APPENDIX A:

GEOTECHNICAL INVESTIGATIONS

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

GEOTECHNICAL INVESTIGATION AND FOUNDATION ENGINEERING REPORT
FOR
HAULED LIQUID WASTE FACILITY
NORTH END WATER POLLUTION CONTROL CENTRE

Prepared for
STANTEC CONSULTING LTD.
905 WAVERLEY STREET
WINNIPEG, MANITOBA
R3T 5P4

Prepared by
THE NATIONAL TESTING LABORATORIES LIMITED
199 HENLOW BAY
WINNIPEG, MANITOBA
R3Y 1G4

December 21, 2009

Table of Contents

1.0 SUMMARY

The National Testing Laboratories Limited were retained to undertake a geotechnical investigation and provide foundation recommendations for the proposed hauled liquid waste facility at the North End Water Pollution Control Centre (NEWPCC). Five testholes were drilled at the site on November 10, 2009. The geotechnical investigation revealed a general soil profile consisting of topsoil at the ground surface, underlain by clay fill, then clay with silt layers, and silt till to the depths explored in the testholes. Based upon the soil and groundwater conditions encountered at the site, the proposed structures may be supported on a raft foundation. Alternatively, the proposed structures may be supported on driven precast concrete piles or cast-in-place concrete friction piles.

2.0 TERMS OF REFERENCE

The National Testing Laboratories Limited were retained to undertake a geotechnical investigation and provide foundation recommendations for the proposed hauled liquid waste facility at the North End Water Pollution Control Centre (NEWPCC). The project site is located at 2230 Main Street in Winnipeg. Authorization to proceed with the geotechnical investigation was provided by Alfred Beghin on October 9, 2009.

3.0 GEOTECHNICAL INVESTIGATION

3.1 Testhole Drilling and Soil Sampling

The subsurface drilling and sampling program was conducted on November 10, 2009 with drilling services provided by Maple Leaf Drilling Ltd. under the supervision of our geotechnical field personnel. Five testholes (TH1 to TH5) were drilled at the site. The testholes were drilled using a truck-mounted drill rig equipped with 125 mm diameter solid stem augers and their locations are shown on the attached Testhole Location Plan. Auger refusal on suspected boulders in the silt till was encountered at depths of 20.7 m and 20.6 m in Testholes TH1 and TH2 respectively. Testholes TH3, TH4 and TH5 were drilled to a depth of approximately 3 m.

Representative soil samples were obtained directly off the augers at depth intervals ranging from 0.8 to 1.5 m. Upon completion of drilling, the testholes were examined for evidence of sloughing and groundwater seepage. The samples were visually classified in the field and returned to our soils laboratory for additional examination and testing.

3.2 Laboratory Testing

Water content and torvane tests were conducted on soil samples recovered from selected testholes and the test results are shown on the attached testhole logs. Unconfined compressive strength testing was conducted and the test result is provided in the table below.

Testhole No.	Depth (m)	Soil Type	Unconfined Compressive Strength (kPa)
TH2	4.9	Clay	75.6

4.0 SUBSURFACE CONDITIONS

4.1 Soil Profile

The general soil stratigraphy, as interpreted from the testhole logs revealed a general soil profile consisting of topsoil at the ground surface, underlain by clay fill, then clay with silt layers, and silt till to the depths explored in the testholes.

Topsoil

Topsoil was encountered at the surface of the testholes. The topsoil was black with organic material. The topsoil layer extended to a depth of approximately 100 mm.

Clay Fill

Clay fill was encountered beneath the topsoil at the testhole locations. The clay fill was black, stiff, moist, and of high plasticity. The clay fill extended to a depth ranging from 0.6 m to 0.8 m below existing grade.

Clay

Clay was encountered beneath the clay fill in the testholes. The clay varied from brown to grey, was soft to stiff, moist, and of high plasticity. The clay extended to a depth of 18.9 m and 19.1 m in Testholes TH1 and TH2 respectively. Water contents of the clay ranged from 28 to 68%.

Silt

Silt layers were encountered within the clay layer in the testholes. The silt was tan, soft, moist and of low plasticity. The thickness of the silt layers ranged from 0.3 m to 1.2 m. Water contents of the silt ranged from 21 to 26%.

Silt Till

Silt till was encountered beneath the clay in Testholes TH1 and TH2. The silt till was tan, compact to dense, moist, and of low plasticity. Auger refusal on suspected boulders in the silt till was encountered at depths of 20.7 m and 20.6 m in Testholes TH1 and TH2 respectively. Water contents of the silt till ranged from 11 to 13%.

4.2 Groundwater

Moderate groundwater seepage was observed in Testhole TH2 from the shallow silt layer. The groundwater level was at a depth of 5.5 m in Testhole TH2 upon completion of drilling. No groundwater seepage was observed in the remaining testholes. Soil sloughing was observed below depths of 5.2 m and 10.7 m in Testholes TH1 and TH2 respectively. No soil sloughing was observed in the remaining testholes. It should be noted that only short-term seepage and sloughing conditions were observed and groundwater levels will normally fluctuate during the year and will be dependent upon precipitation and surface drainage.

5.0 DESIGN RECOMMENDATIONS AND COMMENTS

5.1 Foundations

It is our understanding that the proposed structures will extend approximately 5 to 6 m below the ground surface. Based upon the soil and groundwater conditions encountered at the testhole locations, the proposed structures may be supported on a raft foundation. Alternatively, the proposed structures may be supported on driven precast concrete piles or cast-in-place concrete friction piles.

5.1.1 Raft Foundation

A raft foundation, constructed on firm clay at a depth of approximately 5 to 6 m below grade, may be designed based upon an allowable bearing pressure of 100 kPa. The modulus of subgrade soil reaction at a depth of 5 to 6 m is estimated to be in the range of 5 to 8 MPa/m.

It should be noted that moderate groundwater seepage was observed at a shallow depth in Testhole TH2. Groundwater seepage should be anticipated during excavation for the raft foundation and suitable pumps should be available during construction. It is recommended that testpits be excavated within the building footprints prior to full excavation to observe the groundwater conditions and confirm the requirements for dewatering.

Construction equipment should not be allowed to travel directly on the foundation bearing surface. To minimize disturbance of the bearing surface, excavation with a flat bucket excavator is recommended at the foundation level. All loose and softened soil must be removed from the bearing surface. The clay subgrade has a high volume change potential and therefore, measures should be taken to prevent changes in soil moisture content at the foundation bearing surface. The prepared bearing surface should not be exposed to excessive wetting or drying during construction. The magnitude of volume change is difficult to predict but is estimated to be in the range of 20 to 50 mm. It is recommended that a lean mix concrete working slab be constructed after the foundation bearing surface has been inspected and approved by qualified geotechnical personnel. The lean mix concrete working slab should be constructed directly on the undisturbed clay subgrade. If construction takes place during freezing weather, measures must be taken to prevent frost penetration beneath the foundation bearing surface. Frost heave of the subgrade soil will occur if it is exposed to freezing temperatures.

5.1.2 Precast Concrete Piles

A foundation system suitable to support the proposed structures is a system of driven, prestressed, precast concrete piles. These units, when driven to practical refusal with a hammer capable of delivering a minimum rated energy of 40 KJ per blow, may be assigned the following allowable loads.

Nominal Pile Size	Allowable Load	Refusal Criteria
300 mm	450 kN	5 blows/25 mm
350 mm	625 kN	8 blows/25 mm
400 mm	800 kN	12 blows/25 mm

Pile spacing should not be less than 2.5 pile diameters, measured center to center. Pile heave for piles within 5 pile diameters should be monitored and redriving done where pile heave is found to be significant. Pre-boring to at least 3 m should be considered for all driven piles to enhance pile alignment and minimize vibration levels in adjacent structures during installation. The prebored hole diameter should be slightly larger than the nominal pile diameter. All piles should be driven continuously to their required depth once driving is initiated. Precast concrete piles driven to practical refusal will develop the majority of their capacity from toe resistance, and therefore, no reduction in pile capacity is necessary for group action. The design capacity of a pile group is equal to the number of piles in the group times the allowable capacity per pile.

Auger refusal was encountered within the silt till at depths of 20.7 m and 20.6 m in Testholes TH1 and TH2 respectively. Although driven piles are expected to reach refusal at similar depths, some variation in pile refusal depths should be anticipated. Negligible settlement beyond the elastic compression of the pile can be expected with an end-bearing pile system. A minimum void space of 200 mm should be provided beneath all structural elements to accommodate potential heave of the high plasticity clay. To ensure that the piles achieve their design capacities, full time inspection by qualified geotechnical personnel is recommended during pile installation.

5.1.2 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete friction piles are suitable for light to moderate foundation loads and may be designed based upon the allowable skin friction values shown in the following table.

Depth Interval below Existing Grade (m)	Allowable Skin Friction (kPa)
x to 8 m	11
8 to 15	8
15 to 17	7

Where x = depth at 1 m below top of pile

Pile holes should be poured with concrete as soon as they are drilled to minimize any potential problems of soil sloughing and groundwater seepage. Temporary steel sleeves should be available in the event that groundwater seepage or sloughing of the pile holes is encountered during pile installation. Groundwater, if encountered in the pile holes, should be removed prior to concrete placement.

It is recommended that the pile depth not exceed 17 m below existing grade to avoid penetration of the silt till and potential groundwater seepage below this depth. A minimum void space of 200 mm should be provided beneath all structural elements to accommodate potential heave of the high plasticity clay. Minimum pile spacing should be three pile diameters, measured center to center. If pile groups are required, group action should be considered. Pile settlements are expected to be negligible with the use of cast-in-place concrete friction piles.

5.2 Foundation Walls

Below grade walls should be designed to resist lateral earth pressures based on the following formula:

$$P = K_0 (\gamma D + q)$$

where P = lateral earth pressure at depth D, kPa
K_0 = at rest earth pressure coefficient (0.7)
γ = soil unit weight (18 kN/m^3)
q = live load surcharge within distance D, kPa

The above expression assumes the below grade walls will be drained and there will be no buildup of hydrostatic pressure on the walls. A 1 m wide layer of free draining granular material must be provided adjacent to the below grade walls and a subsurface drainage system must be provided at the base of the walls to prevent the buildup of hydrostatic pressure. The sump collection system should be provided with an alarm system to alert plant operators in the event of a pump failure. Clay soils are often subject to excessive frost action and swelling when used as backfill, which can generate excessive lateral earth pressures on below grade walls. If clay is used to backfill the walls, compaction should not exceed 90% of standard Proctor maximum dry density and moisture content of the clay should not be less than the optimum moisture content. Clay backfill should not be placed within 1 m of the below grade walls.

5.3 Excavation

Temporary excavations will be required for construction of the concrete working slab and walls for the structures. The stability of temporary excavations is a function of several factors, including the total time the excavation is exposed, moisture conditions, soil type and consistency, and the contractor's operations. It is the responsibility of the contractor to maintain safe and stable slopes or design and provide suitable shoring during construction. The design of excavation slopes must recognize the presence of water-bearing silt layers encountered in the testholes. As a guideline, open excavations must be sloped at a minimum gradient of 1 horizontal to 1 vertical within the clay. Excavated slopes should be protected from wetting and weathering by suitable temporary covering. Surface drainage should ensure surface water is directed away from the excavation. The introduction of excessive moisture will often result in unstable excavation conditions. All excavation works must comply with the Province of Manitoba Workplace Safety and Health Act and Guidelines for Excavation Work.

5.4 Foundation Concrete

The clay soils in the Winnipeg area contain sulphates that will cause deterioration of concrete. The class of exposure for concrete in contact with clay soil in the Winnipeg area is considered to be severe (S-2 in CSA A23.1-09 Table 3). The requirements for concrete exposed to severe sulphate attack are provided in the following table.

Parameter	Design Requirement
Class of exposure	S-2
Compressive strength	32 MPa at 56 days
Air content	4 to 7%
Water-to-cementing materials ratio	0.45 max.
Cement	Type HS or HSb

5.5 Pavement

The testholes revealed a soil profile of clay fill, clay, and silt near the ground surface. Although silt was typically encountered at a depth of approximately 2 m, it was encountered at a depth of 1.2 m in Testhole TH3. Silt is a frost-susceptible soil and the potential for frost heave of the pavement surface exists if the silt is present within the depth of annual frost penetration. In the Winnipeg area, the depth of frost penetration is approximately 2 m where the ground surface is kept clear of snow during the winter months. Increased maintenance costs for the pavement should be anticipated if the silt is not removed within the depth of annual frost penetration. To minimize pavement distress related to freezing and thawing of the silt, a minimum soil cover of 1.0 m should be provided above the frost-susceptible layer. To avoid the potential requirement for subexcavation and reduce the risk of frost-related distress in the pavement, it is recommended that the final grades for the pavement areas be set as high as possible.

Preparation of the subgrade for construction of the pavement areas will require removal of organic soils and proof rolling to identify soft areas within the exposed subgrade. All soft or weak subgrade soils identified during proof rolling must be excavated and replaced with crushed limestone subbase. Additional materials, if required to increase the final grade for the pavement area, should consist of crushed limestone sub-base material. Inspection of the subgrade by qualified geotechnical personnel is recommended during subgrade preparation.

The following asphalt pavement sections are recommended for this project:

Material	Thickness (mm)	
	Light Duty Pavement	Heavy Duty Pavement
Asphaltic Concrete	60	80
Base Course	75	75
Sub-Base	250	400

The light duty pavement section should be used where traffic loading will consist of passenger vehicles and light duty trucks. The heavy duty pavement section should be used for pavements subjected to traffic loading greater than passenger vehicles and light duty trucks. In the event concrete pavements are required due to heavy traffic loads, the following pavement section is recommended:

Material	Thickness (mm)
Portland Cement Concrete	200
Base Course	75
Sub-Base	225

Pavement construction should comply with the following City of Winnipeg Standard Construction Specifications:

- CW 3110, Sub-grade, Sub-base and Base Course Construction
- CW 3310, Portland Cement Concrete Pavement Works
- CW 3410, Asphaltic Concrete Pavement Works

Sieve analysis and compaction testing of the crushed limestone base course and sub-base materials should be conducted to ensure that the materials and compaction comply with the design specifications. Concrete testing should be undertaken during construction to ensure the concrete mix supplied to the project meets the specifications requirements. For the hot mix asphaltic concrete, compaction testing and Marshall analysis of the paving mix during construction should be undertaken. This will confirm that the asphaltic concrete has been supplied and installed in accordance with the project specifications.

5.6 Drainage

A weeping tile or subsurface drainage system should be provided at the base of the below grade walls to prevent the buildup of hydrostatic pressure. The collected water should be drained to a central sump and discharged away from the buildings. To minimize infiltration of surface water, a 600 mm clay cap should be provided above the backfill material adjacent to the buildings.

All roof downspouts should be directed away from the buildings and the ground surface around the buildings should be graded to promote drainage away from the foundation and therefore minimize soil swelling and frost action. Final site grading should ensure that all surface runoff is directed away from the buildings using a minimum gradient of 2%. To compensate for potential settlement of backfill materials adjacent to the buildings, the grade should be increased to 10% for the first 2 m from the buildings.

6.0 CLOSURE

Professional judgments and recommendations are presented in this report. They are based partly on an evaluation of the technical information gathered during our site investigation and partly on our general experience with subsurface conditions in the area. We do not guarantee the performance of the project in any respect other than that our engineering work and judgment rendered meet the standards and care of our profession. It should be noted that the testholes may not represent potentially unfavourable subsurface conditions between testholes. If during construction soil conditions are encountered that vary from those discussed in this report, we should be notified immediately in order that we may evaluate effects, if any, on the foundation performance. The recommendations presented in this report are applicable only to this specific site. These data should not be used for other purposes.

We appreciate the opportunity to assist you in this project. Please call me if you have any questions regarding this report.

Don Flatt

Don Flatt, M. Eng., P.Eng.
Senior Geotechnical Engineer

PROVINCE OF MANITOBA
D.G.
FLATT
Member
5062
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
The National Testing Laboratories
Limited
No. 690 Date: Dec 21/09

THE NATIONAL TESTING LABORATORIES LIMITED *Established in 1923*	Project No. STA-944	Drawn by: AP	Figure: 1	Testhole Location Plan NEWPCC Hauled Liquid Waste Facility Winnipeg, Manitoba
	Date: Dec 17, 2009	Reviewed by: DF	Scale: NTS	

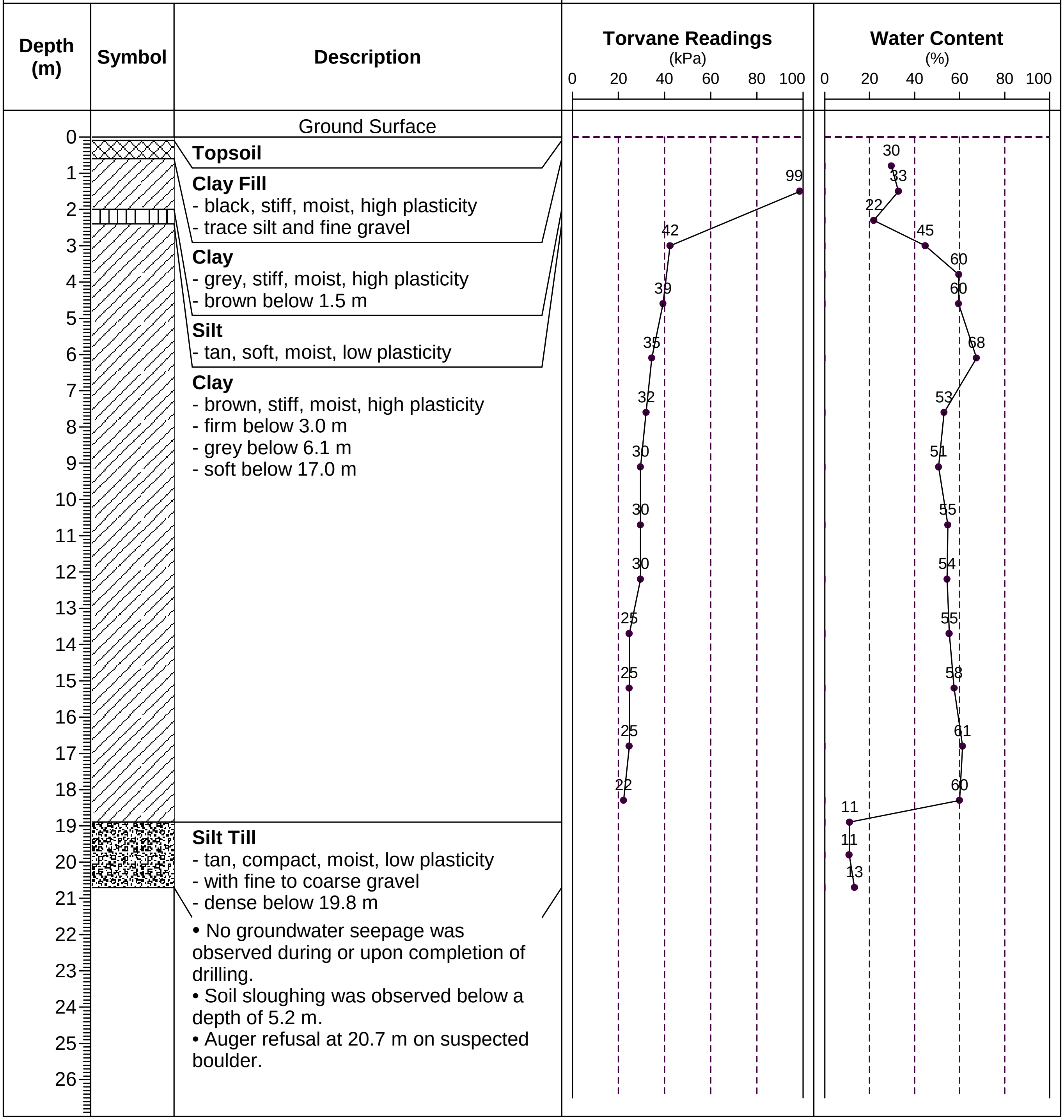
THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

TESTHOLE TH1

Project Name: NEWPCC Hauled Liquid Waste Facility
Client: Stantec Consulting Ltd.
Drilling Contractor: Maple Leaf Drilling Ltd.
Drilling Method: 125 mm Auger

Date Drilled: November 10, 2009
Depth of Testhole: 20.7 m
Logged by: Farouk Fourar
Reviewed by: Don Flatt

Subsurface Profile | **Laboratory Testing**



Ground Surface

Topsoil

Clay Fill
- black, stiff, moist, high plasticity
- trace silt and fine gravel

Clay
- grey, stiff, moist, high plasticity
- brown below 1.5 m

Silt
- tan, soft, moist, low plasticity

Clay
- brown, stiff, moist, high plasticity
- firm below 3.0 m
- grey below 6.1 m
- soft below 17.0 m

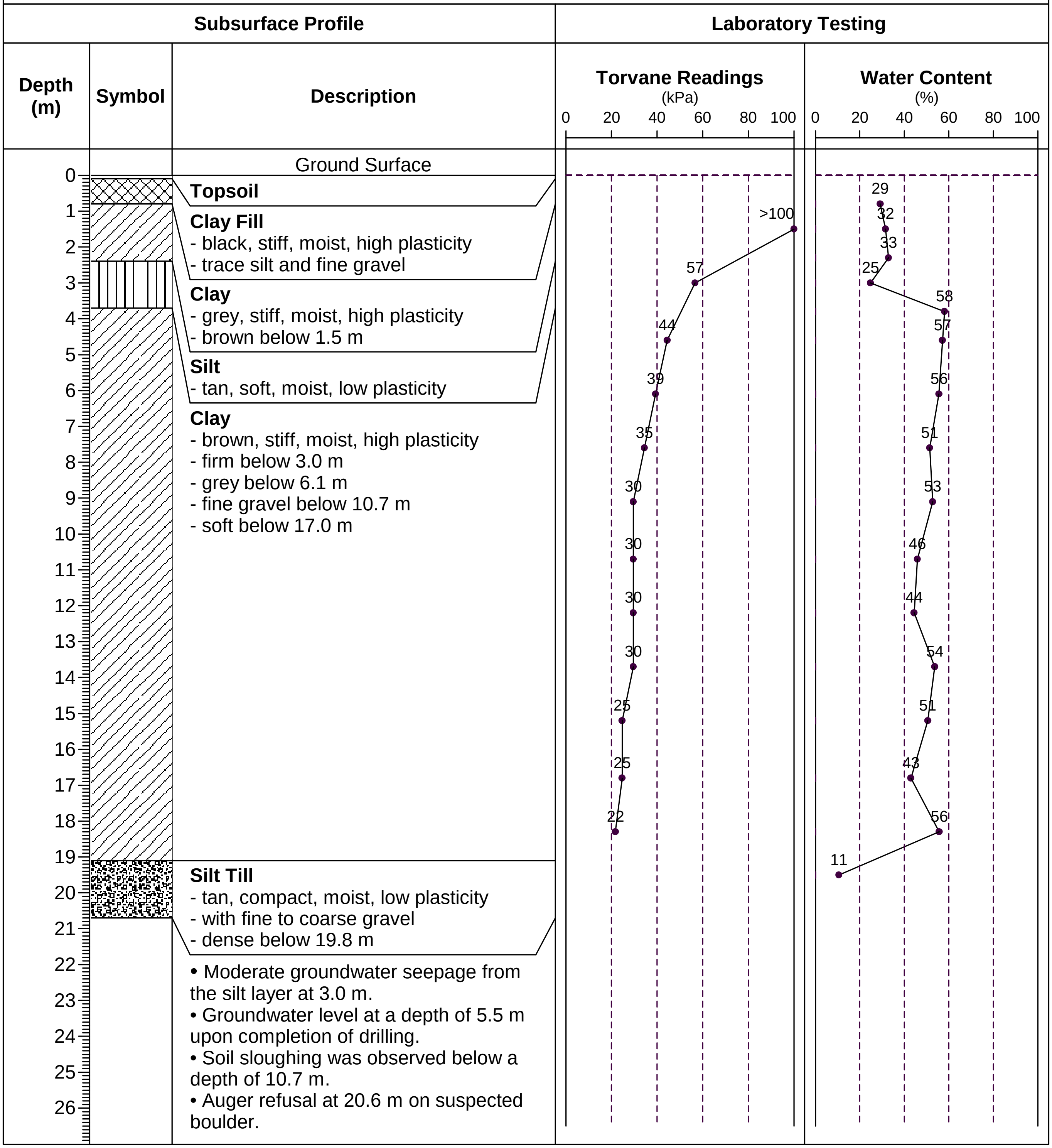
Silt Till
- tan, compact, moist, low plasticity
- with fine to coarse gravel
- dense below 19.8 m

- No groundwater seepage was observed during or upon completion of drilling.
- Soil sloughing was observed below a depth of 5.2 m.
- Auger refusal at 20.7 m on suspected boulder.

TESTHOLE TH2

Project Name: NEWPCC Hauled Liquid Waste Facility
Client: Stantec Consulting Ltd.
Drilling Contractor: Maple Leaf Drilling Ltd.
Drilling Method: 125 mm Auger

Date Drilled: November 10, 2009
Depth of Testhole: 20.6 m
Logged by: Farouk Fourar
Reviewed by: Don Flatt



Ground Surface

Topsoil

Clay Fill
- black, stiff, moist, high plasticity
- trace silt and fine gravel

Clay
- grey, stiff, moist, high plasticity
- brown below 1.5 m

Silt
- tan, soft, moist, low plasticity

Clay
- brown, stiff, moist, high plasticity
- firm below 3.0 m
- grey below 6.1 m
- fine gravel below 10.7 m
- soft below 17.0 m

Silt Till
- tan, compact, moist, low plasticity
- with fine to coarse gravel
- dense below 19.8 m

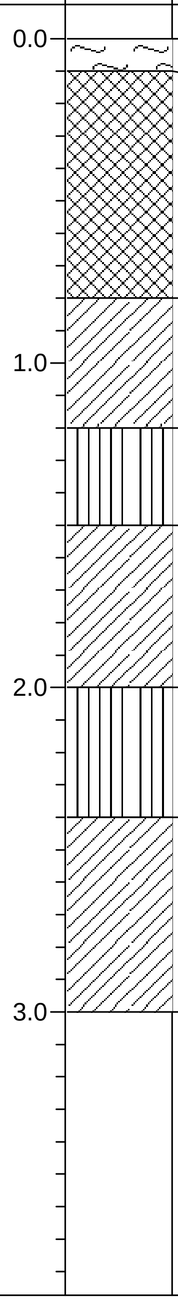
- Moderate groundwater seepage from the silt layer at 3.0 m.
- Groundwater level at a depth of 5.5 m upon completion of drilling.
- Soil sloughing was observed below a depth of 10.7 m.
- Auger refusal at 20.6 m on suspected boulder.

TESTHOLE TH3

Project Name: NEWPCC Hauled Liquid Waste Facility	**Date Drilled: November 10, 2009**
Client: Stantec Consulting Ltd.	**Depth of Testhole: 3.0 m**
Drilling Contractor: Maple Leaf Drilling Ltd.	**Logged by: Farouk Fourar**
Drilling Method: 125 mm Auger	**Reviewed by: Don Flatt**

Subsurface Profile | **Laboratory Testing**

Depth (m) | **Symbol** | **Description**



Ground Surface

Topsoil

Clay Fill
- black, stiff, moist, high plasticity
- trace silt and fine gravel

Clay
- grey, stiff, moist, high plasticity

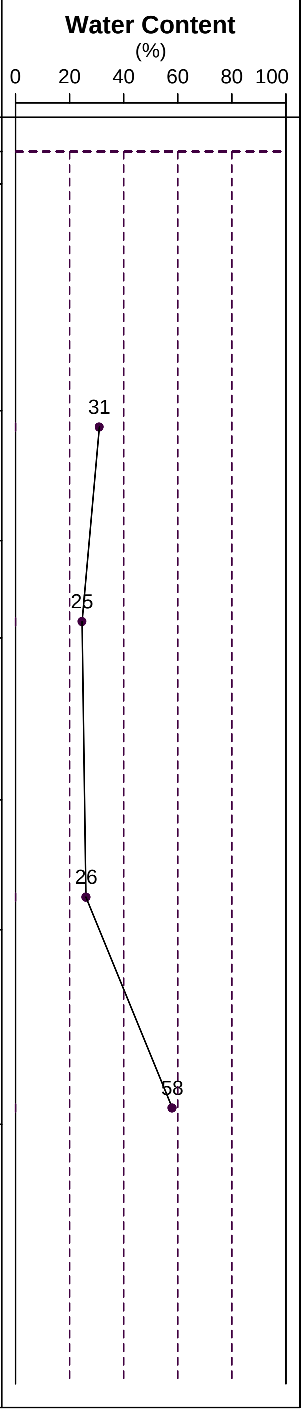
Silt
- tan, soft, moist, low plasticity

Clay
- brown, stiff, moist, high plasticity

Silt
- tan, soft, moist, low plasticity

Clay
- brown, stiff, moist, high plasticity

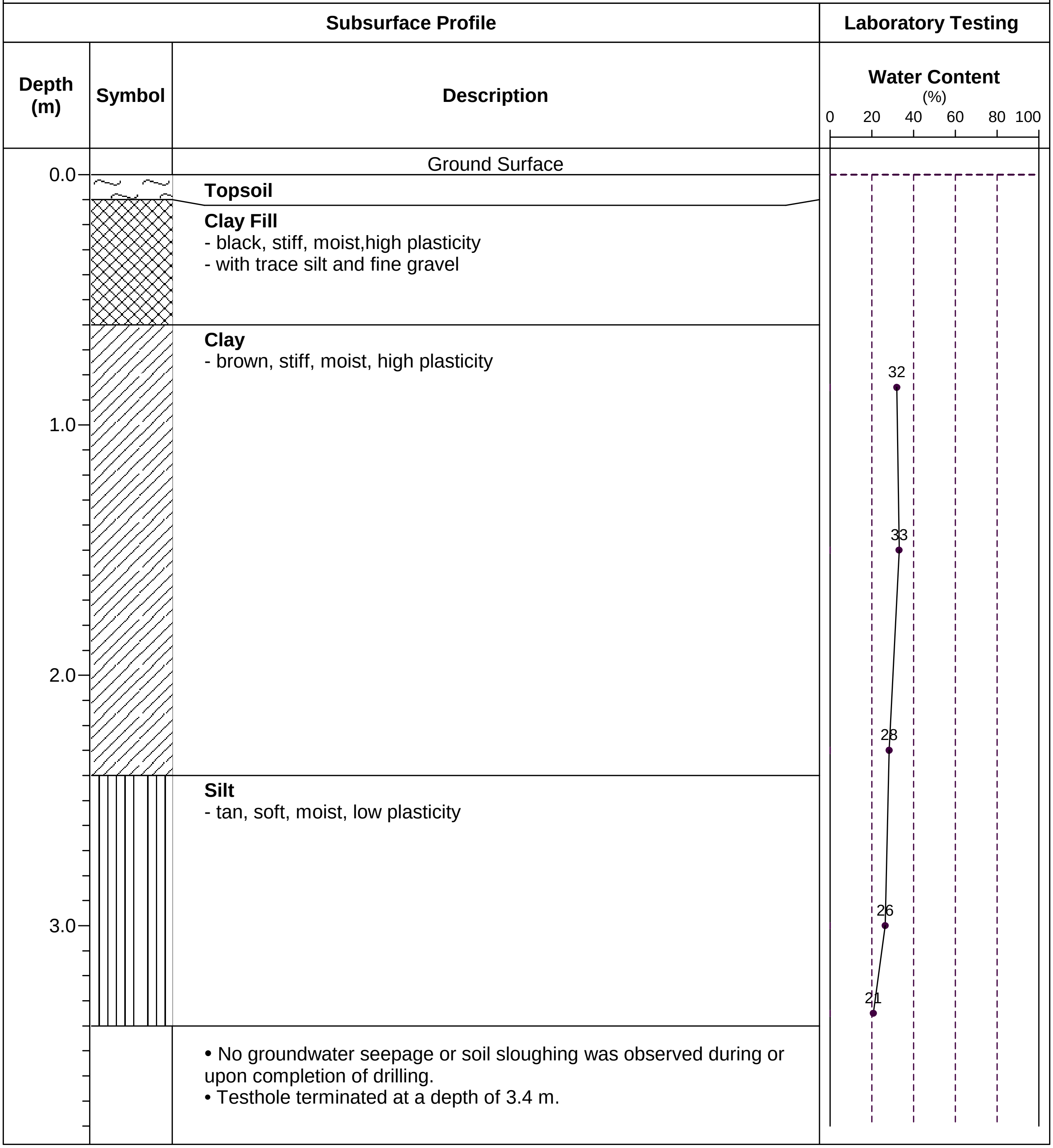
• No groundwater seepage or soil sloughing was observed during or upon completion of drilling.
• Testhole terminated at a depth of 3.0 m.



TESTHOLE TH4

Project Name: NEWPCC Hauled Liquid Waste Facility
Client: Stantec Consulting Ltd.
Drilling Contractor: Maple Leaf Drilling Ltd.
Drilling Method: 125 mm Auger

Date Drilled: November 10, 2009
Depth of Testhole: 3.4 m
Logged by: Farouk Fourar
Reviewed by: Don Flatt



Topsoil

Clay Fill
- black, stiff, moist,high plasticity
- with trace silt and fine gravel

Clay
- brown, stiff, moist, high plasticity

Silt
- tan, soft, moist, low plasticity

• No groundwater seepage or soil sloughing was observed during or upon completion of drilling.
• Testhole terminated at a depth of 3.4 m.

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

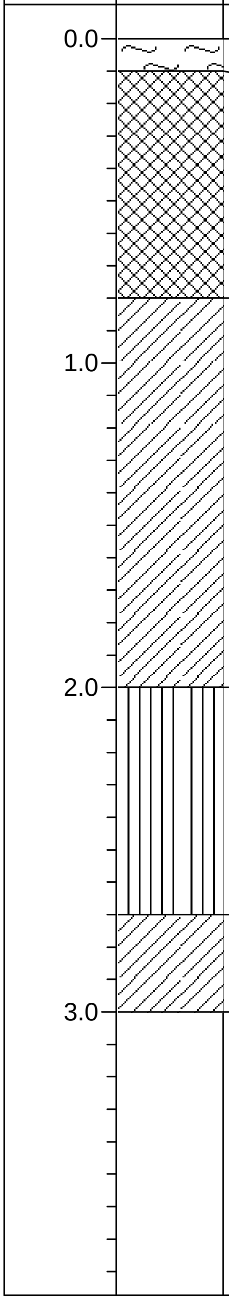
TESTHOLE TH5

Project Name: NEWPCC Hauled Liquid Waste Facility
Client: Stantec Consulting Ltd.
Drilling Contractor: Maple Leaf Drilling Ltd.
Drilling Method: 125 mm Auger

Date Drilled: November 10, 2009
Depth of Testhole: 3.0 m
Logged by: Farouk Fourar
Reviewed by: Don Flatt

Subsurface Profile

Depth (m) | **Symbol** | **Description**



Ground Surface

Topsoil

Clay Fill
- black, stiff, moist, high plasticity
- trace silt and fine gravel

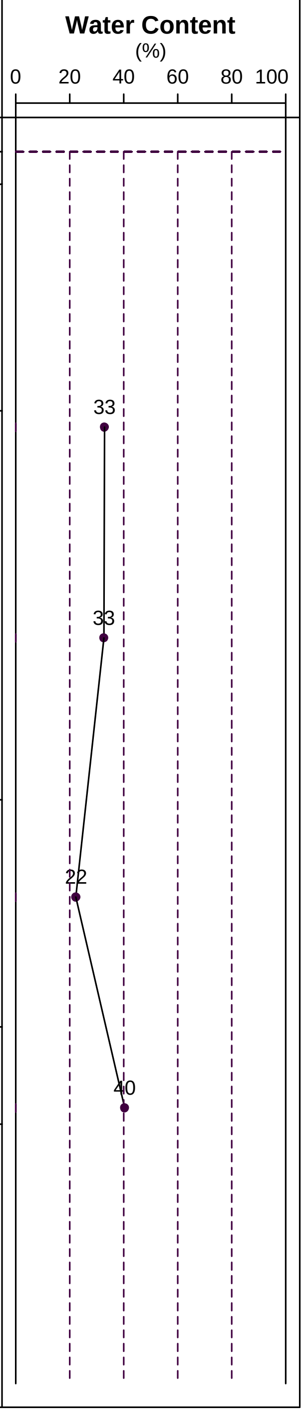
Clay
- brown, stiff, moist, high plasticity

Silt
- tan, soft, moist, low plasticity

Clay
- brown, stiff, moist, high plasticity

• No groundwater seepage or soil sloughing was observed during or upon completion of drilling.
• Testhole terminated at a depth of 3.0 m.

