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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

TOPICAL REPORT NO. 33

BORE-HOLES AT GRAND FALLS, N. B. ACROSS A BURIED CHANNEL OF ANCESTRAL ST. JOHN RIVER

BY

HULBERT A. LEE

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INTRODUCTION

Test borings in Grand Falls, New Brunswick were made in 1961 across the buried channel of the ancestral St. John River. The channel is known to have passed through Grand Falls along the topographic low between Main and Terrace Streets approximately following the same course as that of the Canadian Pacific Railway. It is a direct connection across the short neck of land separating the upper basin of the St. John River from the lower basin. The age of the channel is known to be older than 10,250 years (Lee, 1959). Approximate boundaries of the old channel were first plotted on well-boring information supplied by Mr. Eugene Theriault of Grand Falls, and by the positions of basement walls that showed large cracks and offsets through major settling. Three test holes were placed to give a cross section of this channel.

At the time of writing this report, 2 bore-holes have been completed and the cores have been examined megascopically. Some laws of nature governing infilling of the old channel have been discerned and the information is released now on these 2 bore-holes as an immediate service to officials of the Town of Grand Falls, and to the New Brunswick Hydro-Electric Power Commission, and to private industry that is immediately concerned, so that this information can be applied to the needs of man in terms of ground-water supply and foundation conditions. Results of the final bore-hole will be released later as part B of this report after the writer has returned to headquarters from other summer field work, and examined the core. The scientific aspects will not be known until extensive laboratory studies of the cores have been completed and continuous water level measurements in an observation well have been recorded over an extended period of time. These results will be included in a comprehensive Geological Survey of Canada publication of the St. John River valley.

PURPOSE

Test borings were carried out in the buried channel for 4 main reasons: first, to check in one continuous section the succession of soil strata established earlier both from the examination of many small cuts, and as a natural consequence of the history of the region as determined by the writer's geologic mapping.

Second, to prove the existence of the buried channel and establish its shape. Then to find the reasons why the St. John River was deflected from its earlier course in the western part of the Town and was forced to carve out a new channel through bedrock. Numerous guesses have occurred in the literature as early as 1885.

Third, to establish a continuous reading water-level recorder on one well, BH-1, in the buried channel so as to compare over an extended period the water level in the upper basin of the river (the recharge area) with the water level in the buried channel and to see whether a direct connection exists.

Fourth, to provide basic data on the nature and succession of materials encountered, on the ground-water conditions and strengths of the soils, which will serve as pilot information for ground-water or foundation conditions; two problems of some importance along this buried channel. This topical report gives the results bearing on this fourth reason.

ACKNOWLEDGMENTS

Excellent co-operation was had with the Soils Testing Laboratories section of the Canada Department of Public Works who carried out the borings and strength tests; with the Council and others of the town of Grand Falls for their permission to drill on the town right-of-way and for their willingness to help on practical problems as they developed; and with the New Brunswick Electric Power

