

This report has been prepared at the request of Environmental Protection, Ontario Region, Environment Canada.

**Impact of the Rubblemound Breakwater
at Goderich Harbour on Coastal and
Fluvial Processes**

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MANAGEMENT PERSPECTIVE

This study has been conducted at the request of an inter-Departmental client, Environmental Protection, Ontario Region. It provides valuable information for the management of waterfront resources at Goderich. An interesting discovery resulting from the hydrographic surveys is that the lake bottom in the vicinity of the harbour is subsiding significantly due to subsurface salt mining activity. This subsidence has profound implications for the future maintenance of the harbour structures. This data base of pre- and post-construction surveys will allow future assessments of impacts over longer time periods.

**John Lawrence
Director
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PERSPECTIVE DE GESTION

Cette étude a été effectuée à la demande d'un client inter-ministériel de la Protection de l'environnement, région de l'Ontario. Elle renferme une information précieuse pour la gestion des ressources du secteur riverain à Goderich. Les levés hydrographiques effectués ont permis une découverte intéressante, soit que dans les environs du port le fond du lac s'affaise de manière importante en raison de l'activité d'exploitation minière souterraine du sel. Cette subsidence a d'importantes répercussions sur l'entretien futur des ouvrages portuaires. Cette base de données sur les levés avant et après construction permettra des évaluations futures des incidences à plus long terme.

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ABSTRACT

An environmental monitoring program has been conducted at Goderich Harbour for four years to assess the impact of a new rubblemound breakwater on local coastal and fluvial processes. Hydrographic surveys were carried out to determine changes in water depth and in sediment erosion/deposition patterns. Bed material surveys were carried out to identify initial conditions and to document changes. Results from 1984 to 1988 indicate no adverse environmental impacts due to the new breakwater. However, significant subsidence of the lake bottom in the vicinity of the harbour is taking place as a result of subsurface salt mining activity.

RÉSUMÉ

Un programme de surveillance environnementale a été mené au port de Goderich pendant une durée de quatre ans afin d'évaluer l'incidence d'un nouveau brise-lames en enrochement sur les processus littoraux et fluviaux locaux. Des levés hydrographiques ont été effectués pour déterminer les variations de la profondeur de l'eau et des configurations d'érosion et de dépôt de sédiments. Des relevés des matériaux du fond ont été effectués afin de permettre l'identification des conditions initiales et pour documenter les changements. Les résultats obtenus de 1984 à 1988 indiquent que le brise-lames n'a aucune incidence environnementale nuisible. Cependant, il y a un affaissement important du fond du lac aux environs du port en raison de l'activité d'exploitation minière souterraine du sel.

1.0 BACKGROUND

In 1984-85 Transport Canada expanded Goderich Harbour in order to provide a new wharf for Domtar Ltd. As part of the project, a 610 m long rubblemound breakwater was designed and constructed by Public Works Canada (PWC) (Figures 1 and 2). Prior to approval of the project, environmental concerns were raised about the possibility of the breakwater causing increased sediment deposition at the mouth of the Maitland River and increased erosion rates south of the Harbour. River mouth deposition might aggravate flooding problems on the Maitland River and might lessen the navigability of the mouth of the Maitland River for pleasure craft. Accordingly, Transport Canada agreed to fund a five-year monitoring program at Goderich in order to assess the new breakwater's impact on coastal and fluvial processes.

The Hydraulics Division (now Research and Applications Branch) of the National Water Research Institute was asked to design the monitoring program, analyze the results and prepare reports on the findings. This report presents the results of the five-year monitoring program (preliminary results are available in an earlier report by Bishop (1987)).

Construction of the breakwater began in November 1984 and final armouring was completed in December 1985. By the end of January 1985 the partially built breakwater extended lakeward about half its final length (PWC, Progress Chart, 1985) and can be assumed to have been acting as a substantial, if not total, barrier to the southward littoral drift from that time onward.

The predominant direction of littoral transport at Goderich is southward. The existing entrance channel structures and offshore breakwaters have been in their present configuration since 1916. Prior to the construction of the rubblemound breakwater, sand was transported

into the harbour entrance channel from which it was dredged periodically and dumped offshore and, therefore, was lost to the littoral system. Now, with the rubblemound breakwater in place, sand is expected to accrete on the north side of the harbour. "It is estimated that this accretion will occur for about 500 years before the nearshore area north of the harbour is filled with sand and sand starts to bypass the harbour" (Reinders 1989). Therefore, since at least 1916, the Goderich Harbour structures have formed a man-made littoral cell boundary, thereby creating two cells, within the natural littoral cell from Point Clark to Kettle Point (Reinders 1989). "A littoral cell is a defined section of coast where no input or outflow of sediments takes place across its boundaries. In other words, a littoral cell is a self-contained coastal system, where the ongoing shoreline processes are not affected by the processes of the neighbouring cells. The alongshore limits of such a cell are defined by natural formations or artificial barriers where the net sediment movement changes direction or becomes zero" (Reinders 1988).

2.0 MONITORING PROGRAM

The monitoring surveys were conducted by the Water Resources Branch, Water Survey of Canada, Environment Canada. The three components of the program included:

- i) Hydrographic survey of the Goderich Harbour area, including the Maitland River estuary.
- ii) Hydrographic survey of 5 range lines.
- iii) Bed material survey of nearshore and estuary deposits (Figure 3).

Four surveys have been conducted:

- September 28 - October 1, 1984
- September 10 - 19, 1985

- September 3 - 17, 1986
- September 6 - 16, 1988

No survey was conducted in 1987 because preliminary survey results (Bishop 1987) did not indicate any serious adverse environmental impacts.

The hydrographic surveys were conducted using an automated Hydrographic Data Acquisition System, designated as HYDAC-100 (Durette and Zrymiak 1978). Bottom surface sediment samples were collected using a Shipek 860 sampler. PWC provided assistance by locating, establishing and checking some of the control points used in the survey portion of the study.

2.1 AREA SURVEYS

In order to assess the impact of the new breakwater in the immediate area of Goderich Harbour, hydrographic surveys were scheduled on an annual basis. The limits selected for the study area were: 1.0 km north of the breakwater (to a depth of 5 metres), 1.8 km south of the breakwater (to a depth of 5 metres), 1.0 km west of the harbour to a depth of 10 metres and east within the estuary to the railway bridge (Zrymiak 1986). Figure 4 shows the coverage of the area surveys conducted over the four years.

Analysis of the data by the Water Resources Branch includes use of a software package to smooth and average the raw data. It derives corner elevations on a 30 m x 30 m grid. These computed grid corner elevations are then used in all subsequent analysis and plot generation (i.e. contour plots, grid corner elevation plots, elevation-capacity tables). The capacity refers to the water volume between the lake or river bed and a given elevation.

Results from each of the area surveys are available as:

- 1) points plots of soundings
- 2) plots of grid corner elevations of the bed
- 3) contour plots of bed elevations
- 4) elevation-capacity tables

For visual interpretation, contour plots of differences in elevation between pairs of surveys are available over common survey areas between the following years.

- i) 1984 and 1985 (Figure 5)
- ii) 1984 and 1986 (Figure 6)
- iii) 1985 and 1986 (Figure 7)
- iv) 1984 and 1988 (Figure 8)
- v) 1985 and 1988 (Figure 9)
- vi) 1986 and 1988 (Figure 10)

Grid corner elevation difference plots are available for comparing the same years as those shown in Figures 5 through 10.

2.2 RANGE LINE SURVEYS

In order to establish a data base from which to assess the effects of the new breakwater on downdrift erosion, range line surveys were measured at 5 locations (Figure 11). These locations were chosen to be the same as those of stations H86 to H90 in the Coastal Zone Atlas (Haras and Tsui 1976) for which estimates of subaerial recession rates are available. In 1984, time and weather constraints prevented the Water Resource Branch from collecting any range line data. However, a PWC survey boat did collect profile data at these five locations. The Water Resources Branch collected profile data at all 5 locations using HYDAC in 1985 and 1986, however, in 1988 data was

collected at H86 and H87 only due to time and weather constraints. Although starting from the same baseline markers onshore, the orientations of some of the PWC and HYDAC profiles differ slightly. The PWC profiles were oriented approximately perpendicular to shore (D. Carr, 1987, personal communication), while the HYDAC profiles were oriented accurately in an east-west direction.

The 1984, 1985, 1986 and 1988 range line profiles are shown in Figures 12 to 16. Differences at profiles H86 and H88 are minor, however, significant differences do appear between PWC and HYDAC surveys for profiles H87, H89 and H90. At these locations the shore perpendicularly are considerably off a due east-west direction. These directional differences are thought to be the main reason for the differences in the profiles between 1984 and 1985.

Interpretation of the range line profile results is complicated by the construction of a groyne south of H87 and the dumping of dredged material between the Goderich sewage treatment plant and the newly constructed groyne. The groyne was constructed in 1986 as part of a bluff stabilization and beach nourishment project by the Town of Goderich (Reinders 1985). In 1985 and 1986 PWC dredged Goderich Harbour and between May 9, 1986 and July 31, 1986 dumped approximately 185,000 m³ of sand, gravel, cobbles and boulders on the beach north of the new groyne as shown in Figure 11. This new groyne may be interrupting northward littoral drift, thereby causing some accretion to the south. Profile H87 may have been affected slightly by deposition of sediment suspended during the dredging operations.

2.3 BED MATERIAL

In order to identify initial bed material conditions, and to document changes that might be attributable to the new breakwater, bottom surface sediment samples were collected and analyzed in 1984,

85, 86 and 88. Results of sediment size analyses, undertaken by the Water Resources Branch, of the bed material samples are summarized in Table 1. All samples are sand-size or coarser.

Boyd (1977) reports on sediment samples taken in 1975 and 1976 with locations shown in Figure 17. Results for 4 locations north of the new breakwater are given in Table 2. They show good agreement with the results from 1984-88, indicating relatively minor changes in surface sediment size from 1975 to 1988.

3.0 SUBSIDENCE

The contour plots of differences in bottom elevation clearly indicate a lowering trend over most of the survey area, even in water depths of 10 m where little change would be expected. After checking the analysis of the water level and HYDAC data, this trend was confirmed as being real. At this point, the authors contacted the Domtar Chemicals Group, Sifto Salt Division, Goderich Mine to inquire about the effects of underground salt mining on the lake bottom. Subsequently, discussions were held with the mine engineer, Neil Crocker.

The Goderich salt mine began operations in 1959. Salt is excavated from 13 m high caverns about 540 m below the surface. About one-half of the rock volume in the mining layer is removed. Subsidence of the ground surface, in this case the lake bottom, starts when stresses on the rock pillars between the caverns become supercritical. In the opinion of Mr. Crocker, this occurred in 1978 after which a period of accelerated subsidence occurred for a few years followed by a rate which will reduce over time. He estimates that the average ultimate subsidence will be about 5 m. The time period over which this will occur is not known, but Mr. Crocker estimates several centuries, maybe a thousand years. A capability exists for predicting

subsidence by using a rock mechanics computer model. The Goderich Mine has a proprietary model that might be made available for such predictions.

The areal extent of the salt mine is compared to the HYDAC survey areas in Figure 4. This shows that virtually all of the HYDAC survey area, except the Maitland River estuary and part of the nearshore area north of the rubblemound breakwater, is underlain by the salt mine. According to Mr. Crocker, the surface subsidence is not expected to be uniform over the area, but rather is probably "bowl-shaped", with the greatest subsidence close to the centre of the mine.

Several estimates of subsidence can be made. The top of the north concrete breakwater was surveyed in 1959 and again in 1988 (N. Crocker, 1989, personal communication). Over this time, the elevation at borehole 10 (see Figure 4) subsided by about 0.61 m. In addition, Water Survey of Canada maintains several bench marks in the vicinity of the Harbour. The Gnomen Contact Gauge (GCG) record from 1961 to 1988 is shown in Figure 18, along with data from Gauge 327A from 1970 to 1988. The GCG data indicates subsidence of 0.40 m between 1961 and 1988, with most occurring since 1967. However, the 327A data indicates subsidence of only 0.039 m between 1970 and 1988. As seen in Figure 4, borehole 10 is well within the mining area, while the GCG is very close to the edge and 327A is well outside. The trend to lesser amounts of subsidence with distance from the centre of the mining area agrees with expectations.

The elevation-capacity tables can also be used to provide estimates of subsidence. Capacities must be compared to the same reference elevation, so the computed capacities in the tables have been adjusted for differences in maximum elevation. Using the area common to all four surveys from 1984 to 1988, and

adjusting the capacities from the maximum elevations given in Tables 3 to 6 to the 1 m elevation, gives the results shown in Table 7. The precision of the HYDAC survey is estimated (J. McIlhinney, 1987, personal communication) to be +/- 2 percent of the capacity. The total survey area is shown on Figure 4.

The northshore area referred to in Tables 5 to 7 consists of the area north of the new rubblemound breakwater, excluding the river estuary and the area west of a line running north from the western end of the rubblemound breakwater. This northshore area traps most of the southerly alongshore transport of littoral material and the material transported downstream by the Maitland River. The most recent supply-based estimate of this southerly sediment (grain size of 0.06 mm or greater) transport rate at Goderich is 26,770 m^3/yr (Reinders 1989). According to the report by Reinders (1989), the Goderich Harbour structures present a complete barrier to the alongshore transport of sand and will continue to do so for hundreds of years. Assuming this to be true, the capacities in Table 7 have been adjusted by increasing the capacity by 26,770 m^3/yr in order to estimate subsidence. Interestingly, the results for both the total survey area and for the northshore area (adjusted) show almost no change in capacity between 1984 and 1985, but then show a linear subsidence from 1985 to 1988.

The northshore area shows a subsidence of 0.36 m over the four year period, while the total survey area less the northshore area shows a subsidence of 0.49 m. As expected, the northshore area shows less subsidence because the bulk of it is outside the boundaries of the mine (Figure 4). The sensitivity of the subsidence calculation to the assumed rate (Q) of southerly sediment transport was checked for the northshore area by using different values of Q with the following results:

Q (m ³ /yr)	Subsidence (m)
20,000	0.31
26,770	0.36
30,000	0.38
35,000	0.41
40,000	0.45

These estimates of subsidence can also be compared to the bench mark data which show drops of 0.087 m at the Gromen Gauge and 0.013 m at Gauge 327A from 1984 to 1988.

The sensitivity calculations indicate that the subsidence is not very sensitive to Q. Therefore, given the uncertainties in the magnitude and spatial variation of the subsidence, any estimate of Q from the adjusted volume of accretion north of the rubblemound breakwater is prone to considerable error.

As seen from the range line surveys, there has been very little change in the profiles at H86. From Figure 11, H86 is at the northern edge of the northshore area, well beyond the boundaries of the mine. Therefore, it is not surprising that subsidence there is negligible. However, profile H87 in Figure 13 shows clear evidence of progressive subsidence. Assuming a linear subsidence of 0.5 m from 1984 to 1988, the HYDAC profiles have been adjusted by adding 0.125 m to the 1986 profile elevations and 0.375 m to the 1988 profile elevations in order to compare them with the 1985 profile (the 1984 profile differences are believed to be due to differences in profile orientation). The resulting profiles are shown in Figure 19. Clearly, these adjustments bring the profiles into much closer agreement. As expected, after adjustment for subsidence, there is no evidence of systematic erosion due to the rubblemound breakwater at profile H87. The Goderich Harbour structures have been acting as a man-made littoral cell boundary ever since their construction and therefore, the littoral regime south of the harbour has not been affected by the construction

of the rubblemound breakwater.