Laboratory Testing



GEOTECHNICAL INVESTIGATION AND
FOUNDATION ENGINEERING REPORT
FOR
HAULED LIQUID WASTE FACILITY
SOUTH END WATER POLLUTION CONTROL CENTRE

Prepared for
STANTEC CONSULTING LTD.
905 WAVERLEY STREET
WINNIPEG, MANITOBA
R3T 5P4

Prepared by
THE NATIONAL TESTING LABORATORIES LIMITED
199 HENLOW BAY
WINNIPEG, MANITOBA
R3Y 1G4

December 21, 2009

Table of Contents

1.0 SUMMARY

The National Testing Laboratories Limited were retained to undertake a geotechnical investigation and provide foundation recommendations for the proposed hauled liquid waste facility at the South End Water Pollution Control Centre (SEWPCC). Three testholes were drilled on the project site on November 10, 2009. The geotechnical investigation revealed a general soil profile consisting of topsoil at the ground surface, underlain by clay fill, then clay with silt layers, and silt till to the depths explored in the testholes. Based upon the soil and groundwater conditions encountered at the testhole locations, the proposed structure may be supported on a raft foundation. Alternatively, the proposed structure may be supported on driven precast concrete piles.

2.0 TERMS OF REFERENCE

The National Testing Laboratories Limited were retained to undertake a geotechnical investigation and provide foundation recommendations for the proposed hauled liquid waste facilitiy at the South End Water Pollution Control Centre (SEWPCC). The project site is located at 100 Ed Spencer Drive in Winnipeg. Authorization to proceed with the geotechnical investigation was provided by Alfred Beghin on October 9, 2009.

3.0 GEOTECHNICAL INVESTIGATION

3.1 Testhole Drilling and Soil Sampling

The subsurface drilling and sampling program was conducted on November 10, 2009 with drilling services provided by Maple Leaf Drilling Ltd. under the supervision of our geotechnical field personnel. Three testholes (TH1 to TH3) were drilled at the site. The testholes were drilled using a truck-mounted drill rig equipped with 125 mm diameter solid stem augers and their locations are shown on the attached Testhole Location Plan. Auger refusal was encountered on a suspected boulder in the silt till at a depth of 18.3 m in Testhole TH1. Testholes TH2 and TH3 were drilled to a depth of 3 m.

Representative soil samples were obtained directly off the augers at depth intervals ranging from 0.8 to 1.5 m. Upon completion of drilling, the testholes were examined for evidence of sloughing and groundwater seepage. The samples were visually classified in the field and returned to our soils laboratory for additional examination and testing.

3.2 Laboratory Testing

Water content and torvane tests were conducted on soil samples recovered from selected testholes and the test results are shown on the attached testhole logs. Unconfined compressive strength testing was conducted and the test result is summarized in the table below.

Testhole No.	Depth (m)	Soil Type	Unconfined Compressive Strength (kPa)
TH1	3.4	Clay	92.1

4.0 SUBSURFACE CONDITIONS

4.1 Soil Profile

The general soil stratigraphy, as interpreted from the testhole logs revealed a general soil profile consisting of topsoil at the ground surface, underlain by clay fill, then clay with silt layers, and silt till to the depths explored in the testholes.

Topsoil

Topsoil was encountered at the surface of the testholes. The topsoil was black with organic material. The topsoil layer extended to a depth of approximately 100 mm.

Clay Fill

Clay fill was encountered beneath the topsoil in the testholes. The clay fill was black, stiff, moist, and of high plasticity. The clay fill extended to a depth of 0.6 m in the testholes.

Clay

Clay was encountered beneath the clay fill in the testholes. The clay varied from brown to grey, was firm to stiff, moist, and of high plasticity. The clay extended to a depth of 14.3 m in Testhole TH1 and to the depths explored in the remaining testholes. Water contents of the clay ranged from 26 to 63%.

Silt

A silt layer was encountered in the testholes at a depth of approximately 2 m. The silt was tan, soft, moist and of low plasticity. The thickness of the silt layer ranged from 0.1 m to 0.2 m.

Silt Till

Silt till was encountered at a depth of 14.3 m in Testhole TH1. The silt till was tan, compact, moist, and of low plasticity. Auger refusal on a suspected boulder in the silt till was encountered at a depth of 18.3 m. Water contents of the silt till ranged from 11 to 20%.

4.2 Groundwater

Heavy groundwater seepage was observed from the silt till in Testhole TH1. The groundwater level was at a depth of 8.5 m in Testhole TH1 upon completion of drilling. Soil sloughing was observed below a depth of 14.3 m in Testhole TH1. No soil sloughing was observed in the shallow testholes. It should be noted that only short-term seepage and sloughing conditions were observed and groundwater levels will normally fluctuate during the year and will be dependent upon precipitation and surface drainage.

5.0 DESIGN RECOMMENDATIONS AND COMMENTS

5.1 Foundations

It is our understanding that the proposed structure will extend approximately 5 to 6 m below the ground surface. Based upon the soil and groundwater conditions encountered at the testhole locations, the proposed structure may be supported on a raft foundation. Alternatively, the proposed structure may be supported on driven precast concrete piles. Cast-in-place concrete friction piles are not recommended for this site due to the limited thickness of the clay below the base of the structure and the low strength of the clay.

5.1.1 Raft Foundation

A raft foundation, constructed on firm clay at a depth of approximately 5 to 6 m below grade, may be designed based upon an allowable bearing pressure of 100 kPa. The modulus of subgrade soil reaction at a depth of 5 to 6 m is estimated to be in the range of 5 to 8 MPa/m.

Although no groundwater seepage was observed from the shallow silt layer, groundwater conditions will vary seasonally. Groundwater seepage should be anticipated during excavation for the raft foundation and suitable pumps should be available during construction. It is recommended that testpits be excavated within the building footprints prior to full excavation to observe the groundwater conditions and confirm the requirements for dewatering.

Construction equipment should not be allowed to travel directly on the foundation bearing surface. To minimize disturbance of the bearing surface, excavation with a flat bucket excavator is recommended at the foundation level. All loose and softened soil must be removed from the bearing surface. The clay subgrade has a high volume change potential and therefore, measures should be taken to prevent changes in soil moisture content at the foundation bearing surface. The prepared bearing surface should not be exposed to excessive wetting or drying during construction. The magnitude of volume change is difficult to predict but is estimated to be in the range of 20 to 50 mm. It is recommended that a lean mix concrete working slab be constructed after the foundation bearing surface has been inspected and approved by qualified geotechnical personnel. The lean mix concrete working slab should be constructed directly on the undisturbed clay subgrade. If construction takes place during freezing weather, measures must be taken to prevent frost penetration beneath the foundation bearing surface. Frost heave of the subgrade soil will occur if it is exposed to freezing temperatures.

5.1.2 Precast Concrete Piles

A foundation system suitable to support the proposed structure is a system of driven, prestressed, precast concrete piles. These units, when driven to practical refusal with a hammer capable of delivering a minimum rated energy of 40 KJ per blow, may be assigned the following allowable loads.

Nominal Pile Size	Allowable Load	Refusal Criteria
300 mm	450 kN	5 blows/25 mm
350 mm	625 kN	8 blows/25 mm
400 mm	800 kN	12 blows/25 mm

Pile spacing should not be less than 2.5 pile diameters, measured center to center. Pile heave for piles within 5 pile diameters should be monitored and redriving done where pile heave is found to be significant. Pre-boring to at least 3 m should be considered for all driven piles to enhance pile alignment and minimize vibration levels in adjacent structures during installation. The prebored hole diameter should be slightly larger than the nominal pile diameter. All piles should be driven continuously to their required depth once driving is initiated. Precast concrete piles driven to practical refusal will develop the majority of their capacity from toe resistance, and therefore, no reduction in pile capacity is necessary for group action. The design capacity of a pile group is equal to the number of piles in the group times the allowable capacity per pile.

Auger refusal was encountered within the silt till at a depth of 18.3 m. Although driven piles are expected to reach refusal at a similar depth, some variation in pile refusal depths should be anticipated. Negligible settlement beyond the elastic compression of the pile can be expected with an end-bearing pile system. A minimum void space of 200 mm should be provided beneath all structural elements to accommodate potential heave of the high plasticity clay. To ensure that the piles achieve their design capacities, full time inspection by qualified geotechnical personnel is recommended during pile installation.

5.2 Foundation Walls

Below grade walls should be designed to resist lateral earth pressures based on the following formula:

$$P = K_0\ (\gamma D + q)$$

where P = lateral earth pressure at depth D, kPa
K_0 = at rest earth pressure coefficient (0.7)
γ = soil unit weight (18 kN/m^3)
q = live load surcharge within distance D, kPa

The above expression assumes the below grade walls will be drained and there will be no buildup of hydrostatic pressure on the walls. A 1 m wide layer of free draining granular material must be provided adjacent to the below grade walls and a subsurface drainage system must be provided at the base of the walls to prevent the buildup of hydrostatic pressure. The sump collection system should be provided with an alarm system to alert plant operators in the event of a pump failure. Clay soils are often subject to excessive frost action and swelling when used as backfill, which can generate excessive lateral earth pressures on below grade walls. If clay is used to backfill the walls, compaction should not exceed 90% of standard Proctor maximum dry density and moisture content of the clay should not be less than the optimum moisture content. Clay backfill should not be placed within 1 m of the below grade walls.

5.3 Excavation

Temporary excavations will be required for construction of the concrete working slab and walls for the structures. The stability of temporary excavations is a function of several factors, including the total time the excavation is exposed, moisture conditions, soil type and consistency, and the contractor’s operations. It is the responsibility of the contractor to maintain safe and stable slopes or design and provide suitable shoring during construction. The design of excavation slopes must recognize the presence of water-bearing silt layers encountered in the testholes. As a guideline, open excavations must be sloped at a minimum gradient of 1 horizontal to 1 vertical within the clay. Excavated slopes should be protected from wetting and weathering by suitable temporary covering. Surface drainage should ensure surface water is directed away from the excavation. The introduction of excessive moisture will often result in unstable excavation conditions. All excavation works must comply with the Province of Manitoba Workplace Safety and Health Act and Guidelines for Excavation Work.

5.4 Foundation Concrete

The clay soils in the Winnipeg area contain sulphates that will cause deterioration of concrete. The class of exposure for concrete in contact with clay soil in the Winnipeg area is considered to be severe (S-2 in CSA A23.1-09 Table 3). The requirements for concrete exposed to severe sulphate attack are provided in the following table.

Parameter	Design Requirement
Class of exposure	S-2
Compressive strength	32 MPa at 56 days
Air content	4 to 7%
Water-to-cementing materials ratio	0.45 max.
Cement	Type HS or HSb

5.5 Pavement

The testholes revealed a soil profile of clay fill, clay, and silt near the surface. Silt was encountered at a depth of approximately 2 m below existing grade. Silt is a frost-susceptible soil and the potential for frost heave of the pavement surface exists if the silt is present within the depth of annual frost penetration. In the Winnipeg area, the depth of frost penetration is approximately 2 m where the ground surface is kept clear of snow during the winter months. Increased maintenance costs for the pavement area should be anticipated if the silt is not removed within the depth of annual frost penetration. To minimize pavement distress related to freezing and thawing of the silt, a minimum soil cover of 1 m should be provided above the frost-susceptible layer. Unless the final elevation for the pavement is significantly lower than the existing ground elevation, the pavement structure will have a minimum soil cover of 1 m.

Preparation of the subgrade for construction of the pavement areas will require removal of organic soils and proof rolling to identify soft areas within the exposed subgrade. All soft or weak subgrade soils identified during proof rolling must be excavated and replaced with crushed limestone subbase. Additional materials, if required to increase the final grade for the pavement area, should consist of crushed limestone sub-base material. Inspection of the subgrade by qualified geotechnical personnel is recommended during subgrade preparation.

The following asphalt pavement sections are recommended for this project:

Material	**Thickness (mm)**	
	Light Duty Pavement	**Heavy Duty Pavement**
Asphaltic Concrete	60	80
Base Course	75	75
Sub-Base	250	400

The light duty pavement section should be used where traffic loading will consist of passenger vehicles and light duty trucks. The heavy duty pavement section should be used for pavements subjected to traffic loading greater than passenger vehicles and light duty trucks. In the event concrete pavements are required due to heavy traffic loads, the following pavement section is recommended:

Material	**Thickness (mm)**
Portland Cement Concrete	200
Base Course	75
Sub-Base	225

Pavement construction should comply with the following City of Winnipeg Standard Construction Specifications:

- CW 3110, Sub-grade, Sub-base and Base Course Construction
- CW 3310, Portland Cement Concrete Pavement Works
- CW 3410, Asphaltic Concrete Pavement Works

Sieve analysis and compaction testing of the crushed limestone base course and sub-base materials should be conducted to ensure that the materials and compaction comply with the design specifications. Concrete testing should be undertaken during construction to ensure the concrete mix supplied to the project meets the specifications requirements. For the hot mix asphaltic concrete, compaction testing and Marshall analysis of the paving mix during construction should be undertaken. This will confirm that the asphaltic concrete has been supplied and installed in accordance with the project specifications.

5.6 Drainage

A weeping tile or subsurface drainage system should be provided at the base of the below grade wall to prevent the buildup of hydrostatic pressure. The collected water should be drained to a central sump and discharged away from the building. To minimize infiltration of surface water, a 600 mm clay cap should be provided above the backfill material adjacent to the building.

All roof downspouts should be directed away from the building and the ground surface around the building should be graded to promote drainage away from the foundation and therefore minimize soil swelling and frost action. Final site grading should ensure that all surface runoff is directed away from the building using a minimum gradient of 2%. To compensate for potential settlement of backfill materials adjacent to the building, the grade should be increased to 10% for the first 2 m from the building.

6.0 CLOSURE

Professional judgments and recommendations are presented in this report. They are based partly on evaluation of the technical information gathered during our site investigation and partly on our general experience with subsurface conditions in the area. We do not guarantee the performance of the project in any respect other than that our engineering work and judgment rendered meet the standards and care of our profession. It should be noted that the testholes may not represent potentially unfavourable subsurface conditions between testholes. If during construction soil conditions are encountered that vary from those discussed in this report, we should be notified immediately in order that we may evaluate effects, if any, on the foundation performance. The recommendations presented in this report are applicable only to this specific site. These data should not be used for other purposes.

We appreciate the opportunity to assist you in this project. Please call me if you have any questions regarding this report.

Don Flatt

Don Flatt, M. Eng., P.Eng.
Senior Geotechnical Engineer

PROVINCE OF MANITOBA
D.G.
FLATT
Member
5062
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
The National Testing Laboratories Limited
No. 690 Date: Dec 21/09

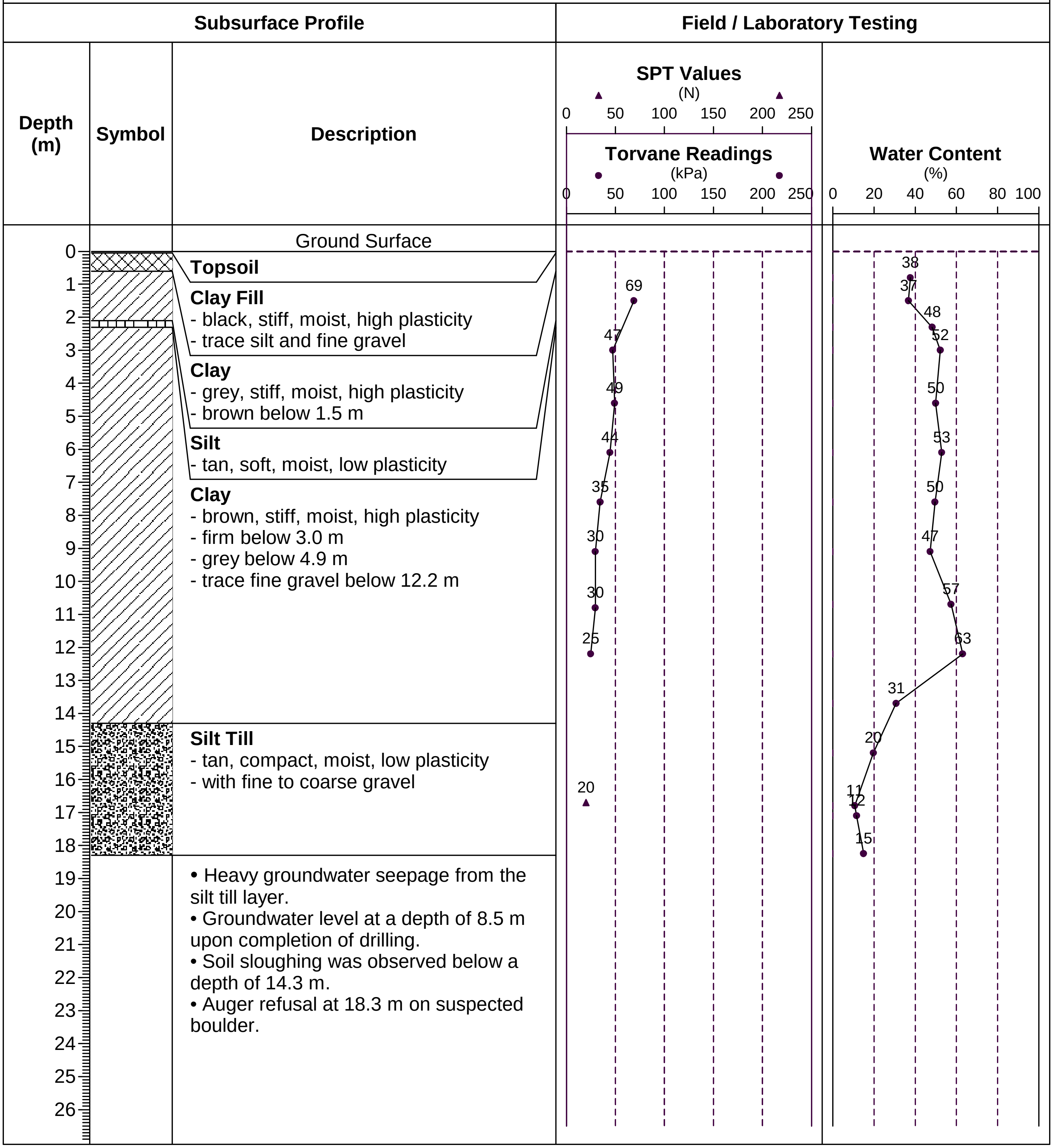
THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

Project No. STA-944	Drawn by: AP	Figure: 1	Testhole Location Plan SEWPCC Hauled Liquid Waste Facility Winnipeg, Manitoba
Date: Dec 17, 2009	Reviewed by: DF	Scale: NTS	

TESTHOLE TH1

Project Name: SEWPCC Hauled Liquid Waste Facility
Client: Stantec Consulting Ltd.
Drilling Contractor: Maple Leaf Drilling Ltd.
Drilling Method: 125 mm Auger

Date Drilled: November 10, 2009
Depth of Testhole: 18.3 m
Logged by: Farouk Fourar
Reviewed by: Don Flatt



Ground Surface

Topsoil

Clay Fill
- black, stiff, moist, high plasticity
- trace silt and fine gravel

Clay
- grey, stiff, moist, high plasticity
- brown below 1.5 m

Silt
- tan, soft, moist, low plasticity

Clay
- brown, stiff, moist, high plasticity
- firm below 3.0 m
- grey below 4.9 m
- trace fine gravel below 12.2 m

Silt Till
- tan, compact, moist, low plasticity
- with fine to coarse gravel

- Heavy groundwater seepage from the silt till layer.
- Groundwater level at a depth of 8.5 m upon completion of drilling.
- Soil sloughing was observed below a depth of 14.3 m.
- Auger refusal at 18.3 m on suspected boulder.

TESTHOLE TH2

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

Project Name: SEWPCC Hauled Liquid Waste Facility
Client: Stantec Consulting Ltd.
Drilling Contractor: Maple Leaf Drilling Ltd.
Drilling Method: 125 mm Auger

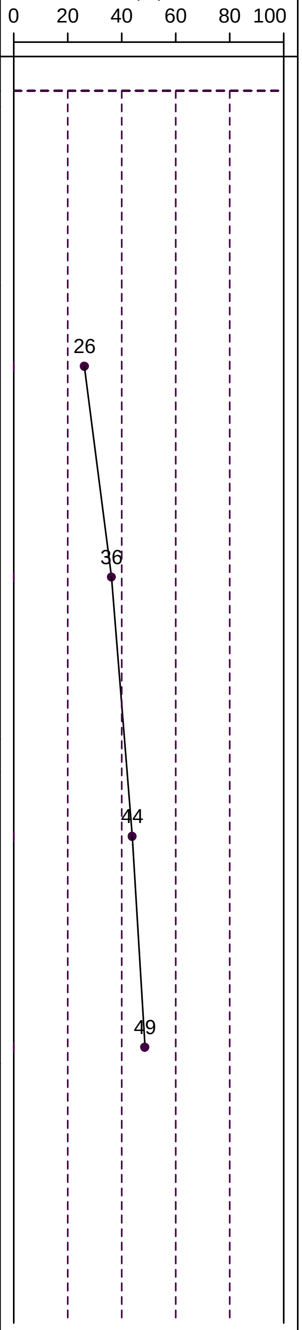
Date Drilled: November 10, 2009
Depth of Testhole: 3.0 m
Logged by: Farouk Fourar
Reviewed by: Don Flatt

Subsurface Profile

Depth (m)	Symbol	Description
		Ground Surface
0.0		**Topsoil**
		Clay Fill - black, stiff, moist, high plasticity - some silt and fine to coarse gravel
		Clay - brown, stiff, moist, high plasticity
1.0		
2.0		**Silt** - tan, soft, moist, low plasticity, clayey
		Clay - brown, stiff, moist, high plasticity
3.0		• No groundwater seepage or soil sloughing was observed during or upon completion of drilling. • Testhole terminated at a depth of 3.0 m.

Laboratory Testing

Water Content
(%)



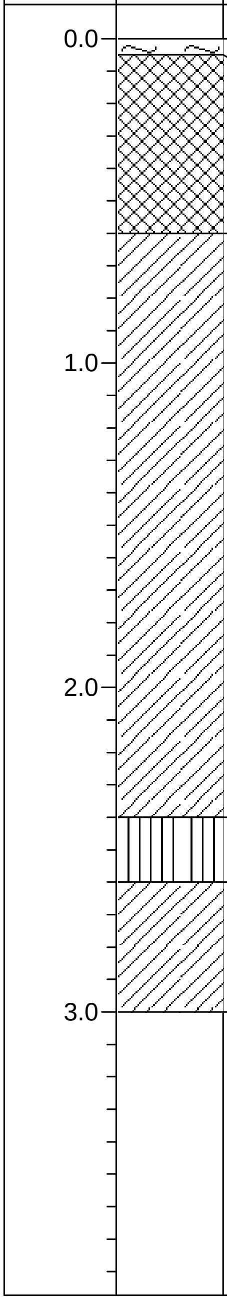
TESTHOLE TH3

Project Name: SEWPCC Hauled Liquid Waste Facility
Client: Stantec Consulting Ltd.
Drilling Contractor: Maple Leaf Drilling Ltd.
Drilling Method: 125 mm Auger

Date Drilled: November 10, 2009
Depth of Testhole: 3.0 m
Logged by: Farouk Fourar
Reviewed by: Don Flatt

Subsurface Profile

Depth (m) | **Symbol** | **Description**



Ground Surface

Topsoil

Clay Fill
- black, stiff, moist, high plasticity
- some silt and fine to coarse gravel

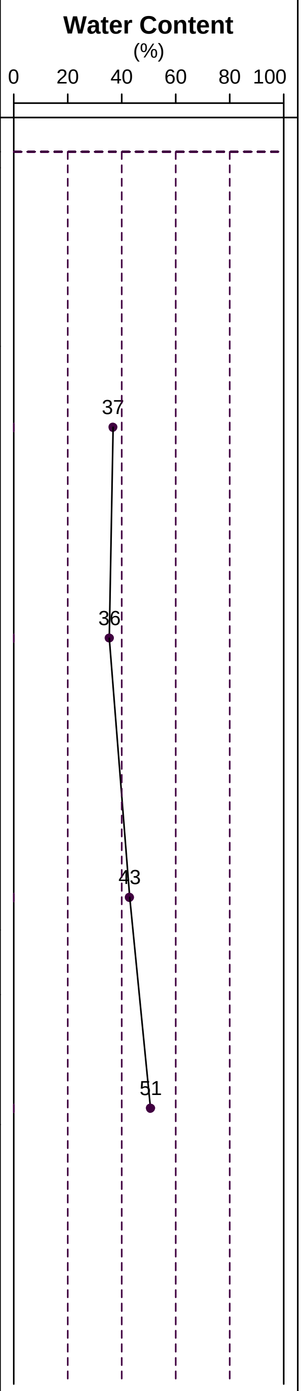
Clay
- brown, stiff, moist, high plasticity

Silt
- tan, soft, moist, low plasticity, clayey

Clay
- brown, stiff, moist, high plasticity

• No groundwater seepage or soil sloughing was observed during or upon completion of drilling.
• Testhole terminated at a depth of 3.0 m.

Laboratory Testing



DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

GEOTECHNICAL REPORT

SOUTH END WATER POLLUTION CONTROL CENTRE

PROPOSED EXPANSION

Prepared for

STANTEC CONSULTING LIMITED

on behalf of

THE CITY OF WINNIPEG

February 2008

Project No. 272939

GEOTECHNICAL REPORT

SOUTH END WATER POLLUTION CONTROL CENTRE

PROPOSED EXPANSION

Prepared for

STANTEC CONSULTING LIMITED

on behalf of

THE CITY OF WINNIPEG

February 2008

Project No. 272939

TABLE OF CONTENTS

1.0 INTRODUCTION

This report summarizes the results of a geotechnical investigation undertaken by Dyregrov Consultants for the proposed expansion of the South End Water Pollution Control Centre. The area and extent of the proposed expansion is illustrated on Figure 1. The work was done at the request of Stantec Consulting Ltd. on behalf of the City of Winnipeg and was authorized by letter of July 19, 2007 under the signature of Mr. Cameron Dyck., P.Eng. Manager, Environmental Infrastructure.

2.0 PROPOSED EXPANSION

The long term expansion of the South End Water Pollution Control Centre is illustrated on Figure 1. It involves large concrete structures including Fermenters, Primary Clarifiers, Bioreactors, Secondary Clarifiers, Support Facilities and several lessor facilities. Also included is a parallel outfall discharge line to the Red River. Details of these facilities are provided in Section 8.1 of the Discussion and Recommendations Section 8.0. It is understood that not all of these facilities are planned to be constructed in the short term.

3.0 SITE DESCRIPTION

The site of the proposed expansion is south of the existing South End Water Pollution Centre (SEWPCC) with lesser works on the east side. The major portion of the site is flat lying with remnants of a snow dump area covering the easterly half of the site. Immediately to the west of the snow dump area is a spoil bank from excavations from the previous construction and is visually estimated to be about 4 to 5 metres in height. An area of dense bush and trees covers the westerly portion of the proposed development area. A number of drainage ditches are in the general area.

4.0 BACKGROUND

The original SEWPCC was constructed in the early 1970's. A major expansion was undertaken circa 1990 and a Disinfection Facility constructed in 1998.

Geotechnical studies were undertaken for the foregoing projects. The test holes and laboratory studies which were undertaken in these studies are included in the attached Appendix A. The reports which were referenced include the following:

* Ripley, Klohn & Leonoff International Ltd.
Report on Subsoil Investigation
Proposed South End Pollution Control Centre
Winnipeg, Manitoba
W - 580, March 8, 1971

* Ripley, Klohn & Leonoff International Ltd.
Report on Installation of Test Caissons
at South End Pollution Control Centre
Winnipeg, Manitoba
W - 619, March 24, 1971

* Ripley, Klohn & Leonoff International Ltd.
Test Holes Drilled at Outfall Stage
Associated with South End Pollution Control Centre
Winnipeg, Manitoba
W - 623, April 14, 1971

* Dyregrov and Burgess
Geotechnical Engineering Report
South End Water Pollution Control Centre
88528, April 15, 1988

* Dyregrov Consultants
Geotechnical Report
Proposed Disinfection Building
South End Water Pollution Control Centre
City of Winnipeg
981754, February 1998

5.0 FIELD INVESTIGATION

Between September 12 and 19, 2007, eighteen test holes were drilled in an area which covered the future plant expansion. The locations of the test holes are illustrated on Figure 1.

The test holes were advanced using truck-mounted drilling equipment which is owned and operated by Subterranean (Manitoba) Ltd. The test holes were either 450 mm or 125 mm in diameter. The deep test holes were carried to auger refusal in the glacial till which underlies the site. Shallow test holes were drilled to approximately 3 metres. Standpipe piezometers were installed in the 125 mm test holes which were carried to auger refusal. The soil profile was examined and classified on a continuous basis as the drilling progressed and sampled on a frequent basis. Disturbed samples were recovered from the auger cuttings and undisturbed samples were obtained in 75 mm Shelby tube samplers for laboratory testing.

Observations were made during the drilling with respect to groundwater, seepage and caving conditions encountered in the test holes. The sealed standpipe piezometers were installed in Test Holes 2007-02, 2007-08, 2007-09, 2007-11, 2007-15 and 2007-16A.

All of the test holes in which the piezometers were not installed were backfilled with excavated materials on completion.

The locations of the test holes were determined by Stantec Consulting Ltd. as well as the ground elevations at the test holes.

Test Holes 2007-12, 2007-13, 2007-14, 2007-20 and 2007-24 were not drilled for reasons of site access problems. Test Holes 2007-16 and 2007-18 could not be drilled at their respective locations due to access and were replaced by Test Hole 2007-16A.

6.0 THE SOIL PROFILE

Based on this investigation, the following describes the general soil profile at the site of the currently proposed development. The data from this investigation is generally consistent with the data from previous investigations.

A thick deposit of highly plastic Lake Agassiz lacustrine silty clay is the predominant component of the soil profile which extends from the ground surface to depths varying from 12.5 to 16.0 metres. The average thickness is approximately 14.3 metres. The clay is common to the Winnipeg area and can be described as firm to stiff in relative consistency. Moisture contents are typically within the 40 to 60 percent range and are relatively uniform with depth. Moisture depletion appears to be restricted to about the upper 3 metres of the soil profile. Plastic and Liquid Limits for the clays are in the order of 30 and 100 percent, respectively, and the Liquidity Indices at this location are estimated to be in the range of 0.3 to 0.4. It should be noted that specific tests were not performed for the determination of these index properties from samples recovered in this recent investigation.

Undrained shear strengths were determined from unconfined compression tests, pocket penetrometer and Torvane tests in the laboratory. A plot of the undrained shear strength profile versus depth is provided as Figure 20. The lower strengths from the unconfined compression tests within the upper 3.6 metres of the profile are probably related to secondary defects (fissuring) that has accompanied moisture depletion within these depths. There is a trend in decreasing strengths with depth.

Covering the site are variable thicknesses of fill, remnant debris from the snow dumps and topsoil. The thickness of these materials, which generally consists of silt, sand and gravel, were as thick as 1.22 metres. This is exclusive of the stockpile of excavated materials from the earlier developments. Also, the area of trees and brush will contain organic topsoil and roots.

Near the upper part of the clay profile, in 8 of the 18 test holes, was a silt layer of variable thicknesses up to 1.22 metres and depths between 0.3 and 1.98 metres. It was tan in color, moist to wet and loose to firm in consistency.

The silty clays are underlain by a glacial silt till deposit. The glacial till is known to be a heterogeneous mixture of sand, gravel, cobble and boulder size materials within a predominately silt matrix. The relative density of the glacial till has been evaluated on the basis of its moisture content and visual examination of the auger cuttings. The elevation of the surface of the glacial till varies from about 214.62 to 220.33 metres. The average elevation is 218.72 metres. The glacial till is typically loose or soft near its surface and becomes more dense with depth, however, caving conditions were encountered within the glacial till deposit which prevented recovery of suitable samples for evaluation. The test holes were advanced by screwing the auger until it met refusal on very dense glacial till or boulders in the till. The action of the drill rig did not suggest the presence of the bedrock, but it could be present. The materials through which the augers were drilled are believed to be layered deposits of fine sand and glacial deposits. Some fine sands were actually recovered. Auger refusal was reached between elevations 208.45 and 213.98 metres.

A detailed description of the soil profile and the results of the field and laboratory testing are summarized on the test hole logs, Figures 2 to 19. The logs from previous studies are included in the Appendix.

7.0 GROUNDWATER CONDITIONS

The groundwater conditions at the site consist essentially of groundwater perched within the relatively pervious silt strata that are within the upper part of the soil profile and a subartesion condition within the underlying glacial till and bedrock.

Groundwater conditions in the upper silt deposits are likely to vary over short distances, since they are not contiguous across the site. Seasonal precipitation will influence the groundwater conditions in the silt.

Piezometric pressures within the glacial till deposit originate in the underlying limestone bedrock, which is the carbonate aquifer that is common to Winnipeg, and these are the most relevant to the construction of relatively deep or large excavations. The standpipe piezometers were installed in Test Holes 2007-02, 2007-08, 2007-09, 2007-11, 2007-12, 2007-15 and 2007-16A with their tips sealed into the glacial till. These were installed to determine the elevation of the piezometric surface within the glacial till deposit. The following table shows the groundwater levels which were taken at the time of installation and 8 days later. The piezometric elevations about one week after installation were between 223.79 and 224.41 metres.

Groundwater Elevations (m)

Piezometer	September 18, 2007	September 19, 2007	September 26, 2007
2007-2	-	223.18	224.33
2007-8	-	224.38	224.15
2007-9	-	223.83	224.41
2007-11	222.99	223.90	224.13
2007-15	221.66	223.49	223.79
2007-16A	221.55	223.92	224.30

Attached as Figures 21 and 22 are the test hole log and hydrograph from the Provincial Groundwater Monitoring Well G05OC0097 which is located in the basement of the SEWPCC. It is noteworthy from the hydrograph that there has been a trend toward higher groundwater levels since the time of the initial construction in 1970 and since the major expansion about 1990. The annual peaks, which are frequent, are apparently associated with Floodway events. As indicated on the hydrograph, the only time in the last 10 years that the bedrock groundwater pressures have risen above 225.0 metres was during the major Floodway operation events of 1997 and 2006.

8.0 DISCUSSION AND RECOMMENDATIONS

8.1 General

The long term additions which are proposed are illustrated on Figure 1. Some of the additions are expected to be similar to some of those that presently exist. The proposed facilities include:

- Preliminary Treatment Expansion will include grit removal tanks which will be comparable to those that presently exist and will be approximately 6.0 metres deep below finished grade at approximately elevation 228.0 metres. They will always contain fluids except when taken out of service for cleaning.
- Standby Power Building will be on grade and will house one or more generators.
- Primary Clarifiers, one of which will be constructed initially, will have a footprint of 45 by 15.6 metres and 5.0 metres in depth (approx. elev. 228.9 metres with a sludge hopper that extends 3.4 metres deeper (elev. 225.5 metres). The clarifiers will maintain fluid except when taken out of service for cleaning.
- Bioreactors will be constructed adjacent to the existing bioreactor and it is anticipated that the floor of the reactors will be at the same elevation as the existing which is 228.1 metres. The four new bioreactors will be 44.1 by 33.9 metres by 6.7 deep. They will be full of fluid at all times except when taken out of service for cleaning.
- Blower/Electrical/Workshop/Odour Control/Alum/Chlorine Rooms will be adjacent to the Bioreactor tanks. These rooms will be at grade, some of which may contain heavy equipment/storage tanks.

- Secondary Clarifiers, two of which are proposed to be constructed initially, will have diameters of 45.7 and 33.5 metres. The depths of the clarifiers will be about 5.1 metres with a central core to a depth of 7.6 metres (elev. 225.0). The clarifiers will be maintained full except for when taken out of service for cleaning.
- The U/V Disinfection Facility will be twinned with the existing facility. It will be 25 metres in length, 5.4 metres in width and to a depth of 3.9 metres (elev.229.0).
- Fermenters will each be 21.3 meters in diameter and will be partially buried. Adjacent to the fermenters will be a DAF Room/truck Bay/Electrical Room/Odour Control Room/ Sludge Holding Tank all of which will be at grade. The DAF room will include four above ground process tanks, each tank approximately 8.1 by 2.6 metres and 2.5 metres high. The sludge holding tank room will contain three above ground sludge tanks, each being about 20 by 9 metres and 2.5 metres high.

