HYDRAULICS DIVISION
TECHNICAL NOTE

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TITLE: Borehole Stratigraphy of Long Point Sediments

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BOREHOLE STRATIGRAPHY OF LONG POINT SEDIMENTS

1.0 Subsurface Sediment Data Base

Two boreholes were drilled by NWRI at Long Point in the summer of 1980 using a wash-boring technique. These boreholes, labelled BH 1 and BH 2 on Figure 1, were sampled to depths of 40 and 59 m below IGLD respectively. Split-spoon samples, collected at 1 - 1.5 m intervals, were described in the field, then bulk-stored in glass jars. One Shelby tube sample was collected from BH 1 for geotechnical testing.

Another borehole, BH 3, was drilled by NWRI to a depth of 38 m below lake level in the fall of 1981 using a hollow-stem auger rig. Split-spoon samples and Shelby tube samples were taken almost continuously down the hole. The split-spoon samples were first described in the field, then placed in tightly sealed plastic sleeves for transportation and storage. A total of seven Shelby tubes were also taken for geotechnical and other purposes.

Also shown on Figure 1 are the locations of four other land-based boreholes on or near Long Point. Near the tip is a 120 m borehole drilled by C.F.M. Lewis in 1963 (Lewis, 1966), hereafter referred to as the Lewis borehole or LBH. Near the western end of the point are four water wells whose logs were obtained from the files of the Ontario Ministry of the Environment.

Samples were collected at close intervals in the three NWRI boreholes and subjected to standard grain-size analysis using the F.A.S.T. method (Duncan and Lahaie, 1979). One-dimensional consolidation tests were also carried out on four samples from BH3 and one from BH1, using the procedure outlined in Terzaghi and Peck (1967). Other tests carried out on BH3 samples included core x-radiography for detecting internal sedimentary structures, moisture content profiles, and undrained shear strength profiles using the fall-cone method (Hansbo, 1957).

1.1 Subsurface Sediments

Summary logs of the three boreholes drilled on Long Point in 1980 and 1981 are presented in Appendix 1. General lithology and other parameters measured in these boreholes are presented in Figures 2 and 3. Spatial relationships and inferred stratigraphy of the inferred sediment units are presented elsewhere. Although there are minor differences between the boreholes, the sedimentary sequences making up the boreholes sampled are consistent enough to be readily described in terms of distinct lithological units. Where the boundaries between these units were not well-defined, their placement was possible based on a visual appraisal of vertical textural profiles, particularly sand-silt-clay percentages and mean phi diameters. Boundaries were then placed at distinct changes in the trends of these parameters.

1.1.1 Sorted clean sand (Unit 1)

This unit consists of well-sorted (standard deviation of around 0.5), gray to grayish brown, medium-textured (2.1 - 2.9 meanϕ) sand. Thin pebbly layers occur occasionally except for BH 3, which shows dark heavy mineral laminations. Organic matter is generally absent except for occasional shells and bits of wood associated with the pebbly layers. The unit thickens eastward from 6.5 m in BH 3, to 20.8 m in BH 2. Average mean grain size for this unit is statistically similar in all boreholes, except for a slight, but significant, difference between BH 3 and BH2.

1.1.2 Interlaminated sandy silt (Unit 2)

The contact between this unit and the clean sand above is distinct and, in the case of BH 1 and 2, is associated with a thin layer of coarser materials (pebbles or granules). The unit is grayish-brown to gray in colour and averages around 5ϕ in mean grain size. It usually grades downward from fine sand with minor silt interlaminations (sand/silt ratio as high as 8) to silt with minor sand interbeds (s/st ratio of less than

0.2) at the bottom. Small-scale ripple-drift cross-laminations are common in the sandy sections of the unit. The thickness of this unit is fairly uniform at between 9 and 11 m in all three boreholes. In BH 3, the unit is divided into two sub-units. The clean sands (Unit 1) occur directly (sharp contact) over a fine-grained sub-unit 2.5 m thick which grades from sandy silt at the top, to clayey silt at the bottom. Below this silt sub-unit, the sediment changes abruptly to the standard Unit 2 sequence described above, i.e. fine sand with silt interlaminations grading downward to silt with decreasing sand and increasing clayey interlaminations. No statistically significant difference was noted between the average mean grain size values for this unit in all the boreholes.