4.0 MAITLAND RIVER ESTUARY

The zones of accretion of littoral sediments are generally as anticipated (Hall and Baird 1984) when a predominantly southward littoral drift has been interrupted by a structure such as the new rubblemound breakwater. Classical littoral drift theory suggests that a fillet beach of sand would form updrift of the breakwater. This has, in fact, occurred but is complicated by flushing of the deposits at the river mouth by the river currents. Material eroded from the zone at the river mouth has probably been displaced westward to the zones of accretion along the rubblemound breakwater and the north concrete breakwater (see Figures 5 to 10); furthermore, some material may be transported into deeper water offshore.

Elevation-capacity tables for 1984, 1985, 1986 and 1988 for the estuary are given in Table 8. Using the area common to all four surveys ($35,100 \text{ m}^2$), and adjusting the capacities from the maximum elevations given in the Tables to the 0.5 m elevation, gives the results shown in Table 9. This shows a mean increase in bed elevation between 1984 and 1985 of 0.10 m, between 1984 and 1986 of 0.16 m, and between 1984 and 1988 of only 0.02 m. Based on relative locations, subsidence over this survey area may be somewhat less than at the Gnomen Gauge and somewhat more than that at Gauge 327A. If it is assumed to be about 0.05 m between 1984 and 1988, the estimates of accretion increase to 0.11 m, 0.18 m and 0.07 m, respectively.

The accretion of sediment in the estuary from 1984 to 1986 can be attributed to the decreased sediment transport capacity of the river resulting from lower river speeds. Erosion of the lake bottom at the river mouth, as seen in Figures 5 to 10, indicates that the accretion in the estuary cannot be due to littoral deposits blocking

the river mouth. After the lake returned to average levels in 1988, the mean bed level in the estuary returned to a level 0.04 m lower than it was in post-construction 1985.

The traditional problems of sand bar formation at the river mouth (Boyd 1977) and of water depths too shallow for navigation by keel boats have not occurred since 1984. This may be due, in part, to the higher than average lake levels during this period. The mean annual level increased each year from 176.39 m IGLD (1955) in 1982 to 177.10 m in 1986. Curves of average (1910 to 1988) and measured lake levels for 1983 to 1988 are shown in Figure 20. The mean monthly level of 177.29 m measured in October 1986 is the highest monthly level in 100 years.

One of the impacts of higher lake levels is to reduce the average speed of the Maitland River discharge in the estuary. Using the results of a PWC sounding survey in June 1985, the river cross-sectional area below datum at the mouth (station 1+20) has been estimated at 200 m² with a top width of 92 m (Figure 21). At another cross-section 240 m upstream (station -1+20) the area has been estimated at 215 m² with a top width of 123 m. From WSC flow measurements at Donnybrook and Summerhill, the maximum instantaneous discharge at the mouth in 1985 has been estimated at 700 m³/s on April 6. The daily mean lake level for April 6, 1985, was 1.11 m above datum. This results in mean river speeds of 2.3 m/s at the mouth and 2.0 m/s at station -1+20. If the lake level had been at its average level, about 0.65 m lower, the corresponding velocities would have been significantly higher at 2.9 m/s and 2.6 m/s respectively.

In addition, it appears that the restriction of the cross-sectional area at the river mouth, caused by the construction of the new breakwater, may be enough to keep the river mouth free of the troublesome sediment deposition of the past. Using the

pre-construction sounding results from an October 1984 PCW survey, the cross-sectional area below datum at station 1+20 has been estimated at 195 m² with a top width of 128 m. The April 6, 1985 peak discharge of 700 m³/s would have produced a mean current of about 2.1 m/s. This is the approximate location of traditional sand bar formation. As mentioned already, the mean current for a discharge of 700 m³/s after breakwater construction was estimated at 2.3 m/s. Currents in this area scoured the toe of the breakwater's armour layer, necessitating scour restoration work and an extra row of armour stone at the toe from station 0+80 to 1+70 (PWC, As Built Drawing, 1986).

Consequently, the anticipated adverse impacts of the new breakwater, namely decreased navigability of the river mouth and increased upstream flooding due to blockage at the river mouth, have not materialized to date.

5.0 CONCLUSIONS

Evidence to date shows that the main environmental concern of the project, namely increased sediment deposition at the mouth of the Maitland River, has not occurred. Restriction of the cross-sectional area at the river mouth by the presence of the new rubblemound breakwater seems to have increased river velocities sufficiently to have actually deepened the channel there. This has occurred in spite of a general fillet beach type accretion of sediment north of the new breakwater.

The Goderich Harbour structures existing prior to 1984 already formed a man-made littoral cell boundary. Therefore, the construction of the rubblemound breakwater on the Harbour's north side has had no incremental impact on the south, or downdrift, side. In the past, PWC has performed regular maintenance dredging of the Harbour entrance channel. Now, the sediments that filled the channel will accrete on the updrift side of the rubblemound breakwater.

Results from hydrographic area and range line surveys indicate an average subsidence of the lake bottom in the vicinity of the Goderich salt mine of about 0.5 m between 1984 and 1988. This has important ramifications for the future maintenance of both the new rubblemound breakwater and the older harbour structures.

RECOMMENDATIONS

1. The results of the five-year monitoring program indicate no adverse environmental impacts due to construction of the rubblemound breakwater. The monitoring program can be discontinued.
2. Transport Canada should investigate the impact of future subsidence on the maintenance of the Goderich Harbour structures.
3. The Maitland Valley Conservation Authority is encouraged to build on this valuable data base by continuing to monitor the subaqueous erosion at the five range lines.

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TABLE 1
Bed Material Sample Sites and Sizes

Sample Number	Easting	Northing	D_{50} (mm)			
			1984	1985	1986	1988
1	4775	5284	23	43	15	0.20
2	4887	5283	12	25	-	-
3	5143	5332	28	38	-	-
4	5315	5365	39	-	-	-
5	5435	5485	5.4	-	-	-
6	4775	5373	0.22	0.20	0.19	0.21
7	4775	5525	0.22	0.19	0.27	0.21
8	4775	5660	0.22	0.30	0.27	0.20
9	4775	5705	0.19	0.20	0.15	0.20
10	4775	5865	0.20	0.19	0.22	38
11	4600	5195	0.69	-	-	-
12	4300	5100	0.26	-	-	-
13	4115	4895	0.22	-	-	-
14	4395	4910	0.15	-	-	-
15	4490	4810	0.15	-	-	-
16	4595	4610	0.16	-	-	-
17	4465	5250	0.32	-	-	-
18	4710	4420	90	45	-	-
19	4860	4030	0.32	90	-	-
20	4860	3500	44	21	-	-
21	4530	4050	16	cobbles	-	-
22	4370	4440	4.7	cobbles	0.12	0.09
23	4080	4660	45	0.19	0.18	32
24	3970	5080	19	0.36	22	0.14
25	4100	5200	0.17	0.18	0.074	0.13
26	3850	4760	0.25	0.21	-	44
27	3850	4880	0.55	-	-	7.9
28	3800	4840	14	0.22	-	0.35
29	4500	5400	0.40	0.29	0.29	0.17
30	4300	5400	-	0.29	0.17	0.19
31	4300	5500	-	0.29	92	0.27
32	4500	5600	-	44	0.23	52
33	4300	5700	-	0.009	0.10	52
34	4500	5800	-	44	0.024	cobbles
35	4300	5900	-	0.009	0.008	39
36	4600	5300	-	-	11	21
37	4400	5300	-	-	2.8	1.5
38	4200	5300	-	-	0.37	0.50
39	4000	5300	-	-	0.28	0.16
40	3900	5200	-	-	0.039	0.11
41	3800	5100	-	-	0.041	0.81
42	3700	5000	-	-	0.082	0.46

Table 2
Bed Material Sample Sizes from Boyd (1977)

Sample Number	Closest Sample in Table 1	April 1975 D_{50} (mm)	October 1976 D_{50} (mm)
A-300-500	32	0.19	0.19
A-305-420	29	0.21	0.13
B-45-173	6	0.26	-
B-45-460	30	0.23	0.22

TABLE 3. 1984 and 1985 elevation-capacity tables for total survey area common to 84, 85, 86 and 88 surveys

COMPUTED JAN 1988		ELEVATION INCREMENT = .25 M.		GRID AREA =		800. SO. W. COMPUTED JAN 1988		ELEVATION INCREMENT = .25 M.		GRID AREA =		800. SO. W.	
ELEVATION (M.)	NO. OF POINTS	SURFACE AREA (SQ. M.)	VOLUME (1000 CU. M.)	ACC. VOLUME (1000 CU. M.)	GRID AREA	ELEVATION (M.)	NO. OF POINTS	SURFACE AREA (SQ. M.)	VOLUME (1000 CU. M.)	ACC. VOLUME (1000 CU. M.)	GRID AREA	ELEVATION (M.)	
-10.75	10.00	8000.	.5	.5		-11.00	2.00	1800.			.2		
-10.50	74.75	76275.	8.6	9.1		-10.75	12.00	12600.			1.5		
-10.25	233.75	286650.	45.1	54.1		-10.50	80.00	84600.			9.8		
-10.00	223.50	487800.	98.9	151.1		-10.25	211.25	274725.			41.8		
-9.75	189.25	658125.	143.2	284.3		-10.00	284.50	530775.			53.3		
-8.50	149.75	789300.	183.8	478.1		-9.75	187.25	689300.			102.5		
-9.25	114.00	891800.	208.5	686.6		-8.50	127.50	814650.			155.8		
-8.00	63.50	967050.	232.4	919.0		-9.25	88.00	802850.			150.8		
-6.75	65.50	1026000.	248.3	1167.3		-8.00	70.25	865475.			183.8		
-8.50	71.75	1090575.	264.7	1432.1		-6.75	56.25	1016100.			210.9		
-8.25	63.75	1147950.	279.3	1711.3		-8.50	72.00	1086300.			237.6		
-8.00	52.00	1194150.	283.5	2004.8		-7.25	42.25	1118925.			243.6		
-7.75	28.75	1221525.	292.6	2287.4		-8.00	66.25	1179550.			265.1		
-7.50	18.25	1238850.	320.5	2617.8		-7.75	34.50	1206600.			277.4		
-7.25	25.00	1261350.	275.1	2892.9		-7.50	23.25	1230825.			286.0		
-7.00	34.25	1292175.	350.5	3243.4		-7.00	21.75	1250100.			314.7		
-6.75	22.00	13111875.	350.9	3574.3		-6.75	28.25	1271525.			310.4		
-6.50	32.25	1341000.	331.8	3806.1		-6.50	29.75	1302300.			3243.0		
-6.25	37.50	1374750.	333.1	4239.2		-6.25	34.75	1335975.			399.0		
-6.00	38.00	1408850.	331.4	4890.6		-6.00	38.00	1367775.			353.2		
-5.75	43.00	1447850.	347.6	4988.6		-5.75	40.75	1404450.			341.2		
-5.50	62.25	1603675.	373.5	5312.0		-5.50	48.25	1446075.			345.7		
-5.25	63.25	1650650.	387.1	5888.1		-5.25	58.25	1495500.			359.1		
-5.00	77.25	1630125.	398.5	6097.6		-5.00	82.00	1571200.			366.1		
-4.75	65.25	1688850.	415.1	6512.7		-4.75	60.25	1626525.			384.4		
-4.50	57.75	1740425.	415.7	6326.4		-4.50	62.75	1633000.			398.9		
-4.25	60.00	1784425.	453.6	7382.0		-4.25	50.50	1728480.			411.3		
-4.00	48.75	1838600.	484.2	7636.2		-4.00	67.00	1718750.			428.3		
-3.75	78.50	1810250.	468.2	8304.3		-3.75	65.00	187250.			434.1		
-3.50	67.00	1970550.	488.3	8189.7		-3.75	67.50	1980000.			455.8		
-3.25	57.00	2021850.	489.0	8288.7		-3.25	75.00	1915500.			478.9		
-3.00	58.00	2074050.	479.0	8767.7		-3.00	49.50	2020050.			479.1		
-2.75	54.50	2123100.	553.7	10321.4		-2.75	66.00	2079450.			503.6		
-2.50	54.50	2172150.	540.9	10362.4		-2.50	52.25	2126475.			513.3		
-2.25	41.00	2318235.	532.7	11395.1		-2.25	52.75	21713850.			525.9		
-2.00	62.25	2266200.	579.6	11974.7		-2.00	54.50	2230000.			523.2		
-1.75	19.00	2421800.	567.9	12522.6		-1.75	48.50	2266550.			549.8		
-1.50	4.50	2425550.	613.4	14806.4		-1.50	46.00	2308050.			568.3		
-1.25	.25	2426175.	600.0	15506.4		-1.50	35.25	2339775.			568.8		
-1.00	.25	2426100.	597.2	13714.4		-1.25	37.50	2313525.			592.6		
-0.75	.25	2404600.	578.5	14282.9		-1.00	31.75	2402100.			588.8		
-0.50	.25	2426400.	567.1	16331.4		-0.50	18.50	2416050.			580.6		
0.00	.25	2426400.	748.0	16563.3		-0.25	7.25	242575.			510.1		
.25	.25	2426400.	748.0	16531.4		.25	.50	2426400.			525.7		
MINIMUM ELEVATION = -10.62		MAXIMUM ELEVATION = .08		MINIMUM ELEVATION = -10.62		MAXIMUM ELEVATION = .17		ACC. VOLUME =		MAXIMUM ELEVATION = .17		ACC. VOLUME =	

TABLE 4. 1986 and 1988 elevation-capacity tables for total survey area common to 84, 85, 86 and 88 surveys