8.2 Foundations

The geotechnical conditions are best suited to the use of hexagonal, prestressed, precast concrete piles that are driven to practical refusal in the underlying glacial till. These have been the type of pile which has been used to support the majority of the structures for the existing plant. The variable condition of the glacial till deposit and the potential problems related to water seepage and bell instability are factors that render the site unsuitable for widespread use of high capacity cast-in-place concrete caissons and this type of foundation is not recommended.

The driven end bearing precast concrete piles can be assigned conventional capacities of 445, 625 and 800 kN for 305, 356 and 406 mm sizes respectively if driven to practical refusal with diesel hammers with a rated energy of not less than 40, 000 Joules. Practical refusal can be defined as final penetration resistance values of 5, 8 and 12 blows per 25 mm or less for 305, 356 and 406 mm diameters respectively for the final 3 sets of pile penetration for hammers with driving energies of 40,000 Joules. If higher energies or other types of hammers are used, they should be evaluated to ensure that the piles are not overstressed and a suitable refusal criteria determined.

Construction practice in Winnipeg normally includes preboring at all driven pile locations usually to diameters that are 50 mm greater than the pile size and to depths of about 3 metres. The preboring is effective in reducing ground vibrations, pile heave and contributes positively to pile verticality. No reduction in individual pile capacity is necessary for reasons related to group action provided that pile heave is monitored, measures are taken to minimize it (preboring) and redriving is done, as necessary, in pile groups. Redriving of all piles in groups should be specified. Piles should not be spaced closer than 2.5 pile diameters centre to centre. Full time pile inspection is recommended for the driven pile installations.

The age of the precast pile concrete should be specified to be at least seven days old prior to driving.

Lightly loaded structures can be supported on cast-in-place concrete friction piles which can be designed on the basis of an allowable shaft adhesion value of 19.2 kPa. The top 3.0 metres of shaft support should be discounted due to potential soil shrinkage away from the pile. A minimum pile diameter of 405 mm should be specified. Temporary casings should be used on an as-required basis, to prevent caving and seepage into the pile borings.

A mixture of friction piles and end bearing piles is not recommended for the support of important structures, nor should groups of friction piles be used for large loads.

Any foundations which might be affected by freezing conditions should be protected from frost heave effects. The use of flat lying rigid insulation, such as Styrofoam HI, can be used to prevent frost penetration into the soil around the piles. Alternatively, the pile lengths should be a minimum of 7.6 metres and should contain full length reinforcement regardless of the design loads.

8.3 Excavations and Shoring

Deep excavations will be required for most of the major structures which may be in open areas and others adjacent to existing facilities. In the open areas, it may be possible to use sloped excavations. Adjacent to the existing facilities, shoring may be required. Because these options will impact on the construction activities and schedules, it is recommended that the successful contractor be required to submit an excavation and shoring plan which should be prepared by or endorsed by a registered Professional Engineer who is skilled in these matters.

The excavation and shoring plan should consider the potential for bottom heave of the deeper excavations due to hydrostatic pressures within the underlying glacial till deposit and bedrock. As noted in Section 7.0, the highest groundwater elevations which have been recorded at the site occurred during the Floodway events which, in 2006, were as high as 226.8 metres. With this groundwater elevation, the maximum depth of excavation to elevation 224.5 metres and the highest elevation of the glacial till (or bottom of the clay deposit), the Factor of Safety against bottom heave is too low. It should be appreciated that all of the foregoing are the extremes of the limits which could be used for the analyses. In general, exclusive of the periods of the Floodway events, the Factors of Safety appear to be adequate, however, the development of the excavation and shoring plan should assess the base heave potential for the deeper excavations.

The design of the excavation slopes should consider the soil stratigraphy and piezometric conditions which might prevail at the time of construction. The presence of the silt deposit should be recognized as sloughing and seepage should be expected during periods of heavy rainfall. The excavation slopes should be immediately protected from drying by covering with suitable materials. Particular attention should be paid to excavation slopes where the new excavations will encroach upon or expose the existing structures.

Temporary shoring should be provided where excavations will encroach on structures that have to be protected. The shoring can be designed on the basis of the earth pressure distribution shown on Figure 23. Ground movement behind the shoring will occur and is largely unavoidable. The amount that will occur cannot be predicted with much accuracy, mainly because the movement is as much a function of excavation procedures and workmanship as it is a function of theoretical considerations.

8.4 Below Grade Walls

Below grade walls including the tanks and any retaining walls should be designed to resist lateral earth pressures that are derived on the basis of the following conventional relationship which produces a triangular pressure distribution:

$$P = K \lambda D$$

where P = lateral earth pressure at depth D (kPa)
K = earth pressure coefficient (0.5)
λ = soil/backfill unit weight (17.3 kN/m^3)
D = depth from surface to point of pressure calculation

The base of the wall should be provided with a filter protected drainage system to prevent the buildup of hydrostatic pressures against the wall. Where drainage is not provided, the hydrostatic pressure should be included assuming a water table to be at the ground surface. The selection of backfill materials should be reviewed during the design and their impact on the foregoing pressures reassessed.

An allowance for surface live loads should be included if a significant load is applied within a distance from the wall equal to the height of the wall. The lateral earth pressure due to the live load should be presumed to be equal to 50 percent of the vertical pressure due to the live load.

8.5 Floor Slabs

Structurally supported floor slabs, generally, should be used throughout. These slabs should be separated from the underlying subgrade by a void of at least 200 mm. It is presumed that the slabs will not be provided with underdrainage and that water can collect beneath them. This is conducive to swelling and heave and a generous allowance for this is recommended.

8.6 Seismic Site Classification

On the basis of a weighted undrained shear strength of the clay profile of 55 kPa, the site falls into Site Class D of the Site Classification for Seismic Site Response of the 2005 NBCC.

8.7 Pavements

Pavement structures should be placed on a prepared subgrade. The silty clay which is below the topsoil and fill (which should be removed and stockpiled or wasted) is a suitable subgrade material. It should be reworked until the moisture content is near its optimum value. It would then be compacted to a uniform density of at least 95 percent of Standard Proctor Density. Any "soft spots" which develop during the subgrade preparation should be subcut and replaced with suitably compacted clay materials. Where silt is encountered, it should be subcut by 750 mm and bridged with a granular fill. A woven geotextile should be placed between the native soil and the granular fill to provide a separation and reinforcement.

On the prepared subgrade the pavement areas for parking and light duty traffic should consist of 50 mm of asphaltic concrete placed on 210 mm of crushed granular base course and for heavy duty traffic for trucking, it should consist of 76 mm of asphaltic concrete on 460 mm of crushed granular base course, or equivalent sections. Concrete pavements would entail 205 mm of reinforced concrete on 75 mm of crushed granular base course.

The materials selection and construction requirements should be to the standards of road construction as set out in the City of Winnipeg Standard Specifications.

8.8 <u>Other</u>

All concrete in contact with the soil should be manufactured with sulphate resistant cement and should be of high quality.

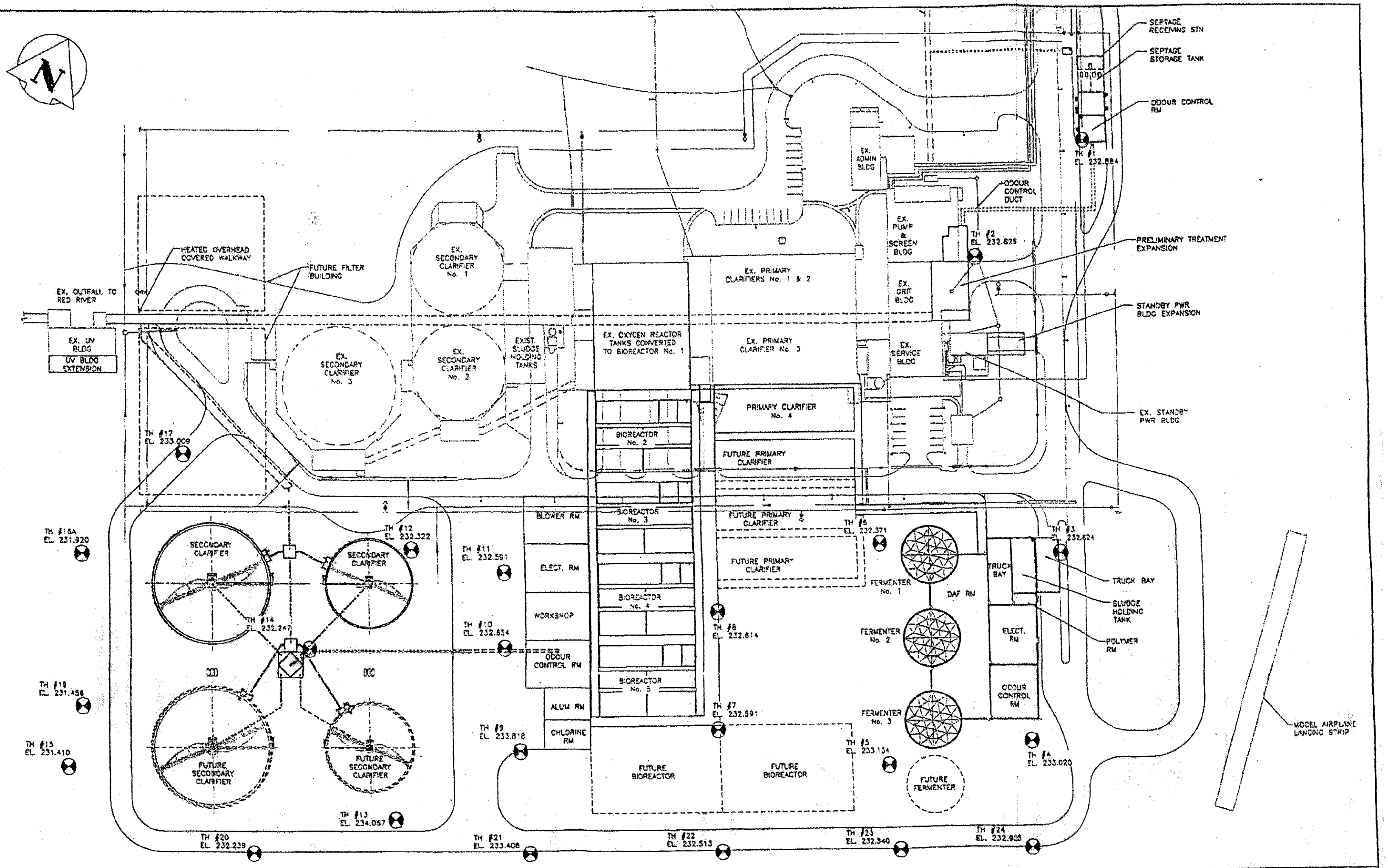
Respectfully submitted,

DYREGROV CONSULTANTS

Per:

A.O. Dyregrov, P.Eng.

PROVINCE OF MANITOBA
A. O.
DYREGROV
25/02/08
REGISTERED PROFESSIONAL ENGINEER



APEGM
Certificate of Authorization
Stantec Consulting Ltd.
No. 1301 Expiry: April 30, 2008

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE DATE

NOTE:
LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

B.M. ELEV.

NO.	REVISIONS	DATE	BY

Stantec Consulting Ltd.
905 Waverley Street, Winnipeg, Manitoba
Tel 204-489-5900 Fax 204-453-9012

DESIGNED BY		CHECKED BY	C.D.
DRAWN BY	K.R.	APPROVED BY	C.D.
HOR. SCALE: VERTICAL:	1:1500	RELEASED FOR CONSTRUCTION:	
DATE	Nov. 15, 2007	DATE	

ENGINEER'S SEAL

TENDER NO. 2007-

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

SOUTH END WATER POLLUTION CONTROL CENTRE
UPGRADING / EXPANSION

TEST HOLES LOCATION

CITY DRAWING NUMBER 1-0102A-D-G0001-001-00B
SHEET OF

FIGURE 1

01/000

DYREGROV
CONSULTANTS

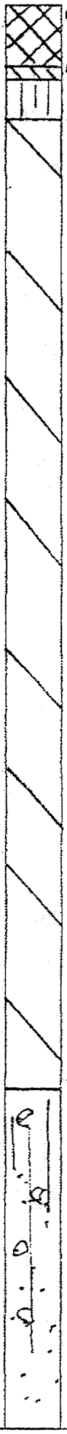
Logged/Drawn: SDG
Checked: AOD

Test Hole No. 2007-01
Project No. 272939

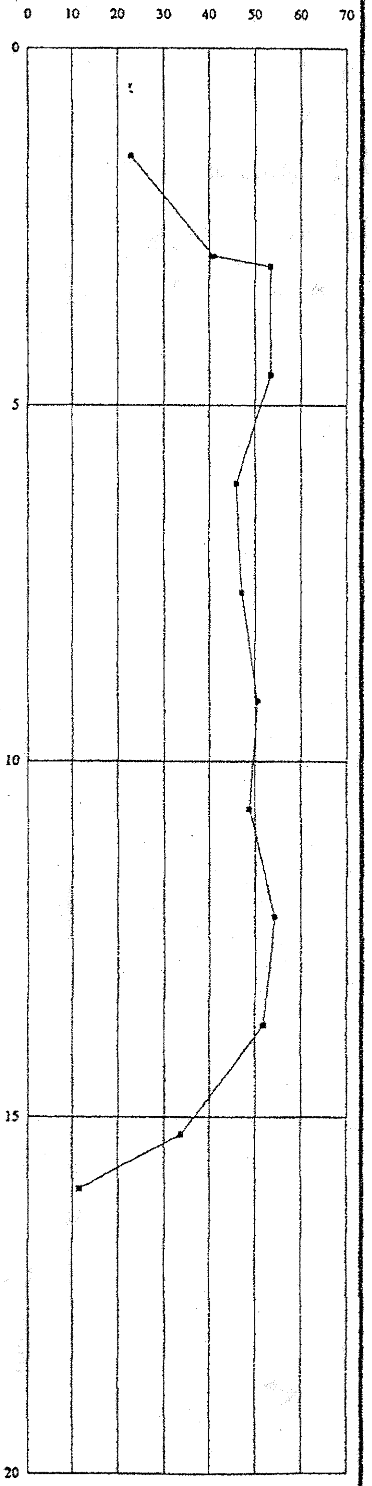
PROJECT: SEWPCC
CLIENT: STANTEC CONSULTING LTD.

DATE OF INVEST : SEPTEMBER 13, 2007
DRILL : SUBTERRANEAN 460 mm AUGER

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	232.88			
	0.50	232.38		0.00-0.91FILL, CLAY, TRACE TO SOME SILT AND GRAVEL	
	1.00	231.88		0.91-1.06 CLAY, BROWN ,STIFF	
	1.50	231.38		1.06-1.68 SILT, TAN, CLAYEY 1.68- 15.39 CLAY	
	2.00	230.88		SILTY, STIFF BROWN AT 2.13	
	2.50	230.38		HIGHLY PLASTIC GYPSUM INCLUSIONS	
	3.00	229.88			Pp-34.3 kPa Tv-45.1 kPa
	3.50	229.38			
	4.00	228.88			
	4.50	228.38			
	5.00	227.88			
	5.50	227.38			
	6.00	226.88			
	6.50	226.38			
	7.00	225.88			
	7.50	225.38			
	8.00	224.88		GREY AT 8.23	
	8.50	224.38			
	9.00	223.88			
	9.50	223.38			
	10.00	222.88			
	10.50	222.38			
	11.00	221.88			
	11.50	221.38			
	12.00	220.88			
	12.50	220.38			
	13.00	219.88			
	13.50	219.38		FIRM	
	14.00	218.88			
	14.50	218.38		TILL INCLUSIONS	
	15.00	217.88		15.39-21.9 GLACIAL SILTY TILL	
	15.50	217.38		SILTY, SANDY, SOME GRAVEL TAN, LOOSE, SOFT	
	16.00	216.88			
	16.50	216.38		COBBLES AND BOULDERS @ 16.45 SANDY	
	17.00	215.88		SEEPAGE	
	17.50	215.38		HOLE SLOUGHED TO 13.8 DRILLED TO 17.37	
	18.00	214.88		AUGER SCREWED TO 21.9	
	18.50	214.38			
	19.00	213.88			
	19.50	213.38			
	20.00	212.88			



MOISTURE CONTENT (%)



NOTES
END OF TEST HOLE AT 21.9 AT
AUGER REFUSAL
WATER LEVEL AT 13.4 IN 10 MINUTES

FIGURE 2

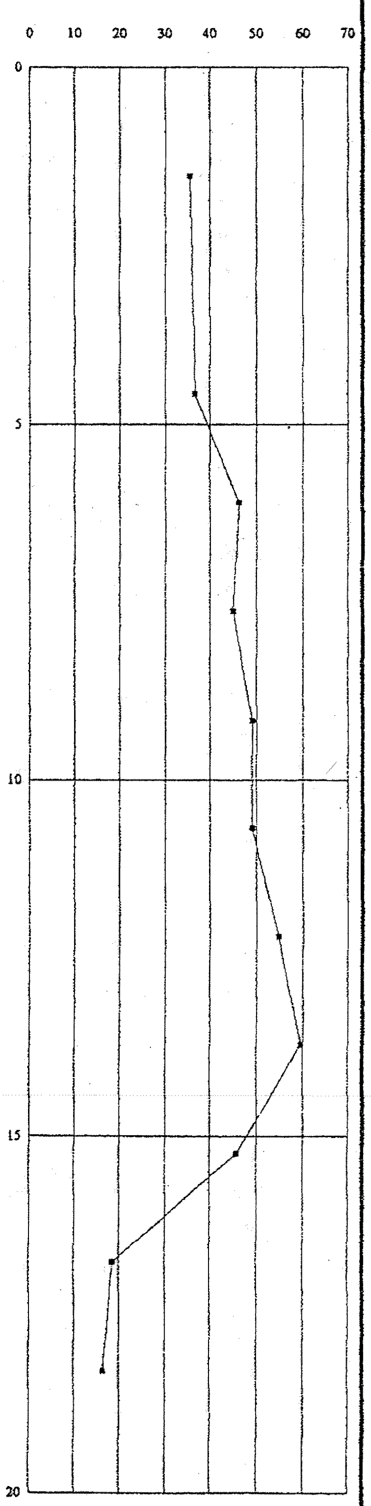
DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-02	Project No. 272939

PROJECT: SEWPCC
CLIENT: STANTEC CONSULTING LTD.

DATE OF INVEST : SEPTEMBER 19, 2007
DRILL : SUBTERRANEAN 125 mm AUGER

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	232.63		0.00-0.30 FILL - SAND, GRAVEL SOME CLAY	
	0.50	232.13		0.30-16.00 CLAY SILTY, STIFF	
	1.00	231.63		HIGHLY PLASTIC MOTTLED BROWN	
	1.50	231.13		GYPSUM INCLUSIONS	
	2.00	230.63			
	2.50	230.13			
	3.00	229.63			
	3.50	229.13			
	4.00	228.63			
	4.50	228.13			
	5.00	227.63			
	5.50	227.13		MOTTLED BROWN, SILTY, HIGH PLASTIC STIFF	
	6.00	226.63			
	6.50	226.13			
	7.00	225.63			
	7.50	225.13			
	8.00	224.63			
	8.50	224.13		GREY AT 8.53	
	9.00	223.63		GREY, SILTY, FIRM TO STIFF,	Cu-38.7 kPa Pp-39.2 kPa
	9.50	223.13		HIGH PLASTIC,	Tv-44.1 kPa W -17.9 kN/M
	10.00	222.63			
	10.50	222.13			
	11.00	221.63			
	11.50	221.13			
	12.00	220.63		GREY. FIRM, HIGH PLASTIC	Cu-29.8 kPa Pp-17.1 kPa
	12.50	220.13		TRACE SILT INCLUSIONS	TV-49.0 kPa W -16.9 kN/M
	13.00	219.63			
	13.50	219.13			
	14.00	218.63			
	14.50	218.13			
	15.00	217.63			
	15.50	217.13			
	16.00	216.63		16.00-19.05 GLACIAL SILTY TILL SILTY, SANDY, SOME GRAVEL	
	16.50	216.13		TAN, LOOSE, SOFT COBBLES AND BOULDERS	
	17.00	215.63		AT 17.0 HOLE SQUEEZING SAND, FINE GRAINED, SOME SILT	
	17.50	215.13		GREY, SATURATED	
	18.00	214.63		SCREWED AUGERS TO REFUSAL	
	18.50	214.13			
	19.00	213.63		COBBLY AND BOULDERY AND VERY DENSE AT 18.6	
	19.50	213.13			
	20.00	212.63			

MOISTURE CONTENT (%)



NOTES

END OF TEST HOLE AT 19.05 AT AUGER REFUSAL ON BOULDERS IN VERY DENSE TILL

HOLE OPEN TO 13.4

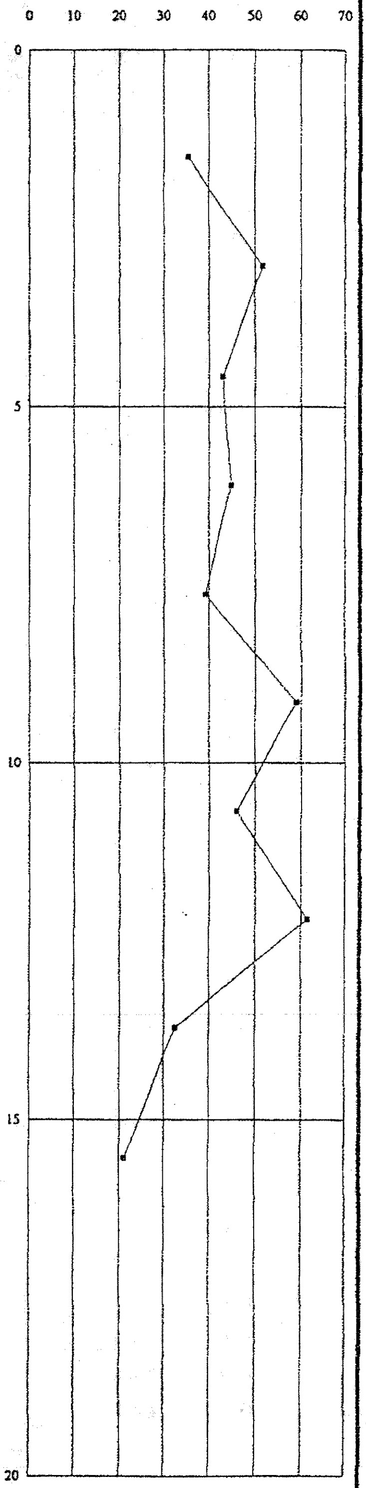
INSTALLED STAND PIPE TO 18.29 WITH BOTTOM 3.05 SLOTTED

FIGURE 3

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-03	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 12 2007 DRILL : SUBTERRANEAN 460 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	232.62		0.00-0.15 FILL, SAND AND CLAY	
	0.50	232.12		0.15-0.76 CLAY, BLACK TO BROWN 0.76-1.06 SILT, TAN, BROWN	
	1.00	231.62		1.06-14.63 CLAY BROWN, SILTY, STIFF HIGHLY PLASTIC	
	1.50	231.12			
	2.00	230.62		0.15 SILT SEAM AT 1.82	
	2.50	230.12			
	3.00	229.62		BROWN, STIFF, SILTY, HIGH PLASTIC, TRACE DECOMPOSED ROOTLETS, TRACE ROOTS	Cu-42.5 kPa Pp-59.8 kPa Tv-73.6 kPa W -16.8 kN/M
	3.50	229.12			
	4.00	228.62			
	4.50	228.12			
	5.00	227.62			
	5.50	227.12			
	6.00	226.62			
	6.50	226.12			
	7.00	225.62			
	7.50	225.12			
	8.00	224.62		GREY AT 8.83	
	8.50	224.12			
	9.00	223.62		GREY, SILTY, FIRM, HIGH PLASTIC TRACE SILT INCLUSIONS	Cu-77.5 kPa Pp-49.1 kPa Tv-44.1 kPa W -17.9 kN/M
	9.50	223.12			
	10.00	222.62			
	10.50	222.12			
	11.00	221.62			
	11.50	221.12			
	12.00	220.62		GREY, SOFT TO FIRM, HIGH PLASTIC, TRACE SILT INCLUSIONS	Cu-59.7 kPa Pp-34.3 kPa Tv-49.0 kPa W -16.9 kN/M
	12.50	220.12			
	13.00	219.62			
	13.50	219.12			
	14.00	218.62			
	14.50	218.12		14.63-22.10 GLACIAL SILTY TILL SILTY, SANDY, SOME GRAVEL TAN, LOOSE, SOFT SQUEEZING AT 15.54	
	15.00	217.62			
	15.50	217.12			
	16.00	216.62			
	16.50	216.12			
	17.00	215.62			
	17.50	215.12			
	18.00	214.62			
	18.50	214.12			
	19.00	213.62			
	19.50	213.12			
	20.00	212.62			

MOISTURE CONTENT (%)



NOTES

END OF TEST HOLE AT 22.10
AUGER SCREWED TO 22.10
HOLE DRY ON COMPLETION

FIGURE 4

DYREGROV CONSULTANTS

Logged/Drawn: SDG
Checked: AOD

Test Hole No. 2007-04

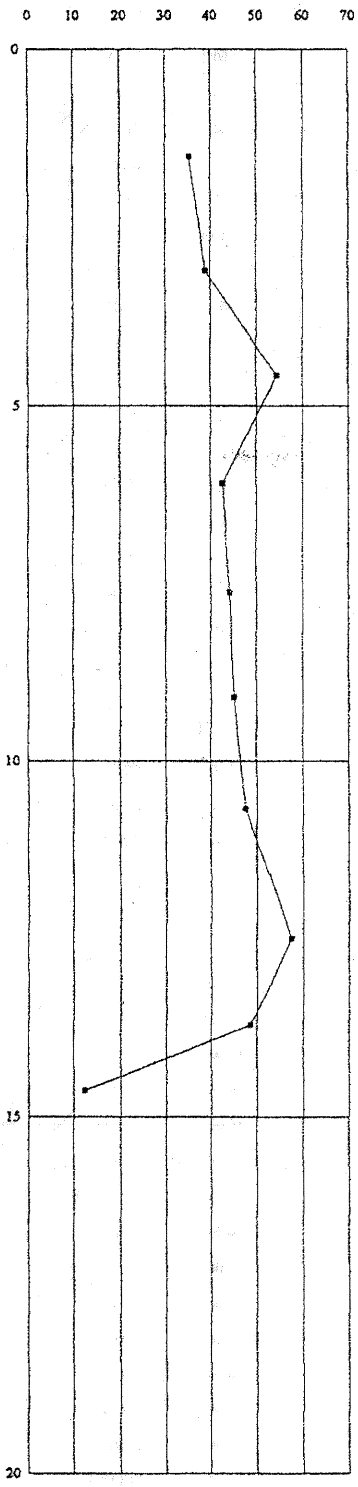
Project No. 272939

PROJECT: SEWPCC
CLIENT: STANTEC CONSULTING LTD.

DATE OF INVEST : SEPTEMBER 12 2007
DRILL : SUBTERRANEAN 460 mm AUGER

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SOIL DESCRIPTION	
	0.00	233.02	0.00-0.61 FILL, SAND, SILT AND CRUSHED LIMESTONE 0.61-1.21 CLAY, BLACK 1.21-1.52 SILT, TAN, WET	
	0.50	232.52		
	1.00	232.02		
	1.50	231.52	1.52-14.32 CLAY SILTY, STIFF HIGHLY PLASTIC MOTTLED BROWN 0.15 SILT SEAM AT 1.98 GYPSUM INCLUSIONS	
	2.00	231.02		
	2.50	230.52		
	3.00	230.02		
	3.50	229.52		
	4.00	229.02		
	4.50	228.52	DARK BROWN TO BROWN, SILTY, STIFF, HIGH PLASTIC, TRACE SULPHATES, TRACE SILT INCLUSIONS, LAMINATED	Cu-47.5 kPa Pp-58.9 kPa Tv-65.7 kPa W -17.1 kN/M
	5.00	228.02		
	5.50	227.52		
	6.00	227.02		
	6.50	226.52		
	7.00	226.02		
	7.50	225.52	BROWN TO LIGHT BROWN, SILTY, TRACE SILT, AND GRAVEL INCLUSIONS, STIFF, HIGH PLASTIC	Cu-75.3 kPa Pp-98.1 kPa Tv-88.3 kPa W -17.5 kN/M
	8.00	225.02		
	8.50	224.52	GREY AT 8.23	
	9.00	224.02		
	9.50	223.52		
	10.00	223.02		
	10.50	222.52		
	11.00	222.02	GREY, SILTY, FIRM TO STIFF, HIGH PLASTIC, TRACE SILT INCLUSIONS	Cu-49.6 kPa Pp-36.8 kPa Tv-59.8 kPa W -16.8 kN/M
	11.50	221.52		
	12.00	221.02		
	12.50	220.52		
	13.00	220.02		
	13.50	219.52		
	14.00	219.02		
	14.50	218.52	14.32-21.03 GLACIAL SILTY TILL SILTY, SANDY, SOME GRAVEL TAN, LOOSE, SOFT COBBLES AND BOULDERS	
	15.00	218.02		
	15.50	217.52		
	16.00	217.02	SQUEESING AT 15.84	
	16.50	216.52		
	17.00	216.02		
	17.50	215.52		
	18.00	215.02		
	18.50	214.52		
	19.00	214.02		
	19.50	213.52		
	20.00	213.02		

MOISTURE CONTENT (%)



NOTES

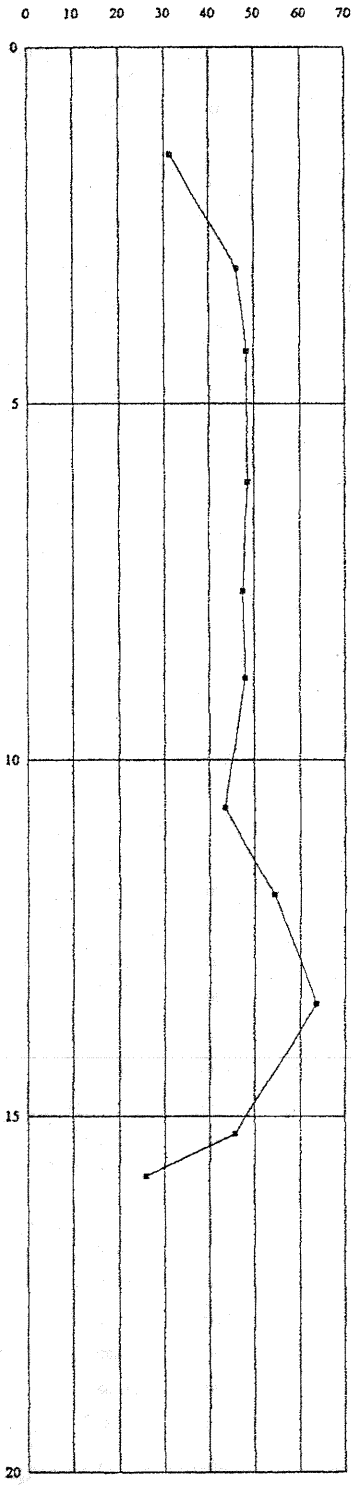
END OF TEST HOLE AT 21.3
AUGER REFUSAL
WATER LEVEL AT 14.02 IN 5 MIN

FIGURE 5

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-05	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 14, 2007 DRILL : SUBTERRANEAN 460 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	233.13		0.00-0.76 FILL, SAND, SILT AND GRAVEL	
	0.50	232.63		0.76- 1.67 CLAY, BLACK TO BROWN	
	1.00	232.13			
	1.50	231.63		1.67-1.98 SILT, TAN, WET	
	2.00	231.13		1.98-15.50 CLAY SILTY, STIFF	
	2.50	230.63		HIGHLY PLASTIC MOTTLED BROWN	
	3.00	230.13		GYPSUM INCLUSIONS	
	3.50	229.63			
	4.00	229.13			
	4.50	228.63			
	5.00	228.13			
	5.50	227.63			
	6.00	227.13		BROWN, STIFF, HIGH PLASTIC, SILTY TRACE SILT INCLUSIONS, LAMINATED	Cu-35.9 kPa Pp-76.6 kPa Tv-63.8 kPa W -17.2 kN/M
	6.50	226.63			
	7.00	226.13			
	7.50	225.63			
	8.00	225.13			
	8.50	224.63		GREY AT 8.23 STIFF TO FIRM	
	9.00	224.13			
	9.50	223.63			
	10.00	223.13			
	10.50	222.63			
	11.00	222.13			
	11.50	221.63			
	12.00	221.13			
	12.50	220.63			
	13.00	220.13			
	13.50	219.63		GREY, SILTY, FIRM, HIGH PLASTIC, TRACE SILT INCLUSIONS	Cu-47.9 kPa Pp-29.4 kPa Tv-49.0 kPa W -16.4 kN/M
	14.00	219.13			
	14.50	218.63			
	15.00	218.13		15.50-24.68 GLACIAL SILTY TILL SILTY, SANDY, SOME GRAVEL TAN, LOOSE, SOFT COBBLES AND BOULDERS	
	15.50	217.63			
	16.00	217.13		SQUEEZING AT 13.10	
	16.50	216.63			
	17.00	216.13			
	17.50	215.63			
	18.00	215.13			
	18.50	214.63		AUGER SCREWED TO REFUSAL	
	19.00	214.13			
	19.50	213.63			
	20.00	213.13			

MOISTURE CONTENT (%)



NOTES

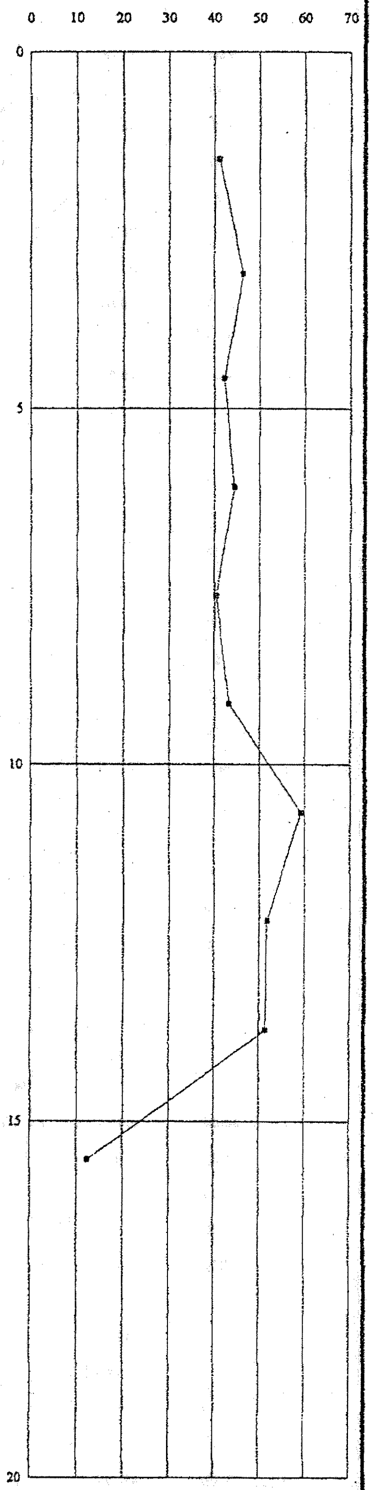
END OF TEST HOLE AT 24.68 AT AUGER REFUSAL
WATER LEVEL AT 15.20 IN 10 MIN

FIGURE 6

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-06	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 13, 2007 DRILL : SUBTERRANEAN 460 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	232.37		0.00-0.30 FILL, GRAVEL, CLAY, BRICKS AND CONCRETE
	0.50	231.87		0.30- 15.24 CLAY, BLACK TO BROWN HIGH PLASTIC, STIFF,
	1.00	231.37		SMALL SILT SEAMS FROM 0.9 TO 1.8
	1.50	230.87		
	2.00	230.37		
	2.50	229.87		
	3.00	229.37		
	3.50	228.87		
	4.00	228.37		
	4.50	227.87		
	5.00	227.37		
	5.50	226.87		
	6.00	226.37		BROWN, STIFF, SILTY, HIGH PLASTIC, TRACE SILT INCLUSIONS SMALL LAMINATIONS Cu-77.9 kPa Pp-88.3 kPa Tv-68.7 kPa W -17.5 kN/M
	6.50	225.87		
	7.00	225.37		
	7.50	224.87		
	8.00	224.37		GREY AT 7.93 STIFF TO FIRM
	8.50	223.87		
	9.00	223.37		
	9.50	222.87		
	10.00	222.37		
	10.50	221.87		
	11.00	221.37		GREY, SILTY, FIRM TO STIFF TRACE SILT INCLUSIONS, HIGH PLASTIC Cu-66.8 kPa Pp-49.1 kPa Tv-52.0 kPa W -16.7 kN/M
	11.50	220.87		
	12.00	220.37		
	12.50	219.87		
	13.00	219.37		
	13.50	218.87		BELOW 13.7 LARGE GLACIAL TILL INCLUSIONS
	14.00	218.37		
	14.50	217.87		
	15.00	217.37		
	15.50	216.87		15.50-22.86 GLACIAL SILTY TILL SILTY, SANDY, SOME GRAVEL TAN, SOFT, LOOSE WET TO SATURATED COBBLES AND BOULDERS
	16.00	216.37		
	16.50	215.87		
	17.00	215.37		
	17.50	214.87		
	18.00	214.37		
	18.50	213.87		AUGER SCREWED TO REFUSAL
	19.00	213.37		
	19.50	212.87		
	20.00	212.37		