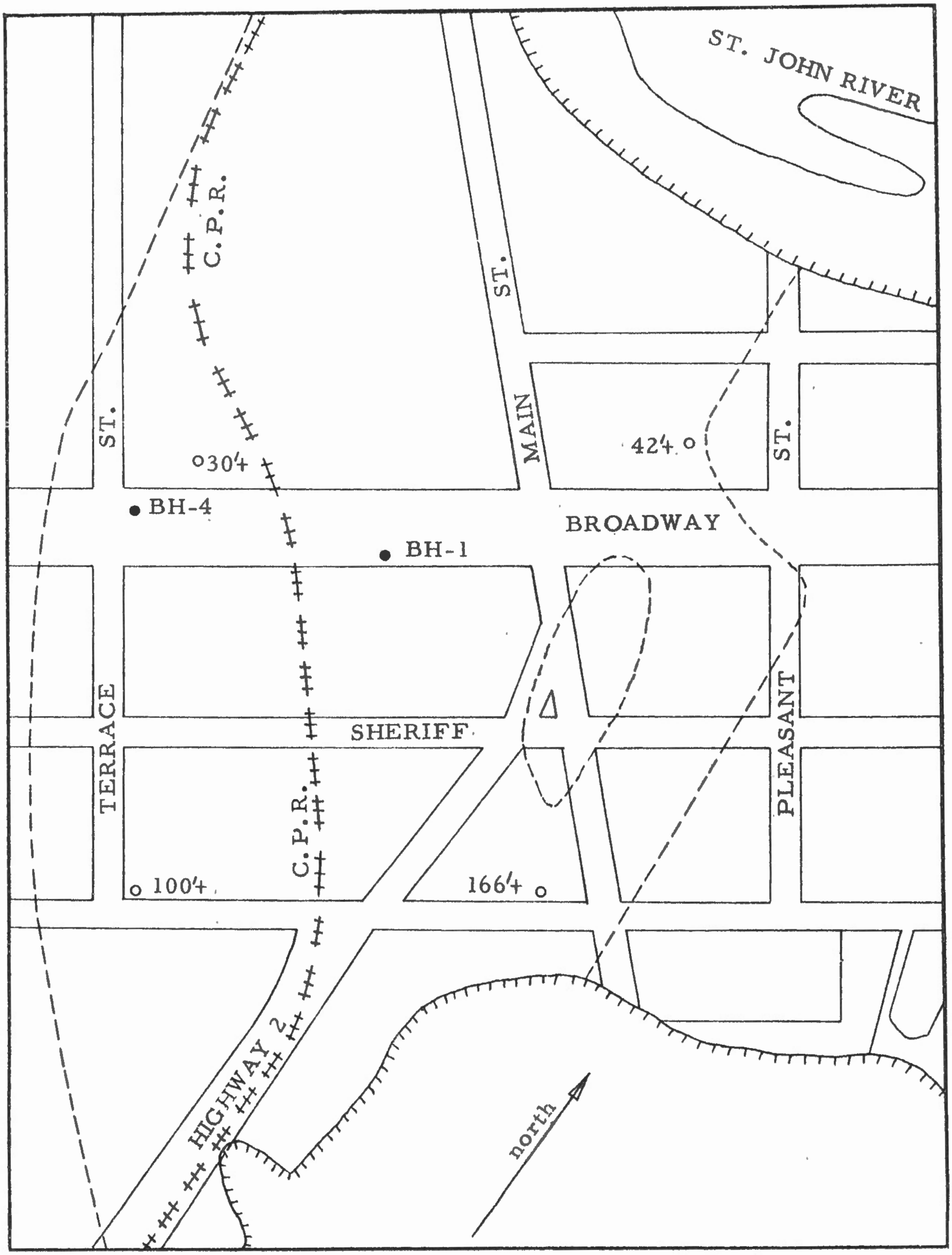

Fig. 1.—LOCATION OF BORE HOLES, GRAND FALLS, N.B.
(Approximate limits of deep buried channel are shown by dashed lines.)
Scale: 1 inch = 300 feet

Note: Holes drilled in 1961 .... ●
Holes drilled before 1961 .... o

Commission for their offer of aid in correlating water levels between the upper river basin and an observation well in the buried channel. The working together of these bodies is highly appreciated and most commendable.

REGIONAL GEOLOGY

The regional geology around Grand Falls is shown on Geological Survey of Canada, Map 24-1959 (in pocket) and in the descriptive notes at the side of the map. Lee reports in the descriptive notes as follows: "The most important glacial feature in the area is the Grand Falls end moraine with associated alluvial fans. [These pass through Grand Falls and are best developed in the hills one mile northwest of Grand Falls C.N.R. station.] The Grand Falls moraine marks an ice-frontal position of a major lobe of the Wisconsin ice-sheet in the St. John River valley. This is indicated by the abundance of erratics such as granite gneiss, derived from north of the St. Lawrence River, and of fossiliferous limestone, similar to outcrops in the Temiscouata Lake region of Quebec. A readvance of the ice-margin is indicated by glacial till overlying proglacial outwash at Parents (47° 09' N; 67° 55' W).