COMPUTED JAN 1988		ELEVATION INCREMENT* -25 M.		GRID AREA- ACC. VOLUME (1000 CU. M.)		SOO. SQ. M.		COMPUTED JAN 1988		ELEVATION INCREMENT* -25 M.		GRID AREA- SURFACE AREA (sq. m.)		ACC. VOLUME (1000 CU. M.)		SOO. SQ. M.	
ELEVATION (M.)	NO. OF POINTS	SURFACE AREA (sq. m.)	VOLUME (1000 CU. M.)	GRID AREA	ACC. VOLUME (1000 CU. M.)	SOO. SQ. M.	GRID AREA	ELEVATION (M.)	NO. OF POINTS	ELEVATION INCREMENT* -25 M.	GRID AREA- SURFACE AREA (sq. m.)	ACC. VOLUME (1000 CU. M.)	SOO. SQ. M.	GRID AREA	MAXIMUM ELEVATION*		
-11.00	1.00	.900.	.1	.1	.1	.1	.1	-11.50	1.00	.900.	.1	.1	.1	.1	.1	.1	
-10.75	29.75	27675.	3.0	3.1	3.1	3.0	3.1	-11.25	22.00	20700.	1.7	1.7	1.7	1.7	1.7	1.7	
-10.50	200.25	207900.	27.5	30.6	30.6	27.5	30.6	-11.00	112.78	122175.	13.9	13.9	13.9	13.9	13.9	13.9	
-10.25	217.25	403425.	76.3	108.9	108.9	76.3	108.9	-10.75	201.75	303750.	83.9	83.9	83.9	83.9	83.9	83.9	
-10.00	248.75	627300.	129.5	238.3	238.3	129.5	238.3	-10.50	223.00	504450.	100.7	100.7	100.7	100.7	100.7	100.7	
-9.75	189.00	788300.	178.4	416.7	416.7	178.4	416.7	-10.25	232.00	719250.	193.6	193.6	193.6	193.6	193.6	193.6	
-9.50	110.00	888300.	211.5	628.2	628.2	211.5	628.2	-10.00	135.78	836325.	195.6	195.6	195.6	195.6	195.6	195.6	
-9.25	75.25	856925.	228.9	857.1	857.1	228.9	857.1	-9.75	100.25	926550.	219.5	219.5	219.5	219.5	219.5	219.5	
-9.00	67.00	1016325.	244.8	1101.5	1101.5	244.8	1101.5	-9.50	90.50	989225.	239.5	239.5	239.5	239.5	239.5	239.5	
-8.75	68.25	1077750.	266.0	1367.4	1367.4	266.0	1367.4	-9.25	46.25	1040850.	253.9	253.9	253.9	253.9	253.9	253.9	
-8.50	48.00	1120850.	285.7	1633.2	1633.2	285.7	1633.2	-8.75	41.75	1078425.	266.7	266.7	266.7	266.7	266.7	266.7	
-8.25	57.25	1172475.	282.8	1916.0	1916.0	282.8	1916.0	-8.00	50.50	1123875.	284.3	284.3	284.3	284.3	284.3	284.3	
-8.00	33.50	1202625.	302.0	2218.0	2218.0	302.0	2218.0	-7.75	85.75	1174050.	295.7	295.7	295.7	295.7	295.7	295.7	
-7.75	23.00	1223325.	280.0	2498.0	2498.0	280.0	2498.0	-7.50	34.75	1206325.	288.2	288.2	288.2	288.2	288.2	288.2	
-7.50	19.50	1240875.	337.4	2835.4	2835.4	337.4	2835.4	-7.25	18.25	1221750.	290.0	290.0	290.0	290.0	290.0	290.0	
-7.25	28.50	1267425.	312.1	3147.5	3147.5	312.1	3147.5	-7.00	17.75	1238625.	292.1	292.1	292.1	292.1	292.1	292.1	
-7.00	35.75	1289600.	322.3	3469.8	3469.8	322.3	3469.8	-6.75	18.75	1257975.	293.6	293.6	293.6	293.6	293.6	293.6	
-6.75	26.00	1323000.	319.0	3788.8	3788.8	319.0	3788.8	-6.50	21.50	1287225.	317.2	317.2	317.2	317.2	317.2	317.2	
-6.50	34.50	1384080.	343.3	4132.1	4132.1	343.3	4132.1	-6.25	32.50	1313225.	330.7	330.7	330.7	330.7	330.7	330.7	
-6.25	42.25	1392075.	346.2	4478.3	4478.3	346.2	4478.3	-6.00	6.75	1313200.	329.3	329.3	329.3	329.3	329.3	329.3	
-6.00	59.00	1421880.	340.3	4810.6	4810.6	340.3	4810.6	-5.75	7.50	1353700.	338.5	338.5	338.5	338.5	338.5	338.5	
-5.75	57.50	1479800.	377.1	5185.7	5185.7	377.1	5185.7	-5.50	21.50	1368325.	332.6	332.6	332.6	332.6	332.6	332.6	
-5.50	59.75	1533375.	369.2	5564.9	5564.9	369.2	5564.9	-5.25	6.00	1428750.	358.8	358.8	358.8	358.8	358.8	358.8	
-5.25	72.25	1588400.	388.9	5953.9	5953.9	388.9	5953.9	-5.00	49.25	1473075.	360.3	360.3	360.3	360.3	360.3	360.3	
-5.00	1651500.	409.3	6362.1	6362.1	409.3	6362.1	-4.75	5.75	1636925.	377.0	377.0	377.0	377.0	377.0	377.0		
-4.75	84.00	1700100.	425.7	6787.8	6787.8	425.7	6787.8	-4.50	61.00	1591425.	394.5	394.5	394.5	394.5	394.5	394.5	
-4.50	64.75	1758375.	429.3	7217.1	7217.1	429.3	7217.1	-4.25	64.75	1649700.	406.4	406.4	406.4	406.4	406.4	406.4	
-4.25	66.25	1818000.	448.4	7665.4	7665.4	448.4	7665.4	-4.00	48.25	1689125.	411.8	411.8	411.8	411.8	411.8	411.8	
-4.00	1874025.	462.2	8127.7	8127.7	462.2	8127.7	-3.75	4.75	1746450.	424.2	424.2	424.2	424.2	424.2	424.2		
-3.75	63.75	1931400.	473.8	8601.4	8601.4	473.8	8601.4	-3.50	63.00	1803150.	456.3	456.3	456.3	456.3	456.3	456.3	
-3.50	72.50	1986650.	483.1	9084.6	9084.6	483.1	9084.6	-3.25	61.75	1858725.	460.7	460.7	460.7	460.7	460.7	460.7	
-3.25	47.75	2039625.	505.4	9589.9	9589.9	505.4	9589.9	-3.00	60.50	1913625.	475.6	475.6	475.6	475.6	475.6	475.6	
-3.00	57.50	2091375.	520.5	10113.4	10113.4	520.5	10113.4	-2.75	67.00	1988075.	486.5	486.5	486.5	486.5	486.5	486.5	
-2.75	56.00	2141775.	517.9	10631.4	10631.4	517.9	10631.4	-2.50	61.25	2028375.	510.3	510.3	510.3	510.3	510.3	510.3	
-2.50	49.00	2185875.	547.5	11179.8	11179.8	547.5	11179.8	-2.25	55.25	2133225.	520.2	520.2	520.2	520.2	520.2	520.2	
-2.25	54.00	2224475.	522.6	11701.4	11701.4	522.6	11701.4	-2.00	52.25	2173050.	518.3	518.3	518.3	518.3	518.3	518.3	
-2.00	44.75	2224750.	588.9	12298.4	12298.4	588.9	12298.4	-1.75	44.25	2210175.	543.7	543.7	543.7	543.7	543.7	543.7	
-1.75	53.00	2322450.	580.4	12875.8	12875.8	580.4	12875.8	-1.50	41.25	2248875.	541.3	541.3	541.3	541.3	541.3	541.3	
-1.50	34.50	2383500.	579.8	13455.6	13455.6	579.8	13455.6	-1.25	43.00	2282875.	562.5	562.5	562.5	562.5	562.5	562.5	
-1.25	4.25	2421000.	659.4	16446.8	16446.8	659.4	16446.8	-1.00	49.00	2428050.	576.0	576.0	576.0	576.0	576.0	576.0	
0.00	3.75	2424375.	943.1	16990.0	16990.0	943.1	16990.0	-0.75	40.00	2426400.	580.1	580.1	580.1	580.1	580.1	580.1	
.25	2.00	2426175.	603.3	17582.3	17582.3	603.3	17582.3	-0.50	1.50	2426400.	595.6	595.6	595.6	595.6	595.6	595.6	
.50	.25	2426400.	145.6	17737.8	17737.8	145.6	17737.8	-0.25	1.25	2401875.	614.4	614.4	614.4	614.4	614.4	614.4	
.75	.25	MAXIMUM ELEVATION*	-10.80	MINIMUM ELEVATION*	-11.30	MAXIMUM ELEVATION*	-10.80	-1.00	14.75	2415150.	656.4	656.4	656.4	656.4	656.4	656.4	
																- .47	

TABLE 5. 1984 and 1985 elevation-capacity tables for northshore area common to 84, 85, 86 and 88 surveys

COMPUTED FEB 1988							ELEVATION INCREMENT= .25 M.							ELEVATION INCREMENT= .25 M.								
COMPUTED FEB 1988			NO. OF POINTS		SURFACE AREA (SQ. M.)		ACC. VOLUME (1000 CU. M.)		GRID AREA=		ACC. VOLUME (1000 CU. M.)			GRID AREA=			ACC. VOLUME (1000 CU. M.)			GRID AREA=		
ELEVATION (M.)			(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)	(1000)		
-10.50	.50	450.			.0	.0																
-10.25	4.25	4275.			.6	.7																
-10.00	4.25	8100.			1.3	2.5																
-9.75	3.75	11475.			2.4	4.9																
-9.50	2.25	13500.			3.2	8.1																
-9.25	3.50	16550.			3.5	11.6																
-9.00	1.00	17590.			3.5	14.3																
-8.75	2.50	18800.			2.7	20.5																
-8.50	3.00	22800.			5.4	25.9																
-8.25	3.00	25200.			5.4	25.9																
-8.00	3.00	27800.			5.9	31.6																
-7.75	5.75	33675.			6.5	38.2																
-7.50	6.50	38600.			7.5	45.6																
-7.25	7.25	47925.			8.9	55.5																
-7.00	6.25	53350.			8.9	64.4																
-6.75	6.75	59175.			14.1	78.6																
-6.50	20.00	77175.			13.0	91.5																
-6.25	21.75	96750.			18.5	110.0																
-6.00	19.50	114500.			20.9	130.9																
-5.75	21.50	133850.			26.9	187.8																
-5.50	28.50	156500.			30.4	188.2																
-5.25	34.00	170775.			35.8	224.0																
-5.00	21.50	180125.			41.0	265.0																
-4.75	33.00	309150.			46.0	311.0																
-4.50	40.25	222875.			51.9	362.9																
-4.25	38.75	257850.			56.5	421.4																
-4.00	34.00	288450.			69.9	491.3																
-3.75	23.00	431100.			74.9	566.1																
-3.50	40.25	345375.			82.0	648.1																
-3.25	38.50	380025.			91.3	739.5																
-3.00	28.50	408975.			95.7	835.2																
-2.75	27.25	431100.			100.3	935.6																
-2.50	17.75	447075.			110.9	1046.5																
-1.50	16.50	469125.			116.5	120.0																
-1.25	12.00	483200.			113.5	128.0																
-1.00	6.25	508175.			127.1	1407.1																
-0.75	10.50	561625.			123.7	1530.8																
-0.50	1.75	563300.			138.5	1669.3																
-0.25	1.75	535950.			138.5	1799.5																
COMPUTED FEB 1988							ELEVATION INCREMENT= .25 M.							ELEVATION INCREMENT= .25 M.							MAXIMUM ELEVATION= -10.32	
COMPUTED FEB 1988							ACC. VOLUME (1000 CU. M.)							ACC. VOLUME (1000 CU. M.)							MINIMUM ELEVATION= -10.18	
COMPUTED FEB 1988							GRID AREA=							GRID AREA=							MAXIMUM ELEVATION= -0.00	
COMPUTED FEB 1988							ACC. VOLUME (1000 CU. M.)							ACC. VOLUME (1000 CU. M.)							MINIMUM ELEVATION= -0.06	

TABLE 6. 1986 and 1988 elevation-capacity tables for northshore area common to 84, 85, 86 and 88 surveys

NORTH SHORE - 1986 (COMB 84-88 AREA)

ELEVATION INCREMENT - .25 M.						ACC. VOLUME		GRID AREA	
NO. OF POINTS		SURFACE AREA (sq. m.)	VOLUME (1000 cu. m.)	ACC. VOLUME (1000 cu. m.)	NO. OF POINTS	ELEVATION (M.)	ACC. VOLUME (1000 cu. m.)	GRID AREA (1000 cu. m.)	
-10.75	1.25	1128.	.1	.1	-11.00	.75	.675.	.1	
-10.50	2.75	3600.	.4	.4	-10.75	3.50	.3825.	.6	
-10.25	4.80	7650.	1.6	2.1	-10.50	3.25	.6780.	.7	
-10.00	2.00	9450.	2.3	4.3	-10.25	3.00	.8450.	2.1	
-9.75	2.75	11925.	2.2	6.5	-10.00	2.00	.11250.	3.4	
-9.50	2.75	14400.	4.0	10.5	-9.75	3.50	.14400.	6.3	
-9.25	2.80	16650.	3.6	14.1	-9.50	1.50	.18750.	9.5	
-9.00	2.00	18450.	4.1	18.2	-9.25	4.00	.19350.	13.3	
-8.75	2.75	21150.	3.0	21.7	-9.00	1.00	.20250.	17.6	
-8.50	2.50	23400.	3.5	28.5	-8.75	2.00	.22050.	23.0	
-8.25	3.50	26550.	6.8	35.5	-8.50	4.50	.26100.	4.3	
-8.00	3.00	29250.	7.0	42.7	-8.25	3.00	.28800.	6.2	
-7.75	5.00	33750.	7.2	50.0	-8.00	5.25	.33525.	6.5	
-7.50	7.25	40275.	7.3	57.4	-7.75	4.75	.37800.	8.3	
-7.25	8.75	49050.	14.1	71.5	-7.50	6.50	.43650.	9.3	
-7.00	5.50	54000.	12.9	84.4	-7.25	10.00	.52680.	10.0	
-6.75	6.50	64350.	14.0	98.4	-7.00	6.25	.58275.	12.6	
-6.50	17.00	78850.	17.8	116.2	-6.75	19.75	.76050.	14.0	
-6.25	20.00	87850.	23.6	138.6	-6.50	16.50	.92925.	16.7	
-6.00	20.25	115878.	28.7	165.6	-6.25	18.75	.92925.	19.0	
-5.75	24.75	138190.	28.4	184.9	-6.00	19.25	.10280.	129.9	
-5.50	19.00	155250.	38.2	233.1	-5.75	19.25	.157575.	156.9	
-5.25	21.50	174800.	38.0	272.1	-5.50	23.00	.148275.	185.8	
-5.00	23.75	195375.	49.1	321.2	-5.25	26.25	.182600.	220.5	
-4.75	31.00	223875.	53.4	374.6	-5.00	26.25	.216225.	260.7	
-4.50	40.25	260100.	60.7	435.3	-4.75	32.75	.265700.	305.6	
-4.25	38.00	295200.	68.6	504.9	-4.50	36.50	.2178850.	353.8	
-4.00	39.75	322875.	77.2	582.1	-4.25	28.75	.365325.	44.9	
-3.75	38.00	354375.	84.0	666.1	-4.00	30.50	.332775.	80.2	
-3.50	41.25	391500.	90.7	756.8	-3.75	36.25	.365400.	632.4	
-3.25	26.00	414000.	102.1	858.9	-3.50	36.50	.398250.	710.1	
-3.00	24.75	436275.	107.8	966.7	-3.25	24.00	.419850.	813.7	
-2.75	22.75	456750.	108.3	1075.9	-3.00	28.50	.442800.	905.8	
-2.50	20.50	475200.	117.6	1193.6	-2.75	17.25	.458325.	1023.9	
-2.25	21.00	494100.	113.2	1306.7	-2.50	21.00	.47725.	1136.0	
-2.00	16.75	509175.	133.4	1440.1	-2.25	14.00	.48825.	1232.0	
-1.75	18.50	526725.	130.7	1570.8	-2.00	21.50	.509175.	1374.3	
-1.50	8.25	538050.	131.6	1702.4	-1.75	13.50	.521325.	1802.3	
-1.25	11.25	545755.	134.5	1837.0	-1.50	14.50	.534375.	1625.8	
-1.00	7.75	552150.	137.2	1874.1	-1.00	16.75	.551250.	1757.8	
-0.75	6.25	557775.	135.8	2110.0	-1.00	7.00	.557550.	1897.5	
-0.50	3.25	560700.	107.7	2217.6	-0.75	8.75	.562725.	2020.5	
-0.25	1.75	562275.	126.6	2344.2	-0.25	1.75	.563400.	2179.3	
0.00	.25	562500.	173.6	2517.8	-0.50	.25	.563175.	2180.6	
.25	.75	563175.	25.4	2843.3	.90	.25	.563400.	148.2	
.75	.25	563400.	269.1	2894.2	-1.00	.25	.563400.	-10.82	
								MAXIMUM ELEVATION - .48	