1.1.3 Uniform clayey silt (Unit 3)

The above (sand-silt) unit overlies gradationally a unit dominated by dark gray silt or clayey silt (silt greater than 45%, mean ϕ size of approximately 6.5). In BH 3, the only borehole where the entire unit (7 m) was sampled, the basal material is somewhat finer (up to 7ϕ). In BH 1 and 2, layers or lenses of fine sand or sandy silt occur occasionally. The unit is characteristically dark gray to brownish gray in colour with faint colour laminations and occasional dark (reduced) patches. Organic matter and shells are rare. This unit is also anomalously fine-grained in BH 3 compared to BH 1 and 2 even though at that site, it was apparently being deposited closer to the then-existing shoreline. However, the average median grain size value for this unit in the Lewis borehole was also very fine.

Unit 3 is almost identical in texture and appearance to the soft, dark gray muds presently being deposited in the deeper (more offshore) parts of the lake. In sharp contrast to the glaciolacustrine unit (unit 4) below, it is soft in consistency and is normally consolidated.

1.1.4 Clay (Unit 4)

This unit was encountered only in BH 3 and the Lewis borehole. It consists of a uniform, fine clay (finer than 9 ϕ), grayish-brown in colour. It is clearly firmer in consistency than the unit above it. Indistinct colour laminations occur throughout, which often show contorted or inclined attitudes. Small reddish spots and irregular silt patches and lenses are common near the base of the section sampled.

Unit 4 is a typical example of the deposits labelled glaciolacustrine clay by Lewis (1966) and St. Jacques and Rukavina (1973). Although the lack of any means of dating the deposit (both fossil pollen and organic matter were extremely rare) and the presence of an erosional disconformity between the units above make it difficult to assign these sediments to a particular glacial lake phase, they were probably laid down in glacial Lake Whittlesey or Warren (ca. 12,800 years B.P.).

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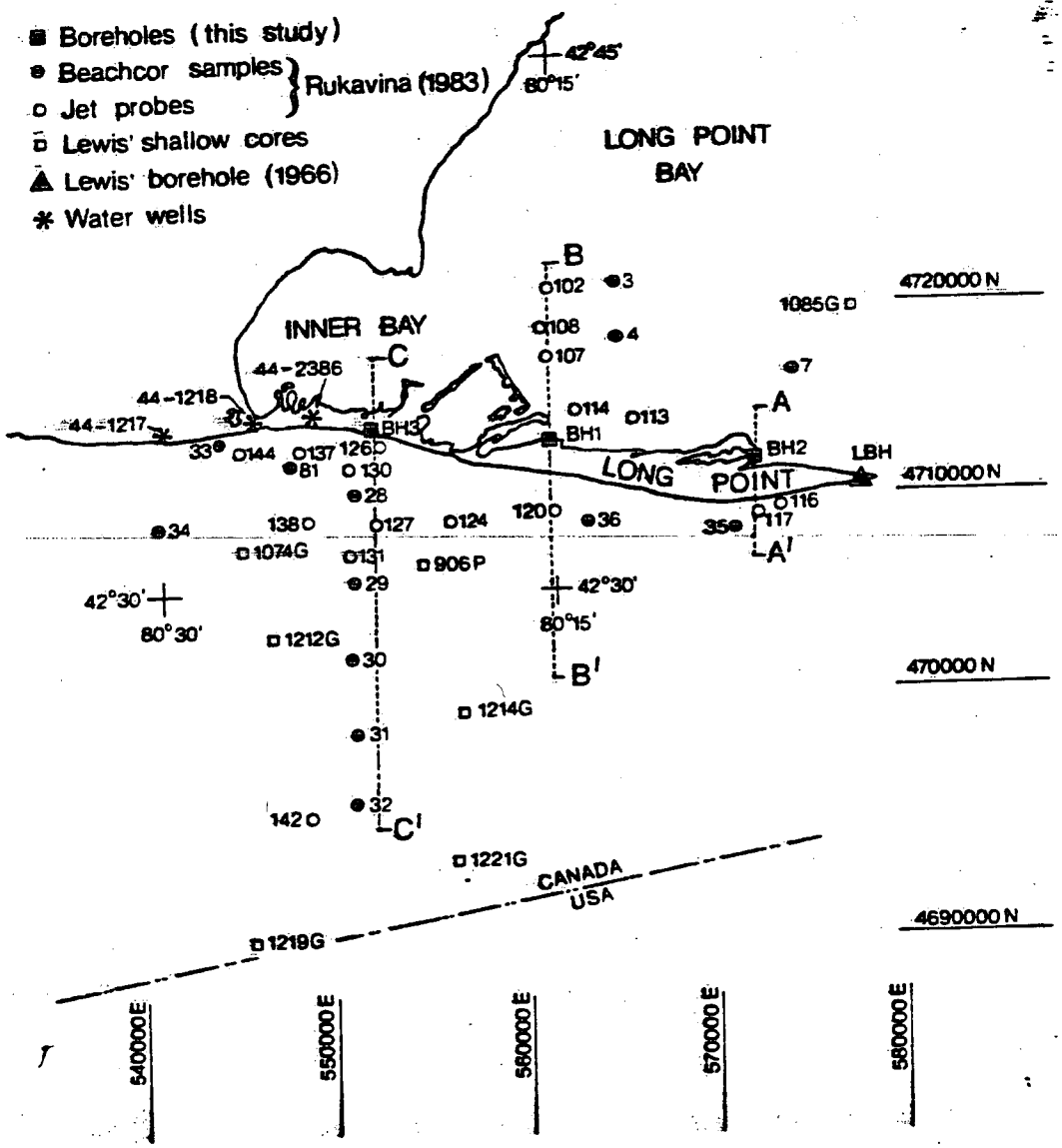