"Glacial rivers from the melting ice-sheet eroded and washed the glacial till south of the moraine, and deposited outwash chiefly in river valleys. When the ice-margin finally withdrew northward the gravel and glacial till of the moraine blocked the channel of the former St. John River, and gave rise to a lake northwest of the town of Grand Falls. This former lake has been named Glacial Lake Madawaska. The great thickness of outwash gravels, deposited by the glacial rivers south of Grand Falls, became terraced as the ancestral St. John River eroded its way laterally and downward to its present position. The numerous and prominent terraces along this part of the river mark the old slip-off slopes. A buried river channel passes under the western part of the town of Grand Falls and is nearly filled by about 170 feet of glacial drift. The postglacial course of the river is through a bedrock gorge that is still actively migrating headwards. Large potholes have been formed in the bedrock floor of the gorge. Well-rounded and nearly spherical cobbles can still be seen in some of the potholes. These cobbles and some sand were the abrading agents used by swirling waters to carve the 'wells in the rocks'".

Stratigraphy of the area is given from the surface down as:

(a) alluvial gravel, sand, and silt, or peat, or marl, or slope-wash colluvium, (geologic map-unit 7)

(b) peat, dated 10,200 years

(c) varved clay, buff silt, and black clay containing wood and manganese and giving off an odour of H_2S (geologic map-unit 6B)

(d) supra-till glacio-fluvial gravel and sand (geologic map-unit 2A

(e) grey gravelly clay till, impervious (geologic map-unit 2A)

(f) sub-till gravel and sand (geologic map-unit 5A, 5B)

(g) bedrock (Palaeozoic)

Knowledge of this stratigraphy not only lends much to the evaluation of the geologic history, but provides a framework to which the engineer and geologist can correlate bore-hole records for site foundation and ground-water investigations. Many of the units are lenticular in shape and their presence or absence can only be determined at any one place by bore-holes.

GROUNDWATER AND SOILS

The results tabulated in this report and the conditions stated below apply directly only to the individual bore-holes described, and a professional engineer should be consulted for extension or application of this information.

Availability and Chemistry of Groundwater in BH-1 and BH-4

Bore-hole 4 was drilled on the north side of Broadway just east of Terrace Street. Water level was recorded in the hole each morning before drilling began. Hence the water level represents the aquifer open to the bottom of the drill casing. Higher impervious layers would be fairly effectively sealed off by the casing, and lower aquifers would still not be penetrated.

The readings show a pulsating drop of water-levels as drilling proceeded and only thin aquifers were encountered. The static water-level was recorded for 2 days at the end of drilling, and it stood at a depth for both days of 104 feet. Bedrock was encountered in this hole at a depth of 159 feet and it was drilled to a depth of 179 feet.

Bore-hole 1 was drilled on the south side of Broadway at the bottom of the depression between Terrace and Main Streets. Two static water-levels were recorded in the hole separated by a layer of impervious gravelly clay till and some dry sub-till gravels.

The upper aquifer represents a perched water-table. It is about 12 feet thick. As a supply of groundwater, it is probably not of large areal extent, and furthermore the overlying clays contain manganese, a condition not conducive to good groundwater chemistry. The perched water-table is responsible for the poor drainage condition of the depression, and may be a factor in the wash-out problem along the Highway a few streets to the south.

The lower aquifer in BH-1 is important. It is much more extensive than the upper, and extends throughout a vertical distance of 120 feet. There is reason to believe that it has good width, and in length joins the St. John River near the site of an existing municipal well. The cleanest sands (poorly-graded sands) are fortunately near the bottom of the aquifer, and hence,if a well were developed on this site, water could be utilized from most of the aquifer. Pumping tests have not been made on this lower aquifer, but a 2½ inch casing, perforated below the impervious gravelly clay till, has been left in the hole for observation and water-level recording purposes. Pumping tests can still be run.

The chemistry of water in the lower aquifer has not been done. Reference can only be made to a report on the water-chemistry of existing municipal wells: "Thomas, J.F.J. (1960): Industrial Water Resources of Canada: The Atlantic Provinces, and the Saint John River Drainage Basins in Canada, 1954-56: Canada Dept. of Mines and Technical Surveys, Mines Branch, Water Survey Rept. No. 11, 158 pages".