TABLE 7

Estimates of Subsidence for Total Survey Area and Northshore Area

Total Area Common to 84, 85, 86 and 88 Surveys ($2,426,400 \text{ m}^2$)

Year	Capacity (m^3) to Max. Elev.	Max. Elev. (m)	Adj. Capacity to +1.0 m elev.	Avg. Diff (m) in Elev. from 1984
84	16,331,400	0.08	18,563,688	-
85	16,545,400	0.17	18,559,312	+ 0.002
86	17,737,900	0.53	18,878,308	- 0.13
88	15,996,700	-0.47	19,563,508	- 0.41

Northshore Area ($563,400 \text{ m}^2$)

Avg. Diff (m)
Adjusting for
Sediment transp

84	2,220,900	-0.26	2,930,784	-	-
85	2,307,300	-0.06	2,904,504	+ 0.05	0.00
86	2,691,500	0.53	2,956,298	- 0.05	- 0.14
88	2,190,600	-0.48	3,024,432	- 0.17	- 0.36

Total Survey Area less Northshore Area ($1,863,000 \text{ m}^2$)

84	15,632,904	-
85	15,654,808	- 0.01
86	15,922,010	- 0.16
88	16,539,076	- 0.49

TABLE 8. 1984-88 elevation-capacity tables for Maitland River estuary common to 84, 85, 86 and 88 surveys

GODERICH HARBOUR - 1984 ESTUARY						
***** CAPACITY CURVE ROUTINE *****						
COMPUTED JAN 1988						
ELEVATION (M.)	NO. OF POINTS	ELEVATION INCREMENT - .25 M.	SURFACE AREA (SQ. M.)	ACC. VOLUME (1000 CU. M.)	GRID AREA - 900. SQ. M.	
-3.75	.25	.25	225.	.0	.0	
-3.50	.25	.25	450.	.2	.3	
-2.75	4.00	4.00	4050.	.2	1.1	
-2.25	4.75	4.75	8325.	.8	2.4	
-2.00	6.50	6.50	15975.	1.3	4.5	
-1.75	3.25	3.25	18800.	3.7	6.1	
-1.50	6.75	6.75	24075.	4.2	10.2	
-1.25	3.75	3.75	27450.	5.5	15.8	
-1.00	2.75	2.75	28925.	5.4	21.2	
-.75	5.25	5.25	34650.	7.5	28.7	
-.50	.50	35100.	7.6	.56.3	0.00	
-.25	-3.56	MAXIMUM ELEVATION -	.27	46.0	.50	
						MINIMUM ELEVATION -
						-2.43
						MAXIMUM ELEVATION -
						-2.03
						MINIMUM ELEVATION -
						-2.70

GODERICH HARBOUR - 1986 ESTUARY						
***** CAPACITY CURVE ROUTINE *****						
COMPUTED JAN 1988						
ELEVATION (M.)	NO. OF POINTS	ELEVATION INCREMENT - .25 M.	SURFACE AREA (SQ. M.)	ACC. VOLUME (1000 CU. M.)	GRID AREA - 900. SQ. M.	
-2.75	1.50	.25	1350.	.1	.1	
-2.50	1.25	.25	2475.	.4	.5	
-2.25	7.00	7.00	8775.	1.8	2.3	
-2.00	9.00	9.00	16875.	3.2	5.8	
-1.75	2.25	2.25	18900.	4.8	10.3	
-1.50	2.00	2.00	20700.	2.4	12.7	
-1.25	4.00	4.00	24300.	7.5	20.3	
-1.00	2.75	2.75	26775.	6.0	26.2	
-.75	4.50	4.50	30825.	7.5	33.7	
-.50	2.00	2.00	32625.	8.8	42.5	
-.25	2.75	2.75	35100.	7.4	49.9	
0.00						MINIMUM ELEVATION -
						-0.06
						MAXIMUM ELEVATION -
						-2.03
						MINIMUM ELEVATION -
						-2.70

TABLE 9

Estimates of Accretion in Maitland River Estuary
Common to 84, 85, 86 and 88 Surveys ($35,100 \text{ m}^2$)

Year	Capacity (m^3) to Max. Elev.	Max. Elev. (m)	Adj. Capacity to + 0.5 m Elev.	Adj. Diff (m) in Elev. from 1984
84	46,000	- 0.27	73,027	-
85	49,900	- 0.06	69,556	+ 0.10
86	59,100	0.26	67,524	+ 0.16
88	37,900	- 0.48	72,298	+ 0.02

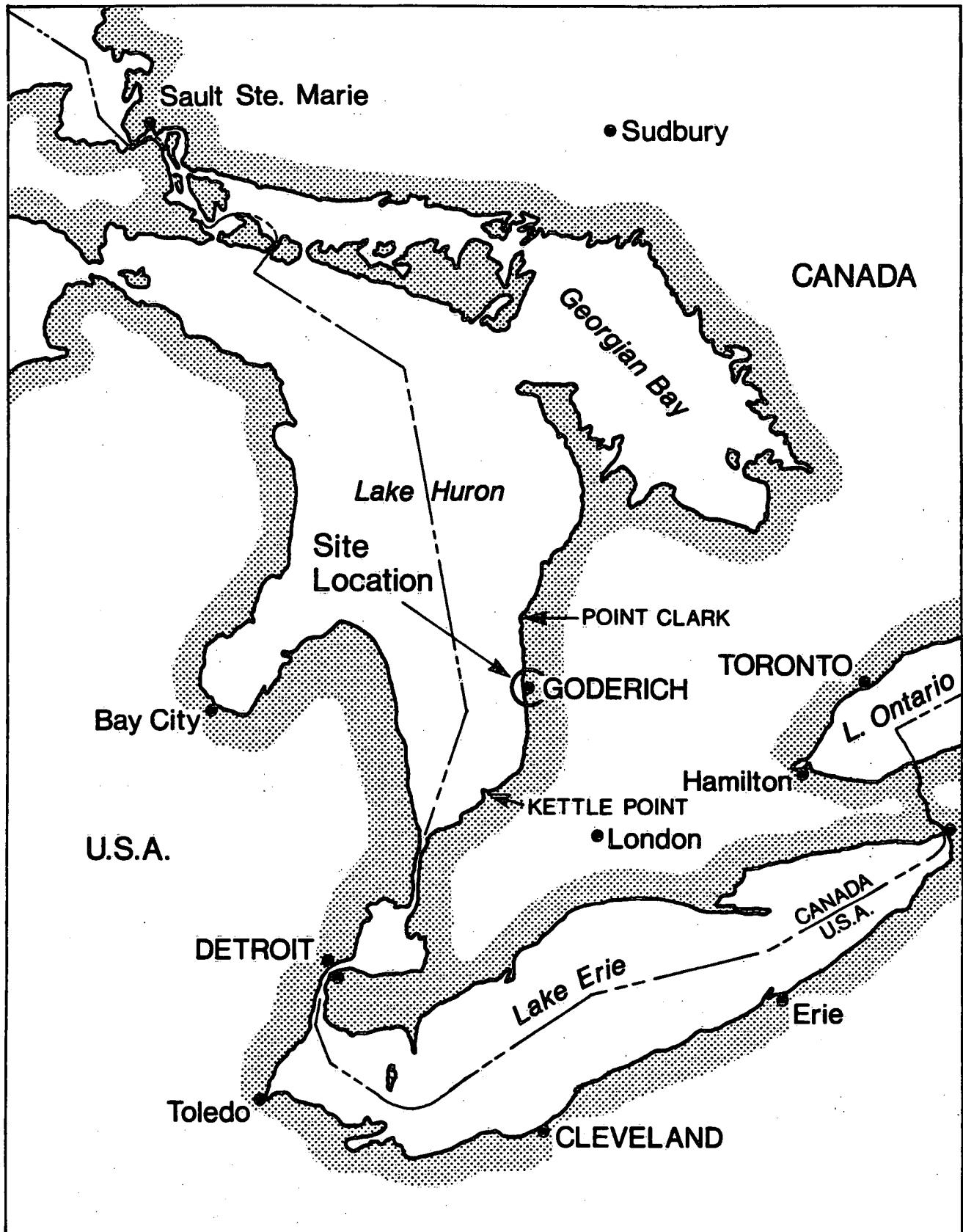


Figure 1 Site Location Plan

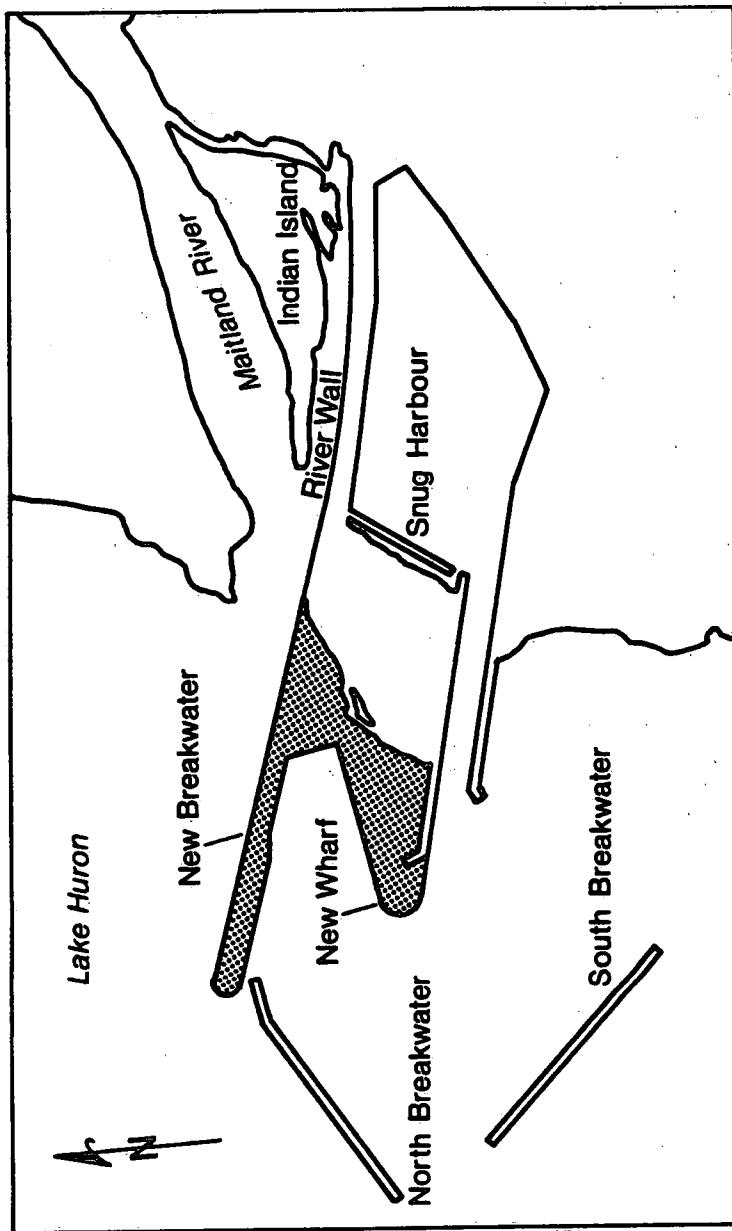


Figure 2 Locations of new breakwater and wharf at Goderich Harbour.