Figure 1. Location and distribution of subsurface sediment data in the Long Point area collected from various sources. Position shown as Lat./Long. and UTM.

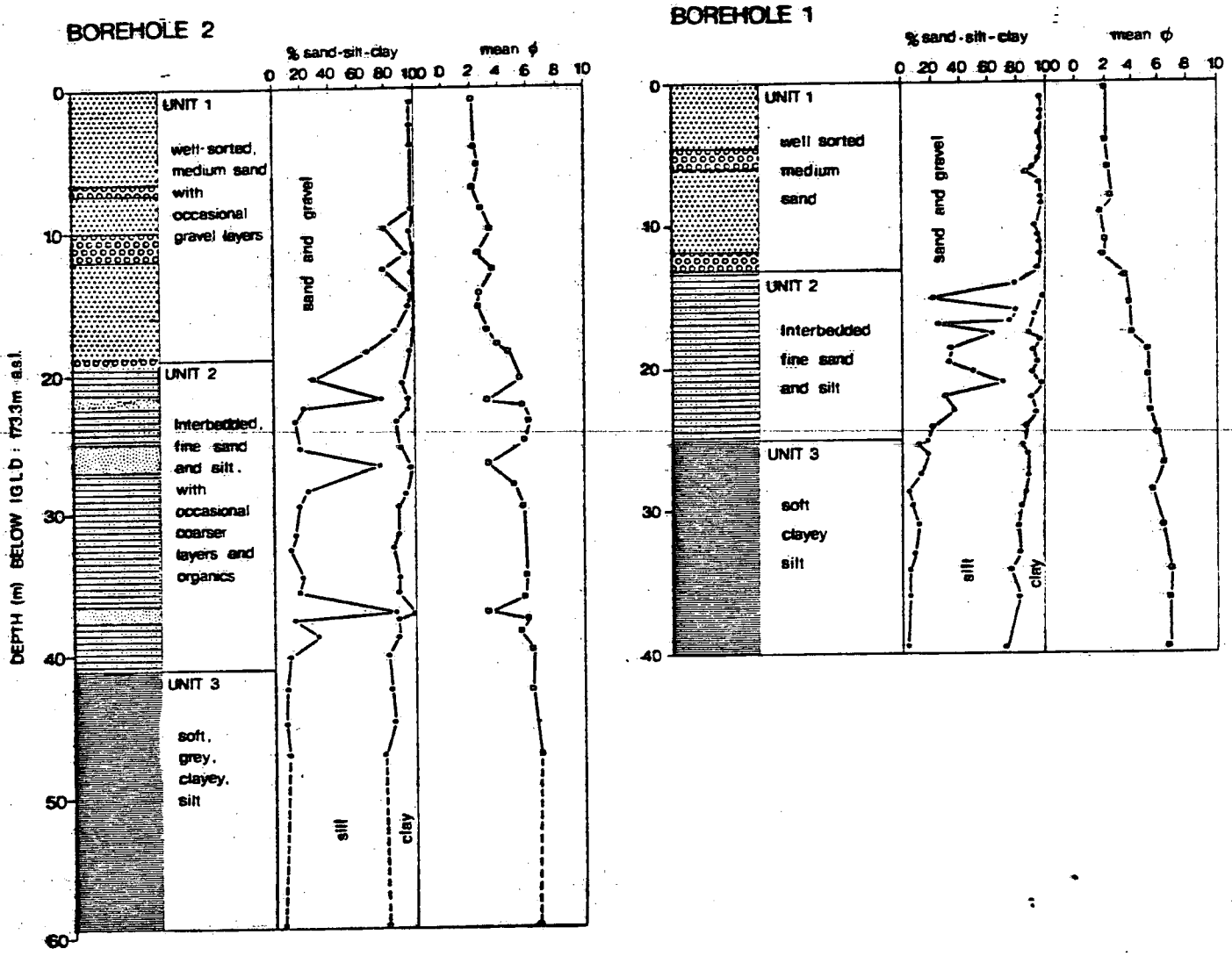

Figure 2. Interpreted sedimentary units and profiles of