Strengths of The Soils in BH-1

Undisturbed continuous samples of material were collected in shelby tubes from the surface to a depth of 30 feet. Strength tests and atterberg limits were run on the organic and clay strata by the Soil Testing Laboratories of Canada Department of Public Works. This information is of direct use to C.P.R. district engineer. See table 2, in the pocket, for results of these tests.

The clay fails under light loads, and it now seems probable that the large cracks and offsets observed in basement walls and used first for outlining the old channel seem to be due to settling over the underlying strata of plastic clay.

DESCRIPTIVE LOGS OF BORE-HOLES

Positions of the first two boreholes drilled, BH-1 and BH-4 are shown on Figure 1, as well as information from other known boreholes in the vicinity.

Graphic logs of BH-1 and BH-4 are enclosed in the pocket and should be used in cross-reference to the descriptive logs that follow. The soils are described according to the 'Unified Soil Classification System' (Table 1), to correspond with the logs of other boreholes along the St. John River such as is reported in 'Water Resources of the Saint John River Basin', an interim report (1953), by the International Saint John River Engineering Board.

Table 1

UNIFIED SOIL CLASSIFICATION
(Including Identification and Description)

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 3 inches and basing fractions on estimated weights)		
1	2		3	4	5		
Coarse-grained Soils More than half of material is larger than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.		
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
			GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
	Sands More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.		
			SP	Poorly-graded sands, gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.		
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).		
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).		
					Identification Procedures on Fraction Smaller than No. 40 Sieve Size		
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)
Fine-grained Soils More than half of material is smaller than No. 200 sieve size.	Silts and Clays	Liquid limit less than 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium
			OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight
	Silts and Clays	Liquid limit greater than 50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium
			CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium
Highly Organic Soils			Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.		

After: Corps of Engineers, U.S. Army,

Technical memorandum, No. 3-357, 1953.

Description of Materials, Sampled in BH-1

Sample Number	Description of Sample	Depth of Sample	Progressive Depth
1 to 5	Slopewash (fill and natural); grey, fine mat, sand and woody peat (OH-Pt-SM).	0 - 9'	9'
5 to 9	Highly organic soils (gyttja), spongy, silty and sandy layers in upper part of gyttja (Pt).	9' - 18'	18'
9 to 13	Organic clay; black when fresh, greyish buff on exposure contains some wood; high plasticity, odour of H_2S when tested with dilute Hcl, contains finely disseminated black manganese, clay minerals in proportions of chlorite 30% to illite 70%, (Unit 6B on geologic map, Lake Madawaska and Oxbow Lake sediments, (OH).	18' - 25'	25'
13 to 15	Inorganic clays of high plasticity; blue-grey characterized by worm-like fracture openings, no odour when tested with dilute Hcl, clay minerals in proportions of chlorite 30% to illite 70%, white and blue mineral vivianite (hydrous ferric phosphate present as scattered blobs, (CH).	25' - 29'	29'
15	Inorganic silts and very fine sands; gravelly, particles up to about $\frac{3}{4}$-in. maximum size, subrounded, proportions 9% gravel, 33% sands, and 38% non plastic fines, unit 6B on geologic map, Lake Madawaska and Oxbow Lake sediments, (SM).	29' - 30'	30'
16	Gravel-sand-silt mixture, particles up to 3-in. maximum size, rounded, proportions 60% gravel, 32% sands, 8% slightly plastic fines, unit 2A on geologic map, (GM).	30' - 32'	32'

