levels would be a complex modeling problem. The ready movement of the dredged sediment would necessitate consideration of disposal beyond the influence of the lake and bay mouth currents.

Alternatives to large scale dredging such as John Finnegan's suggested drag line or limit to shallow draft use should be evaluated thoroughly.

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