measured grain-size parameters in Boreholes 1 and 2. Locations are shown in Figure 1.

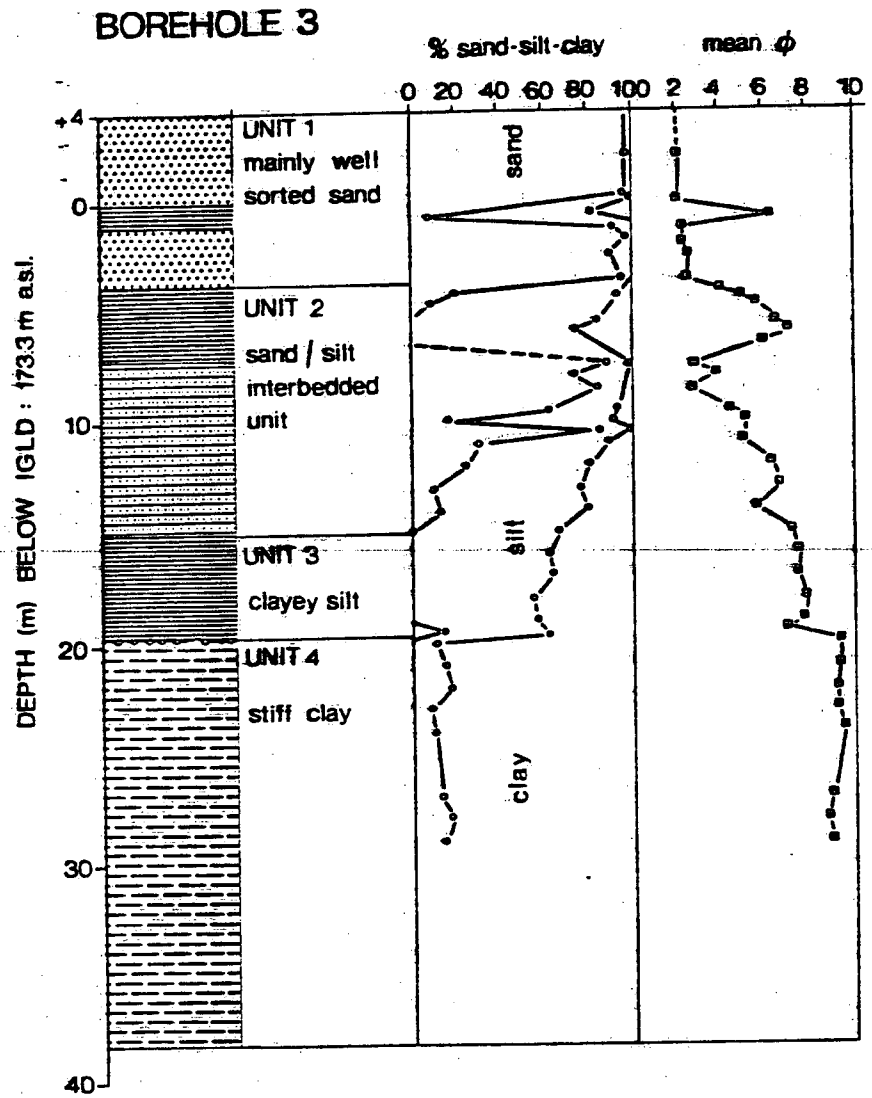

Figure 3. Interpreted sedimentary units and profiles of measured grain-size parameters in Borehole 3. Location shown in Figure 1.