MOISTURE CONTENT (%)



NOTES

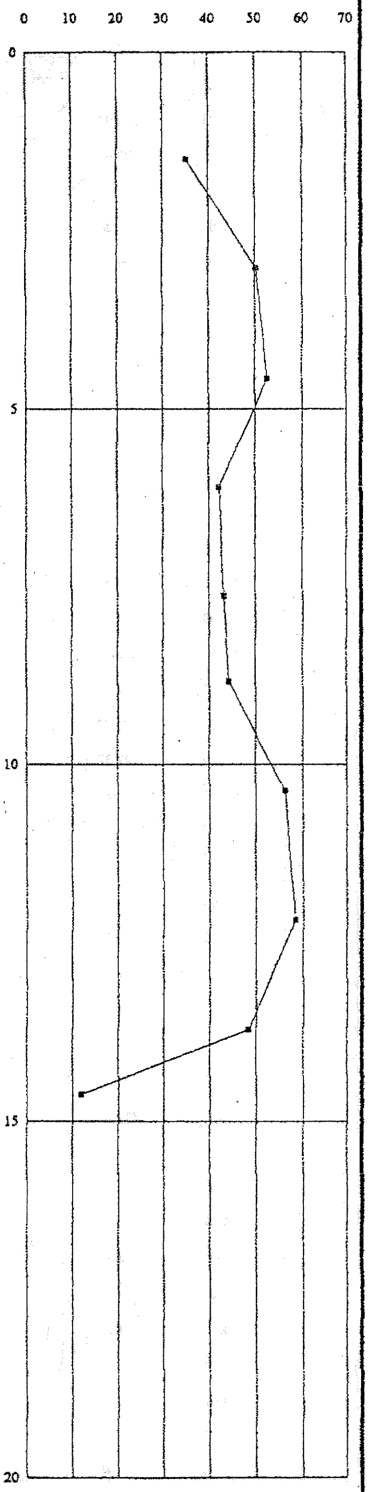
END OF TEST HOLE AT 22.86 AT
AUGER REFUSAL
WATER LEVEL AT 17.70 IN 10 MIN

FIGURE 7

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-07	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 14, 2007 DRILL : SUBTERRANEAN 460 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	233.13		0.00-0.30 FILL, SAND, AND GRAVEL	
	0.50	232.63		0.30- 14.33 CLAY, BLACK TO BROWN SILTY, HIGH PLASTIC,	
	1.00	232.13		VERY STIFF TO STIFF TAN SILT LAYER OF 80mm AT 1.37	
	1.50	231.63		MOTTLED BROWN,	
	2.00	231.13			
	2.50	230.63			
	3.00	230.13			
	3.50	229.63			
	4.00	229.13			
	4.50	228.63		BROWN, STIFF, SILTY, HIGH PLASTIC, TRACE SULPHATE POCKETS	Cu-40.9 kPa Pp-85.8 kPA
	5.00	228.13		TRACE ROOTLETS, TRACE SILT INCLUSIONS	Tv-51.0 kPa W -17.6 kN/M
	5.50	227.63			
	6.00	227.13			
	6.50	226.63			
	7.00	226.13			
	7.50	225.63			
	8.00	225.13			
	8.50	224.63			
	9.00	224.13			
	9.50	223.63		GREY AT 9.15 STIFF TO FIRM	
	10.00	223.13			
	10.50	222.63		GREY, SILTY, FIRM TO STIFF, HIGH PLASTIC, TRACE SILT	Cu-65.3 kPa Pp-49.1 kPa
	11.00	222.13		INCLUSIONS, GRAVEL STONES AT BOTTOM 50 mm DIA	Tv-59.6 kPa W -16.8 kN/M
	11.50	221.63			
	12.00	221.13			
	12.50	220.63			
	13.00	220.13			
	13.50	219.63			
	14.00	219.13			
	14.50	218.63		14.33-22.56 GLACIAL SILTY TILL SILTY, SANDY, SOME GRAVEL	
	15.00	218.13		TAN, LOOSE, SOFT COBBLES AND BOULDERS	
	15.50	217.63			
	16.00	217.13		SQUEEZING AT 15.24	
	16.50	216.63			
	17.00	216.13			
	17.50	215.63			
	18.00	215.13			
	18.50	214.63		AUGER SCREWED TO REFUSAL	
	19.00	214.13			
	19.50	213.63			
	20.00	213.13			

MOISTURE CONTENT (%)



NOTES

END OF TEST HOLE AT 22.56 AT
AUGER REFUSAL

FIGURE 8

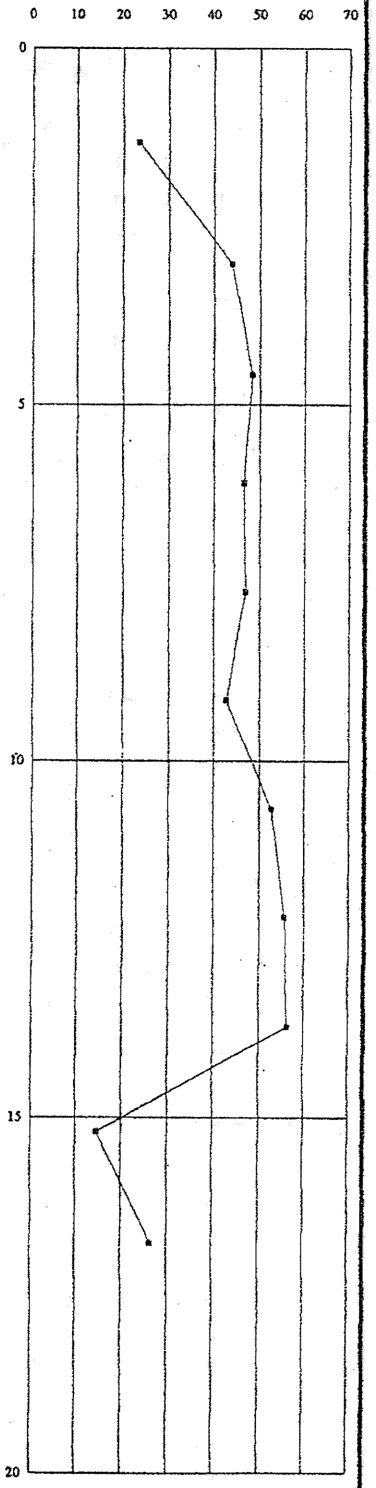
DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-08	Project No. 272939

PROJECT: SEWPCC
CLIENT: STANTEC CONSULTING LTD.

DATE OF INVEST : SEPTEMBER 18, 2007
DRILL : SUBTERRANEAN 460 mm AUGER

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	232.61		0.00-0.30 FILL, SAND, SOME GRAVEL,
	0.50	232.11		0.30- 1.22 CLAY, BLACK TO BROWN SILTY, HIGH PLASTIC
	1.00	231.61		
	1.50	231.11		1.22-1.83 SILT CLAYEY, TAN, FIRM
	2.00	230.61		1.83-14.64 CLAY SILTY, STIFF HIGHLY PLASTIC MOTTLED BROWN
	2.50	230.11		
	3.00	229.61		
	3.50	229.11		THIN SILT SEAMS FROM 3.0 TO 4.5
	4.00	228.61		
	4.50	228.11		
	5.00	227.61		
	5.50	227.11		
	6.00	226.61		BROWN, STIFF, SILTY, HIGH PLASTIC, TRACE SILT INCLUSIONS, TRACE SULPHATE POCKETS, TRACE ROOTLETS Cu-68.7 kPa Pp-98.1 kPa Tv-68.7 kPa W -17.6 kN/M
	6.50	226.11		
	7.00	225.61		
	7.50	225.11		
	8.00	224.61		
	8.50	224.11		
	9.00	223.61		
	9.50	223.11		GREY AT 9.15 STIFF TO FIRM
	10.00	222.61		
	10.50	222.11		
	11.00	221.61		
	11.50	221.11		
	12.00	220.61		
	12.50	220.11		
	13.00	219.61		
	13.50	219.11		
	14.00	218.61		
	14.50	218.11		
	15.00	217.61		14.64-22.56 GLACIAL SILTY TILL SILTY, SANDY, SOME GRAVEL, CLAYEY TAN, LOOSE, SOFT WET TO VERY WET AT 16.7
	15.50	217.11		
	16.00	216.61		EASY DRILLING FROM 16.7 TO 18.3
	16.50	216.11		
	17.00	215.61		
	17.50	215.11		
	18.00	214.61		
	18.50	214.11		
	19.00	213.61		AUGER SCREWED TO REFUSAL
	19.50	213.11		COBBLY AND BOULDERY AT 19.2
	20.00	212.61		DIFFICULT DRILLING BELOW 21.3

MOISTURE CONTENT (%)



NOTES

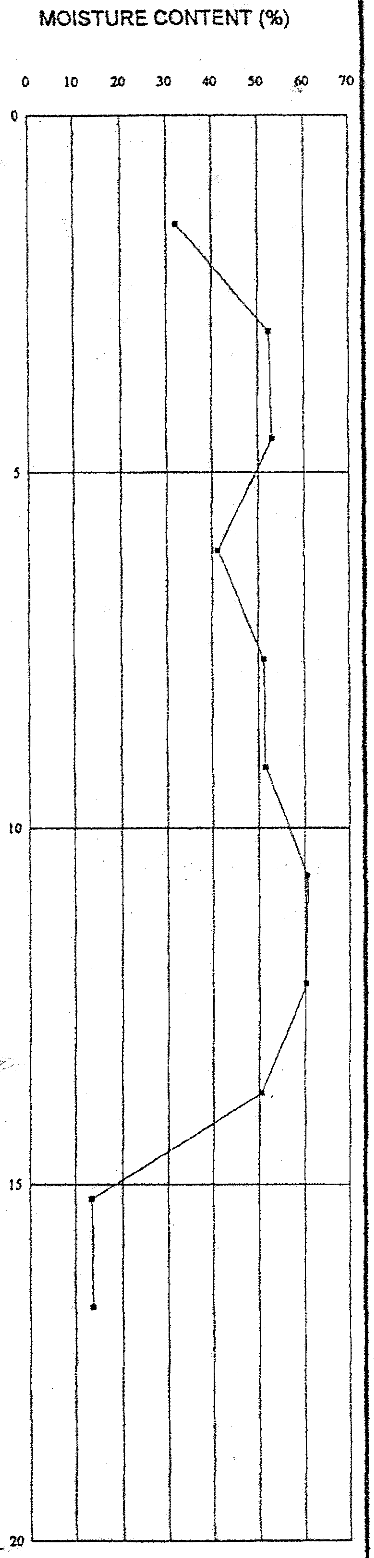
END OF TEST HOLE AT 22.56 AT
AUGER REFUSAL
HOLE OPEN TO 11.6

INSTALLED 15.85 PIEZOMETER WITH BOTTOM 3.05
SLOTTED

FIGURE 9

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-09	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 18, 2007 DRILL : SUBTERRANEAN 125 mm SOLID STEM	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	232.82		0.00-0.46 FILL, SANDY GRAVEL WITH SILT	
	0.50	232.32		0.46-14.33 CLAY BLACK TO BROWN,	
	1.00	231.82		SILTY, VERY STIFF TO STIFF HIGHLY PLASTIC	
	1.50	231.32			
	2.00	230.82			
	2.50	230.32			
	3.00	229.82			
	3.50	229.32			
	4.00	228.82		GREY AT 7.6	
	4.50	228.32			
	5.00	227.82			
	5.50	227.32			
	6.00	226.82			
	6.50	226.32			
	7.00	225.82			
	7.50	225.32		DARK GREY, SILTY, FIRM, HIGH PLASTIC, TRACE SILT INCLUSIONS	Cu-74.8 kPa Pp-36.8 kPa Tv-49.0 kPa W -17.9 kN/M
	8.00	224.82			
	8.50	224.32			
	9.00	223.82			
	9.50	223.32			
	10.00	222.82			
	10.50	222.32		GREY, FIRM, SILTY, HIGH PLASTIC TRACE SILT & GRAVEL INCLUSIONS,	Cu-68.3 kPa Pp-36.8 kPa Tv-62.6 kPa
	11.00	221.82			
	11.50	221.32			
	12.00	220.82			
	12.50	220.32			
	13.00	219.82		HOLE OPEN TO 12.8	
	13.50	219.32			
	14.00	218.82			
	14.50	218.32		14.33-23.78 GLACIAL SILT TILL SILTY, SANDY, SOME GRAVEL	
	15.00	217.82		TAN, LOOSE, SOFT COBBLES AND BOULDERS	
	15.50	217.32			
	16.00	216.82		EASY DRILLING FROM 16.7 TO 18.3 FINE GREY SATURATED SAND	
	16.50	216.32			
	17.00	215.82			
	17.50	215.32			
	18.00	214.82			
	18.50	214.32		AUGER SCREWED TO REFUSAL	
	19.00	213.82		COBBLY AND BOULDERY FROM 19.9 TO 23.78	
	19.50	213.32			
	20.00	212.82			



NOTES

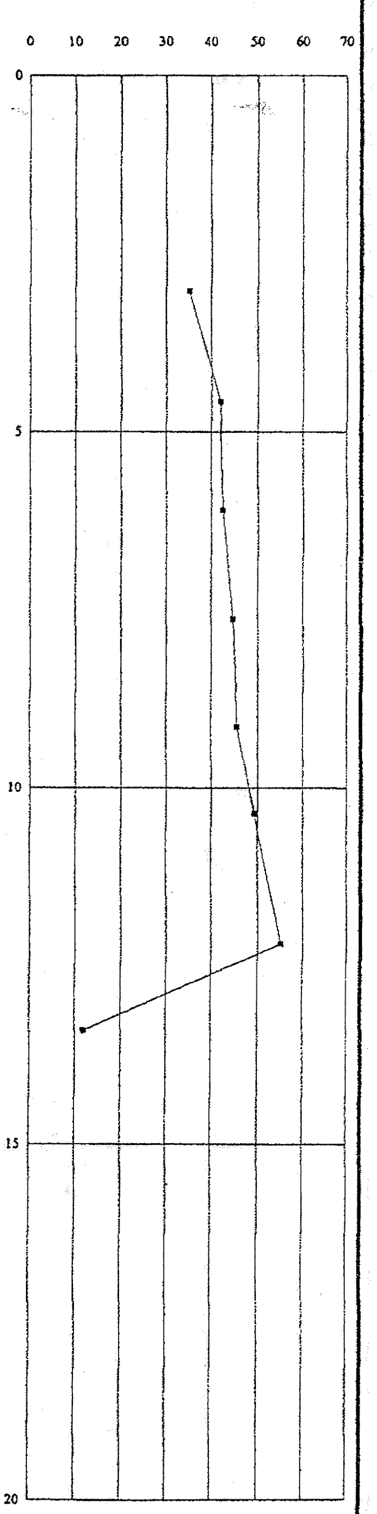
END OF TEST HOLE AT 23.78 AT AUGER REFUSAL

FIGURE 10

DYREGROV CONSULTANTS
Logged/Drawn: SDG
Checked: AOD
Test Hole No. 2007-10
Project No. 272939
PROJECT: SEWPCC
CLIENT: STANTEC CONSULTING LTD.
DATE OF INVEST : SEPTEMBER 14, 2007
DRILL : SUBTERRANEAN 460 mm AUGER

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	232.65		0.00-0.76 FILL, SAND, SILT AND GRAVEL
	0.50	232.15		0.76- 1.67 CLAY, BLACK TO BROWN
	1.00	231.65		
	1.50	231.15		1.67-1.98 SILT, TAN, WET
	2.00	230.65		1.98-12.95 CLAY
	2.50	230.15		SILTY, STIFF, HIGH PLASTIC, MOTTLED BROWN, GYPSUM INCLUSIONS
	3.00	229.65		BROWN, SILTY, FIRM, HIGH PLASTIC, TRACE SILT INCLUSIONS LAMINATIONS Cu-21.0 kPa Pp-36.8 kPa Tv-62.8 kPa W -16.7 kN/M
	3.50	229.15		
	4.00	228.65		
	4.50	228.15		
	5.00	227.65		
	5.50	227.15		
	6.00	226.65		
	6.50	226.15		
	7.00	225.65		
	7.50	225.15		
	8.00	224.65		
	8.50	224.15		GREY AT 8.23 STIFF TO FIRM
	9.00	223.65		
	9.50	223.15		GREY, SILTY, STIFF, HIGH PLASTIC, TRACE SILT INCLUSIONS Cu-66.4 kPa Pp-68.7 kPa Tv-87.3 kPa W -16.9 kN/M
	10.00	222.65		
	10.50	222.15		
	11.00	221.65		
	11.50	221.15		
	12.00	220.65		
	12.50	220.15		
	13.00	219.65		12.95-20.43 GLACIAL SILTY TILL SILTY, SANDY, SOME GRAVEL TAN, LOOSE, SOFT COBBLES AND BOULDERS
	13.50	219.15		
	14.00	218.65		SQUEEZING AT 13.10
	14.50	218.15		
	15.00	217.65		
	15.50	217.15		
	16.00	216.65		
	16.50	216.15		
	17.00	215.65		
	17.50	215.15		
	18.00	214.65		
	18.50	214.15		
	19.00	213.65		AUGER SCREWED TO REFUSAL
	19.50	213.15		
	20.00	212.65		

MOISTURE CONTENT (%)

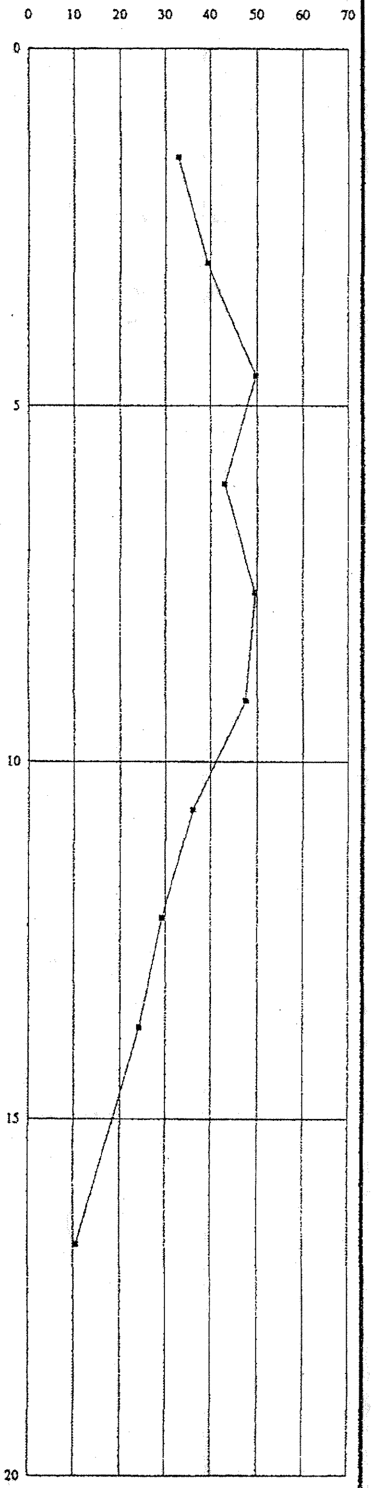


NOTES
END OF TEST HOLE AT 20.43
AUGER REFUSAL
TEST HOLE DRY UPON COMPLETION

FIGURE 11

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-11	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 18, 2007 DRILL : SUBTERRANEAN 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	232.59		0.00-0.30 FILL, CLAY, SOME GRAVEL	
	0.50	232.09		0.30-14.02 CLAY SILTY, DARK GREY, HIGH PLASTIC	
	1.00	231.59		VERY STIFF TO STIFF,	
	1.50	231.09			
	2.00	230.59		150 mm SILT LAYER AT 2.28	
	2.50	230.09		MOTTLED BROWN BELOW 2.50	
	3.00	229.59			
	3.50	229.09			
	4.00	228.59			
	4.50	228.09		BROWN, SILTY, STIFF, HIGH PLASTIC, TRACE SILT AND FINE GRAVEL INCLUSIONS	Cu-57.1 kPa Pp-58.9 kPa Tv-63.8 kPa W -17.4 kN/M
	5.00	227.59			
	5.50	227.09			
	6.00	226.59			
	6.50	226.09			
	7.00	225.59			
	7.50	225.09		GREY AT 7.62 STIFF TO FIRM	
	8.00	224.59			
	8.50	224.09			
	9.00	223.59			
	9.50	223.09			
	10.00	222.59			
	10.50	222.09			
	11.00	221.59		GREY, SILTY, FIRM TO SOFT, HIGH PLASTIC, TRACE SILT, SAND AND GRAVEL INCLUSIONS TRACE SULPHATES	Cu-42.2 kPa Pp-49.1 kPa Tv-36.3 kPa
	11.50	221.09			
	12.00	220.59			
	12.50	220.09			
	13.00	219.59			
	13.50	219.09			
	14.00	218.59			
	14.50	218.09		14.02-22.26 GLACIAL SILT TILL SILTY, SANDY, SOME GRAVEL TAN, LOOSE, SOFT COBBLES AND BOULDERS	
	15.00	217.59			
	15.50	217.09		SQUEEZING AT 14.32	
	16.00	216.59			
	16.50	216.09			
	17.00	215.59			
	17.50	215.09			
	18.00	214.59		DARK GREY SAND AT 18.3 WATER ENCOUNTERED	
	18.50	214.09			
	19.00	213.59		COBBLY AND BOULDERY FROM 20.42 TO 21.95	
	19.50	213.09			
	20.00	212.59			



NOTES

END OF TEST HOLE AT 22.26 AT AUGER REFUSAL

HOLE OPEN TO 11.3 UPON COMPLETION

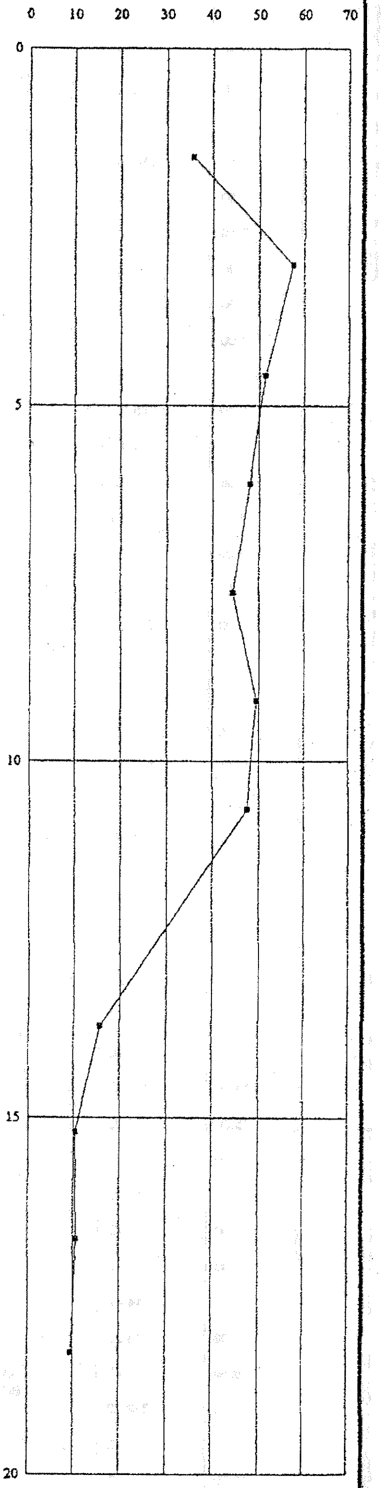
18.29 PIEZO INSTALLED WITH BOTTOM 3.05 SLOTTED

FIGURE 12

DYREGROV CONSULTANTS
Logged/Drawn: SDG
Checked: AOD
Test Hole No. 2007-15
Project No. 272939
PROJECT: SEWPCC
CLIENT: STANTEC CONSULTING LTD.
DATE OF INVEST : SEPTEMBER 17, 2007
DRILL : SUBTERRANEAN 125 mm AUGER

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	231.41		0.00-0.20 TOPSOIL	
	0.50	230.91		0.20-12.80 CLAY DARK GREY TO BROWN, SILTY, STIFF HIGH PLASTIC,	
	1.00	230.41			
	1.50	229.91			
	2.00	229.41			
	2.50	228.91		MOTTLED BROWN AT 2.4	
	3.00	228.41			
	3.50	227.91			
	4.00	227.41			
	4.50	226.91			
	5.00	226.41			
	5.50	225.91			
	6.00	225.41		SILTY, DARK BROWN - GREY MOTTLED FIRM, HIGH PLASTIC	Cu-47.4 kPa Pp-36.8 kPa Tv-68.7 kPa W -17.1 kN/M
	6.50	224.91			
	7.00	224.41			
	7.50	223.91			
	8.00	223.41		GREY AT 8.23	
	8.50	222.91		STIFF TO FIRM	
	9.00	222.41			
	9.50	221.91		GREY, SILTY, FIRM TO STIFF, HIGH PLASTIC, TRACE SILT INCLUSIONS	Cu-71.5 kPa Pp-49.1 kPa Tv-59.8 kPa W -19.3 kN/M
	10.00	221.41			
	10.50	220.91			
	11.00	220.41		FIRM TO SOFT	
	11.50	219.91			
	12.00	219.41			
	12.50	218.91			
	13.00	218.41		12.80-22.25 GLACIAL SILT TILL SILTY, SANDY, SOME GRAVEL TAN, LOOSE, SOFT COBBLES AND BOULDERS	
	13.50	217.91			
	14.00	217.41		HOLE SQUEEZING IN AT 14	
	14.50	216.91			
	15.00	216.41		MEDIUM DENSE AT 14.9	
	15.50	215.91		DENSE BELOW 15.8	
	16.00	215.41		SEEPAGE BETWEEN 15.2 AND 16.8	
	16.50	214.91			
	17.00	214.41			
	17.50	213.91			
	18.00	213.41			
	18.50	212.91		AUGER SCREWED TO REFUSAL	
	19.00	212.41			
	19.50	211.91		COBBLY AND BOULDERY BELOW 20.12	
	20.00	211.41			

MOISTURE CONTENT (%)



NOTES

END OF TEST HOLE AT 22.25 ON PROBABLE BOULDERS

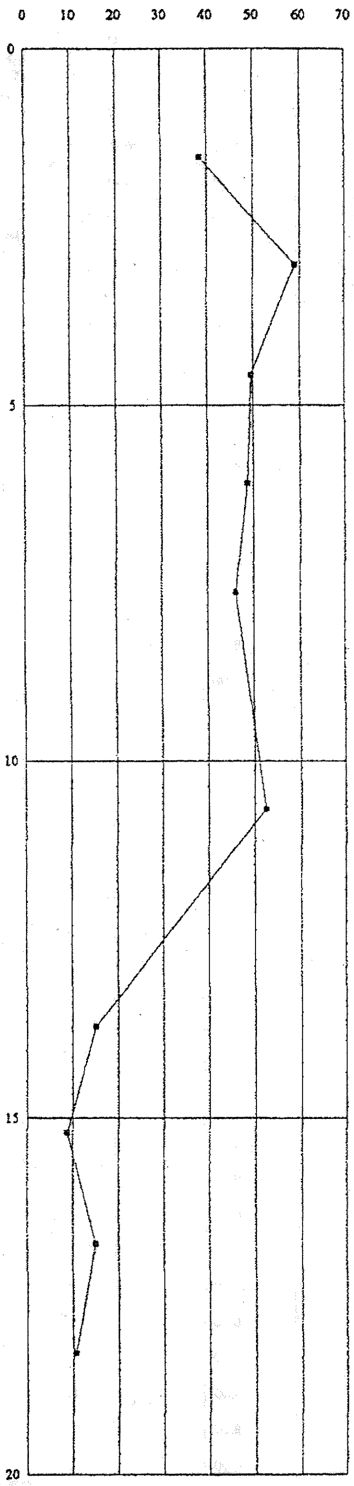
HOLE OPEN TO 11.28 AT COMPLETION OF DRILLING
STANDPIPE 18.3 LONG WAS INSTALLED WITH
TIP AT 18.2 BELOW GRADE

FIGURE 13

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-16A	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 17, 2007 DRILL : SUBTERRANEAN 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION	
	0.00	231.92		O.OO-0.15 TOPSOIL	
	0.50	231.42		O.15-12.50 CLAY BROWN, SILTY, VERY STIFF TO STIFF	
	1.00	230.92		HIGH PLASTIC MOTTLED BROWN	
	1.50	230.42		TRACE SILT INCLUSIONS	
	2.00	229.92			
	2.50	229.42			
	3.00	228.92		SILTY, STIFF HIGHLY PLASTIC	Cu-22.0 kPa Pp-36.8 kPa
	3.50	228.42		MOTTLED BROWN GYPSUM INCLUSIONS	Tv-51.0 kPa W -16.5 kN/M
	4.00	227.92		TRACE SILT INCLUSIONS LAMINATION STRUCTURE	
	4.50	227.42			
	5.00	226.92			
	5.50	226.42			
	6.00	225.92			
	6.50	225.42			
	7.00	224.92			
	7.50	224.42			
	8.00	223.92		GREY AT 7.93	
	8.50	223.42			
	9.00	222.92			
	9.50	222.42			
	10.00	221.92			
	10.50	221.42			
	11.00	220.92			
	11.50	220.42			
	12.00	219.92			
	12.50	219.42		12.50-22.86 GLACIAL SILT TILL	
	13.00	218.92		SILTY, SANDY, SOME GRAVEL TAN, LOOSE, SOFT	
	13.50	218.42		COBBLES AND BOULDERS FEW CLAY SEAMS AND INCLUSIONS	
	14.00	217.92		COBBLY AND BOULDERY, MORE DENSE BELOW	
	14.50	217.42		13.7	
	15.00	216.92			
	15.50	216.42		MORE SOFT AND LOOSE BELOW 15.2	
	16.00	215.92			
	16.50	215.42			
	17.00	214.92			
	17.50	214.42			
	18.00	213.92			
	18.50	213.42		HARDER DRILLING FROM 18.3 TO 19.8, BOULDERY, WATER ON AUGERS	
	19.00	212.92			
	19.50	212.42			
	20.00	211.92			

MOISTURE CONTENT (%)



W/L DATE	ELEV
Sept 18/07	221.1
Sept 18/07	223.46

NOTES

END OF TEST HOLE AT 22.86 AT AUGER REFUSAL

PIEZOMETER INSTALLED TO 18.29 WITH BOTTOM 3.05 SLOTTED

FIGURE 14

DYREGROV **CONSULTANTS**	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-17	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 18, 2007 DRILL : SUBTERRANEAN 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	233.01	▨	0.00-1.22 FILL CLAY MATRIX, SOME GRAVEL
	0.50	232.51	▨	
	1.00	232.01	▨	
	1.50	231.51	▧	1.22-1.83 CLAY BLACK TO DARK GREY, SILTY, HIGH PLASTIC, STIFF TO VERY STIFF
	2.00	231.01	▥	1.83-2.44 SILT, TAN, MOIST, FIRM
	2.50	230.51	▧	2.44-3.05 CLAY BROWN, SILTY, STIFF, HIGH PLASTIC
	3.00	230.01	▧	
	3.50	229.51		END OF TEST HOLE AT 3.05 IN BROWN SILTY CLAY
	4.00	229.01		

MOISTURE CONTENT (%)

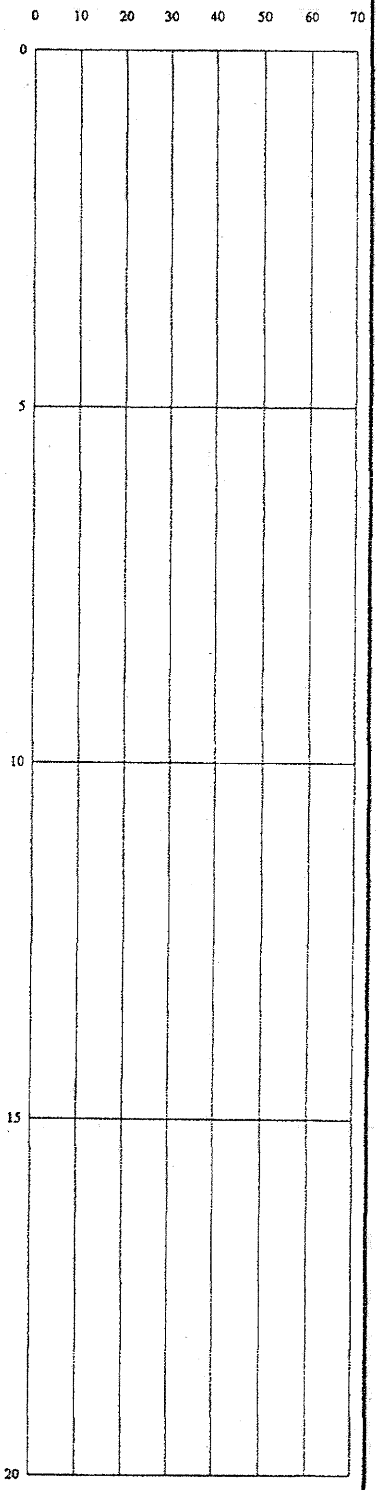


FIGURE 15

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-19	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 17, 2007 DRILL : SUBTERRANEAN 125 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	S Y M	SOIL DESCRIPTION
	0.00	231.77		0.00-0.15 TOPSOIL
	0.50	231.27		0.15-3.05 CLAY SILTY, VERY STIFF TO STIFF
	1.00	230.77		HIGH PLASTIC,
	1.50	230.27		MOTTLED BROWN
	2.00	229.77		
	2.50	229.27		
	3.00	228.77		
	3.50	228.27		END OF TEST HOLE AT 3.05 IN BROWN CLAY
	4.00	227.77		

MOISTURE CONTENT (%)

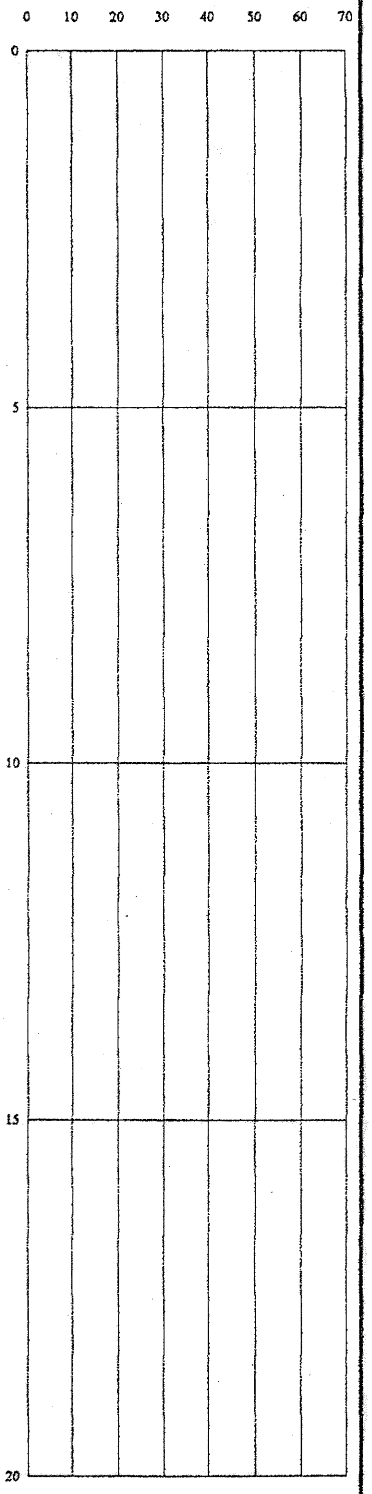


FIGURE 16

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-21	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 14, 2007 DRILL : SUBTERRANEAN 450 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	233.41		
	0.50	232.91	☒	0.00-0.60 FILL SANDY, GRAVELLY, CLAYEY, SILTY, PLASTIC, GARBAGE
	1.00	232.41	▨	0.60-3.05 CLAY BROWN, SILTY, STIFF TO VERY STIFF, HIGH PLASTIC
	1.50	231.91	▨	
	2.00	231.41	▨	MOTTLED BROWN AT 1.8
	2.50	230.91	▨	TAN 75 mm SILT SEAM AT 2.2
	3.00	230.41	▨	
	3.50	229.91		END OF TEST HOLE AT 3.05 IN BROWN CLAY
	4.00	229.41		