Sample Number	Description of Sample	Depth of Sample	Progressive Depth
17	Well-graded sandy gravel, particles up to 3-in. maximum size, proportions 64% subrounded gravels, 32% sand and 4% non plastic fines, unit 2A on geologic map (GW).	35 ' - 37'	37'
18	Gravel-sand mixtures, particles up to 4-in. maximum size, proportions 74% gravel, 24% sand, and 2% non plastic fines, unit 2A on geologic map, (GP).	40' - 42'	42'
19, 19a, 21	Gravelly clays glacial till, particles up to about 3-in. maximum size, about 70% fines, of medium plasticity impervious, forms perched water table to surface level, unit 2A on geologic map, (CL).	43' - 45' 50' - 52' 55' - 57'	59'
22	Gravel-sand-silt mixture, particles up to 3-in. maximum size, rounded, proportions 52% gravels, 37% sand, 6% non plastic fines, dry in place, oxidized zone near elevation of fluctuating ground water table, shown by yellow iron coatings on pebbles and buff colour of fines, granite erratics from north shore of St. Lawrence, indicating glacial origin for strata, unit 5A on geologic map, (GM).	60' - 62'	62'
23	Gravel-sand-silt mixture, particles up to 2-in. maximum size, rounded, proportions 40% gravel, 41% sand, 11% non-plastic fines, oxidized zone with yellow iron coatings on pebbles and buff colour of fines, unit 5A on geologic map, (GM).	70' - 72'	72'
24	Gravel-sand-silt mixture, particles up to $1\frac{1}{4}$-in. maximum size, rounded, proportions 27% gravels, 64% sands, 9% non plastic fines, unit 5A on geologic map (GM).	80' - 82'	82'

Sample Number	Description of Sample	Depths of Sample	Progressive Depth
26	Silty sands, gravelly, particles up to 2-in. maximum size, proportions 39% gravels, 48% sands, 13% non plastic fines, unit 5A on geologic map, (SM).	82' - 83'	83'
28	Well-graded sands, grey-brown, medium- to fine-grained little fines, unit 5A on geologic map, (SW).	90' - 92'	92'
30	Silty sands dark grey, occasional particle up to $\frac{3}{4}$-in. maximum size, rounded, proportions 3% gravel, 79% sand, 18% non plastic fines, unit 5A on geologic map (SM).	93' - 95'	95'
32	Silty sands, gravelly, grey, particles up to 2-in. maximum size, rounded, proportions 43% gravel, 48% sand, 9% slighty plastic fines, unit 5A on geologic map, (SM).	102' - 104'	104'
35	Silty sands, gravelly, particles up to 1-in. maximum size, well rounded, proportions 25% gravels, 67% sands, 8% non plastic fines, unit 5A on geologic map, (SM).	110' - 112'	112'
37	Gravel-sand-silt mixtures, particles up to 3-in. maximum size, subrounded, proportions 51% gravel, 41% sand, 8% slightly plastic fines, unit 5A on geologic map,(GM).	112' - 114'	114'
39	Silty sand, particles up to $\frac{3}{4}$-in. maximum size, well rounded, proportions 7% gravel, 85% sand, 8% slightly plastic fines, unit 5A on geologic map, (SM).	120' - 122'	122'
41	Silty sand, grey, proportions 88% sand, 12% slightly plastic fines, unit 5A on geologic map (SM).	129' - 131'	131'

Sample Number	Description of Sample	Depth of Sample	Progressive Depth
43	Clayey sands, gravelly, particles up to 1-in. maximum size, well rounded, proportions 11% gravels, 78% sands, 11% moderately plastic fines, unit 5A on geologic map (SC).	139' - 141'	141'
45	Silty sands, gravelly, particles up to $1\frac{1}{2}$-in. maximum size, rounded, proportions 39% gravels, 51% sands, 10% slightly plastic fines, oxidized zone with yellow iron coating on pebbles but fines still grey, ancient water table (?), unit 5A (?) or older on geologic map (SM).	145' - 147'	147'
47	Silty sands, gravelly, characteristic buff, colour, particles up to 2-in. maximum size, well-rounded, proportions 12% gravels, 80% sands, 8% non plastic fines, colour of fines buff, unit 5A (?) or older on geologic map, (SM).	150' - 152'	152'
49	Poorly-graded sands, coarse, particles up to $\frac{3}{4}$-in. maximum size, proportions 2% gravels, 95% sands, and 3% slightly plastic fines, unit 5A (?) or older on geologic map,(SP).	160' - 162'	162'
51	Poorly-graded gravelly sands; particles up to $\frac{3}{4}$-in. maximum size, proportions 19% gravel, 80% sand, 1% slightly plastic fines, unit 5A (?) or older on geologic map,(SP).	170' - 172'	172'
53	Gravelly very fine sands, brown, particles up to 4-in. maximum size, slightly plastic fines, unit 5A (?) or older on geologic map, (ML).	180' - 182'	182'
Rock core	Limestone, argillaceous limestone, dark grey, fine grained with numerous calcite fracture fillings up to $\frac{1}{4}$-in. maximum width. Rock at depth 182'	193' - 204'	204'