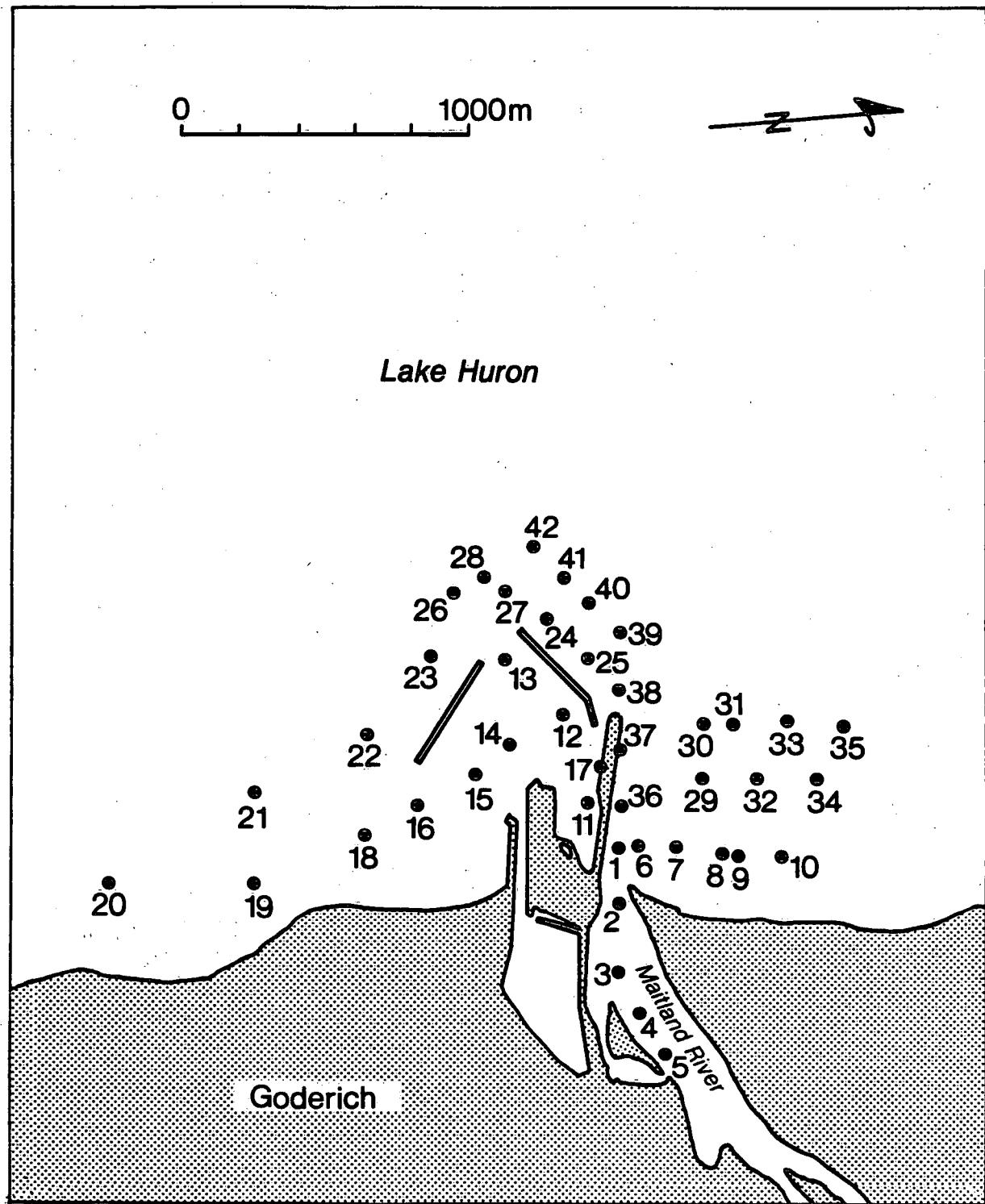


Figure 3 Bed Material Sample Locations

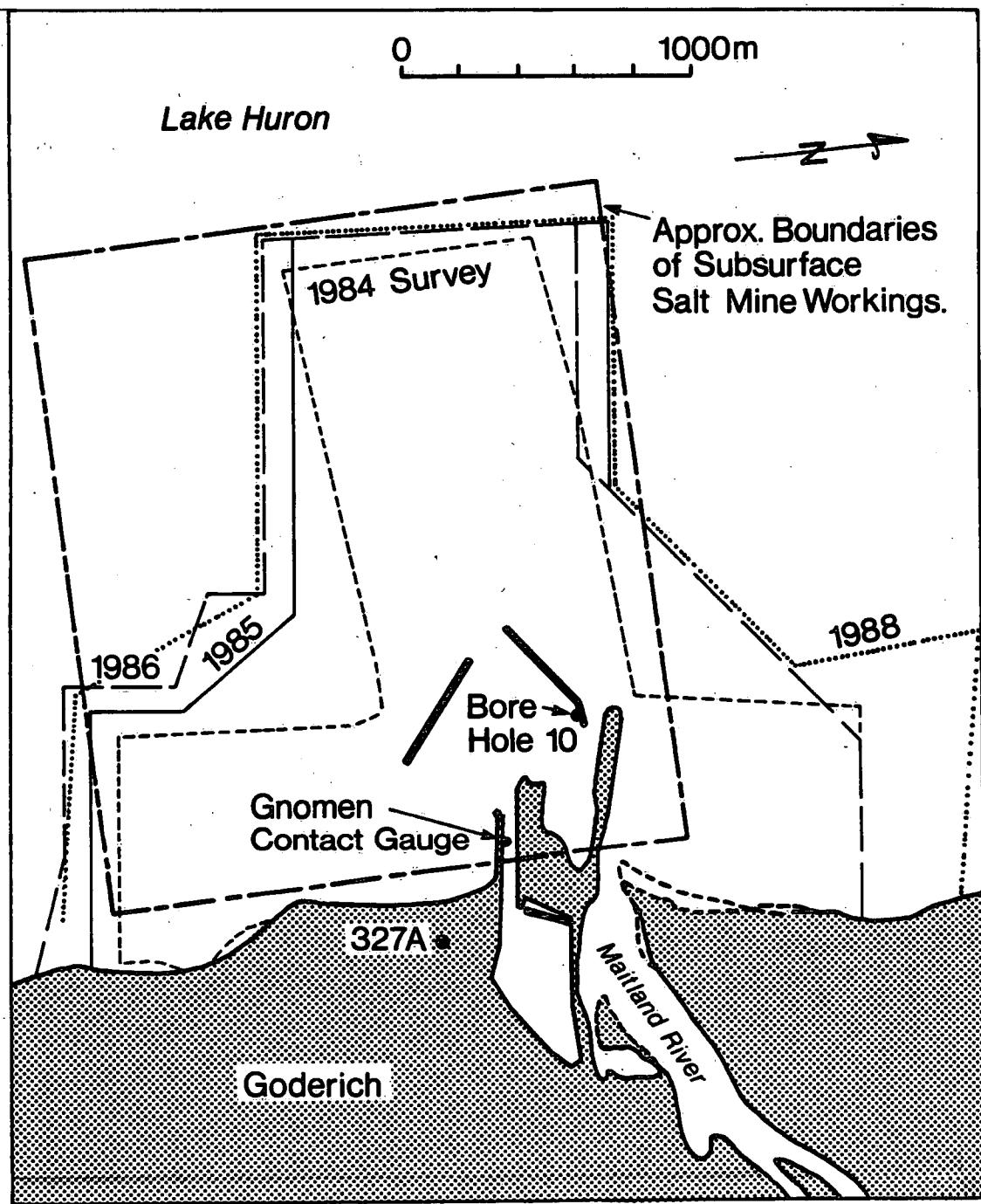
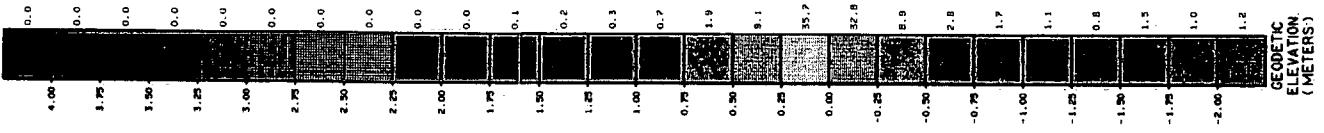


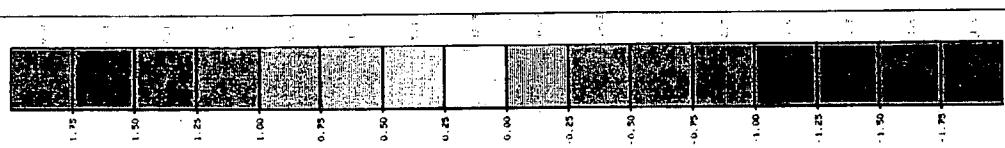
Figure 4 Hydrographic Survey Areas

GODERICH HARBOUR FULL AREA (1985 - 84 DIFF.)

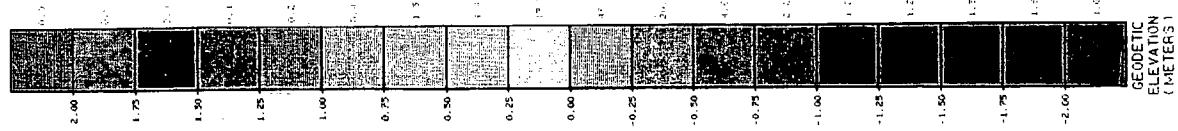


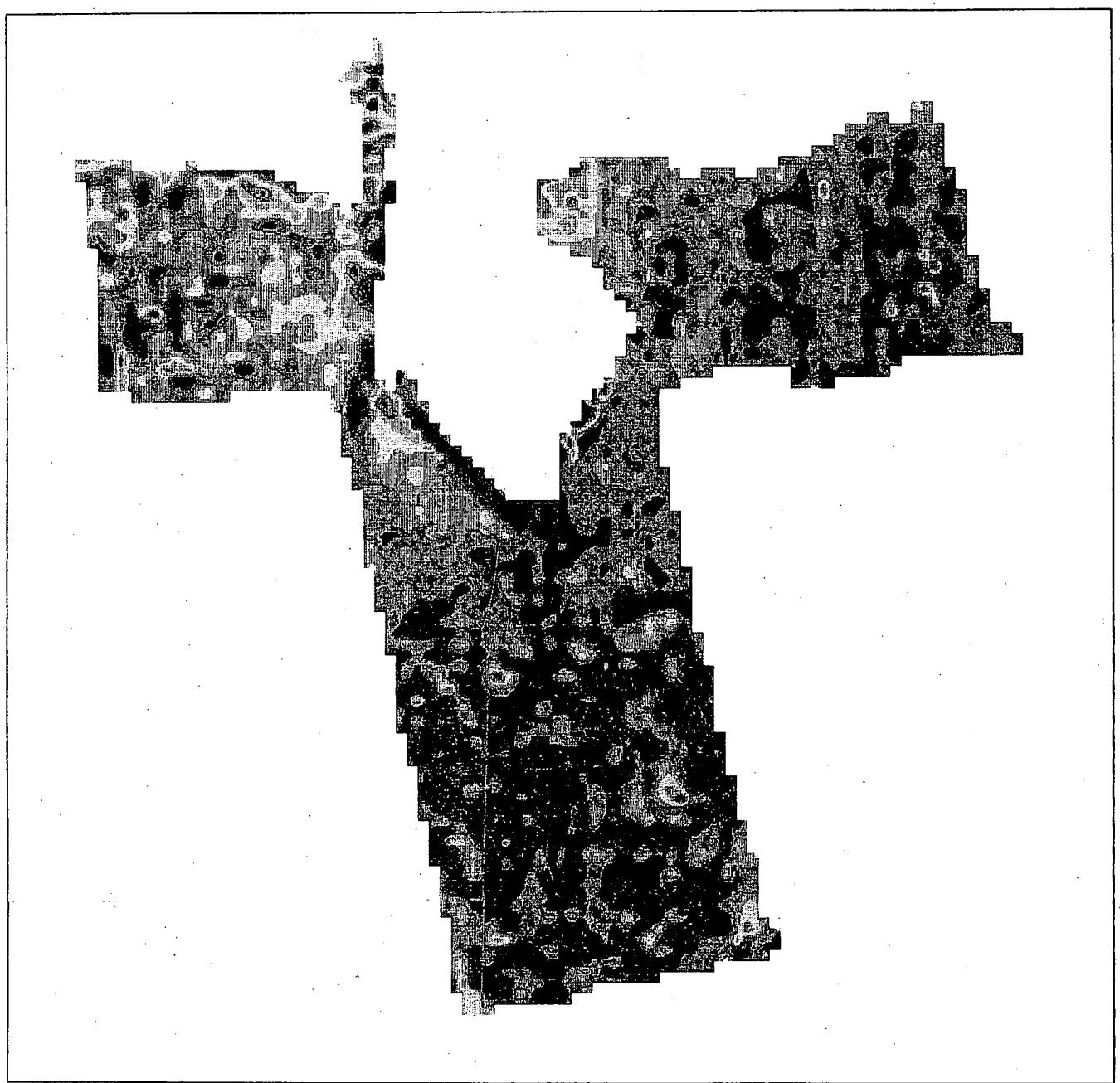
GODERICH HARBOUR STUDY CONTOURS OF DIFFERENCES 86-84

GEOGRAPHIC
ELEVATION
(METERS)



GODERICH HARBOUR STUDY CONTOURS OF DIFFERENCES 86-85



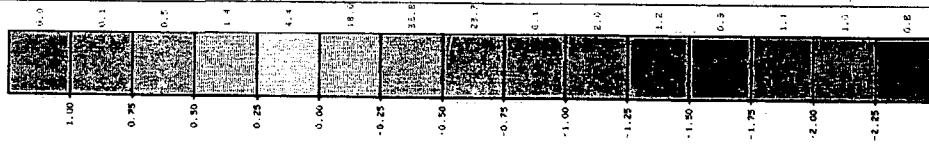
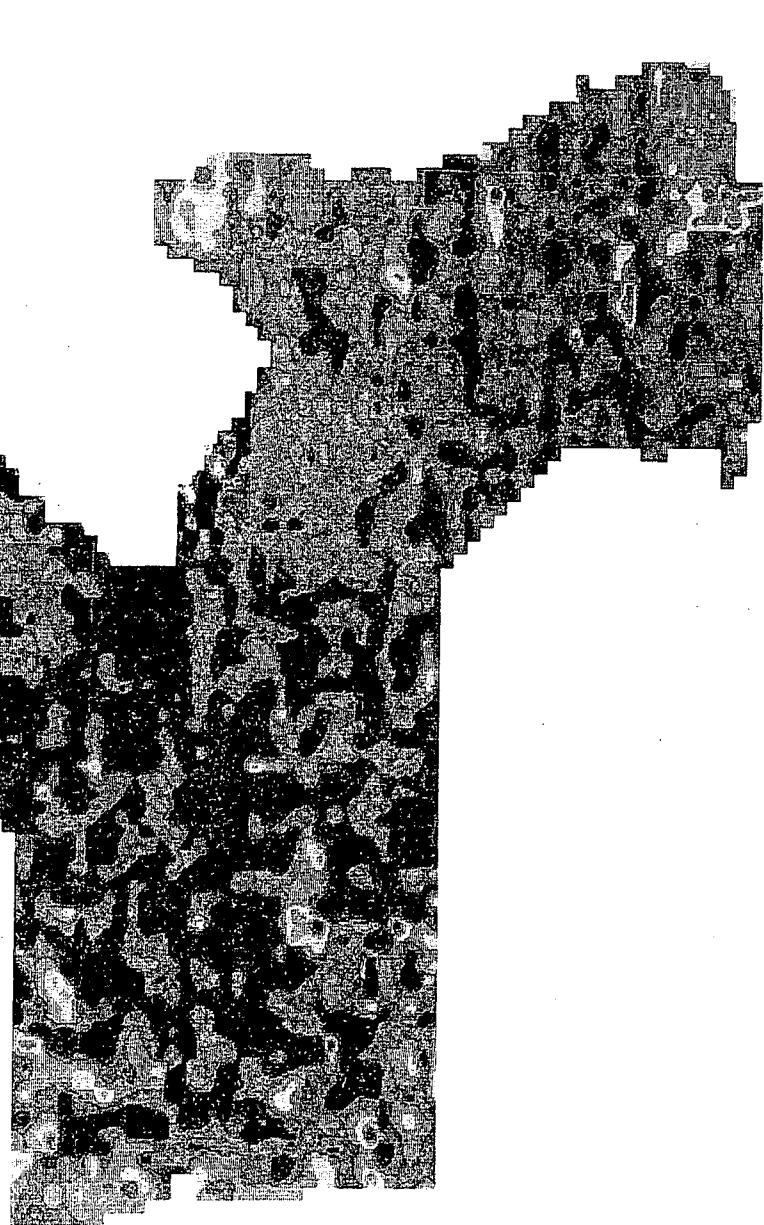