MOISTURE CONTENT (%)

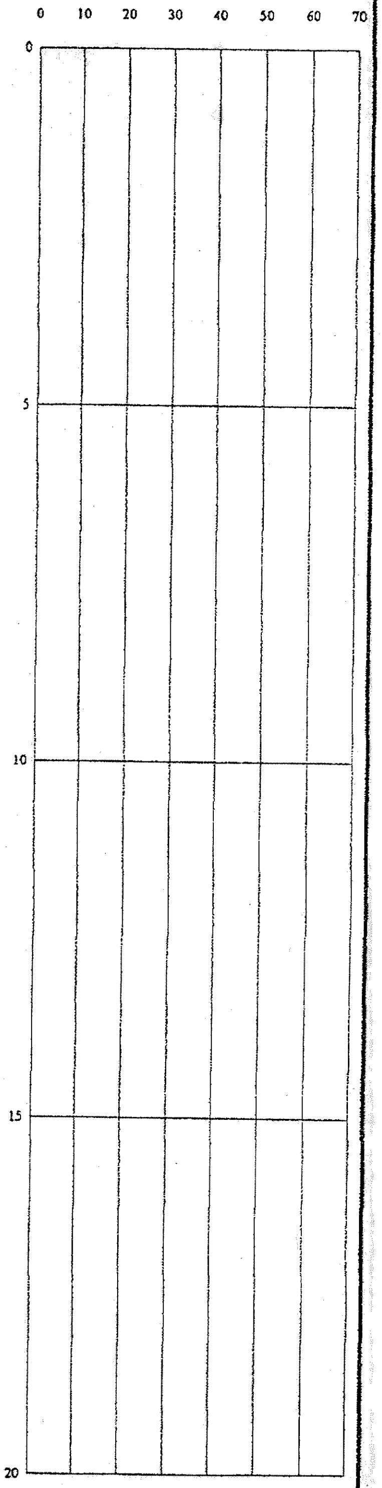


FIGURE 17

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-22	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 14, 2007 DRILL : SUBTERRANEAN 450 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	232.51		0.00-0.38 FILL SAND, SOME GRAVEL, SILT
	0.50	232.01		0.38-2.74 CLAY BROWN, SILTY, STIFF TO VERY STIFF, HIGH PLASTIC
	1.00	231.51		
	1.50	231.01		MOTTLED BROWN AT 1.5 50 TO 75 mm SILT LENSES BETWEEN 1.52 & 1.82
	2.00	230.51		
	2.50	230.01		
	3.00	229.51		
	3.50	229.01		END OF TEST HOLE AT 2.74 IN BROWN CLAY

MOISTURE CONTENT (%)

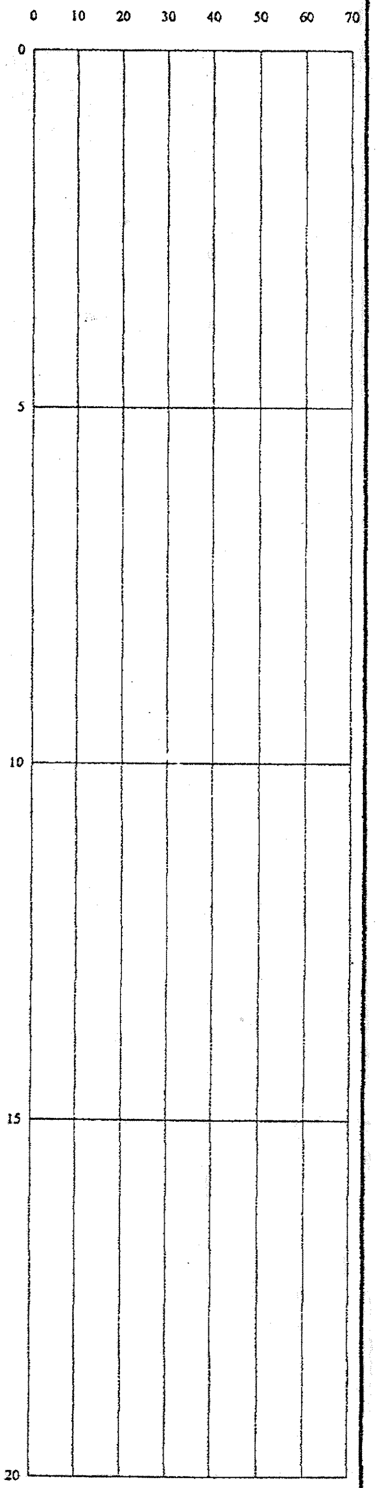


FIGURE 18

DYREGROV CONSULTANTS	Logged/Drawn: SDG Checked: AOD	Test Hole No. 2007-23	Project No. 272939
PROJECT: SEWPCC CLIENT: STANTEC CONSULTING LTD.		DATE OF INVEST : SEPTEMBER 14, 2007 DRILL : SUBTERRANEAN 450 mm AUGER	

SAMPLE NO.	DEPTH (M)	ELEV. (M)	SYM	SOIL DESCRIPTION
	0.00	232.84	☒	0.00-0.46 FILL SAND, GRAVEL, CLAY
	0.50	232.34	▨	0.46-1.68 CLAY BROWN, SILTY, STIFF TO VERY STIFF, HIGH PLASTIC
	1.00	231.84	▨	
	1.50	231.34	▥	1.68-1.98 SILT TAN, WET, LOW TO NON PLASTIC
	2.00	230.84	▨	1.98-2.74 CLAY BROW, SILT, HIGH PLASTIC STIFF
	2.50	230.34	▨	
	3.00	229.84		
	3.50	229.34		END OF TEST HOLE AT 2.74 IN BROWN CLAY

MOISTURE CONTENT (%)

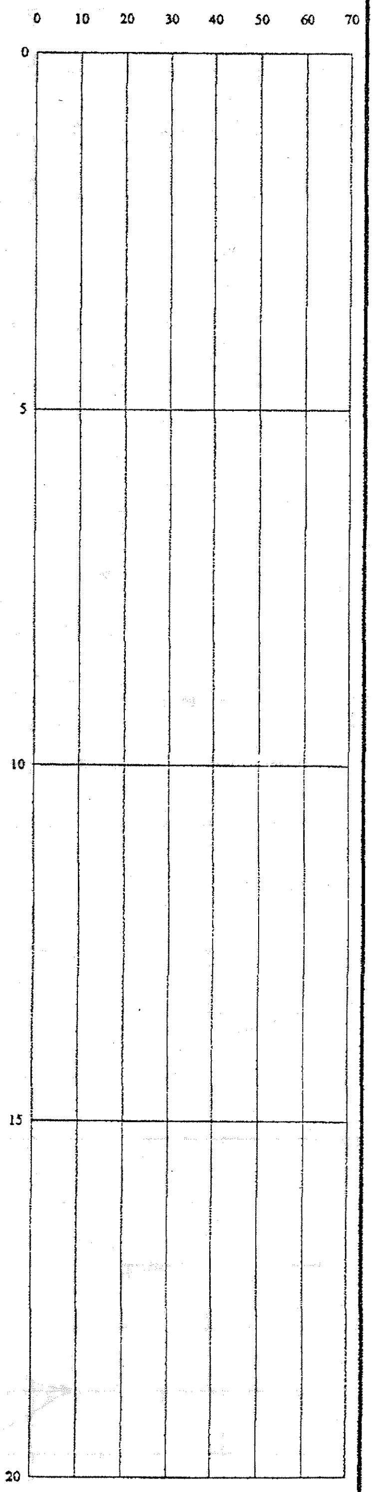
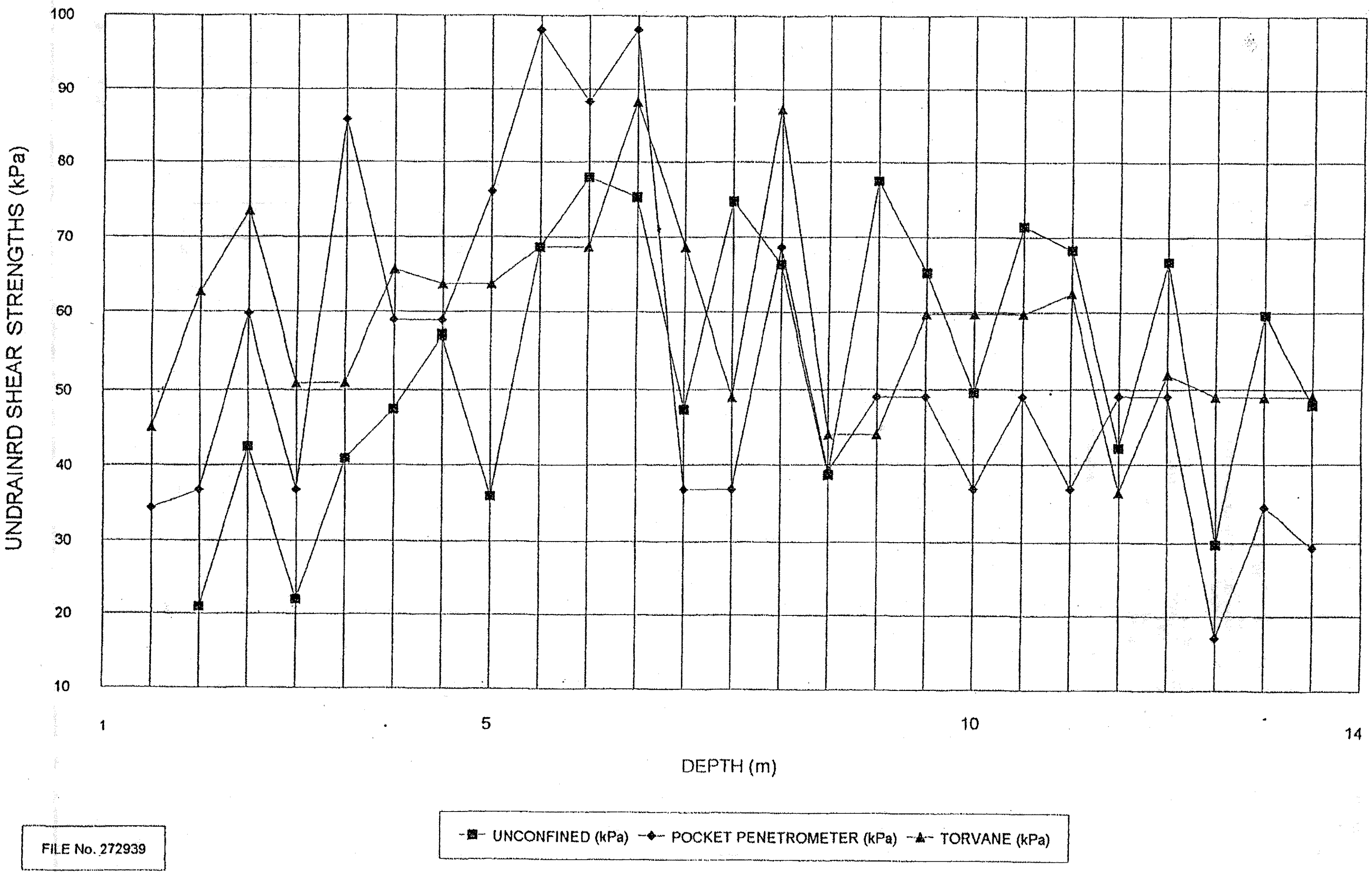


FIGURE 19

SEWPCC

UNDRAINED SHEAR STRENGTHS vs DEPTH (M)



FILE No. 272939

FIGURE 20

LOCATION: RIVER LOT 0153 IN PARISH OF St. Norbert

Owner: CITY OF WPG/WRB
Driller: M.R. HALL DRILLING LTD
Well Name: G05OC007 MO-16 SEWPCC
Well Use: OBSERVATION
Water Use:
UTMX: 637014
UTMY: 5517555
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 233.629
Accuracy Z: 1 EXACT <10CM
Date Completed: 1971 Jan 01

WELL LOG

From (ft.)	To (ft.)	Log
0	5.0	DARK BROWN CLAY
5.0	6.0	SILTY BROWN CLAY
6.0	33.0	BROWN CLAY
33.0	47.0	GREY CLAY
47.0	55.0	SANDY STONY BROWN TILL
55.0	66.5	SILTY FINE SAND, COARSE GRAVEL STREAKS
66.5	71.0	LIMESTONE
71.0	72.0	SHATTERED LIMESTONE
72.0	76.0	LIMESTONE
76.0	77.0	SHATTERED LIMESTONE
77.0	81.9	LIMESTONE
81.9	82.9	SHATTERED LIMESTONE
82.9	99.9	LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	67.8	casing	4.00			IRON	
67.8	99.9	open hole	4.00				

Top of Casing: 18.0 ft. below ground

No pump test data for this well.

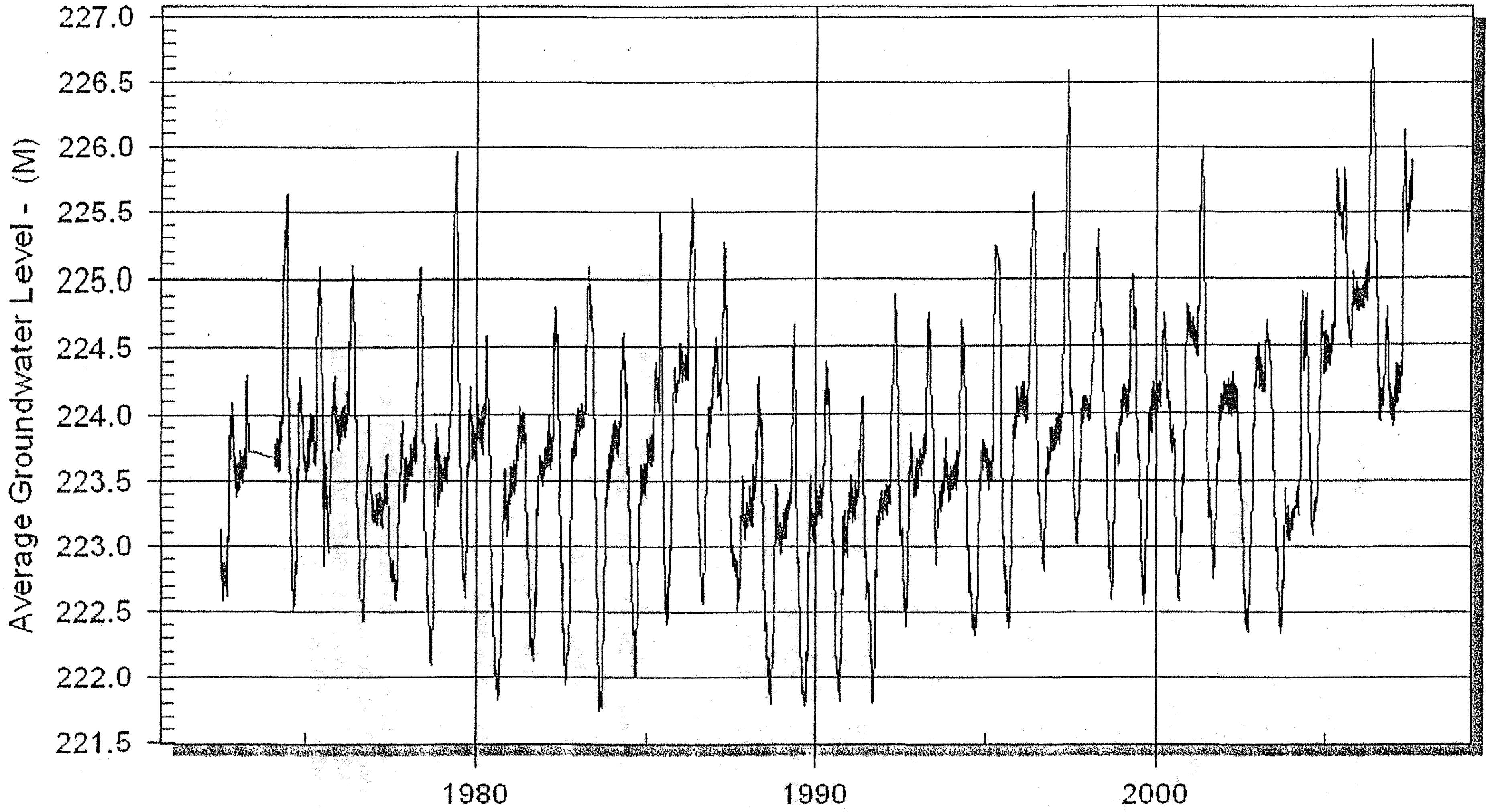
REMARKS

SOUTH EAST WINNIPEG POLLUTION CONTROL CENTRE, TEST HOLE #3, WELL IN BASEMENT, SE CORNER, DOWN 4 FLIGHTS OF STAIRS, BOILER ROOM, CASING CEMENTED IN PLACE, E-LOGGED TO 98 FT, CHEMICAL ANALYSIS GROUND LEVEL ELEV MEASURED 233.629 M

FIGURE 21

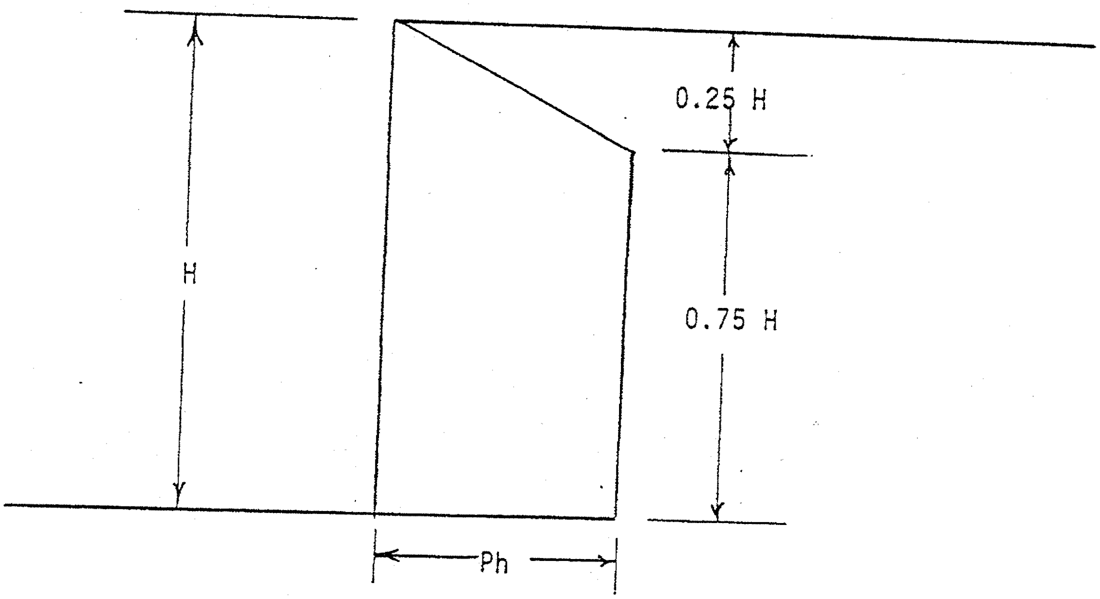
G05OC007 SEWPCC MO-16 153 ST NORBERT

GROUND LEVEL ELEVATION 233.629 METRES (766.50 FEET)



Prepared by Manitoba Water Stewardship 27 Aug 2007

FIGURE 22



$Ph = 0.4\gamma H$

Where: Ph = Lateral earth pressure on shoring (kPa)

Y = Soil unit weigth (17.28 kN/M³)

H = Wall height (M)

Note: Add surface load surcharge where applicable

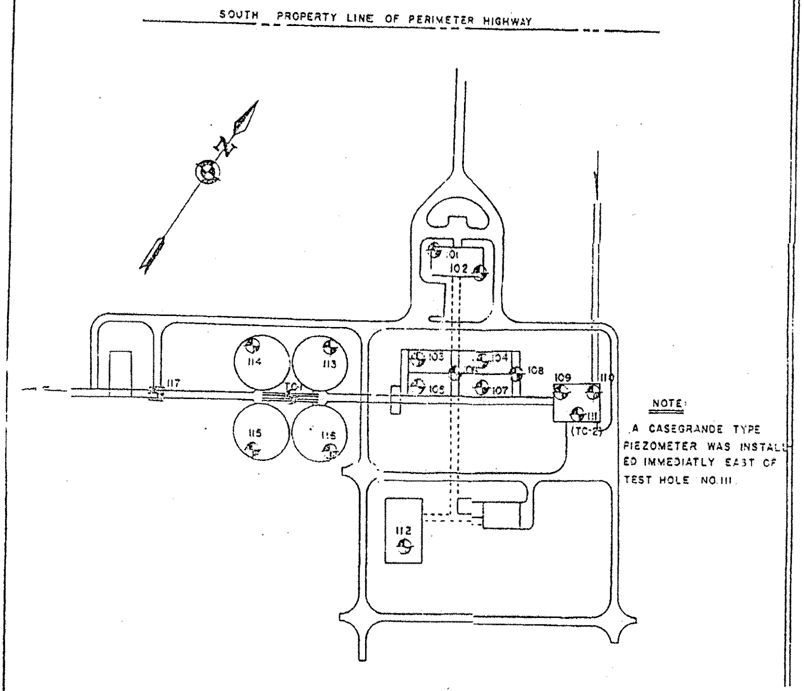
DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

SEWPCC
EARTH PRESSURES
TEMPORARY SHORING

SCALE NTS
DATE 23-11-07
MADE TJH
CHKD AOD
JOB 272939
FIGURE 23

87528

TITLE: REPORT ON SUBSOIL INVESTIGATION
PROPOSED SOUTH END POLLUTION
CONTROL CENTRE
LOCATION: WINNIPEG, MANITOBA
CLIENT: METROPOLITAN CORPORATION OF
GREATER WINNIPEG
c/o W.L. WARDROP & ASSOCIATES
JOB NO: W-580 DATE: March 8, 1971



NOTE:
A CASEGRANDE TYPE PIEZOMETER WAS INSTALLED IMMEDIATLY EAST OF TEST HOLE NO.111.

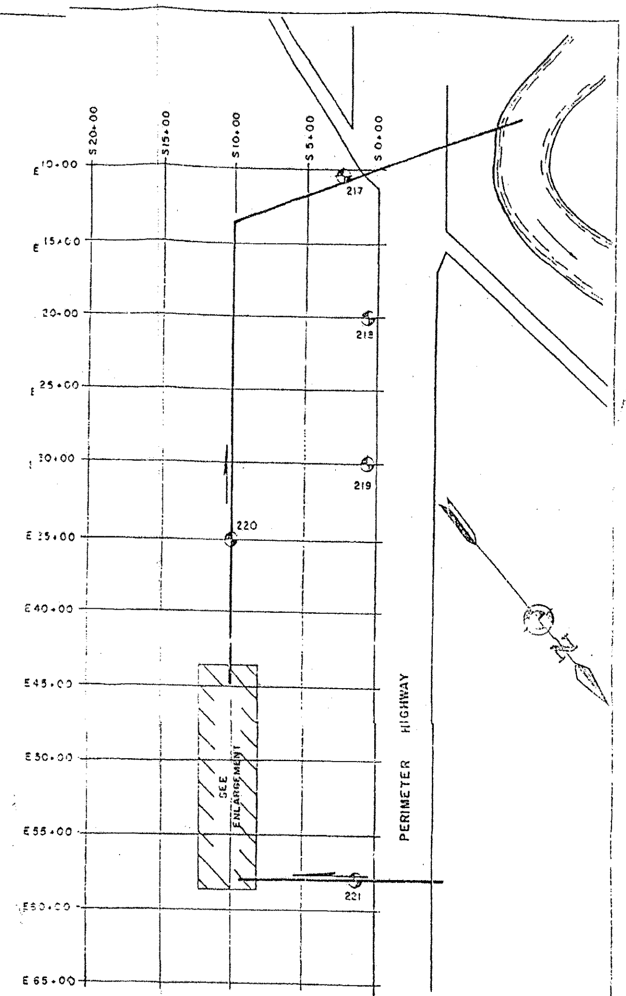
ENLARGEMENT OF TREATMENT PLANT AREA

SCALE: 1in = 200ft

LEGEND:

16"dia. POWER AUGER TEST HOLE

(TC-2) - DENOTES TEST HOLE DRILLED WITH A 4"dia TRI-CONE BIT.



GENERAL SITE LAYOUT AND LOCATION

SCALE: 1in = 500ft.

01	JAN 15.	ADDITION OF TEST HOLE No 221.
REV.	DATE	REVISION DETAILS

DESIGN
DRAWN C J V
DATE DEC 24/70
SCALE AS SHOWN

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS
CANADA
VANCOUVER · EDMONTON · CALGARY · WINNIPEG

PROJECT
SOUTH END POLLUTION CONTROL CENTRE

TITLE
TEST HOLE LOCATION and SITE LAYOUT

CLIENT
W. L. WARDROP AND ASSOCIATES

DATE OF ISSUE 12/24/70
APPROVED R S
PROJECT No. WG0580
DWG No. C-W-580-01

DATE November 12, 1970

TEST HOLE LOG

HOLE NO. 101

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	3"Sy		1
10	3"Sy		2
15	3"Sy		3
20 21	3"Sy		4
26	3"Sy		5
30 31	3"Sy		6
36	3"Sy		7
40	3"Sy		8
45	3"Sy		9
50			
54			

SYMBOL

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

CLAY - mottled brown & grey
- highly plastic
- layered structure
- frequent small tan silt lumps
- firm to stiff
- moist

26.0'

CLAY - dark grey
- highly plastic
- layered structure
- frequent small partings of silt & till-like material
- soft to firm
- moist to damp

45.0'

GLACIAL TILL - tan--grey color
- medium plastic, clayey silt binder, soft, wet

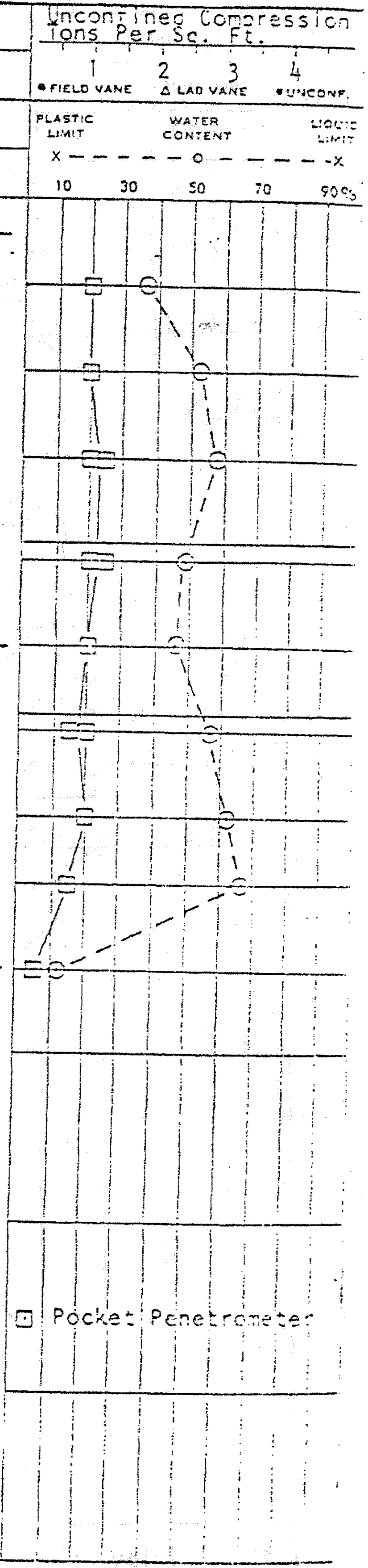
At 52' - layer of dark grey clay

From 53' - numerous cobbles

54.0'

NOTES

1. Water at 54.0 ft depth.
2. Slight sloughing of till at 45.0 ft depth.
3. Hole discontinued at 54.0 ft depth in Glacial Till.



Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

TEST HOLE LOG

DATE December 1, 1970

HOLE NO. 102

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV	O.D. I.D.	BLOWS FT.	NO.
5	Bag		1
10	2"Sy		2
15	Bag		3
20	2"Sy		4
25	Bag		5
30	2"Sy		6
35	Bag		7
40	2"Sy		8
45	Bag		9
50			
52	Bag		10

SYMBOL

DESCRIPTION OF MATERIAL

TOPSOIL - black, highly organic

1.0'

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm, moist

7' to 8'

At 7'-8' - SILT LAYER - tan, medium dense
- low plastic, wet

At 5' & 15' - occasional silt partings

At 15' - occasional inclusions of gypsum crystals

21.0'

CLAY - dark grey
- highly plastic
- layered structure
- firm, moist
- occasional partings of silt and till-like material (frequent from 40.0 ft depth on)

47.0'

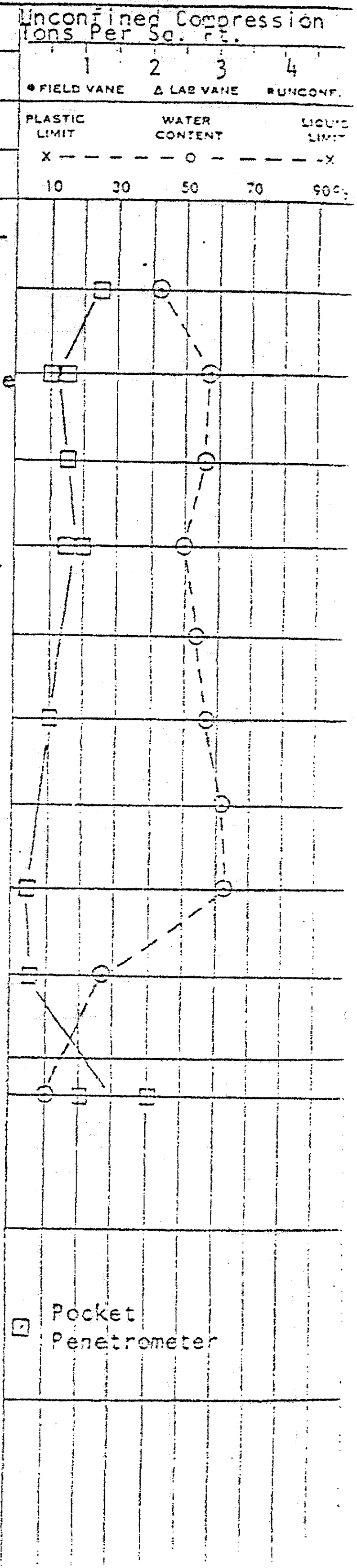
GLACIAL TILL - light grey color
- low to non-plastic clayey silt binder
- soft, wet
- pebbles to 3/4"

At 52' - Till becomes firm to stiff

52.0'

NOTES

1. No water.
2. No sloughing of test hole.
3. Hole discontinued at 52.0 ft depth. (Maximum Auger Depth).



Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

TEST HOLE LOG

DATE November 12, 1970

HOLE NO. 103

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	Bag		1
10			
13	2"Sy		2
15	Bag		
20	2"Sy		3
			4
25	Bag		5
30	2"Sy		6
35	Bag		7
40	2"Sy		8
45	Bag		9
50			10
52	Bag		

SYMBOL

DESCRIPTION OF MATERIAL

0.6' TOPSOIL - black, highly organic

4' to 5' SILT LAYER - tan color
- medium dense,
- low plastic
- moist

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist
- frequent small silt lumps and organic spots

18.5'

CLAY - dark grey
- highly plastic
- layered structure
- firm
- moist
- frequent small partings of silt & till-like material

At 22' - inclusions of decayed organic

42.5'

GLACIAL TILL - light grey
- low to medium plastic clayey silt binder
- stones to 2", soft, wet to saturated

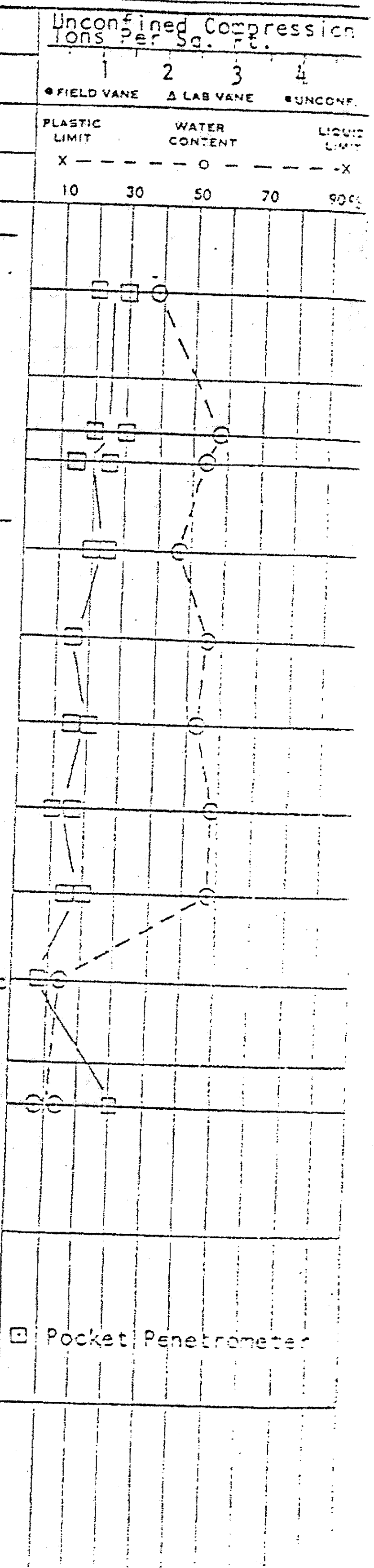
52.5' At 52.5' - becomes hard & moist

NOTES

1. No water.

2. No sloughing of test hole.

3. Hole discontinued at 52.5 ft depth in glacial till.



Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT

SOUTH END POLLUTION CONTROL CENTRE

LOCATION

WINNIPEG, MANITOBA

DATE November 12, 1970

TEST HOLE LOG

HOLE NO. 104

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	Bag		1
10	2"Sy		2
15	Bag		3
20	2"Sy		4
25	Bag		5
30	2"Sy		6
35	Bag		7
40	2"Sy		8
47	Bag		9
50			
52	Bag		10

SYMBOL

DESCRIPTION OF MATERIAL

TOPSOIL - black, highly organic

1.0'

3' to 4' SILT LAYER - tan color, low plastic, clayey - wet, soft

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm, moist
- occasional partings of silt and gypsum crystals

23.0'

CLAY - dark grey
- highly plastic
- soft to firm
- damp
- occasional partings of non-plastic silt & till-like material
- some pebbles to ¼"

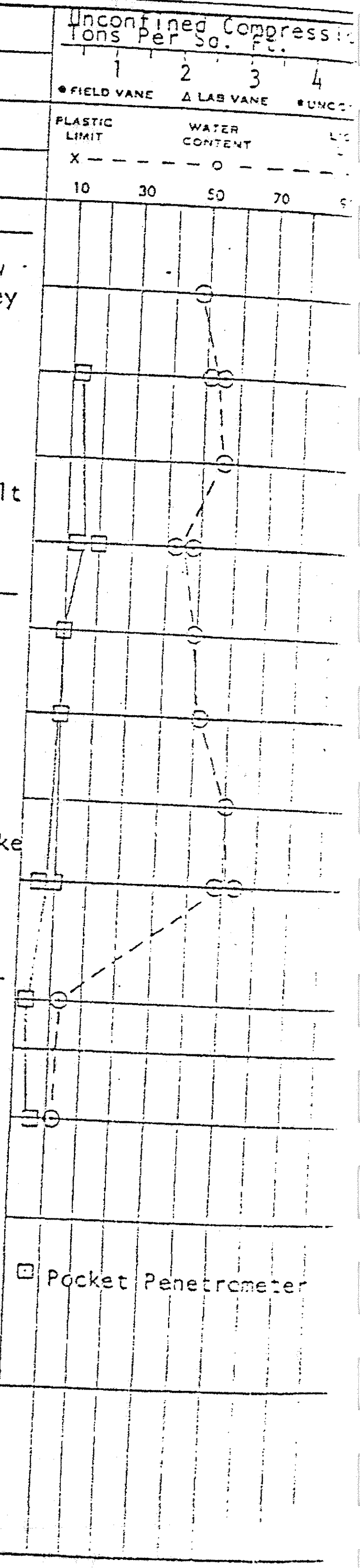
46.0'

GLACIAL TILL - light grey color
- low to medium plastic
- clayey silt binder
- soft, wet
- stones to 1½"

52.0'

NOTES

1. No water.
2. No sloughing of test hole.
3. Hole discontinued at 52.0 ft depth (maximum auger depth) in soft glacial till.



Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

TEST HOLE LOG

DATE December 12, 1970

HOLE NO. 105

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

SAMPLE DATA			
WEIGHT HAMMER			
HEIGHT DROP			
DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	2"Sy		1
10	Bag		2
15	2"Sy		3
20	Bag		4
25	2"Sy		5
30	Bag		6
35	2"Sy		7
40	Bag		8
45	2"Sy		9
50			10
52.5	Bag		

SYMBOL

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist
- occasional partings of silt and of gypsum crystals

At 5' - numerous seams of tan silt

30.0' CLAY - dark grey
- highly plastic
- layered structure
- soft to firm
- damp to wet
- occasional small partings of silt & till-like material

42.5' GLACIAL TILL - light grey color,
- low to medium plastic clayey silt binder, soft, wet
- pebbles to 3/4"

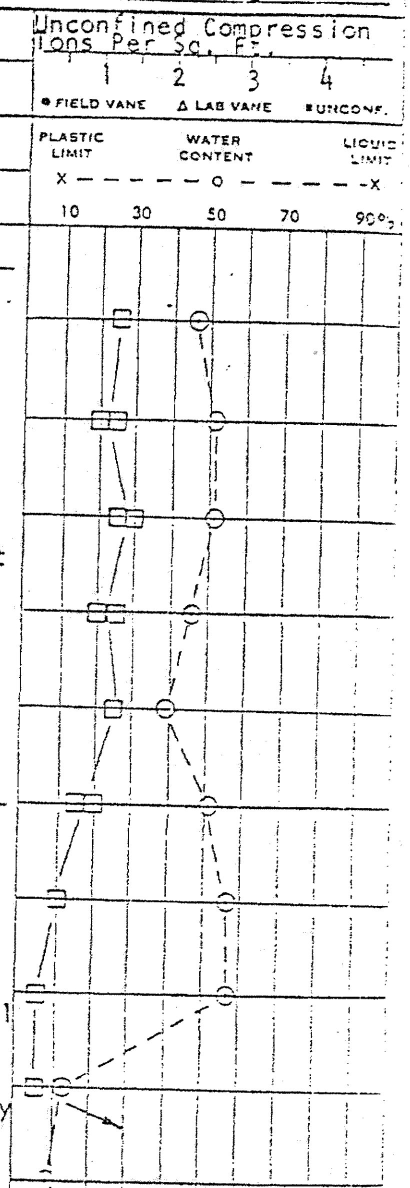
At 47' to 48' - till is pinkish in color.

At 52' - till becomes hard, moist

52.5'

NOTES

1. No water.
2. No sloughing of test hole.
3. Hole discontinued at 52.5 ft in hard Glacial Till.



⊡ Pocket Penetrometer

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

TEST HOLE LOG

DATE December 1, 1970

HOLE NO. 106

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

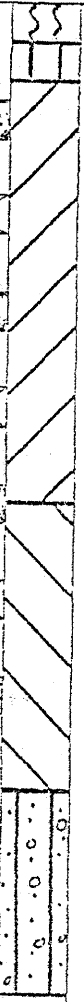
ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH / ELEV.	O.D. / I.D.	BLOWS / FT.	NO.
5	Bag		1
10	2"Sy		2
15	Bag		3
20	2"Sy		4
25	Bag		5
30	2"Sy		6
35	Bag		7
40	2"Sy		8
45	Bag		9
50			10
52	Bag		

SYMBOL



DESCRIPTION OF MATERIAL

TOPSOIL - black, highly organic

1.0'

1' to 3.5' SILT LAYER - tan, low plastic

- medium dense
- wet, soft,

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist

From 20' - occasional partings of non-plastic silt.

26.0'

CLAY - dark grey
- highly plastic
- layered structure
- soft to firm
- moist to damp

At 40' - frequent partings of non-plastic silt and of till-like material

41.0'

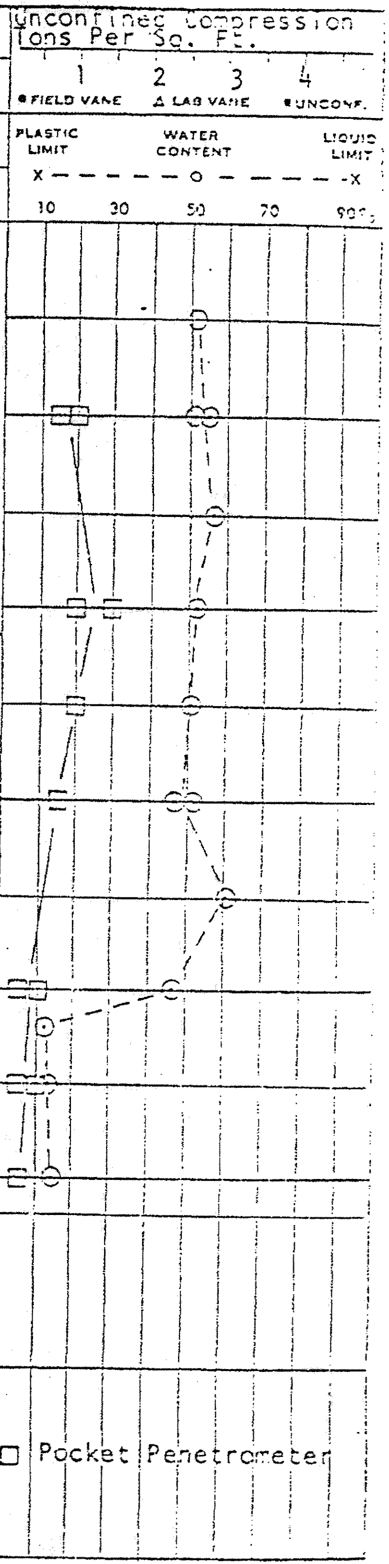
GLACIAL TILL - light grey color
- medium plastic clayey silt binder, pebbles to 3/4"
- soft, wet

At 45' - inclusions of dark grey clay as above

52.0'

NOTES

1. No water.
2. No sloughing of test hole.
3. Hole discontinued at 52.0 ft depth in soft Glacial Till.



Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

RKL 67-3

PLATE NO. A-K-580-3

TEST HOLE LOG

DATE December 1, 1970

HOLE NO. 107

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH / ELEV.	O.D. / I.D.	BLOWS / FT.	NO.
5	2"Sy		1
10	Bag		2
15	2"Sy		3
20	Bag		4
25	2"Sy		5
30	Bag		6
35	2"Sy		7
40	Bag		8
45			
47	Bag		9
50	Bag		10

SYMBOL

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

3' to 5' SILT LAYER - tan, low plastic
- soft, damp

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist

At 5' - clay is nuggetty textured
At 15' - occasional partings of non-plastic silt & of gypsum crystals

24.0'

CLAY - dark grey
- highly plastic
- layered structure
- soft to firm
- damp
- occasional partings of non-plastic silt

45.0'

GLACIAL TILL - light grey color
- medium plastic
- clayey, silt binder
- soft, wet
- stones to 1½"

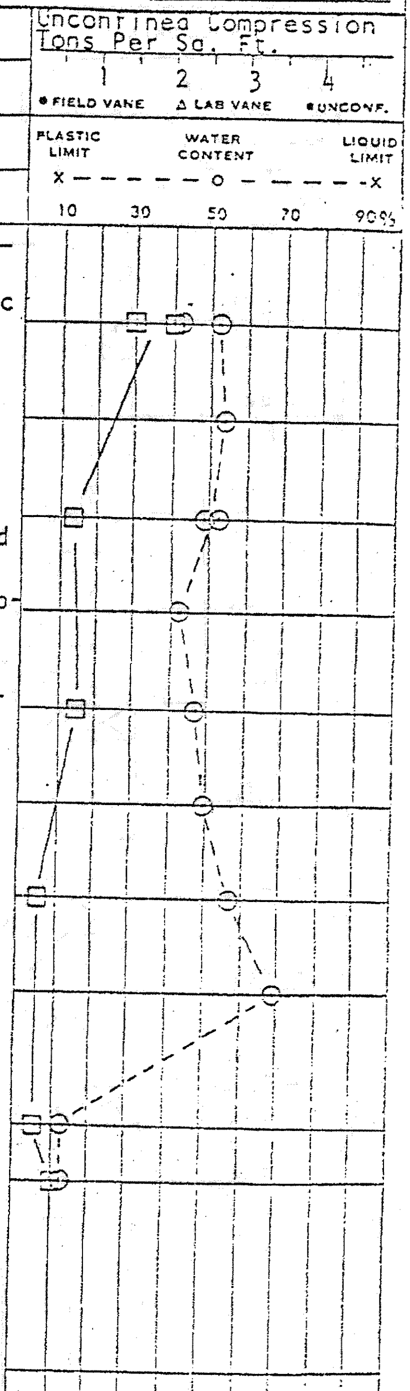
52.0'

NOTES

1. No water.

2. No sloughing of test hole.

3. Hole discontinued at 52.0 ft depth in soft Glacial Till.



⊡ Pocket Penetrometer

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT
SOUTH END POLLUTION CONTROL CENTRE

LOCATION
WINNIPEG, MANITOBA

DATE December 1, 1970

TEST HOLE LOG

HOLE NO. 108

SAMPLE DATA	ELEV. COLLAR
WEIGHT HAMMER	ELEV. GROUND
HEIGHT DROP	CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	2"Sy		1
10	Bag		2
15	2"Sy		3
20	Bag		4
25	2"Sy		5
30	Bag		6
35	2"Sy		7
40	Bag		8
45	2"Sy		9
50	Bag		10

SYMBOL

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

3' to 5' SILT LAYER - tan, low plastic
- soft, damp to wet

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist
- occasional partings of non plastic silt

At 5'- clay has nuggetty texture

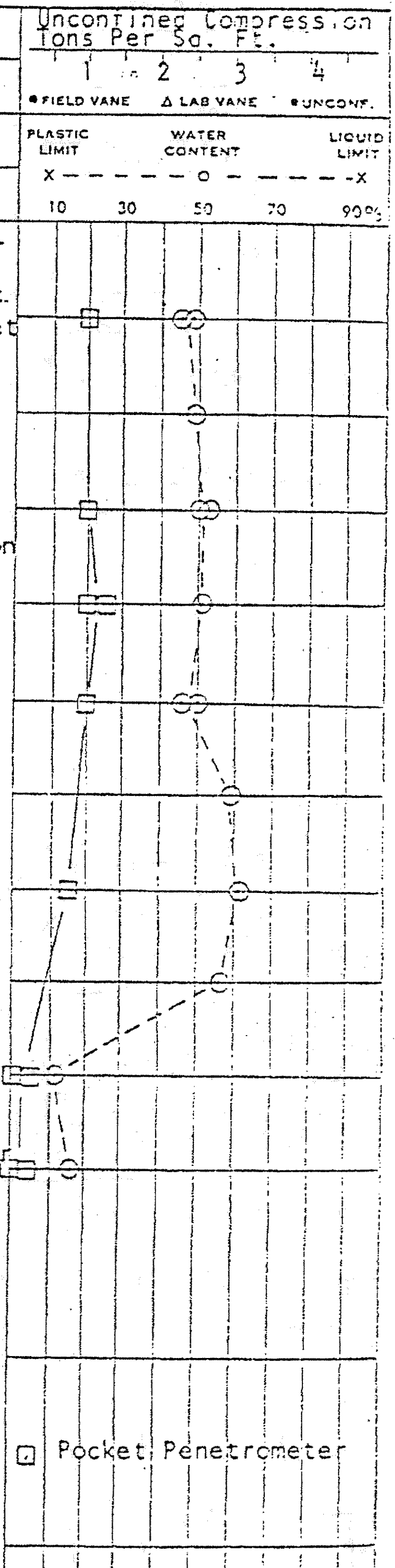
23.0' CLAY - dark grey
- highly plastic
- layered structure
- firm
- damp to wet
- occasional partings of non-plastic silt & of till-like material

44.0' GLACIAL TILL - light grey color
- medium plastic clayey silt binder
- soft, wet
- pebbles to 3/4"

52.0'

NOTES

1. No water.
2. No sloughing of test hole.
3. Hole discontinued at 52.0 ft depth in soft, wet, Glacial Till.



Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

RKL 67-3

TEST HOLE LOG

DATE December 2, 1970

HOLE NO. 109

ELEV. COLLAR

RIG: Power Auger

ELEV. GROUND

TECHNICIAN: J. Adams

CO-ORD. LOCATION

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	2"Sy		1
10	Bag		2
15	2"Sy		3
20	Bag		4
25	2"Sy		5
30	Bag		6
35	2"Sy		7
40	Bag		8
45	Bag		9
50	Bag		10

SYMBOL

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

3' to 5' SILT LAYER - tan, low plastic
- soft, damp to wet

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist
- frequent small partings of non-plastic silt

27.0'

CLAY - dark grey
- highly plastic
- layered structure
- firm
- damp
- numerous small partings of non-plastic silt & of till like material

47.0'

GLACIAL TILL - light grey color
- medium plastic
- clayey silt binder
- soft, wet

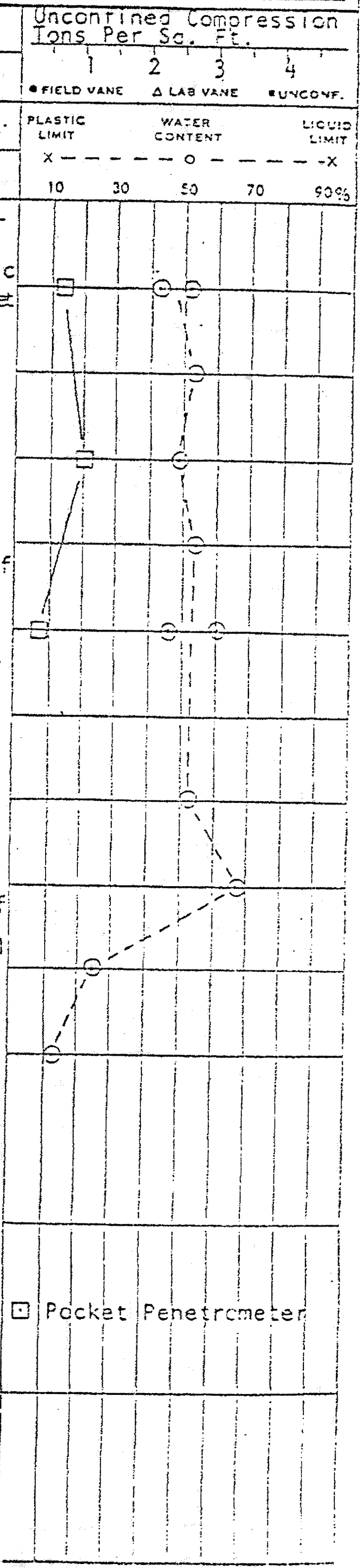
51.5'

NOTES

1. No water.

2. No sloughing of test hole.

3. Refusal on boulder at 51.5 ft depth in soft Glacial Till.



Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

DATE December 2, 1970

TEST HOLE LOG

HOLE NO. 110

SAMPLE DATA
WEIGHT HAMMER
HEIGHT DROP
ELEV. COLLAR
ELEV. GROUND
CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	Bag		1
10	2"Sy		2
15	Bag		3
20	2"Sy		4
25	Bag		5
30	2"Sy		6
35	Bag		7
40	2"Sy		8
45	Bag		9
50	Bag		10
52	Bag		11

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

2' to 3' SILT LAYER - tan, low plastic
- soft, damp to wet

CLAY - mottled brown & grey
- highly plastic
- layered structure
- stiff
- moist
- frequent partings of non-plastic silt & gypsum crystals

At 21' - odd ½" silt seam, tan
- non-plastic

24.0'

CLAY - dark grey
- highly plastic
- layered structure
- firm
- damp
- frequent small partings of till-like material.

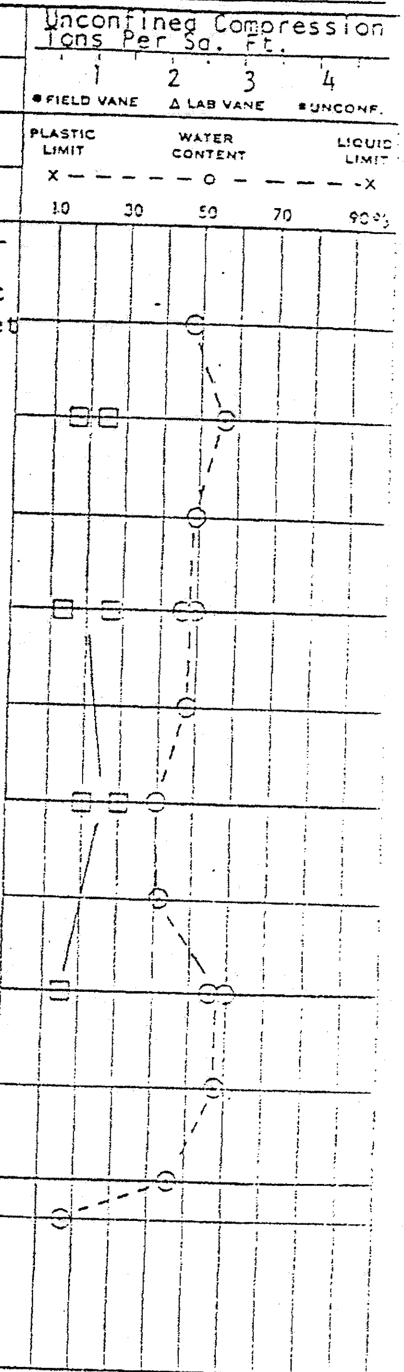
50.0'

GLACIAL TILL - light grey color
- medium plastic clayey-silt binder, soft
- wet

52.0'

NOTES

1. No water.
2. No sloughing of test hole.
3. Refusal on boulder at 52.0 ft depth in soft Glacial Till.



⊡ Pocket Penetrometer

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE
LOCATION WINNIPEG, MANITOBA

RKL 67

DATE December 2, 1970

TEST HOLE LOG

HOLE NO. 111

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	2"Sy		1
10	Bag		2
15	2"Sy		3
20	Bag		4
25	2"Sy		5
30	Bag		6
35	2"Sy		7
40	Bag		8
45	2"Sy		9
50	Bag		10
52	Bag		
53	Bag		11,12 13

SYMBOL

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

5' to 6' SILT LAYER - tan, low to non-plastic
- soft, damp

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist
- frequent small partings of non-plastic silt and of gypsum crystals

25.0'

CLAY - dark grey
- highly plastic
- layered structure
- firm
- moist to damp
- frequent small partings of till-like material

51.0'

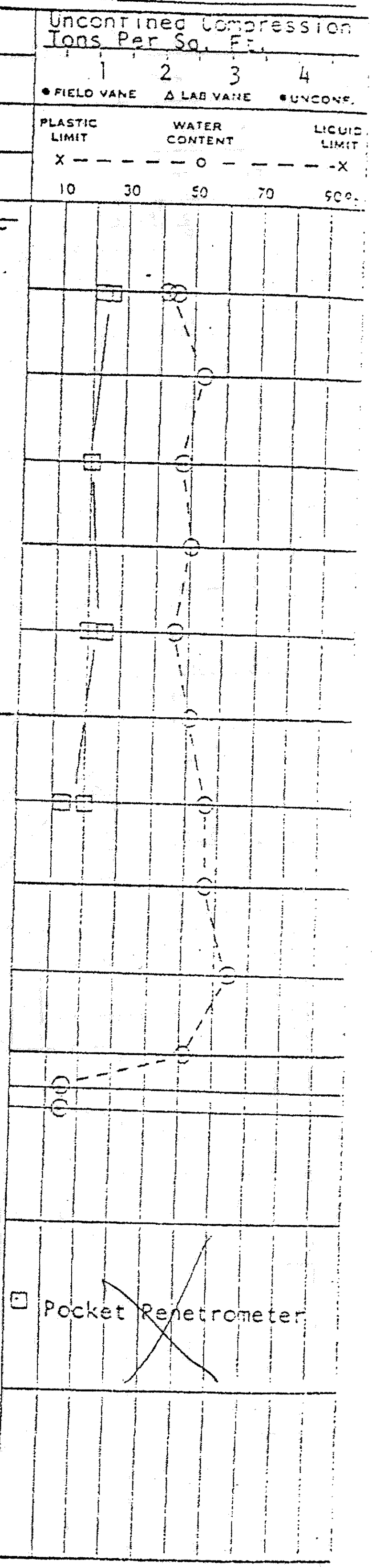
GLACIAL TILL
- light grey, medium plastic, clayey, silt binder, soft, wet

At 53' - becomes drier & dense

53.0'

NOTES

1. No water.
2. No sloughing of test hole.
3. Refusal at 53.0 ft depth on boulder in dense Glacial Till.



Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

RKL 67-3

PLATE NO A-W-580-

TEST HOLE LOG

DATE December 2, 1970

HOLE NO. 112

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	Bag		1
10	2"Sy		2
15	Bag		3
20	2"Sy		4
25	Bag		5
30	2"Sy		6
35	Bag		7
40	2"Sy		8
45	Bag		9
50			

SYMBOL

DESCRIPTION OF MATERIAL

TOPSOIL - black, highly organic

1.0'

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist
- frequent small partings of non-plastic silt

27.0'

CLAY - dark grey
- highly plastic
- layered structure
- soft to firm
- occasional small partings of non-plastic silt

At 40' - numerous ½" seams of light grey Glacial Till pebbles to ¼"

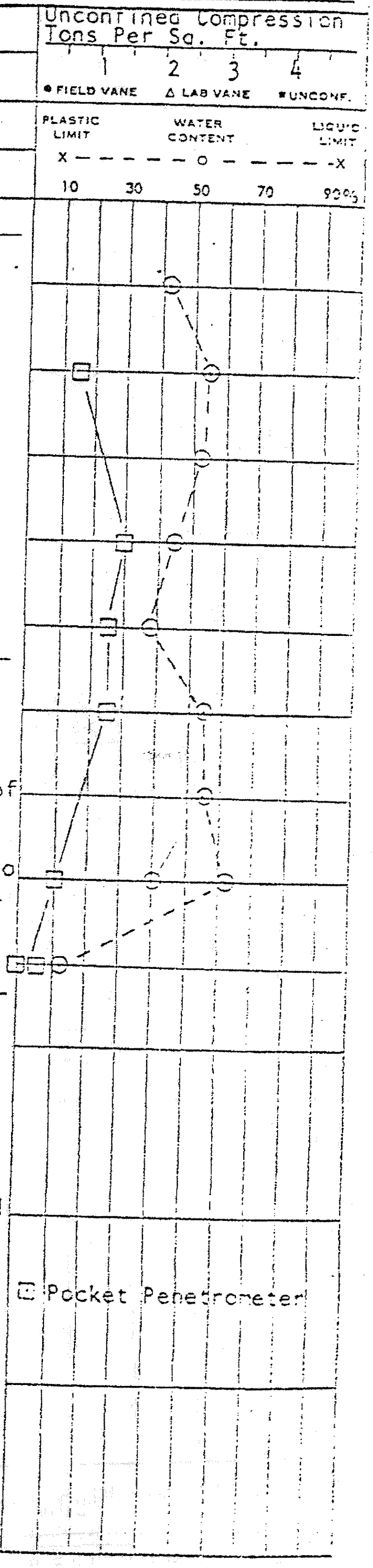
41.0'

GLACIAL TILL
- light grey color
- medium plastic, clayey-silt binder
- soft, wet to saturated
- pebbles to 3/4"

47.0'

NOTES

1. No water.
2. Sloughing experienced in Glacial Till from 41.0 ft depth.
3. Hole discontinued at 47.0 ft depth in Glacial Till (due to drill failure).



Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT
SOUTH END POLLUTION CONTROL CENTRE

LOCATION
WINNIPEG, MANITOBA

TEST HOLE LOG

DATE November 12, 1970

HOLE NO. 113

SAMPLE DATA				SYMBOL	
WEIGHT HAMMER					ELEV. COLLAR
HEIGHT DROP					ELEV. GROUND
					CO-ORD. LOCATION
DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.		DESCRIPTION OF MATERIAL
5	Bag		1		
10	2''Sy		2		
15	Bag		3		
20	2''Sy		4		
25	Bag		5		
30	2''Sy		6		
35	Bag		7		
40	2''Sy		8		
45	Bag		9		
50			10		
52.5	Bag				

0.5' TOPSOIL - black, highly organic

1.0' SILT - light grey
- moist
- loose, organic

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist
- occasional small partings of gypsum

From 1' to 7' - numerous seams of very fine, tan, silty, sand, wet to sat.

19.0' CLAY - dark grey
- highly plastic
- layered structure
- soft to firm, damp
- frequent small partings of of till-like material

At 45' - traces of organic material

47.0' GLACIAL TILL
- light grey
- medium plastic, clayey silt binder, soft, wet to saturated
- pebbles to ½''

52.5'

NOTES

1. Indication of water at 7.0 ft and at 47.0 ft depths.

2. Some sloughing of sand layer(s) at 7.0 ft depth.

3. Hole discontinued at 47.0 ft depth in soft Glacial Till.

Unconfined Compression Tons Per Sq. Ft.

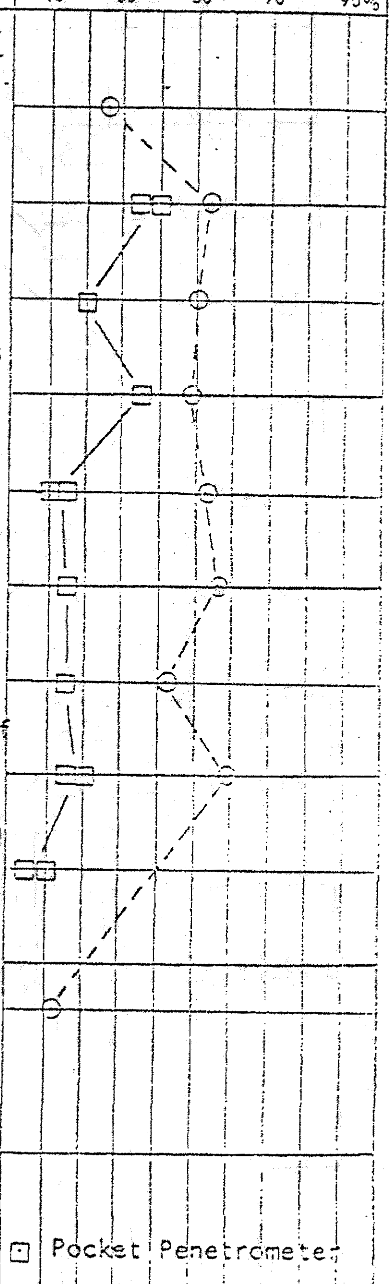
1 2 3 4

● FIELD VANE △ LAB VANE ■ UNCONF.

PLASTIC LIMIT WATER CONTENT LIQUID LIMIT

x – – – – – o – – – – – x

10 30 50 70 90%



Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG MANITOBA

TEST HOLE LOG

DATE November 13, 1970

HOLE NO. 114

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	2"Sy		1
10	Bag		2
15	2"Sy		3
20	Bag		4
25	2"Sy		5
30	Bag		6
35	2"Sy		7
40	Bag		8
45	2"Sy		9
50	Bag		10

SYMBOL

DESCRIPTION OF MATERIAL

TOPSOIL - black, highly organic

2.0'

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff, moist
- frequent small partings of non-plastic silt & of gypsum crystal
- rust stains & organic spots

At 4' - 5' - layer(s) of tan silt

26.0'

CLAY - dark grey, highly plastic
- layered structure
- soft to firm
- moist to damp
- frequent small partings of till-like material

42.0'

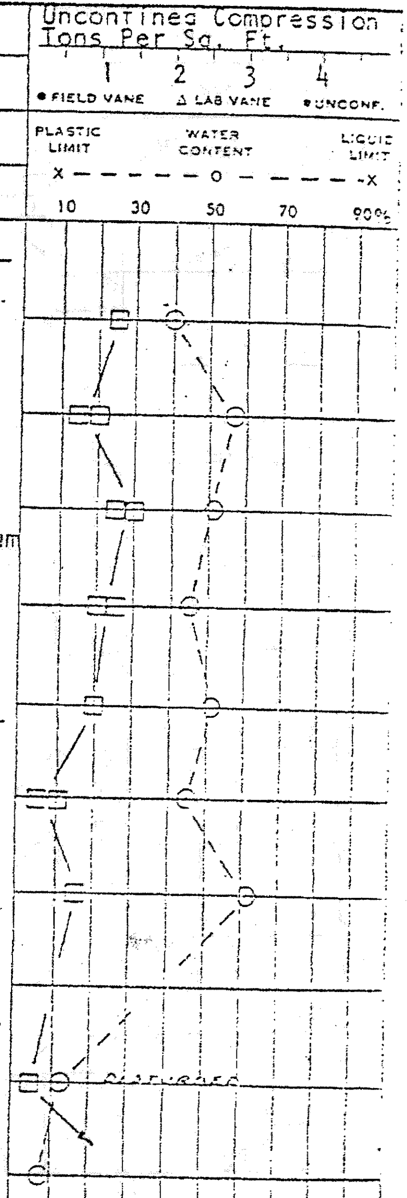
GLACIAL TILL - light grey, medium plastic, clayey silt binder
- soft, wet to saturated

At 46' - becomes drier & quite dense

50.0'

NOTES

1. No water.
2. No sloughing of test hole.
3. Refusal at 50.0 ft depth on boulders on dense Glacial Till.



⊡ Pocket Penetrometer

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS

PROJECT
SOUTH END POLLUTION CONTROL CENTRE

LOCATION

DATE December 18, 1970

TEST HOLE LOG

HOLE NO. 115

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	2"Sy		1
10	Bag		2
15	2"Sy		3
20	Bag		4
25	2"Sy		5
30	Bag		6
35	2"Sy		7
40	Bag		8
45	2"Sy		9
50			
52.5	Bag		10

SYMBOL

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

4.0' CLAY - grey, silty, organic
- medium to highly plastic
- firm, nuggetty

CLAY - mottled brown & grey
- highly plastic
- laminated structure
- stiff
- silt lumps
- nuggetty to 10 ft

At 20' - small spots of weathered rock

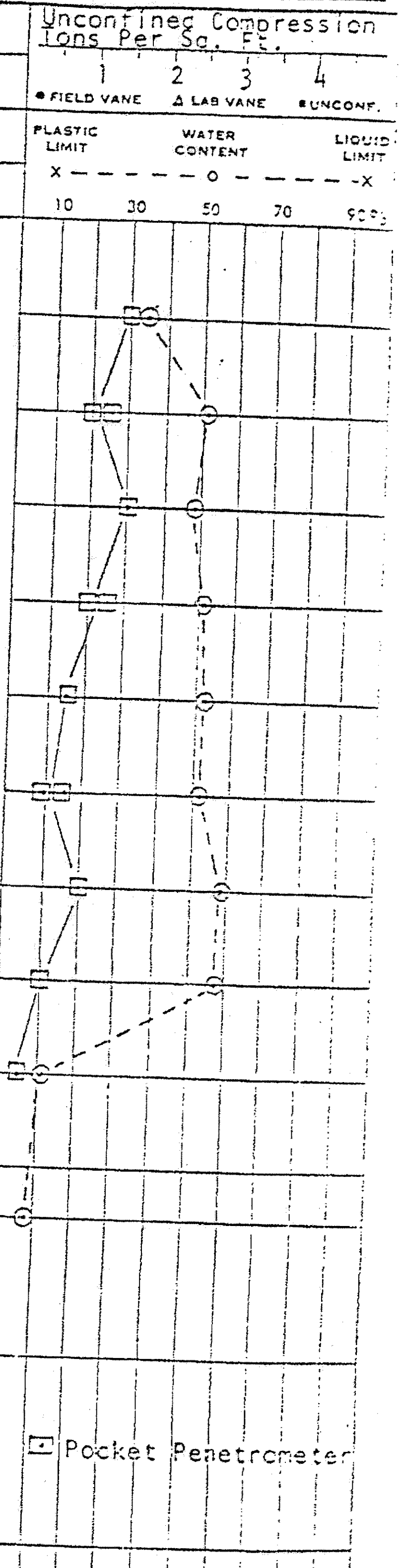
23.0' CLAY - grey
- highly plastic
- laminated structure
- firm to stiff
- odd silt lump
- occasional spots of weathered rock

42.0' GLACIAL TILL - light grey
- medium plastic
- soft to firm to dense
- till becomes dryer & harder at 51.0 ft depth
- pebbles to 3/4"

52.5'

NOTES

1. Hole terminated at 52.5 ft depth in till.
2. No free water encountered.
3. No sloughing.



Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT

SOUTH END POLLUTION CONTROL CENTRE

LOCATION

WINNIPEG, MANITOBA

HAL 67-3

TEST HOLE LOG

DATE December 18, 1970

HOLE NO. 116

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	2"Sy		1
10	Bag		2
15	2"Sy		3
20	Bag		4
25	2"Sy		5
30	Bag		6
35	2"Sy		7
40	Bag		8
45	2"Sy		9
50			
52.5	Bag		10

SYMBOL

DESCRIPTION OF MATERIAL

TOPSOIL - black, highly organic medium plastic

1.0'

CLAY - grey, silty, organic
- medium plastic, moist

4.0'

5.0'

SILT - tan, moist
- non-plastic

CLAY - mottled brown & grey
- highly plastic
- firm to stiff
- laminated structure
- silt lumps

At 10' - large spots of weathered rock

At 20' - rust spots

25.0'

CLAY - grey
- highly plastic
- laminated structure
- silt lumps
- occasional small pebbles
- firm to soft

44.0'

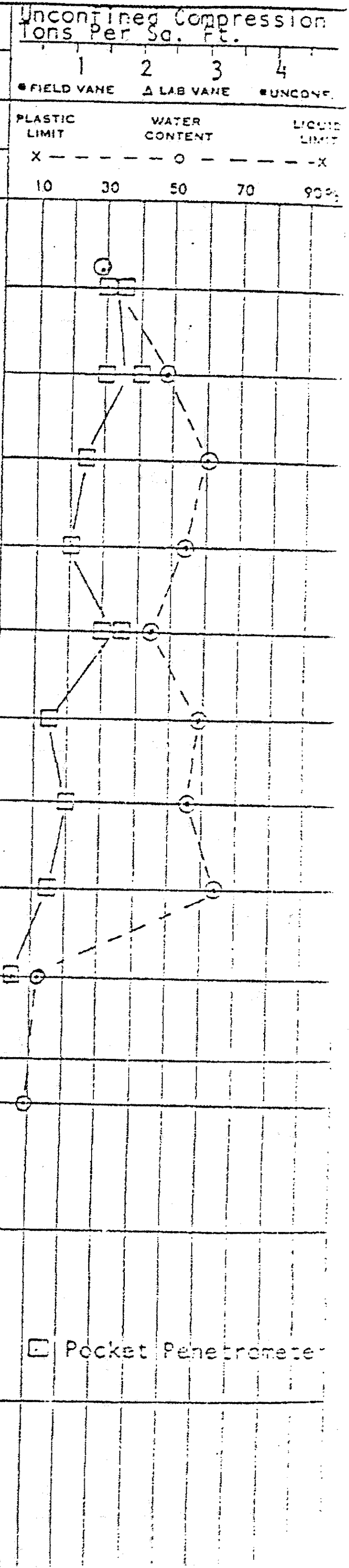
GLACIAL TILL - light grey
- medium plastic
- soft to firm

At 52' - till becomes stiff to hard

52.5'

NOTES

1. No water encountered.
2. No sloughing.
3. Hole terminated at 52.5 ft depth in till.



Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

TEST HOLE LOG

DATE December 18, 1970

HOLE NO. 117

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

SYMBOL

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	Bag		1
10	2"Sv		2
15	Bag		3
20	2"Sv		4
25	Bag		5
30	2"Sv		6
35	Bag		7
40	2"Sv		8
45	Bag		9
50			
51.5	Bag		10

DESCRIPTION OF MATERIAL

TOPSOIL - black, highly organic wet

1.0'

CLAY - grey, nuggetty, wet organic

4.0'

SILT - grey & tan mixture
- rust spots
- low to non-plastic

6.0'

CLAY - mottled brown & grey
- highly plastic
- laminated structure
- firm to stiff
- silt lumps
- odd small spots of weathered rock and gypsum at 15.0 ft
- numerous thin silt seams at 21.0 ft depth

26.0'

CLAY - grey
- highly plastic
- laminated structure
- firm to soft
- occasional silt lumps and pebbles

47.0'

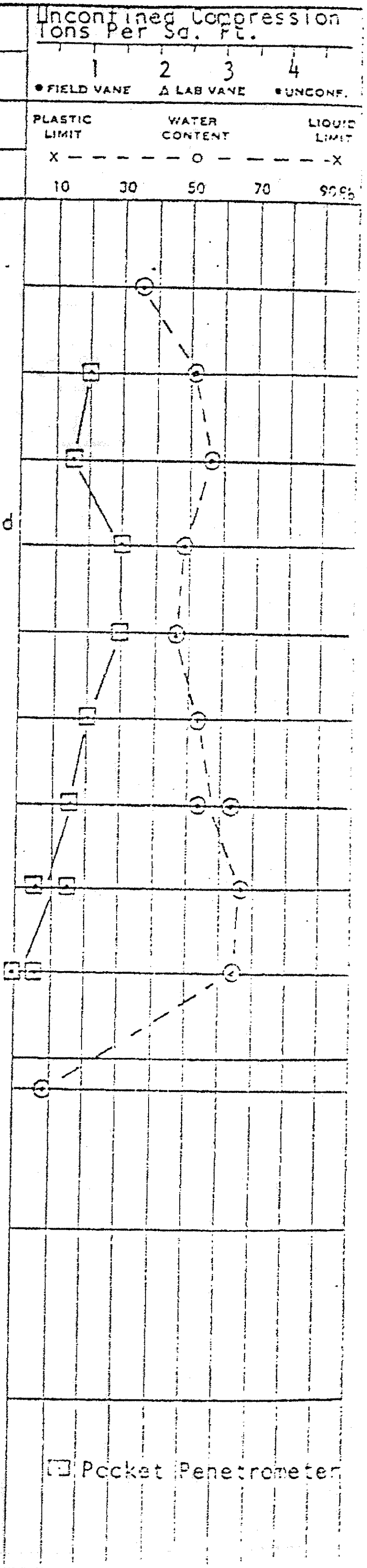
GLACIAL TILL - light grey
- medium plastic
- soft to firm

At 51' - till is dryer & more dense
- stones to 4"

52.5'

NOTES

1. No free water.
2. No sloughing.
3. Hole terminated on boulders at 52.5 ft depth.



Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

TEST HOLE LOG

DATE December 9, 1970

HOLE NO. 217

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

Unconfined Compression Tons Per Sq. Ft.