Description of Materials Sampled in BH-4

Sample Number	Description of samples	Depth of Sample	Progressive Depth
1 to 8	Inorganic silts and very fine sands, grey brown slightly plastic, occasional pebble $\frac{3}{4}$-in. maximum size, firm and moist in place, alluvium, unit 7 on geologic map (ML).	0' - 15'	15'
8 to 9	Sand-silt mixture with cobbles; particles up to 4 inches maximum size, slightly plastic fines, firm and moist in places, interbedded with thin layers of poorly graded sands, alluvium, unit 7 on geologic map, (SM).	15' - 18'	18'
10 to 13	Interbedded well graded sands with inorganic silts and very fine sands, grey brown; silts slightly plastic, occasional pebble 1/8-in. maximum size; sands oxidized, firm and moist in place, alluvium, unit 7 on geologic map, (SW and ML).	18' - 27'	27'
14 - 20	Inorganic silts and very fine sands; brown, non plastic fines, firm and moist in place, occasional pebbles 4-in. maximum size; clay laminae, grey, about 1/8-inch thick and spaced at $2\frac{1}{2}$-in. intervals between depths 34 ft. to 44 ft. varves, unit 6B Lake Madawaska sediments on geologic map (ML and CH).	27' - 49'	49'
20	Gravel-sand-silt mixtures, particles up to about 1-inch maximum size, subrounded with black manganese coatings, unit 2A or 5A on geologic map (GM).	49' - 50'	50'
21,22	Gravel-sand mixture, little fines, grey, particles up to 1-in. maximum size, subrounded, non plastic fines, unit 2A or 5A on geologic map (GP).	52' - 54' 62' - 64'	54' 64'

Sample Number	Description of samples	Depth of Sample	Progressive Depth
23	Cobble gravel - sand mixtures, little fines, grey particles up to 3-in. maximum size, subrounded, hard, non plastic fines, unit 2A or 5A on geologic map (GP).	72' - 74'	74'
24	Well-graded gravels, grey, particles up to 1-in. maximum size, angular to subangular, no fines, unit 2A or 5A on geologic map (GW).	82' - 84'	84'
25	Silty sands, gravelly; particles up to ½-in. maximum size, hard and subrounded, grey, about 20% slightly plastic fines, well compacted and moist in place, unit 2A or 5A on geologic map (SM).	92' - 94'	94'
26	Poorly-graded gravels, particles range about 1/32-in. to 1/2-in. sizes, limestone pebbles numerous, damp and loose in place, unit 2A or 5A on geologic map (GP).	102' - 104'	104'
27	Gravel-sand-silt mixtures, oxidized zone, particles up to 3 inches maximum size, subangular, some rotted, about 15% non plastic fines, moist and loose in place, unit 2A or 5A on geologic map, (GM).	112' - 114'	114'
28	Poorly-graded sands, coarse with average size about 1/8-in., subrounded, little non plastic fines, wet in place, unit 2A or 5A on geologic map, contains erratics of quartzite and red slate derived from bedrock in Lake Temiscouta region of Quebec, unit 2A/on geologic map (SP) or 5A	122' - 124'	124'
29	Poorly graded gravelly sands, grey, particles range about 1/32-in. to 1/2-in. sizes, trace of non plastic fines, damp in place, unit 2A or 5A on geologic map (SP).	132' - 134'	134'
30, 31	Silty gravel, particles range up to 2-in. maximum size, about 15% non plastic fines, wet in place, unit 2A or 5A on geologic map, (GM).	142' - 144' 150' - 152'	144' 152'