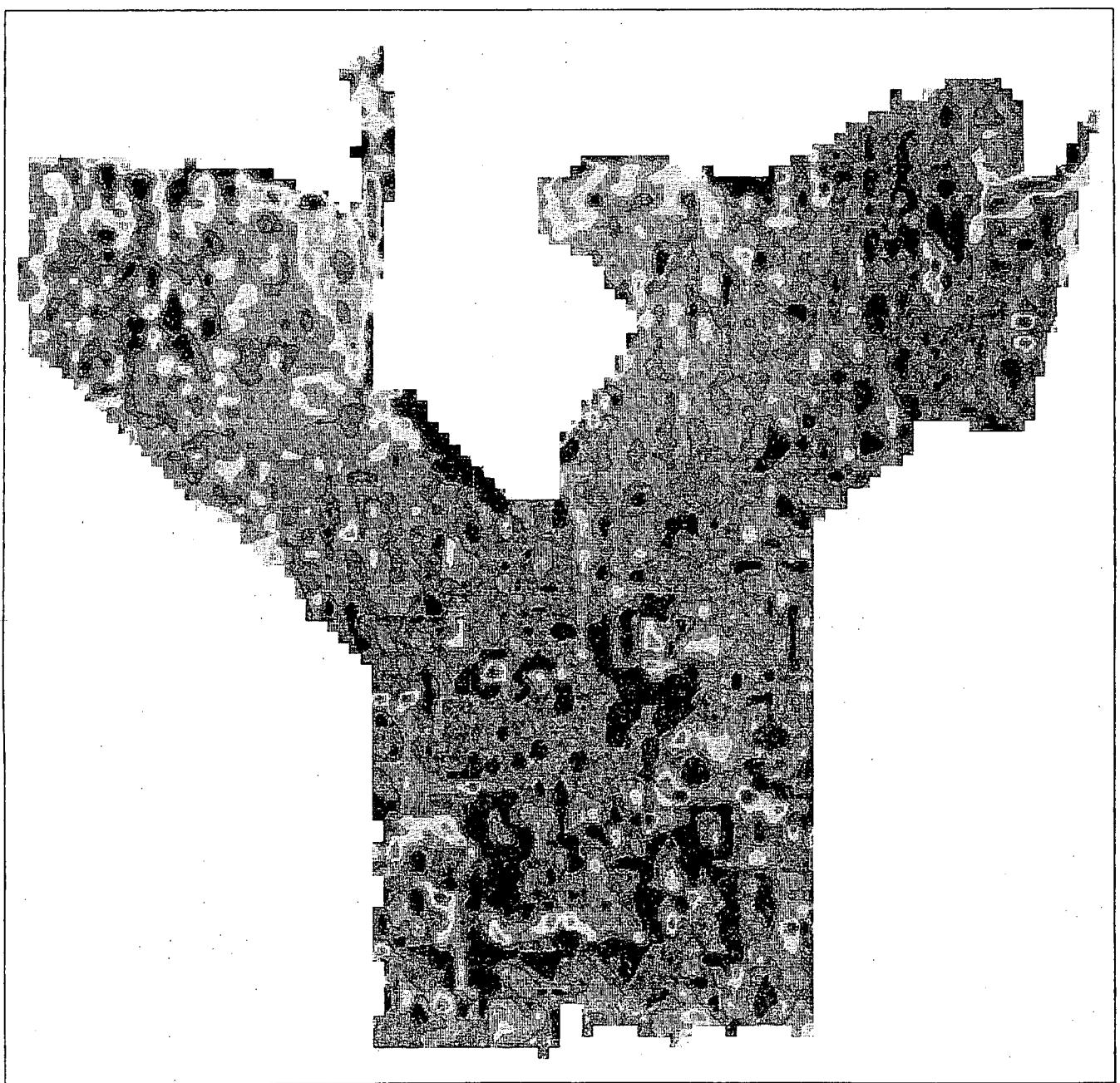
GODERICH HARBOUR FULL AREA (1988 - 1984 DIFF.)

GEOGRAPHIC
ELEVATION
(METERS)

GODERICH HARBOUR FULL AREA (1988 - 1985 DIFF.)

GEODETIC
ELEVATION
(METERS)