1 2 3 4

● FIELD VANE △ LAB VANE ■ UNCONF.

PLASTIC LIMIT X — WATER CONTENT O — LIQUID LIMIT X

10 30 50 70 90%

DEPTH / ELEV	O.D. / I.D.	BLOWS / FT.	NO.
5	Bag		1
10	Bag		2
15	Bag		3
20	Bag		4
25	Bag		5
30	Bag		6

SYMBOL

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

CLAY - mottled brown & grey

- highly plastic
- layered structure
- firm to stiff
- moist

26.0' CLAY - dark grey, highly plastic

- layered structure
- firm
- moist to damp

30.0'

NOTES

1. No water.
2. No sloughing of test hole.
3. Hole discontinued at 30.0 ft depth in firm grey clay.

☐ Pocket Penetrometer

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT
SOUTH END POLLUTION CONTROL CENTRE

LOCATION
WINNIPEG, MANITOBA

TEST HOLE LOG

DATE December 13, 1970

HOLE NO. 218

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

Unconfined Compress
Tons Per Sq. Ft.

1 2 3 4

● FIELD VANE △ LAB VANE ● UNC

PLASTIC LIMIT WATER CONTENT L

X — — — — — O — — — —

10 30 50 70

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	2"Sy		1
10	Bag		2
15	2"Sy		3
20	Bag		4
25	2"Sy		5
30	Bag		6
35	2"Sy		7
40	Bag		8
45	2"Sy		9
50	Bag		10

SYMBOL

DESCRIPTION OF MATERIAL

TOPSOIL - black, highly organic

1.0 SILT - tan, non-plastic
- loose
- saturated

5.0

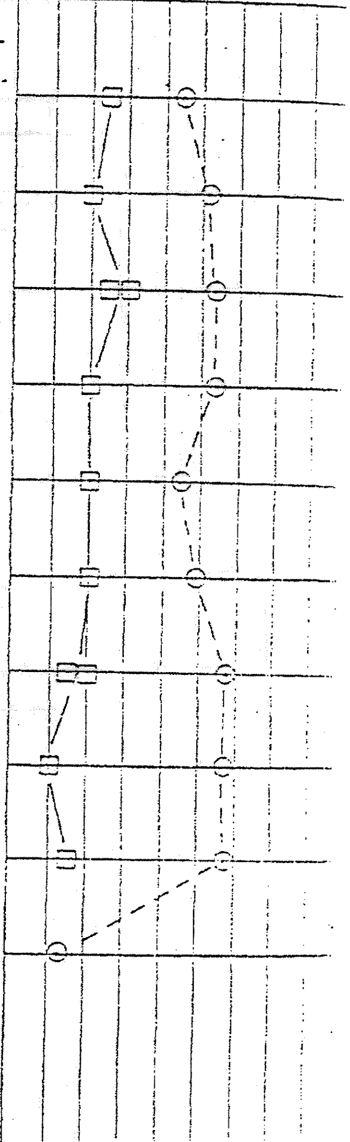
CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist
- occasional small partings of non-plastic silt

23.0

CLAY - dark grey
- highly plastic
- firm
- damp to wet
- frequent small partings of till-like material

50.0 GLACIAL TILL - light grey
- medium plastic
- clayey silt binder
- soft to firm
- wet

52.5



NOTES

1. Water at 5.0 ft in silt layer.
2. Sloughing of silt from 1.0 ft to 5.0 ft level.
3. Hole discontinued at 52.5 ft dpeth in soft Glacial Till.

☐ Pocket Penetromete

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT
SOUTH END POLLUTION CONTROL CEN

LOCATION
WINNIPEG, MANITOBA

RKL 67-3

PLATE NO.

TEST HOLE LOG

DATE December 21, 1970

HOLE NO. 219

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

DEPTH / ELEV.	O.D. / I.D.	BLOWS / FT.	NO.
5	Bag		1
10	2"Sy		2
15	Bag		3
20	2"Sy		4
25	Bag		5
30	2"Sy		6
35	Bag		7
40			

SYMBOL

DESCRIPTION OF MATERIAL

TOPSOIL - black, highly organic

1.0'

SILT - tan, wet to saturated
- non-plastic

4.0'

CLAY - mottled brown & grey
- highly plastic
- laminated structure
- stiff to firm
- silt lumps
- occasional gypsum inclusions

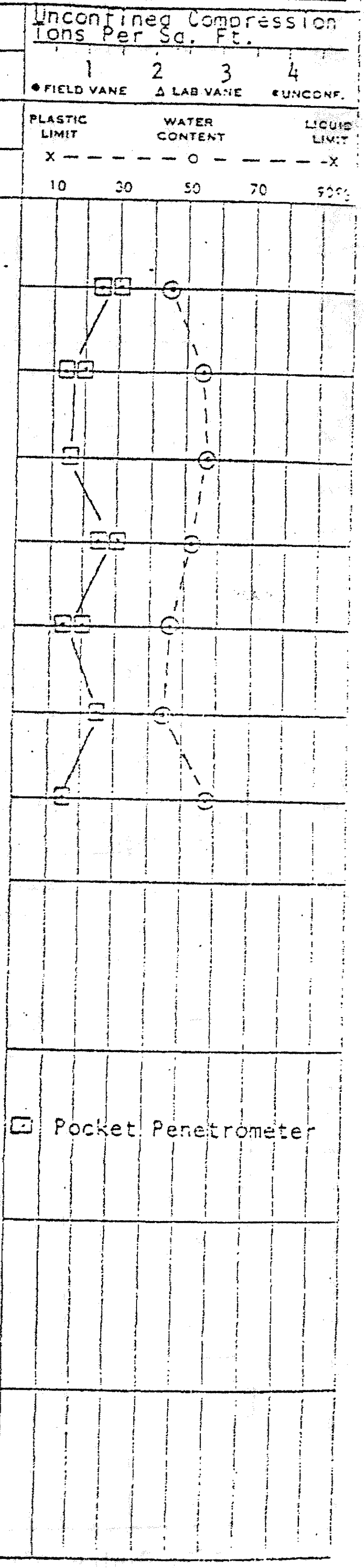
20.0'

CLAY - grey
- highly plastic
- laminated structure
- firm
- silt lumps & inclusions

35.0'

NOTES

1. Hole terminated at 35.0 ft depth in clay.
2. No free water encountered.
3. No sloughing.



Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT
SOUTH END POLLUTION CONTROL CENTRE

LOCATION
WINNIPEG, MANITOBA

RKL 67-3

A-W-580-

TEST HOLE LOG

DATE December 8, 1970

HOLE NO. 220

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

SYMBOL

Unconfined Compression Tons Per Sq. Ft.

1 2 3 4

● FIELD VANE △ LAB VANE * UNCONF.

PLASTIC LIMIT X — — — WATER CONTENT O — — — LIQUID LIMIT -X

10 30 50 70 90%

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	Bag		1
10	2"Sy		2
15	Bag		3
20	2"Sy		4
25	Bag		5
30	2"Sy		6

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

6' to 8' SILT LAYER - tan, low plastic
- soft, wet

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm
- moist
- frequent small partings of non-plastic silt

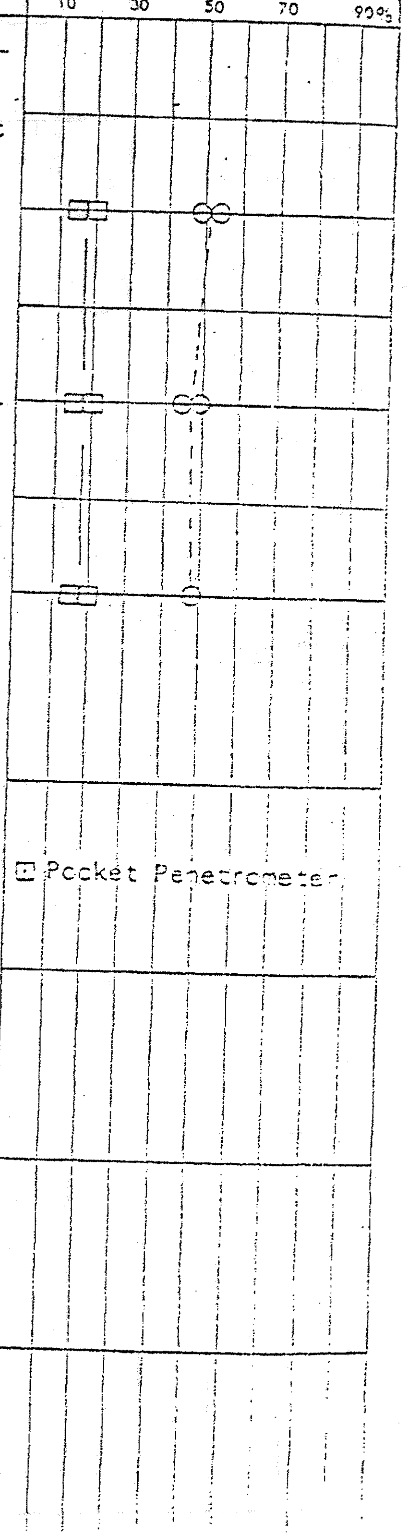
20.0'

CLAY - dark grey
- highly plastic
- layered structure
- firm, moist
- frequent small partings of non-plastic silt & of till-like material

31.5'

NOTES

1. No water.
2. No sloughing of test hole.
3. Hole discontinued at 31.5 ft depth in grey clay



Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT
SOUTH END POLLUTION CONTROL CENTRE

LOCATION
WINNIPEG, MANITOBA

TEST HOLE LOG

DATE January 15, 1971

HOLE NO. 221

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

SAMPLE DATA			
WEIGHT HAMMER			
HEIGHT DROP			
DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
5	Bag		1
10	3"Sy		2
15	Bag		3
20	3"Sy		4
25	Bag		5
30	3"Sy		6
35	Bag		7
40	3"Sy		8
45	Bag		9

SYMBOL

DESCRIPTION OF MATERIAL

1.0' TOPSOIL - black, highly organic

7'-9' SILT - tan, medium dense, damp

CLAY - mottled brown & grey
- highly plastic
- layered structure
- firm to stiff
- moist

At 18' - partings of white gypsum crystals

23.0'

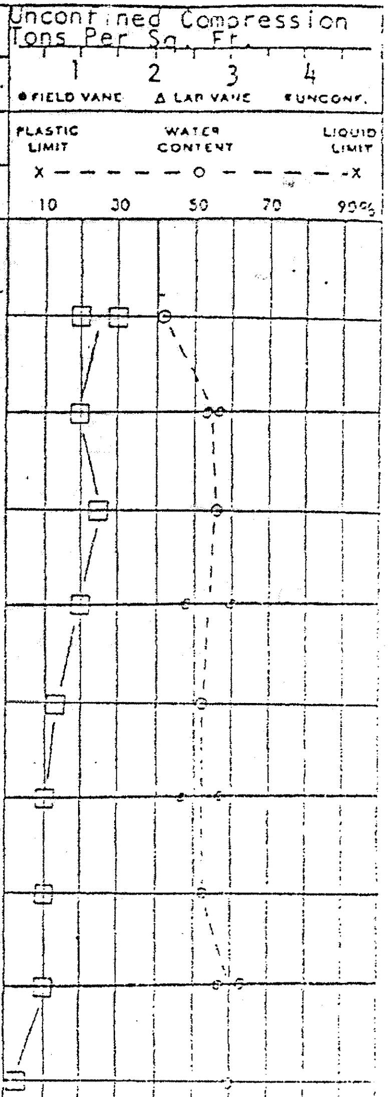
CLAY - dark grey
- highly plastic
- layered structure
- soft to firm
- damp to wet
- numerous small partings of light grey till-like material
- frequent silt lumps to 1/2 inch

45.0'

NOTES

1. Hole discontinued at 45.0 ft depth in grey clay.

2. No water. No sloughing.



⊡ Pocket Penetrometer

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

Plate No. A-W-SPC-23

TEST HOLE LOG

DATE December 24, 1970

HOLE NO. T.C. 1

SAMPLE DATA				SYMBOL	
WEIGHT HAMMER					ELEV. COLLAR RIG: Acker
WEIGHT DROP					ELEV. GROUND TECHNICIAN: J. Adams
DEPTH / ELEV.	O.D. / I.D.	BLOWS / FT.	NO.		CO-ORD. LOCATION

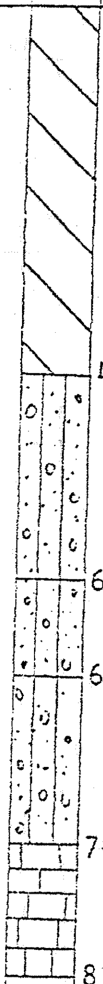
COHESION – TONS/SQ. FT.: 0.2 0.6 1.0 1.4 1.8 ● FIELD VANE △ LAB VANE ✱ UNCONF.

PLASTIC LIMIT X – – – – – WATER CONTENT O – – – – – LIQUID LIMIT –X

10 30 50 70 90%

DESCRIPTION OF MATERIAL

Depth: 40, 50, 60, 70, 80



OVERBURDEN

49.0' TILL-LIKE - till
- light grey
- soft

60.0' TILL-LIKE - light grey
- firmer than above

65.0' GLACIAL TILL - light grey
- hard
- cuttings were mostly light grey fine sands

74.0' LIMESTONE - 74' to 77' very solid
- 77' to 79' softer lime stone, loss of water from pump

81.0' 79'-81' - very solid limestone

NOTES

1. Auger refusal at 65.0 ft depth
2. Tricone used 65.0 - 81.0 ft depth.
3. Complete water loss below 77 ft depth.

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

RKL 47-3

PLATE No. A-W-580-

TEST HOLE LOG

DATE December 24, 1970

HOLE NO. T.C. 2

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

SYMBOL

ELEV. COLLAR RIG: Acker

ELEV. GROUND TECHNICIAN: J. Adams

CO-ORD. LOCATION

COHESION – TONS/SQ. FT.

0.2 0.6 1.0 1.4 1.8

● FIELD VANE △ LAB VANE ■ UNCONF.

PLASTIC LIMIT X – – – – – – WATER CONTENT O – – – – – – LIQUID LIMIT X

10 30 50 70 90%

DEPTH FEET	O.D. I.D.	BLOWS FT.	NO.
40			
50			
60			
70			

DESCRIPTION OF MATERIAL

OVERBURDEN - See Test Bore #111

50.0'

TILL-LIKE - light grey
- soft
- auger refusal at 60.5'

60.5'

LIMESTONE -
- 60.5' to 62.0' solid limestone
- 62.0' to 63.0' layer of softer broken limestone
- 63.0' to 63.5' solid limestone
- 63.5' to 65.0' broken limestone
- 65.0' to 68.0' solid limestone

68.0'

NOTES

1. Water circulated into hole was lost.

2. End of hole. At 68.0 ft was in limestone.

Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANIC & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

TITLE: REPORT ON INSTALLATION OF TEST CAISSONS AT SOUTH END POLLUTION CONTROL CENTRE T.P.

LOCATION: WINNIPEG, MANITOBA

CLIENT: W. L. WARDROP & ASSOCIATES LTD.

JOB NO: W - 619 DATE: March 24, 1971

Ripley, Klohn & Leonoff International Ltd.

SHEET 1 of 2

TEST HOLE LOG

DATE March 4, 1971

HOLE NO. Test Caisson #1

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR TECH: J. Odermatt

ELEV. GROUND RIG: Williams Auger

CO-ORD. LOCATION 8+20S & 57+88E

Unconfined Compression Tons Per Sq. Ft. 1 2 3 4

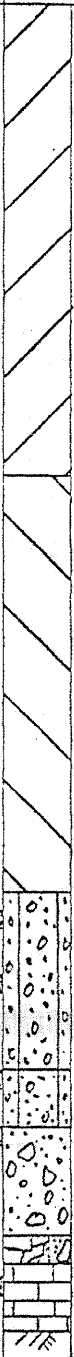
● FIELD VANE Δ LAB VANE ■ UNCONF.

PLASTIC LIMIT X — WATER CONTENT O — LIQUID LIMIT X

10 30 50 70 90%

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
10			
20			
30			
40			
50	Bag		1
	Bag		2
	Bag		3
60	Bag		4
70	Bag		5

SYMBOL



DESCRIPTION OF MATERIAL

CLAY - mottled brown & grey
- highly plastic
- layered structure

25.0'

CLAY - grey
- highly plastic
- layered structure

47.5'

TILL-LIKE MATERIAL
- light grey, very sandy
- silt binder
- soft & wet, clayey
- some cobbles & some sand layers or pockets

57.0'

GLACIAL TILL - light tan
- very sandy dilates
- soft cobbles
- very little silt binder

60.0'

GRAVEL - sandy with angular broken limestone (less than 18 inches dia.)

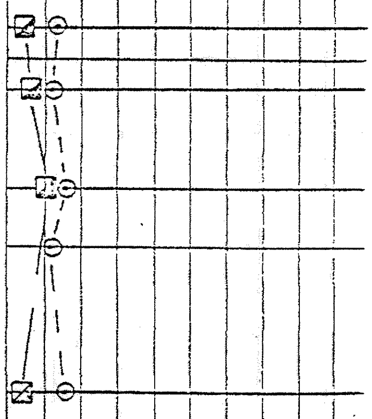
66.0'

67.5'

LIMESTONE - hard, broken
- fractured, sand & gravel inclusions

71.0'

LIMESTONE - hard, sound rock
- competent rock



▨ Pocket Penetrometer Disturbed Sample

Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

SHEET 2 OF 2

TEST HOLE LOG

DATE [illegible] 1971

HOLE NO. Test Caisson #1

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

COHESION – TONS/SQ. FT.

0.2 0.6 1.0 1.4 1.8

● FIELD VANE △ LAB VANE ■ UNCONF.

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT

X — — — — — O — — — — — X

10 30 50 70 90%

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.	SYMBOL	DESCRIPTION OF MATERIAL

NOTES

1. Signs of free water at 48.5 ft.
2. Water inflow very rapid at 54.0 ft
3. In five minutes water rose to a depth of 34.0 ft below ground level.
4. Hole caved at 54.0 ft (to a depth of 51.0 ft).
5. End of hole in limestone at 71.0 ft.
6. Water inflow measured at 60 gpm during attempts to dewater the caisson.

Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

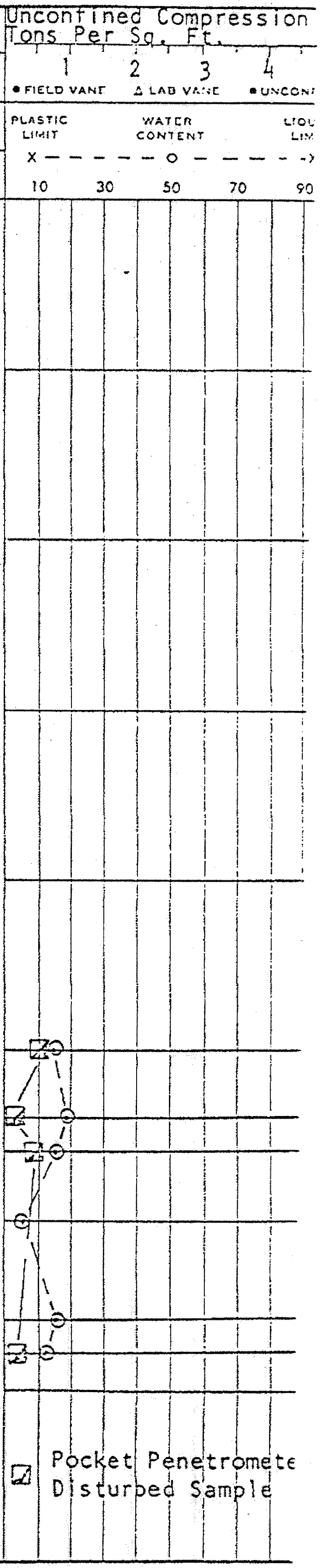
TEST HOLE LOG

DATE March 5, 1971

HOLE NO. Test Caisson #2

SAMPLE DATA	ELEV. COLLAR	TECH: J. Odermatt
WEIGHT HAMMER	ELEV. GROUND	RIG: Williams Auger
HEIGHT DROP	CO-ORD. LOCATION	7+90S & 58+39E

DEPTH / ELEV.	O.D. / I.D.	BLOWS / FT.	NO.	DESCRIPTION OF MATERIAL
				CLAY - mottled brown & grey
10				- highly plastic
20				- layered structure
				25.0'
30				CLAY - grey
40				- highly plastic
				- layered structure
50	Bag		1	50.0' TILL-LIKE MATERIAL - light grey - silt binder - sandy, clayey, soft
	Bag		2	54.0' SAND - light tan, silty, soft
	Bag		3	- wet - pebbles to 3/8" diameter
60	Bag		4	60.0' GLACIAL TILL - light tan, sandy - soft, very little silt binder, numerous boulders less than 24 inches dia.
	Bag		5	66.0' SAND - light tan, coarse, at 68 ft - till-like, putty whitish-grey, numerous boulders
70	Bag		6	68.0'
				71.0' LIMESTONE - hard - competent rock



☑ Pocket Penetrometer Disturbed Sample

Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENT

LOCATION WINNIPEG, MANITOBA

SHEET 2 OF 2

TEST HOLE LOG

DATE March 5, 1971

HOLE NO. Test Caisson #2

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR

ELEV. GROUND

CO-ORD. LOCATION

SYMBOL

COHESION – TONS/SQ. FT.

0.2 0.6 1.0 1.4 1.8

● FIELD VANE △ LAB VANE ■ UNCONF.

PLASTIC LIMIT WATER CONTENT LIQUI LIMI

X — — — — — O — — — — — X

10 30 50 70 90%

DEPTH / ELEV.	O.D. / I.D.	BLOWS / FT.	NO.

DESCRIPTION OF MATERIAL

NOTES

1. Trace of water at 54.0 ft. Hole caving badly.
2. At 57.5 ft water started flowing in. Water rose to a depth of 41.5 ft. below ground surface.
3. Hole was left open overnight and depth to water was 31.0 ft, and depth to soil was 56.0 ft.
4. End of hole was at 71.0 ft in hard solid competent limestone.
5. Water inflow measured at 75 gpm during attempts to dewater caisson.

Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

PROJECT SOUTH END POLLUTION CONTROL CENTRE

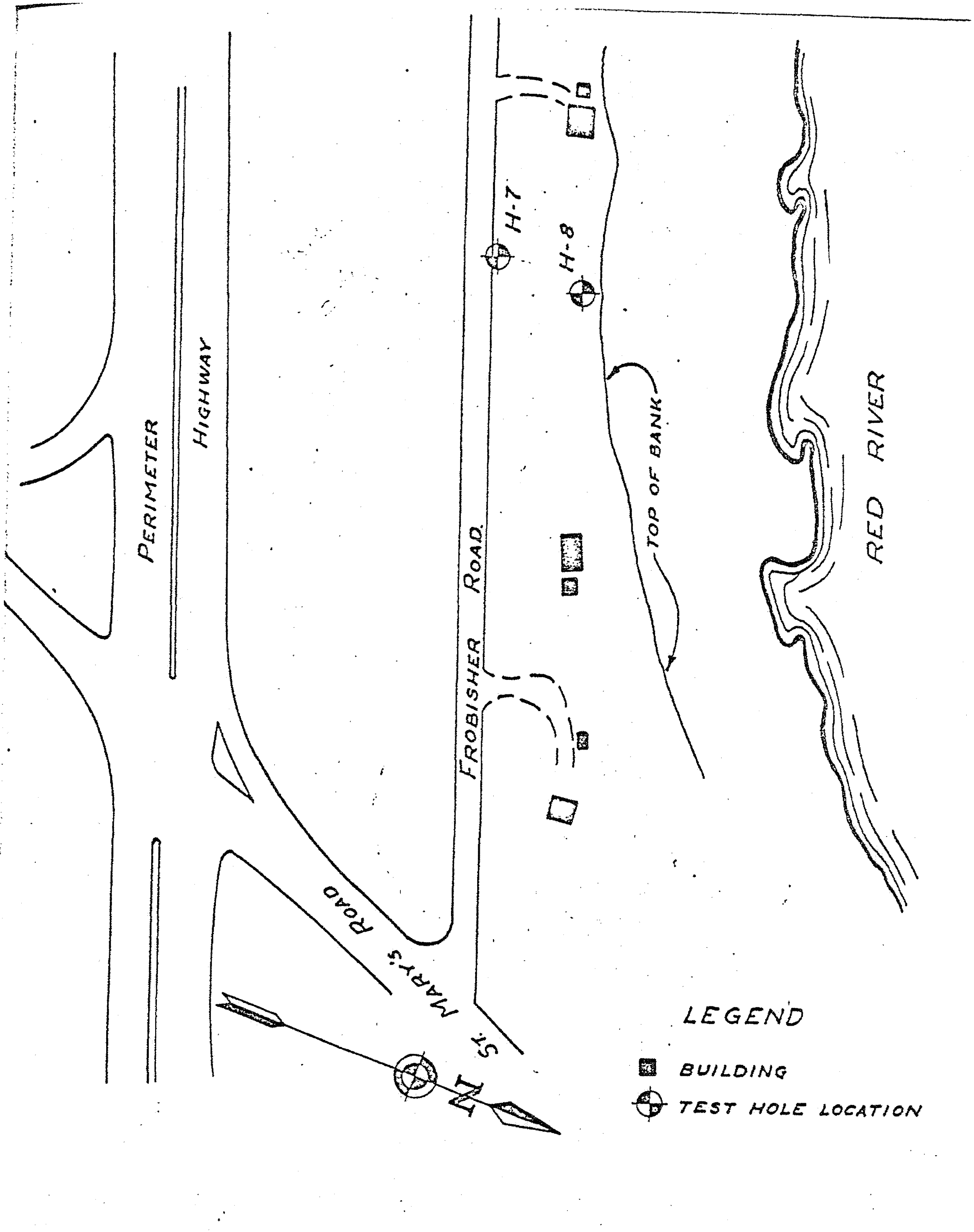
LOCATION WINNIPEG, MANITOBA

TITLE: TEST HOLES DRILLED AT OUTFALL STAGE ASSOCIATED WITH SOUTH END POLLUTION CONTROL CENTRE

LOCATION: WINNIPEG, MANITOBA

CLIENT: METRO WATERWORKS & WASTE DISPOSAL DIVISION

JOB NO: W-623 DATE: April 14, 1971



SCALE 1"=100'

pley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS
NCOUVER — EDMONTON — CALGARY — WINNIPEG CANADA

ENT: M. C. G. W.

5709 - R.K.L.

SUBSOIL INVESTIGATION
SEWAGE OUTFALL LOCATION
TEST-HOLE LOCATION PLAN.

APPROVED R. S.

DATE 23/03/71

A-W-623-01

DATE March 24, 1971

TEST HOLE LOG

HOLE NO. 1

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

ELEV. COLLAR TECH: C. J. Vann

ELEV. GROUND (759.9) RIG: 16" Power Auger

CO-ORD. LOCATION

SYMBOL

Unconfined Compression Tons Per Sq. Ft.

1 2 3 4

● FIELD VANE △ LAB VANE ■ UNCONF.

PLASTIC LIMIT WATER CONTENT LIQUID LIMIT

X — — — — — O — — — — — X

10 30 50 70 90%

DEPTH ELEV.	O.D. I.D.	BLOWS FT.	NO.
10			
	3"Sy		1
20			
	3"Sy		2
30			
	3"Sy		3
40			
	3"Sy		4
50			
60			

DESCRIPTION OF MATERIAL

CLAY - dark brown
- sandy, silty
- frequent inclusions of gypsum crystals

7.0'

CLAY - mottled brown & grey
- highly plastic
- laminated structure
- gypsum crystals
- silt lumps
- firm to stiff

24.0'

CLAY - grey
- highly plastic
- laminated structure
- silt lumps
- at 45'0" - numerous till-like inclusions and material is wet and soft

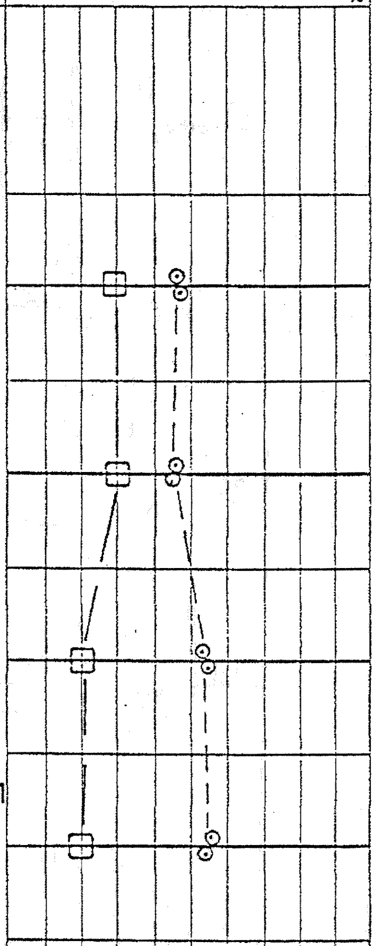
50.0'

TILL-LIKE - light tan-grey
- clayey, silt binder
- firm
- damp to wet, cobbles from 54'0"

60.0'

NOTES

1. Water at 50'0" in till.
2. Hole discontinued at 60'0", the maximum extent of the auger.



☐ Pocket Penetrometer Undisturbed Sample

Ripley, Klohn & Leonoff International Ltd.

CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

SEWAGE OUTFALL

SOUTH END POLLUTION CONTROL CENTRE

LOCATION

WINNIPEG MANITOBA

TEST HOLE LOG

DATE March 24, 1971

HOLE NO. 2

ELEV. COLLAR TECH: C. J. Vann

ELEV. GROUND (758.8) RIG: 16" Power Auger

CO-ORD. LOCATION

SAMPLE DATA

WEIGHT HAMMER

HEIGHT DROP

DEPTH / ELEV.	O.D. / I.D.	BLOWS FT.	NO.
10	3"Sy		1
20	3"Sy		2
30	3"Sy		3
40	3"Sy		4
50			
	Bag		5
60			

SYMBOL

DESCRIPTION OF MATERIAL

CLAY - dark brown, sandy, silty
- moist
- firm to stiff

6.0'

CLAY - mottled brown & grey
- highly plastic
- laminated structure
- gypsum inclusions at 10'0"
- silt lumps
- from 6'0" to 8'0" - numerous layers of tan silt
- at 17'0" to 19'0" - layer of grey clay

30.0'

CLAY - grey, highly plastic
- laminated structure
- silt lumps, firm to stiff
- at 35'0" - frequent inclusions of till-like material, at 46'0" - large seams of soft till-like material

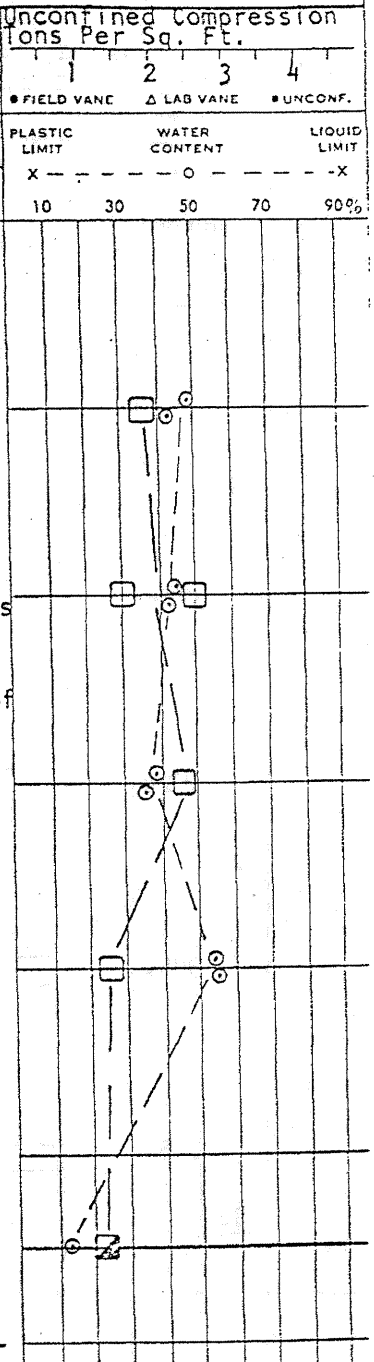
50.0'

TILL-LIKE - light tan-grey
- soft, damp to wet
- cobbles & boulders from 55'0"

60.0'

NOTES

1. Water at 50'0", fifteen minutes after drilling.
2. Hole ended at 60'0", the maximum depth of the auger.



☐ Pocket Penetrometer Undisturbed Sample

▨ Pocket Penetrometer Disturbed Sample

Ripley, Klohn & Leonoff International Ltd.
CONSULTING ENGINEERS | SOIL MECHANICS & FOUNDATIONS

SEWAGE OUTFALL
SOUTH END POLLUTION CONTROL CENTRE

LOCATION WINNIPEG, MANITOBA

RKL 67.3

PLATE No. A-W-62

GEOTECHNICAL ENGINEERING REPORT

SOUTH END WATER POLLUTION CONTROL CENTRE

Prepared For

WARDROP ENGINEERING INC.