Sample Number	Description of samples	Depth of Sample	Progressive Depth
Rock core	<u>Limestone, argillaceous limestone</u>, grey, fine grained with numerous calcite fracture fillings up to $\frac{1}{4}$-in. maximum width.	159' to 180'	180'

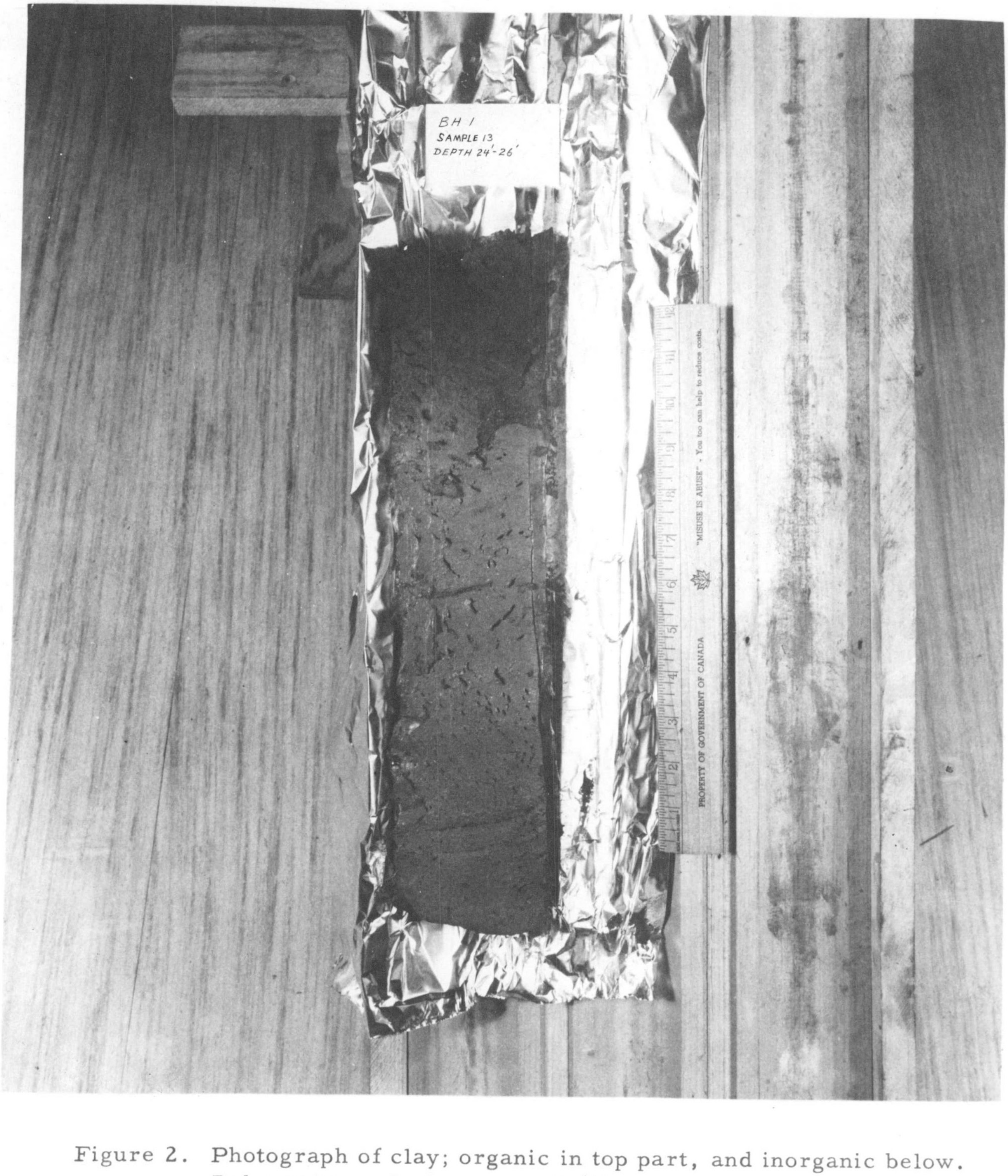

Figure 2. Photograph of clay; organic in top part, and inorganic below. Belongs to geologic map-unit 6B.