APPENDIX 1

Summary Logs of Log Point Boreholes

Summary Log L.P. BH #1 (July/80)

0 = 175.3 m asl	(Ground Level).
0 - 1510 cm (Unit 1)	Gray to grayish brown medium (2.0 - 2.9) sand; generally well-sorted, except for pebbly layers (470, 550, 600, 1070 cm). Shells often associated with coarse layers. Wood rare (1280 cm). Gravelly layer (1310 - 1510 at base of unit.
1510 - 2680 cm (Unit 2)	Below gravelly layer, material changes to gray, fine sand (3.8) with silt interlaminations and lenses becomingmore common with depth. Bottom material is classified as sandy silt (5.4). Scattered plant fragments, wood pieces, and shells present.
2680 - 4180 cm (Unit 3)	Dark gray soft clayey silt with occasional sandy interlaminations in upper portion, becoming more clayey and less sandy with depth. Rare wood and organic matter. (3570 cm:artesian flow).
4180 - 5395 cm	Drilled down but no sample taken. Material on bit - soft gray clay (Glaciolacustrine?).

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Summary Log L.P. BH #2 (July 1980)

0 = 175.4 m asl	(Ground Level).
0 - 2080 cm	Brownish-gray (grading to gray 10 YR 5/1 at bottom), well sorted medium sand (2.0 to 2.6 ϕ) with occasional pebble bands and siltier layers. Wood fragments within pebbly sand layer at 1350 cm.
2080 - 3000 cm	At 2080 - 2090 and 2408 - 2424, bands of gray coarser sand and shells are present. Remainder of unit composed of gray fine-medium sand interlaminated with silty and clayey layers. Black plant fragments common.
3000 - 6130 cm	3000 - 4100 cm: Gray to dark gray (10.5 YR 4/1) sandy silt to silt (5.5 to 5.9 ϕ), firm to stiff in consistency. Sand layers occur at 3964 and 4830. Material gets finer from 4100 on down (6.1 ϕ) but sand fraction still around 10%. Silty clay material shows almost a "fissile" cleavage property and an apparently low moisture content. Interlaminations and lenses of coarser material persist to EOH. (Artesian flow at 3810, 4270 cm).

Summary Log L.P. BH #3 (October 1981)

0 = 175.7 m asl	(Ground Level).
0 - 650 cm (Unit 1)	Brown to brownish-gray well-sorted medium sand (2.1 - 2.7 ϕ) uniform except for common darker laminations (heavy minerals in bottom section) and occasional ice-rafted (?) pebbles. Organic debris (twigs, leaves, root fragments) common and occasionally form thin layers.
650 - 899 (Unit 2a)	Sharp contact separates sand unit above from Unit 2. Dark olive gray silt to clayey silt characterized by faint inclined laminations, scattered shell hash and organic debris, and partly dissolved bivalve shells. Rare indications of worm burrowing (fibres, mottling).
899 - 1740 (Unit 2b)	Contact not sampled. Unit grades slowly from grayish brown fine silty sand (2.8 ϕ) at top to dark gray clayey silt (6.6 ϕ) at the bottom. Sand layers and lenses interfinger regularly with silty layers, with silt layers more frequent in downward direction. Inclined contacts, vague low angle cross-laminations. Organic matter common and usually associated with sediment contacts and in sand layers.
1740 - 2263 (Unit 3)	Dark gray clayey silt, ranging in mean size from 7.1 to 7.9 ϕ. Very uniform, with faint dark subhorizontal laminations. Gas bubbles common throughout. Rate shells, silt or fine sand lenses. Effervesces in HCl.

2263 - EOH (4054 cm) (Unit 4)	Grayish brown (2.5 and 5/2) clay; stiff to firm in consistency. Plastic and greasy feel. Uniform in texture, although vague colour banding and laminations common. Laminations often contorted and inclined. Rare dark gray and reddish clay balls and flecks, no shells. Rare "ice-rafted" pebble. Siltier laminations and lenses become more common near base of borehole.