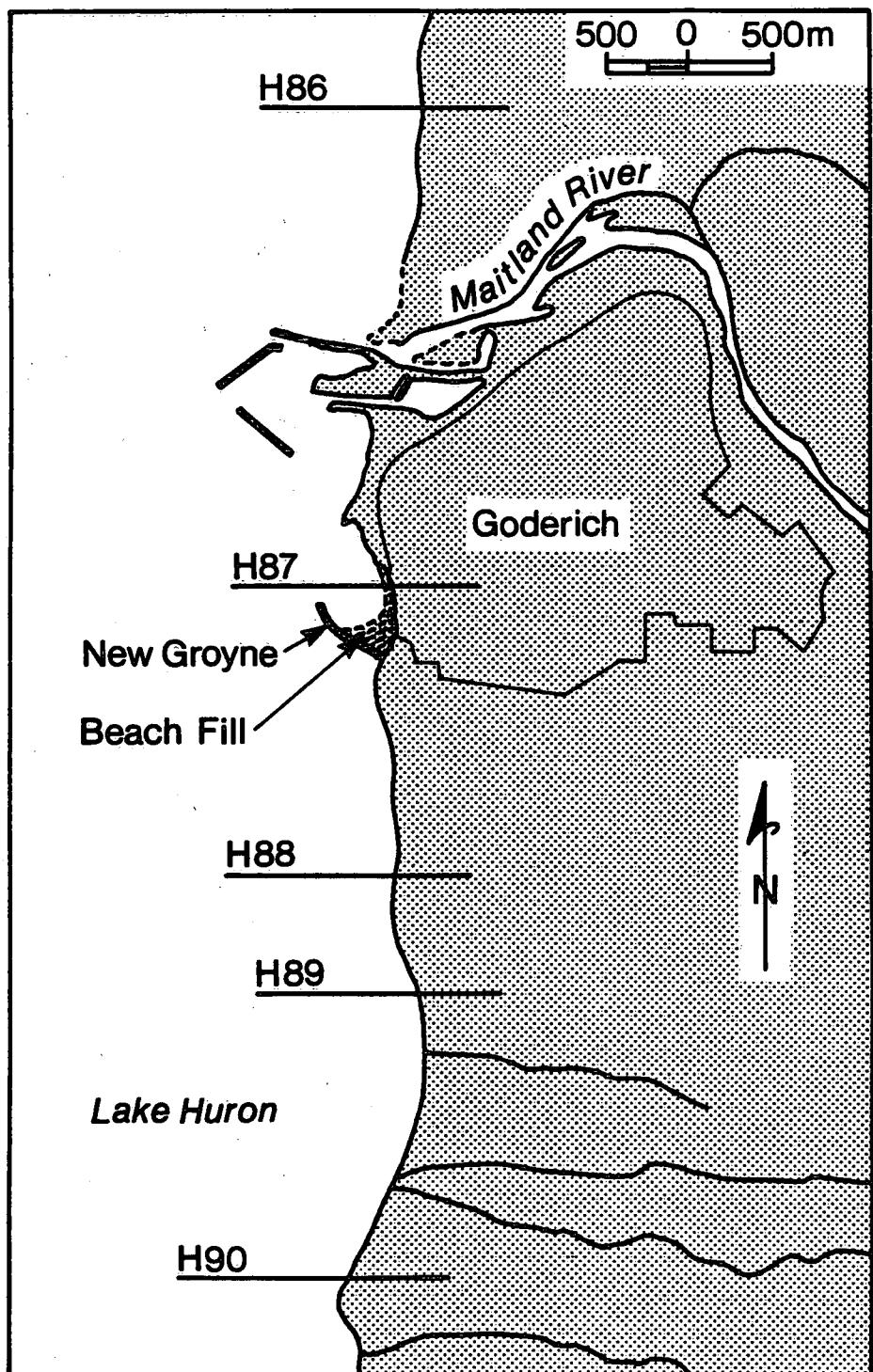


Figure 11 Range Line Locations

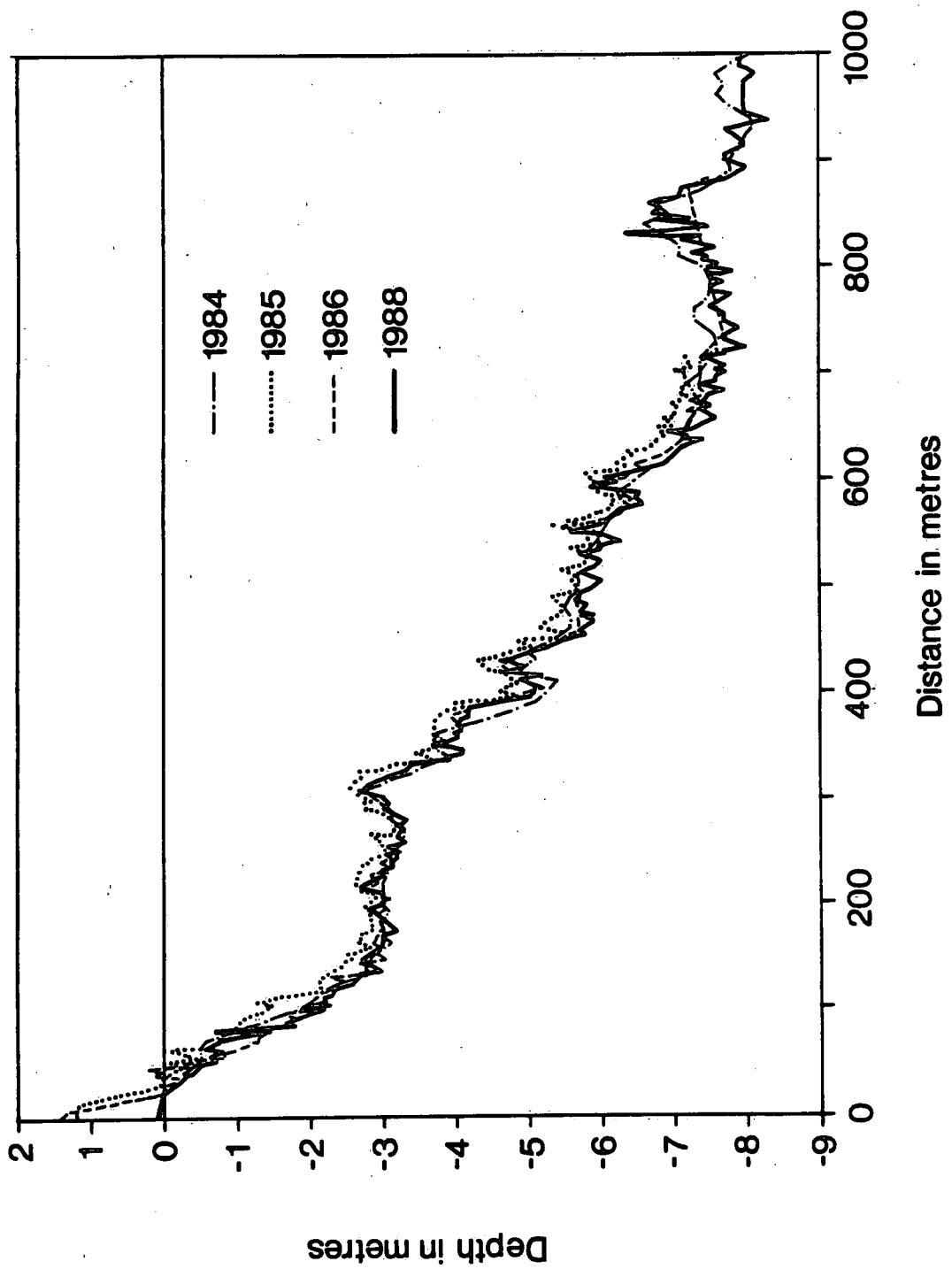


Figure 12 Profiles of H86

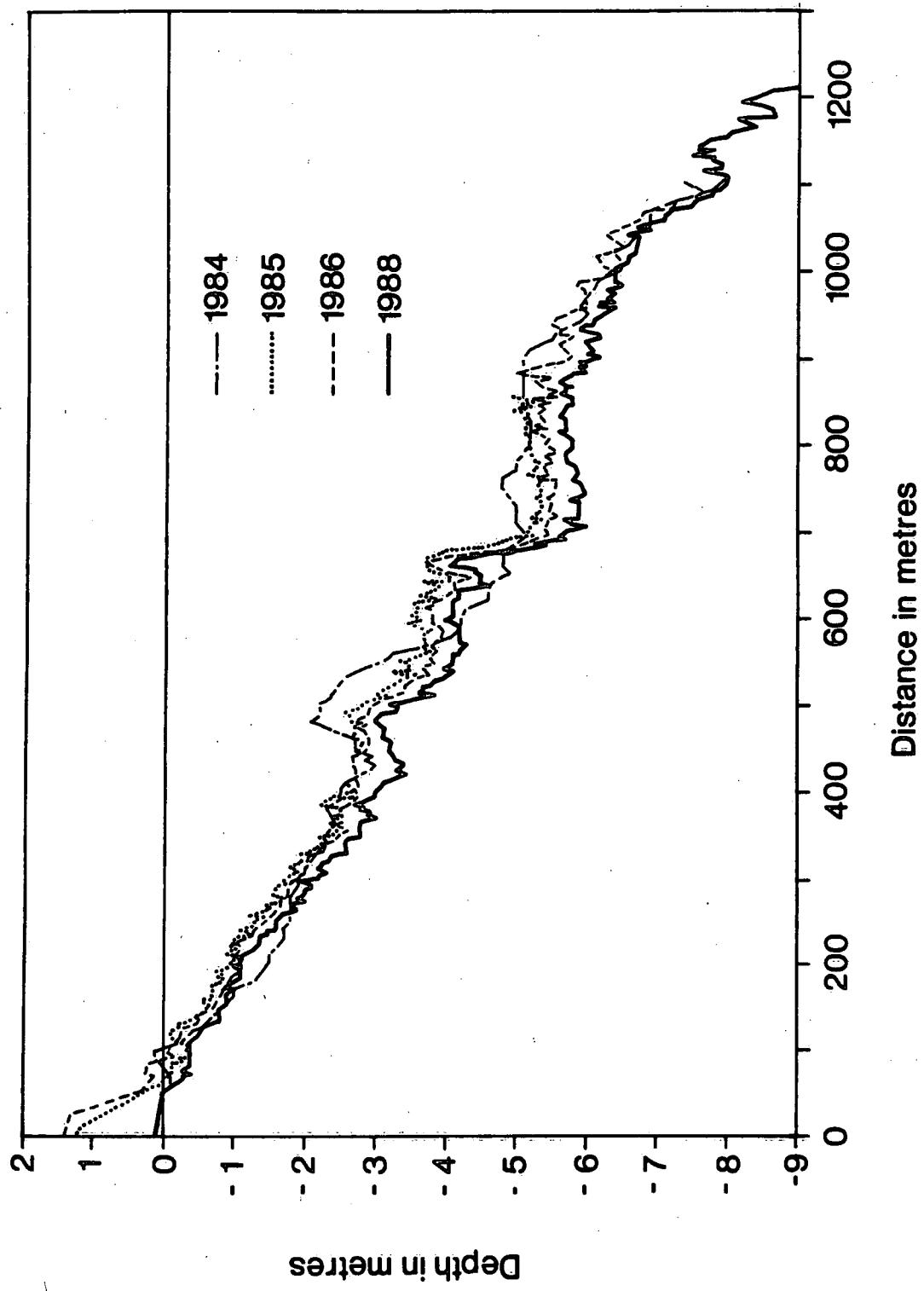


Figure 13 Profiles of H87

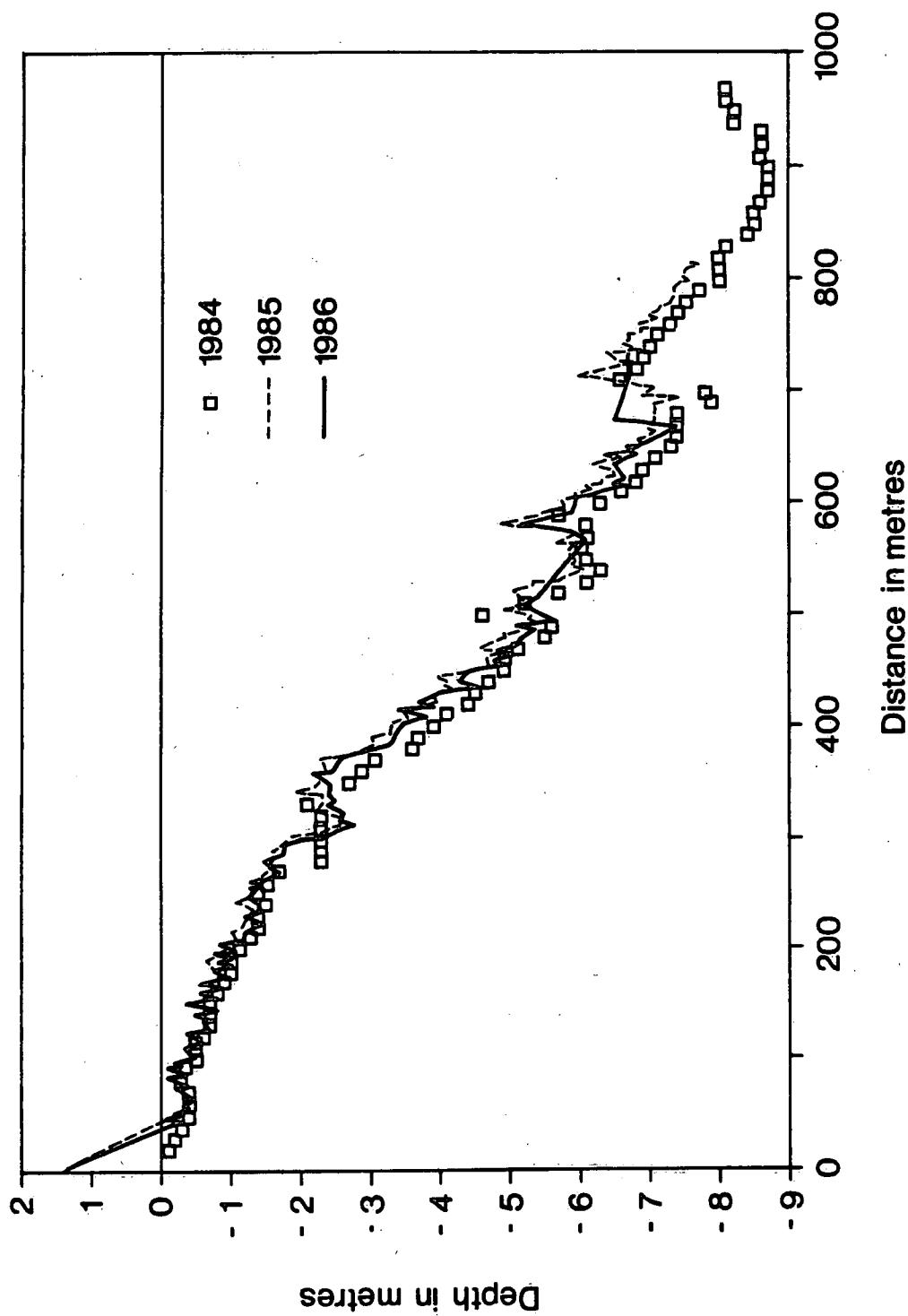


Figure 14 Profiles of H88

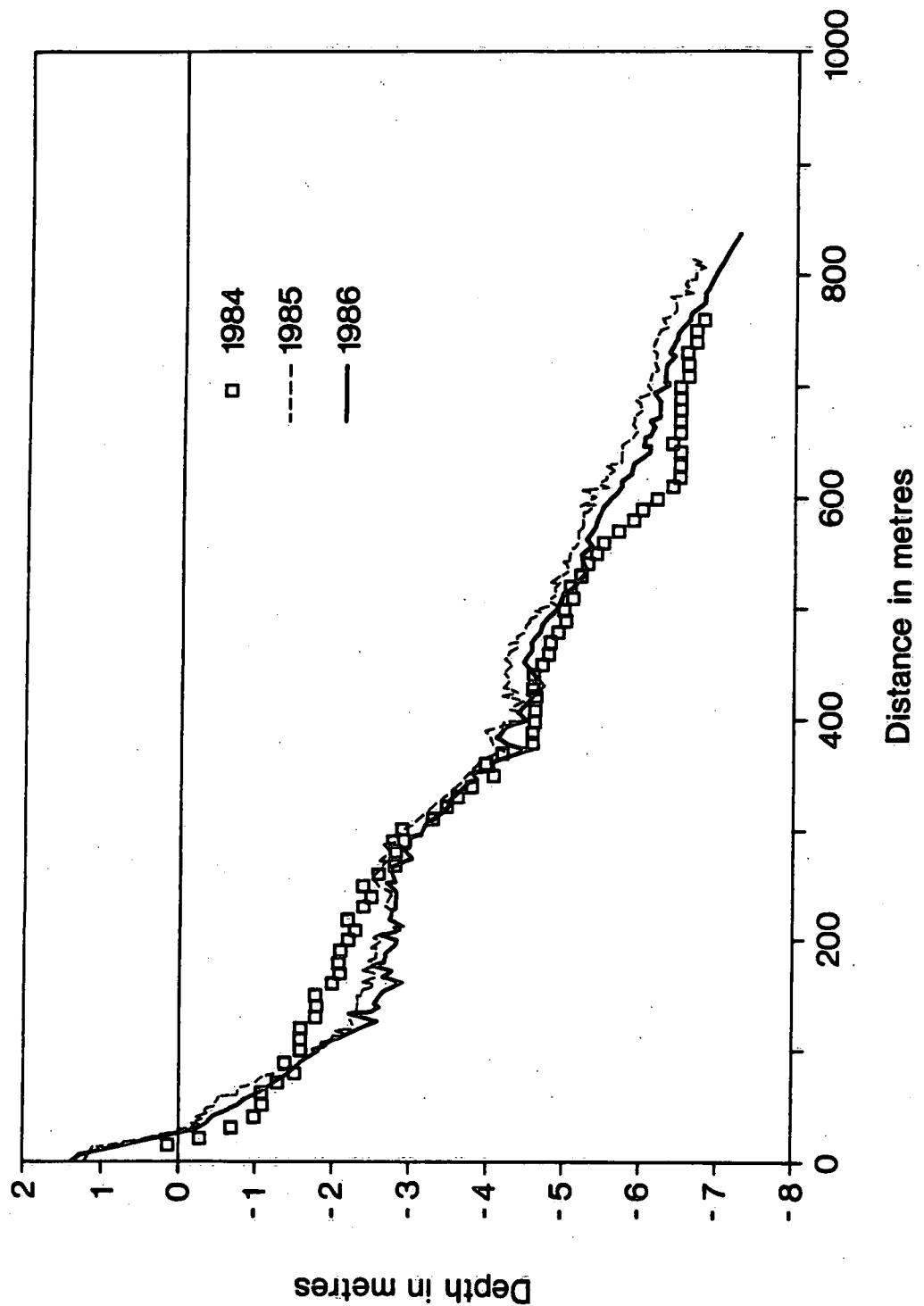


Figure 15 Profiles of H89

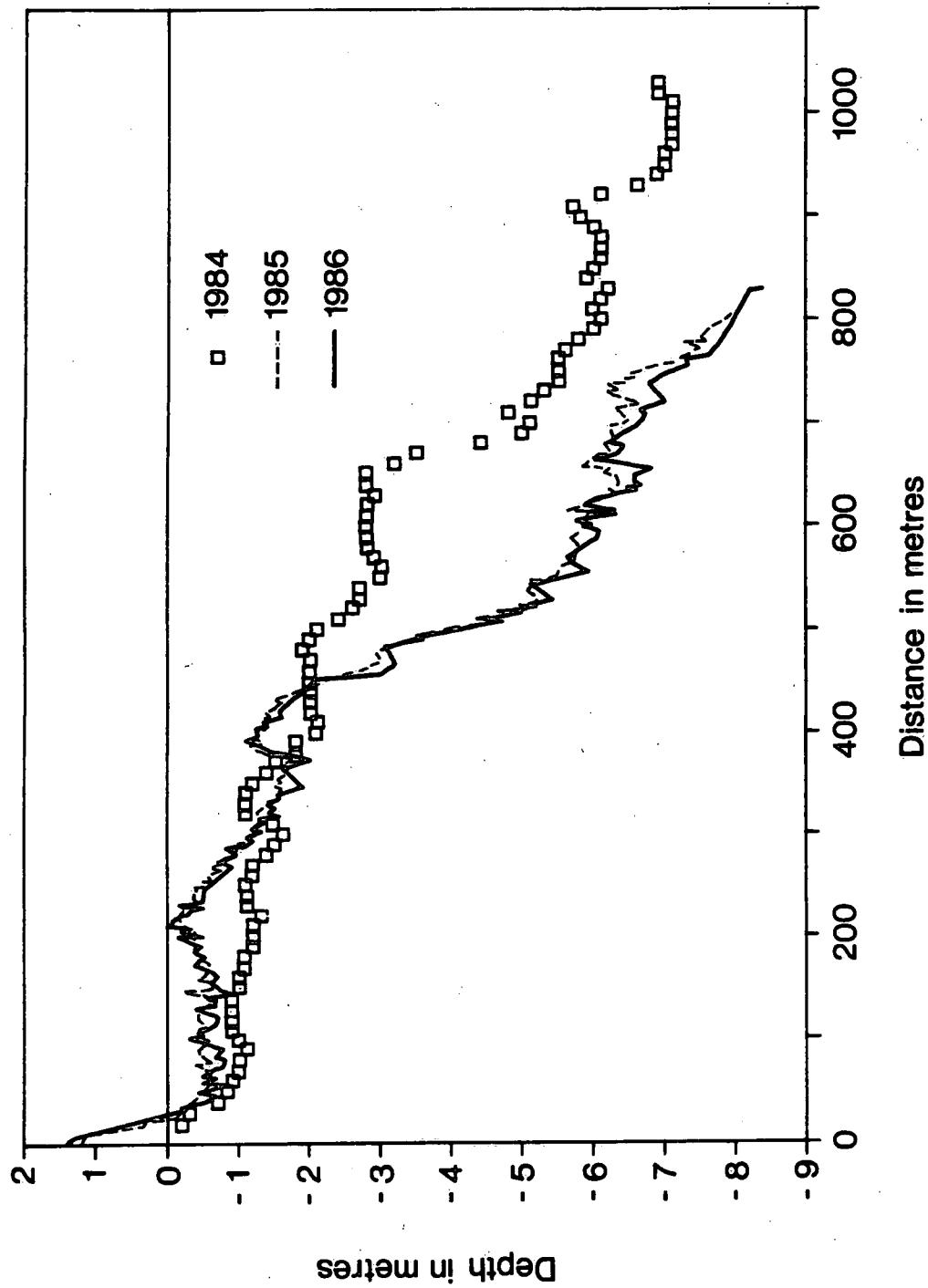


Figure 16 Profiles of H90

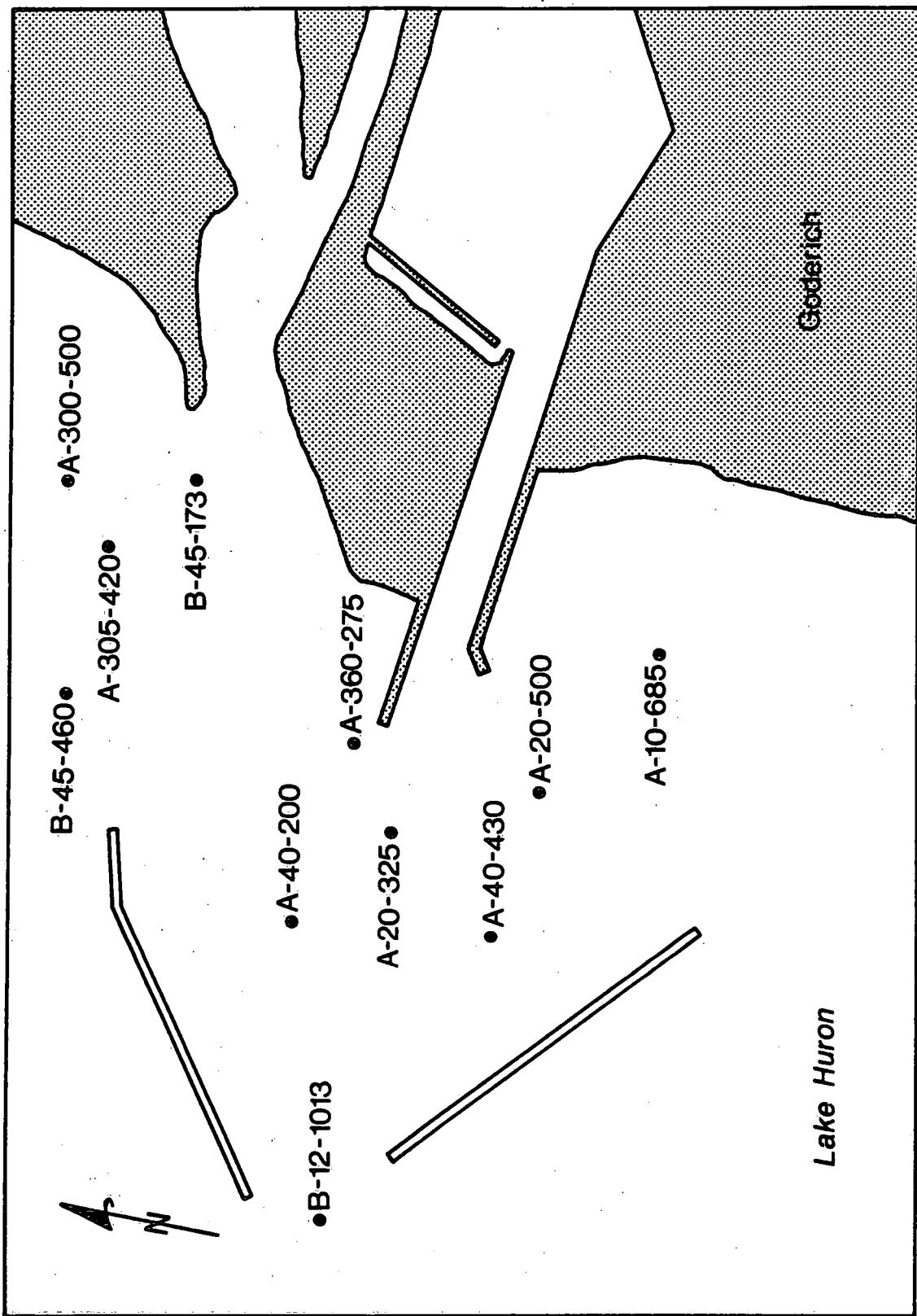


Figure 17 Soil Sample Location Map (after Boyd 1977)

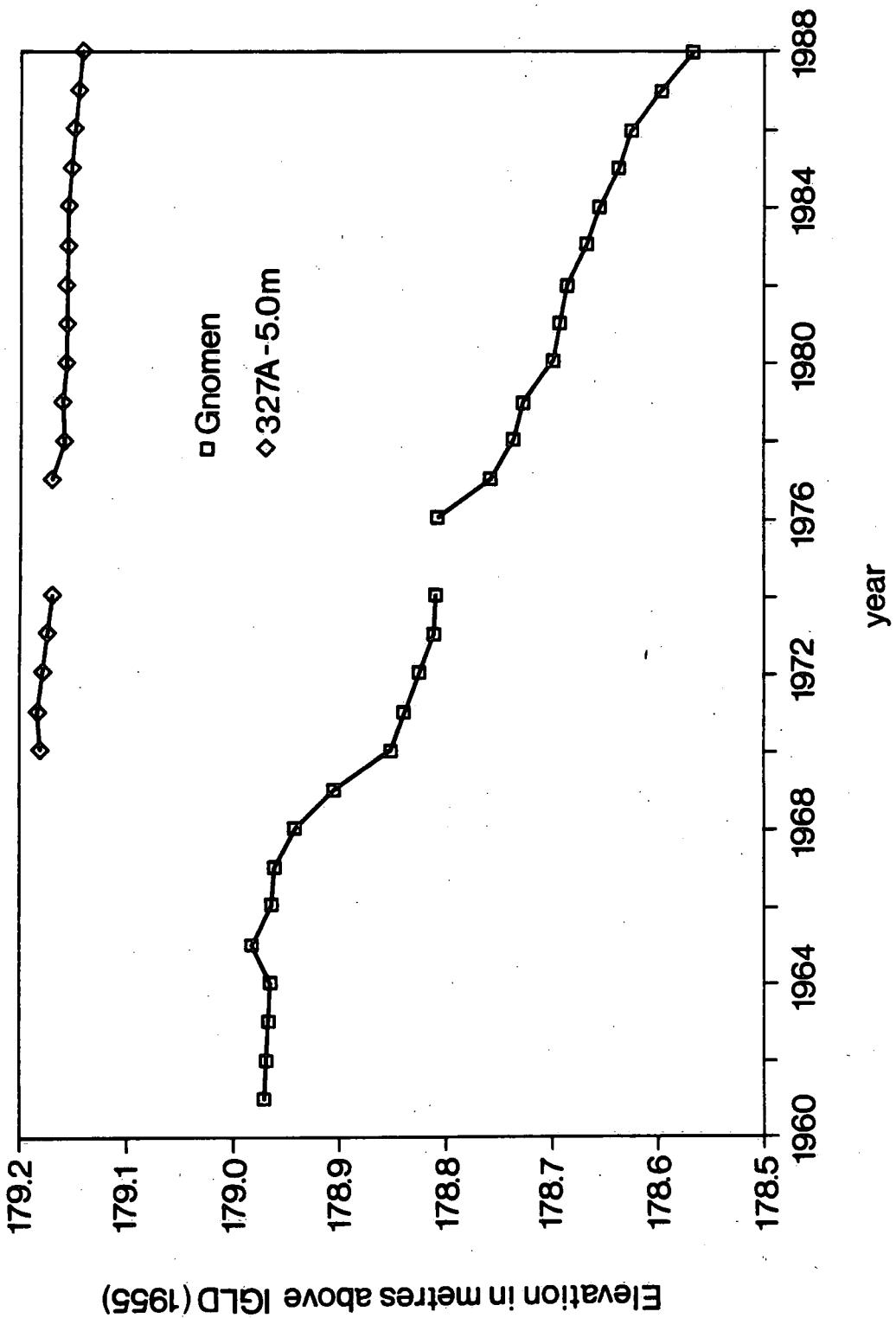


Figure 18 Goderich Bench Marks

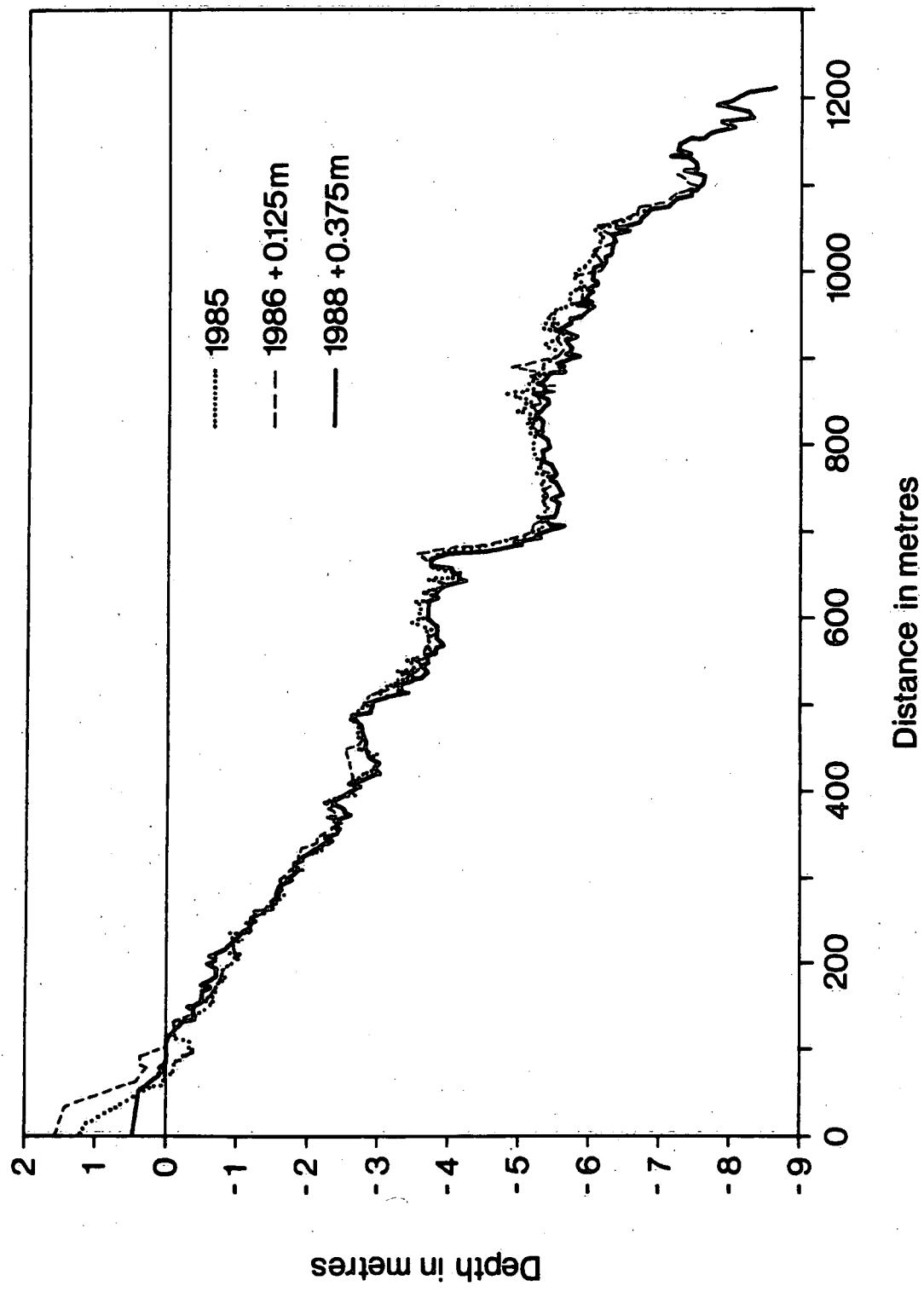


Figure 19 Profiles of H87 with adjustments for subsidence

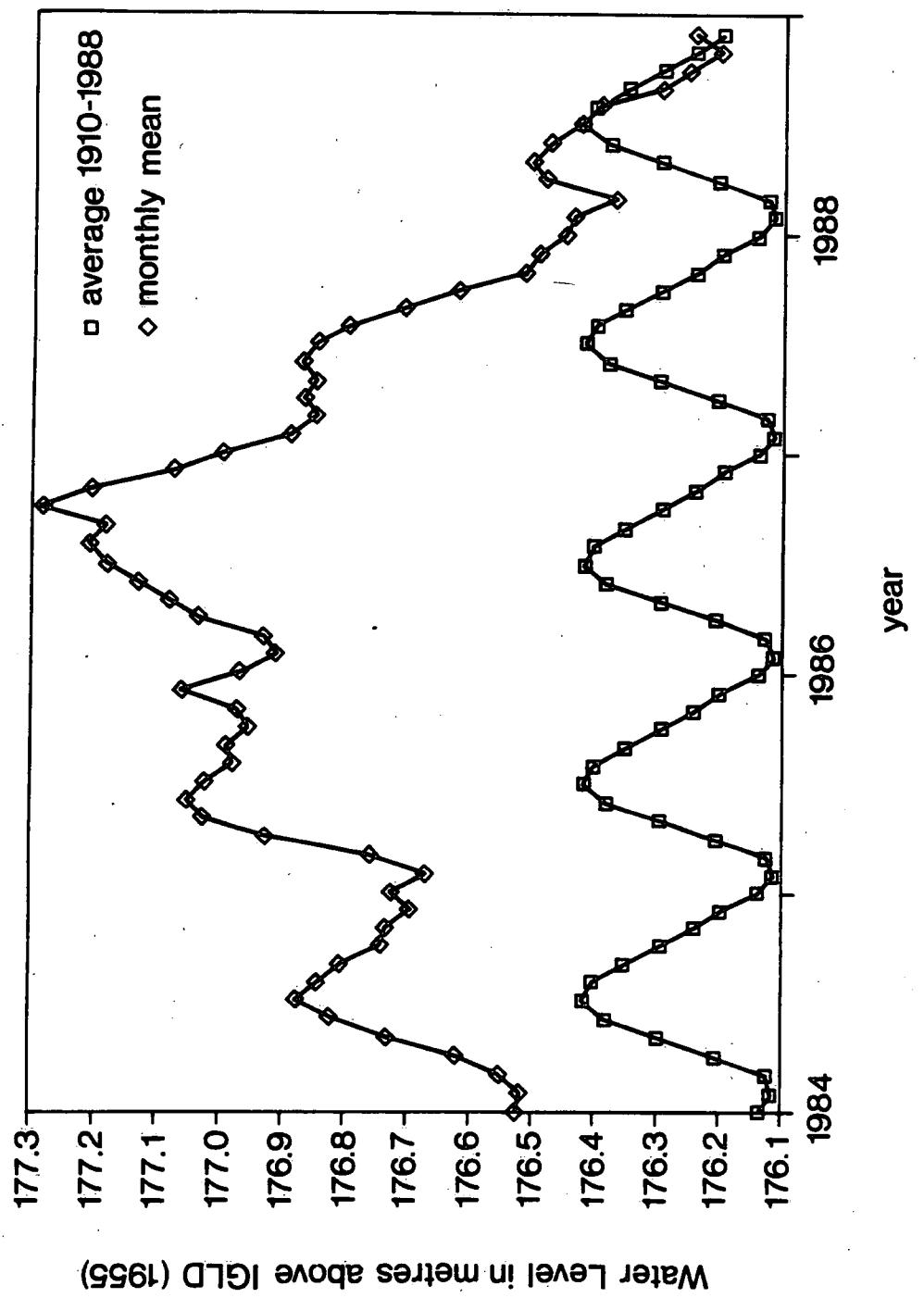


Figure 20 Lake Huron Water Levels at Goderich

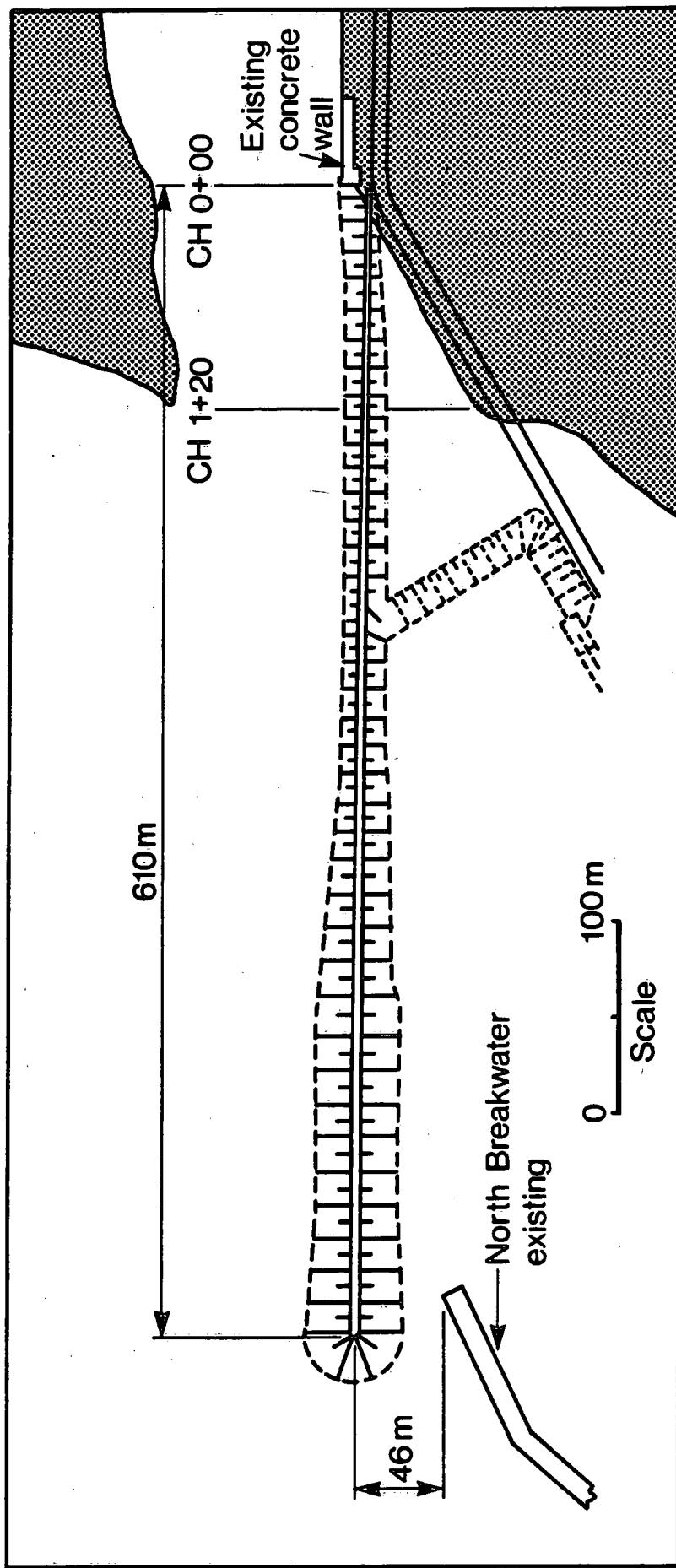


Figure 21 Detail at Maitland River Mouth