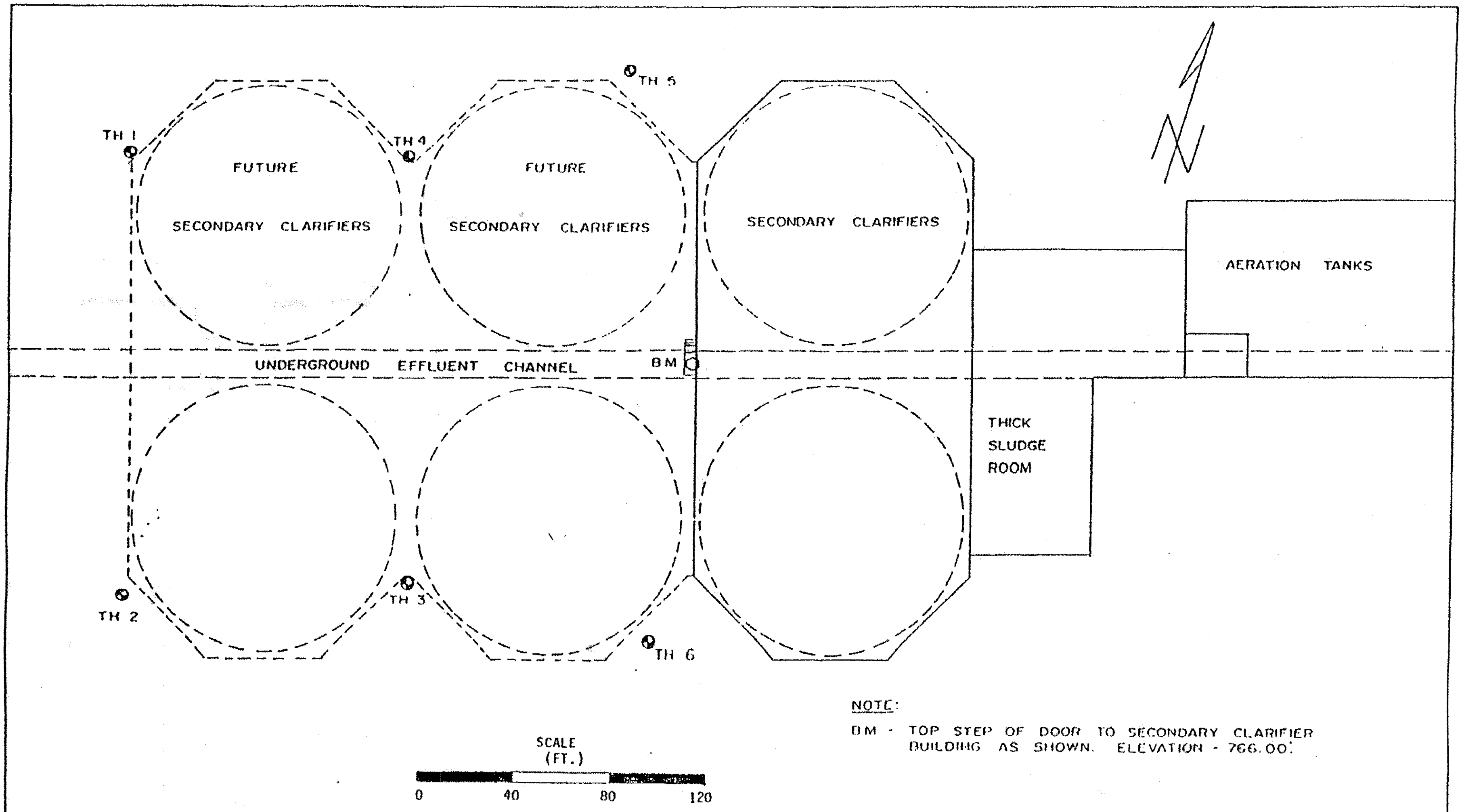
MACLAREN ENGINEERS INC.

On Behalf of

THE CITY OF WINNIPEG

April 15, 1988

Project No. 88528



NOTE:

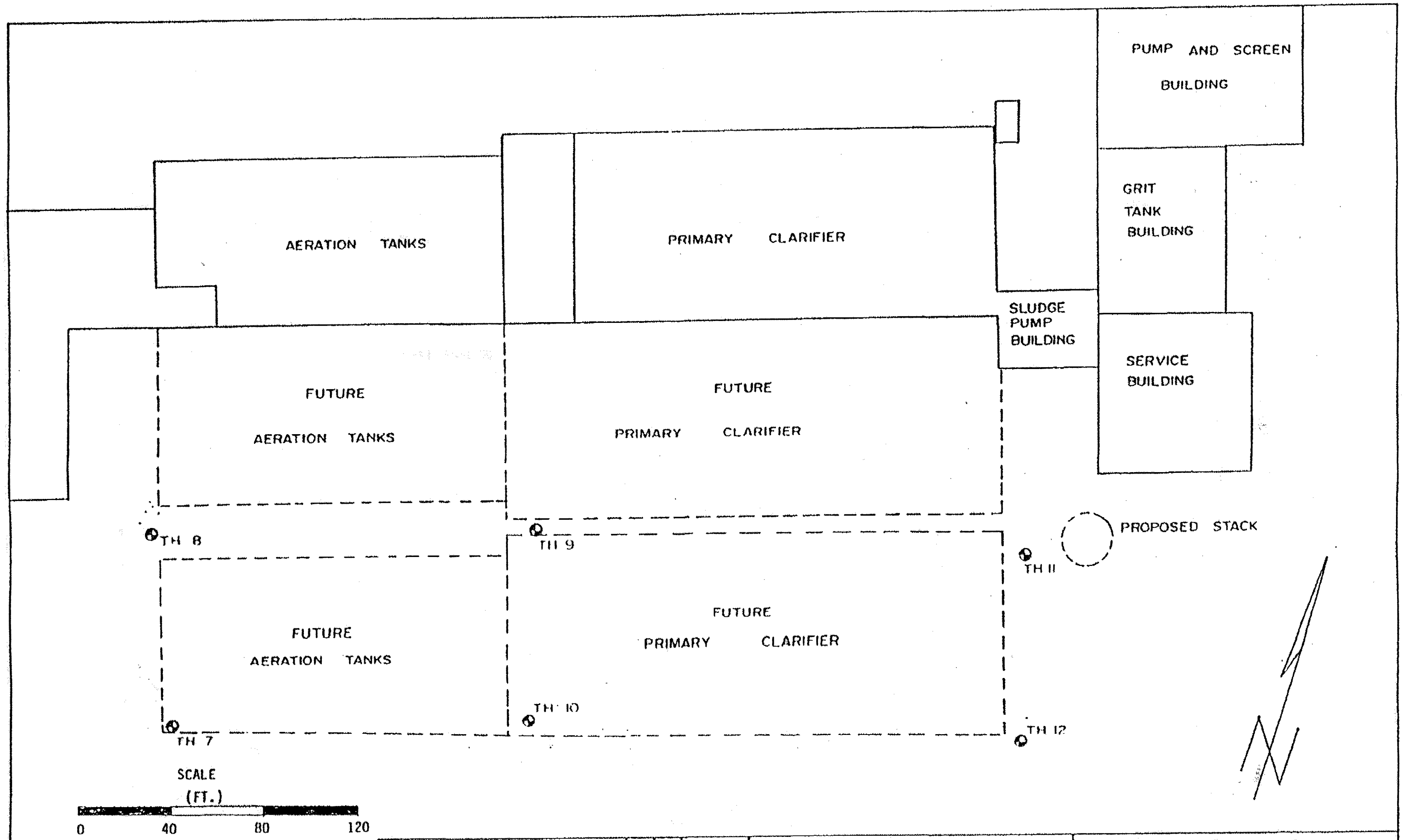
BM - TOP STEP OF DOOR TO SECONDARY CLARIFIER BUILDING AS SHOWN. ELEVATION - 766.00'.

REV	DESCRIPTION	DWN	APP	DATE

DYREGROV & BURGESS
CONSULTING GEOTECHNICAL ENGINEERS

APP'D NCB
DATE 22/01/88
SCALE:
JOB NO. 88528

TEST HOLE LOCATION PLAN
SOUTH END WATER POLLUTION CONTROL
CENTRE - WINNIPEG, MAN.
DWG. NO. 1



REV	DESCRIPTION	DWN	APP	DATE

DYREGROV & BURGESS
CONSULTING GEOTECHNICAL ENGINEERS

APP'D: NCB
DATE 28/01/88
SCALE:
JOB NO. 88528

TEST HOLE LOCATION PLAN
SOUTH END WATER POLLUTION CONTROL
CENTRE - WINNIPEG, MAN.
2
DWG. NO.

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT

South End Water Pollution Control Centre

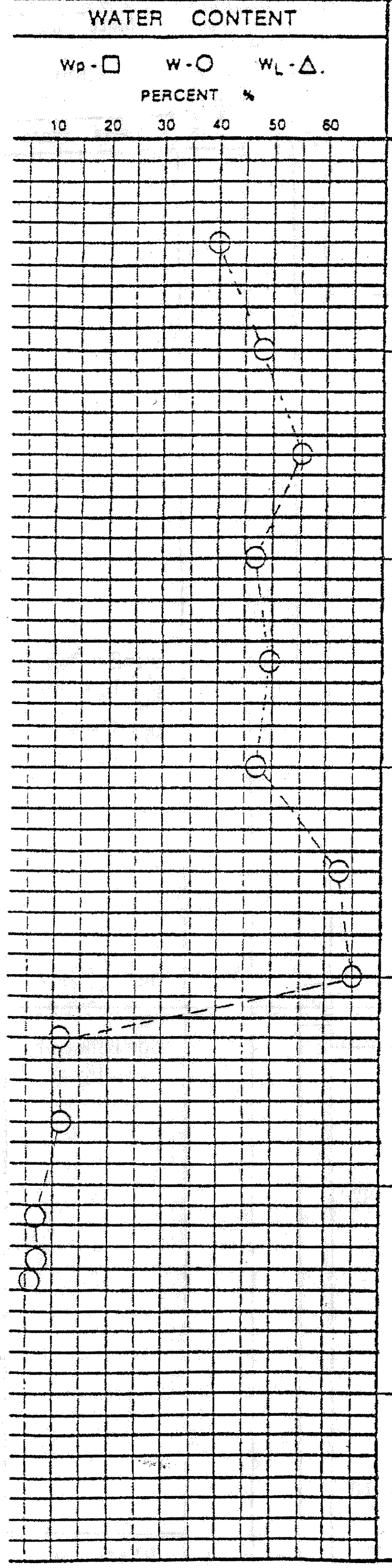
LOGGED/DWN. SDG

CKD. NCB

DATE OF INVEST. 29/02/88

JOB NO. 88528

HOLE NO. 1



DEPTH (FT)

SOIL SYMBOL

SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 762.17'

SOIL SAMPLE

CONDITION

TYPE

PENETRATION RESISTANCE

DRILL TYPE

18" Auger

OTHER TESTS

0

Fill -clay, trace gravel

Clay -black

Clay -silty, brown

Silt -tan, moist

Clay -mottled brown
-highly plastic
-stiff to firm
-gypsum inclusions to 17'

10

U

qu=2170psf
γ_w=105.6pcf
pp=3165psf
Tv=1620psf

20

grey

30

U

qu=855psf
γ_w=102.2pcf
pp=1750psf
Tv=890psf

40

Glacial Till
-silty, sandy, gravelly
-tan, medium dense to soft
-wet to saturated
-cobbly and/or bouldery
-dense to very dense at 51'
-slight seepage at 56'
-medium dense below 56'

50

60

Notes:
1. Auger refusal at 59'.
2. Installed sealed standpipe at 47'. Bottom 3' of standpipe slotted.
3. Water level at 29.5' from grade on March 16/88.

Plate 3

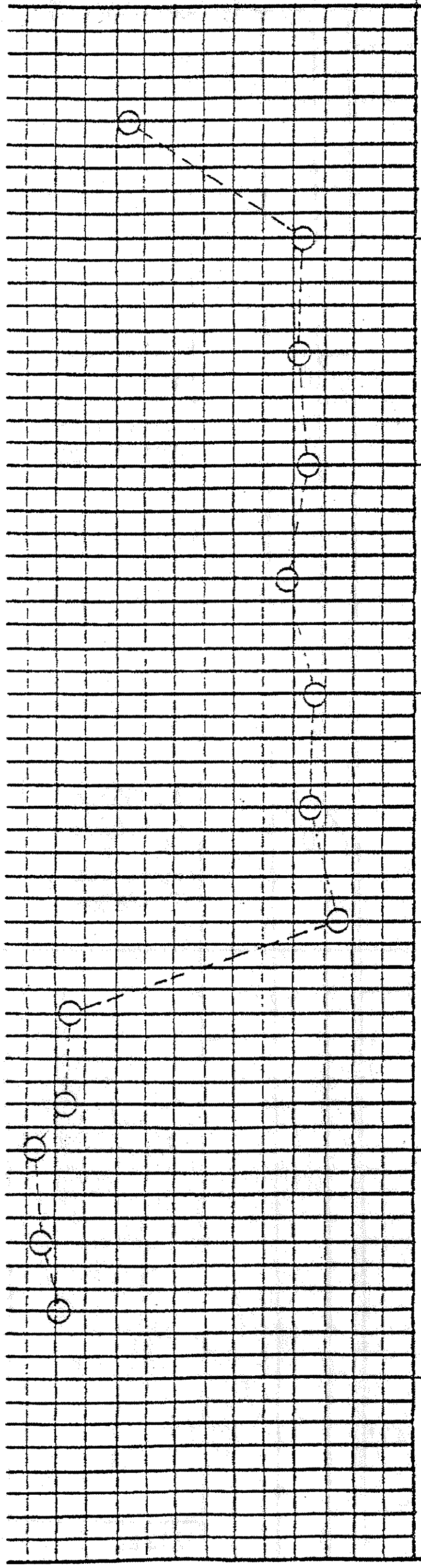
DYREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

LOGGED/DWN. SDG
CKD. NCB
DATE OF INVEST. 29/02/88
JOB NO. 88528
HOLE NO. 2

WATER CONTENT
Wp - ☐ W - ○ W_L - △.
PERCENT %



DEPTH (FT)
0
10
20
30
40
50
60

SOIL SYMBOL

SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 763.06'

Topsoil

Clay -silty
-brown

Silt -tan
-moist to wet

Clay -mottled brown
-highly plastic
-stiff to firm

— — — grey

Glacial Till
-silty, sandy, gravelly
-tan, soft to medium dense
-wet to saturated
-dense to very dense at49'
-cobbly and bouldery below 52'
-medium dense below 59'

Notes:
1.Auger refusal at 67'.
2.Water level at 38' from grade in about 5 minutes.

SOIL SAMPLE
CONDITION
TYPE
PENETRATION RESISTANCE

U

U

DRILL TYPE
18" Auger

OTHER TESTS

qu=2290psf
γ_W=113.3pcf
pp=4150psf
Tv>2000psf

qu=1275psf
γ_W=105.6pcf
pp=1850psf
Tv=905psf

Plate 4

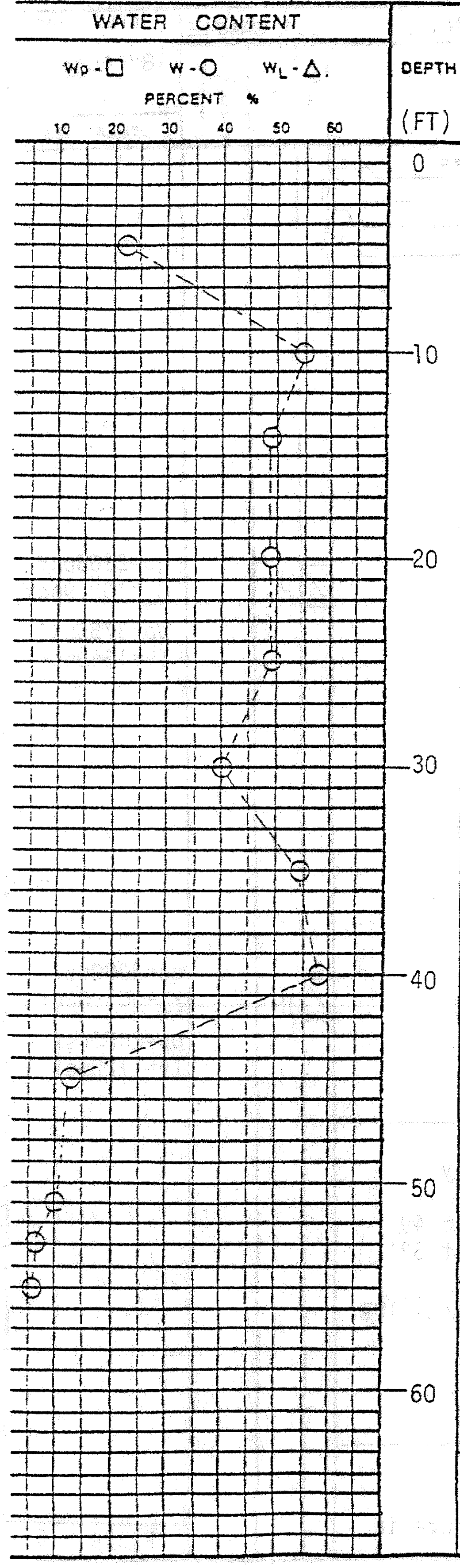
DYREGROV & BURGESS

BOREHOLE LOG

PROJECT
South End Water Pollution Control Centre

LOGGED/DWN. SDG
CKD. NCB
DATE OF INVEST. 29/02/88
JOB NO. 88528
HOLE NO. 3

WATER CONTENT



SOIL SYMBOL

SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 763.27'

SOIL SAMPLE: CONDITION | TYPE | PENETRATION RESISTANCE

DRILL TYPE: 18" Auger

OTHER TESTS

Topsoil

Clay -silty, brown

Silt -tan
-moist, firm

Clay -mottled brown
-highly plastic
-stiff to firm

U

qu=1595psf
γ_w=106.7pcf
pp=2880psf
Tv=1660psf

--- grey

U

qu=2115psf
γ_w=110.5pcf
pp=2200psf
Tv=1320psf

Glacial Till
-silty, sandy, gravelly
-tan, soft
-dense to very dense at 52'
-bouldery below 54'
-medium dense below 56'

Notes:
1.Auger refusal at 63'.
2.Water level at 47' from grade in about 5 minutes.

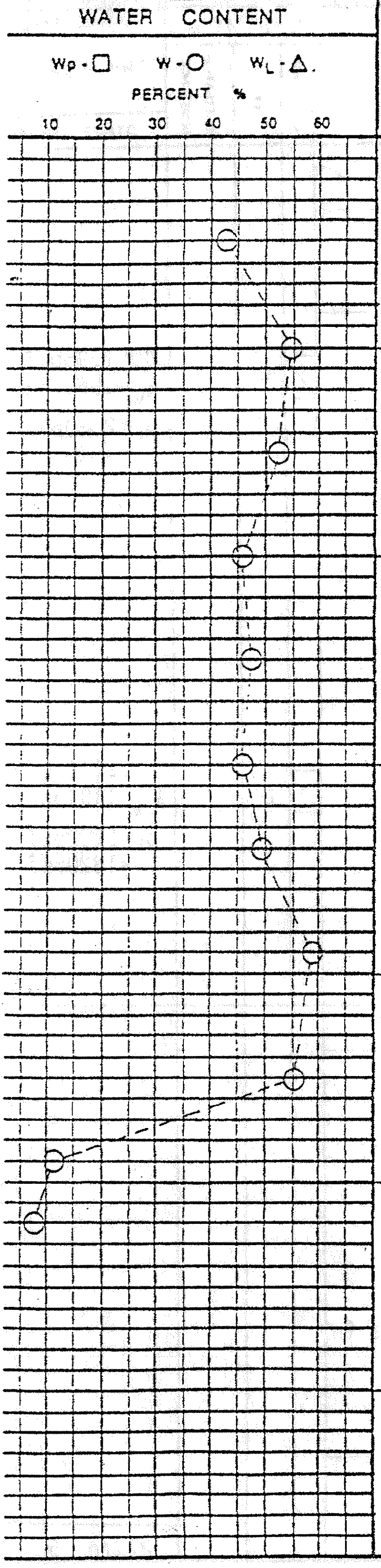
DYREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

LOGGED/DWN. SDG
CKD. NCB
DATE OF INVEST. 1/03/88
JOB NO. 88528
HOLE NO. 4

DRILL TYPE 18" Auger



DEPTH (FT)
0
10
20
30
40
50
60

SOIL SYMBOL

SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 764.18'

Fill -clay, trace gravel

Clay -black

Clay -silty, brown

Silt -tan, clayey, moist

Clay -mottled brown
-highly plastic
-stiff to firm

— — — grey

Glacial Till
-silty, sandy, gravelly
-tan, medium dense
-6" thick clay seams to 49'
-dense to very dense at 52'
-bouldery below 51'
-slight seepage upon drilling to 53'

Notes:
1. Auger refusal at 62.5'
Water level at 44' from grade in about 5 minutes.

SOIL SAMPLE
CONDITION TYPE PENETRATION RESISTANCE

U (at 20')

U (at 41')

OTHER TESTS

qu=2865psf
γ_W=109.9pcf
pp=3750psf
Tv=1640psf

qu=2080psf
γ_W=101.0pcf
pp=2050psf
Tv=1120psf

Plate 6

DYREGROV & BURGESS

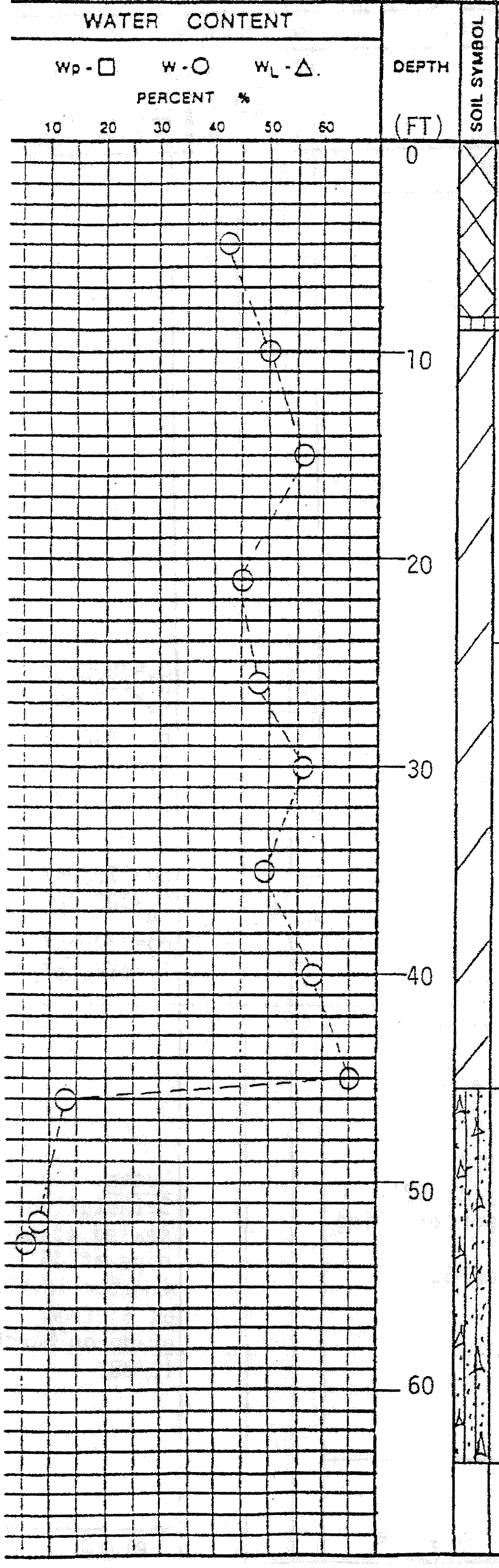
BOREHOLE LOG

PROJECT
South End WAter Pollution Control Centre

LOGGED/DWN. SDG
CKD. NCB
DATE OF INVEST. 1/03/88
JOB NO. 88528
HOLE NO. 5

DRILL TYPE
18" Auger

DATUM
SURFACE ELEVATION 763.35'



SOIL DESCRIPTION

Fill -clay
-trace gravel
-organic clay

Silt -tan, moist, trace sand

Clay -mottled brown
-highly plastic
-stiff to firm

--- grey

Glacial Till
-silty, sandy gravelly
-tan, soft to medium dense
-dense at 52'
-very dense and bouldery at 53'
-slight seepage at 56'
-medium dense below 57'

Notes:

1.Auger refusal at 63.5'.
2. Water level at 42' upon completion of drilling.

SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE

U

U

OTHER TESTS

qu=1450psf
γ_W=104.6pcf
pp=2850psf
Tv=1510psf

qu=2530psf
γ_W=109.2pcf
pp=2100psf
Tv=1200psf

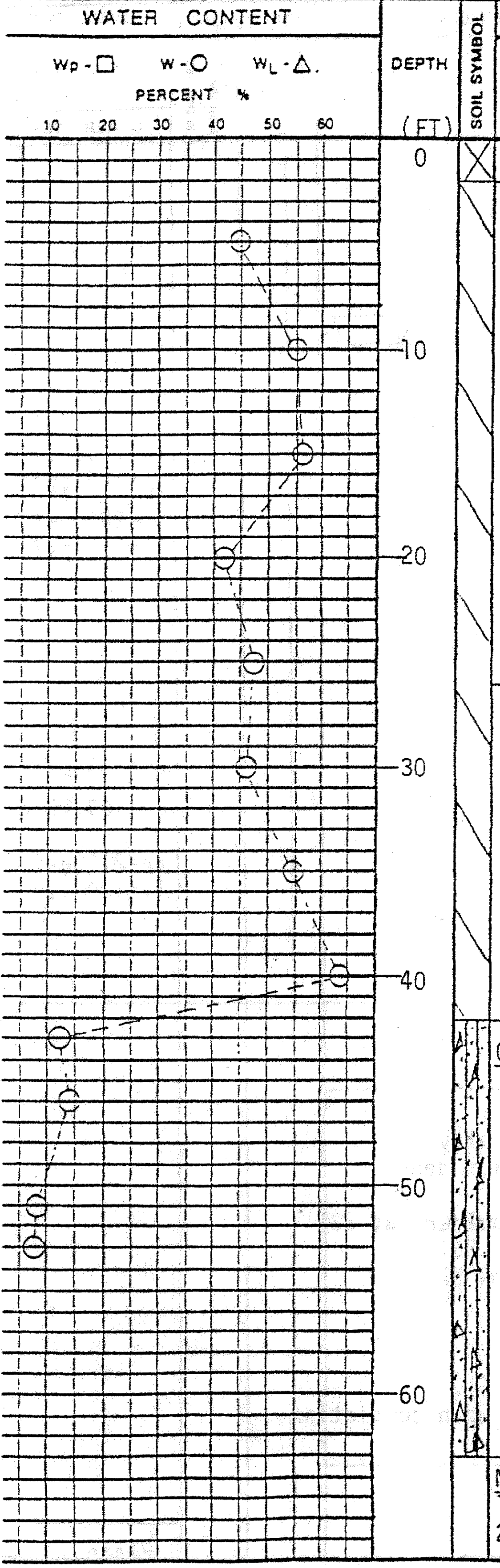
DYREGROV & BURGESS

BOREHOLE LOG

PROJECT: South End Water Pollution Control Centre

LOGGED/DWN. SDG
CKD. NCB
DATE OF INVEST. 1/03/88
JOB NO. 88528
HOLE NO. 6
DRILL TYPE: 18" Auger

WATER CONTENT
DATUM
SURFACE ELEVATION 762.06'



SOIL DESCRIPTION

Fill -clay, some gravel

Clay -mottled brown
-highly plastic
-stiff to firm

--- grey

Glacial Till
-silty, sandy , gravelly
-tan, soft
-wet to saturated
-medium dense at 51'
dense and bouldery at 52'
-slight seepage upon drilling to 54'
-medium dense below 55'

SOIL SAMPLE CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
◪	U		qu=3500psf γ_w=112.8pcf pp=3640psf Tv=1870psf
◪	U		qu=1700psf γ_w=103.4pcf pp=2300psf Tv=1240psf

Notes:
1.Auger refusal at 63'.
2.Water level at 50' from grade upon completion of drilling

Notes: (Cont'
3.Installed sealed standpipe at 45'.
4.Water level at 6' from grade on Marc 16/88.

Plate 8

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

LOGGED/DWN. SDG

CKD. NCB

DATE OF INVEST. 1/03/88

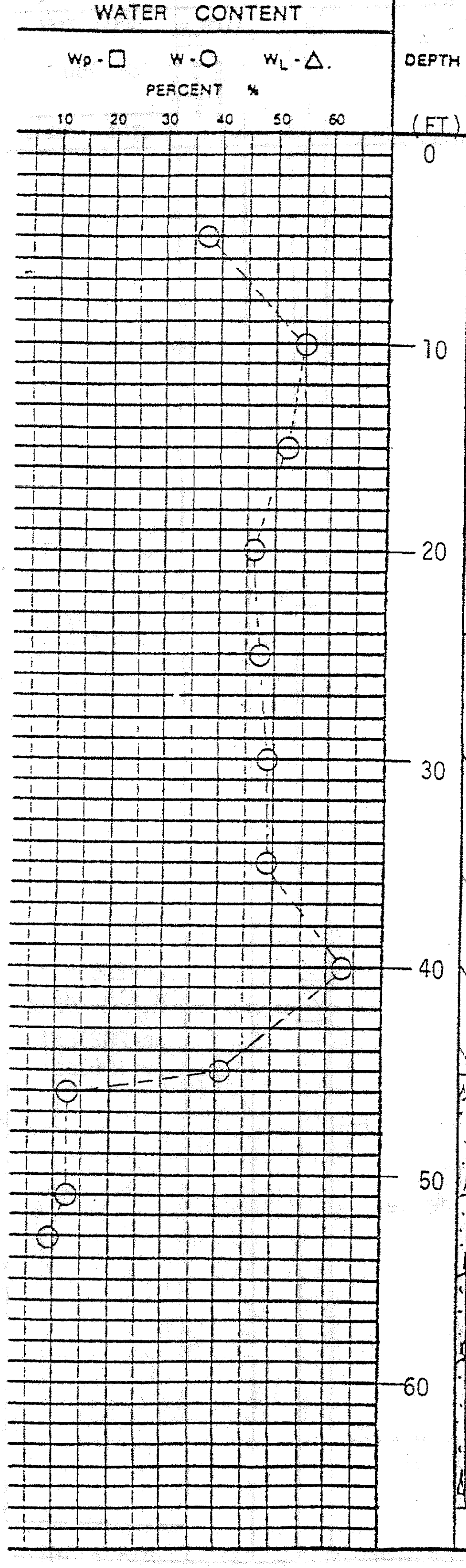
JOB NO. 88528

HOLE NO. 7

DRILL TYPE 18" Auger

DATUM

SURFACE ELEVATION 762.90'



DEPTH (FT)	SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
0	Fill -clay, some gravel, cobbly				
	Clay -black				
	Clay -silty, brown				
	Silt -tan, moist				
	Clay -mottled brown -highly plastic -stiff to firm				
10					
		▨	U		qu=2305psf γ_w=106.7pcf pp=3235psf Tv=1720psf
20					
		▨	U		qu=1935psf γ_w=107.5pcf pp=3700psf Tv=1900psf
	-grey				
30					
40					
	Glacial Till -silty, sandy, gravelly -tan, soft to medium dense -bouldery -very sandy at 53' -dense at 53' -seepage at 53' -medium dense below 54'				
50					
60					

Notes:
1. Auger refusal at 66' on possible bedrock.
2. Water level at 40' from grade upon completion of drilling.

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

LOGGED/DWN. SDG

CKD. NCB

DATE OF INVEST. 1/03/88

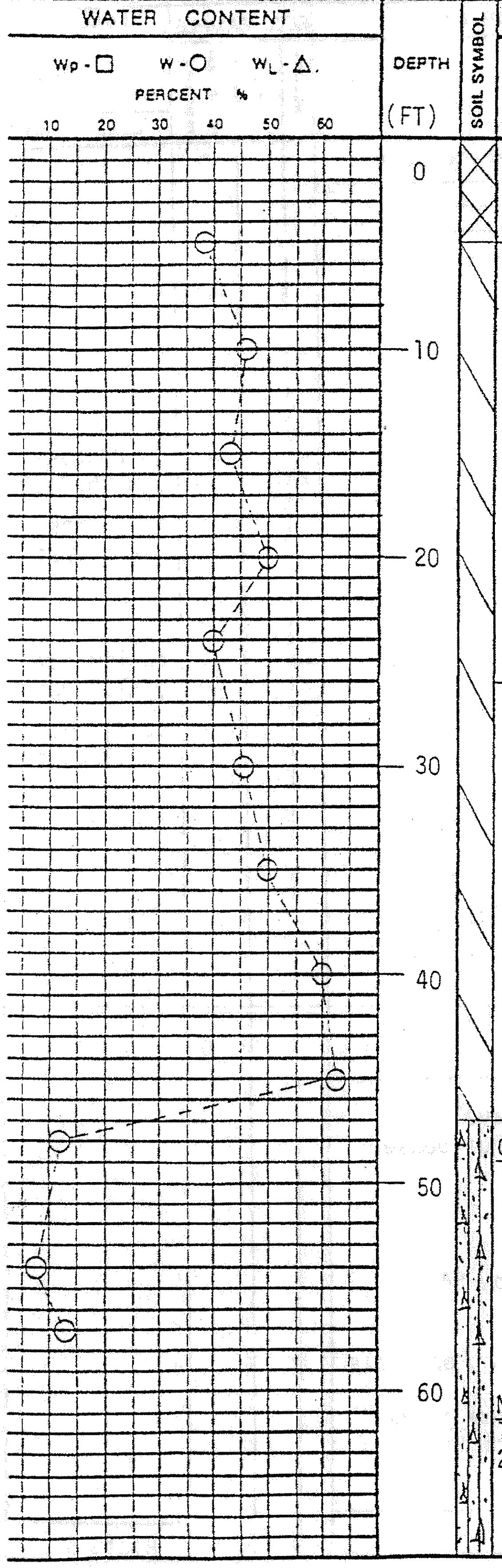
JOB NO. 88528

HOLE NO. 8

DRILL TYPE 18" Auger

DATUM

SURFACE ELEVATION 764.81'



SOIL DESCRIPTION

Fill -clay, trace gravel

Clay -mottled brown
-highly plastic
-stiff to firm

--- grey

Glacial Till
-silty, sandy, gravelly
-tan, soft to medium dense
-cobbly
-dense at 54'
-very sandy below 55'
-bouldery at 56'
-slight seepage at 57'

Notes:
1. Auger refusal at 68' on bedrock.
2. Slight seepage. No measurable amount of water.

SOIL SAMPLE CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
	U		qu=2795psf γ_W=110.0pcf pp=4265psf Tv>2000psf
	U		qu=2500psf γ_W=103.8pcf pp=2025psf Tv=1050psf

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

LOGGED/DWN. SDG

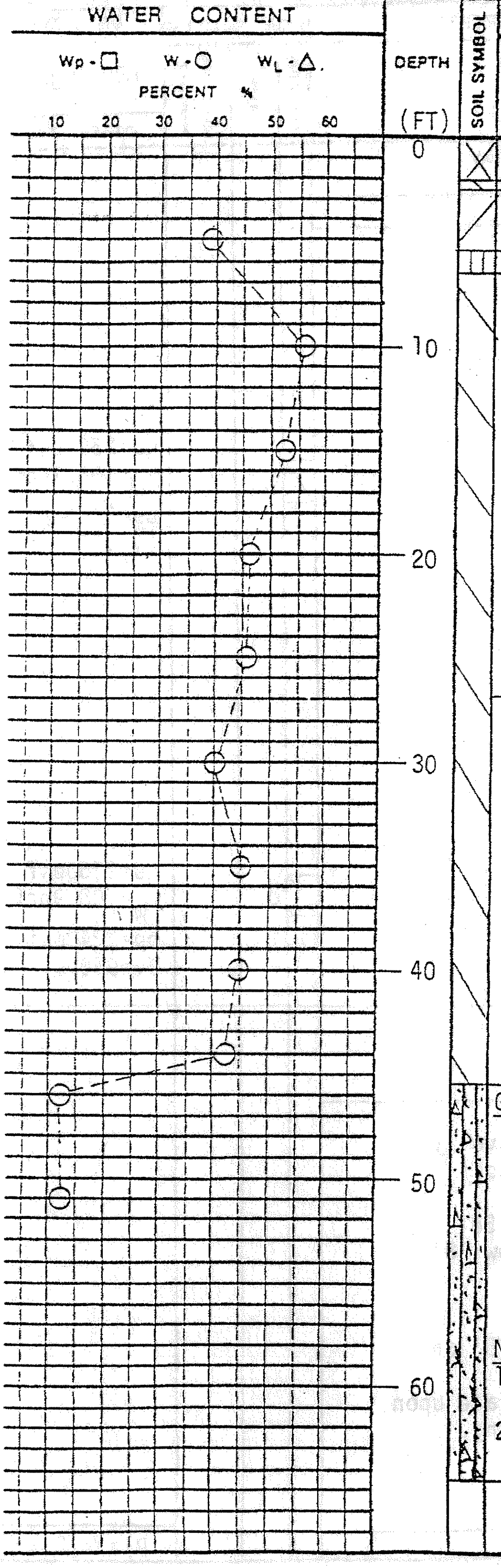
CKD. NCB

DATE OF INVEST. 2/03/88

JOB NO. 88528

HOLE NO. 9

DRILL TYPE 18" Auger



SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 763.38'

Fill -clay, silt, trace gravel

Clay -black

Clay -silty
-brown

Silt -tan, moist

Clay -mottled brown
-highly plastic
-stiff to firm

--- grey

Glacial Till
-sitly, sandy, gravelly
-tan, clayey to 48'
-saturated, soft, cobbly
-slight seepage at 54'
-bouldery below 56'
dense from 56 to 58'
-medium dense below 58'

Notes:
1. Auger refusal at 64.5' in broken bedrock.
2. Water level at 43 and hole open to 44' upon completion.

SOIL SAMPLE TYPE	OTHER TESTS
U	qu=1620psf γ_w=105.8pcf pp=2785psf Tv=1490psf
U	qu=2525psf γ_w=108.0pcf pp=3640psf Tv=1860psf

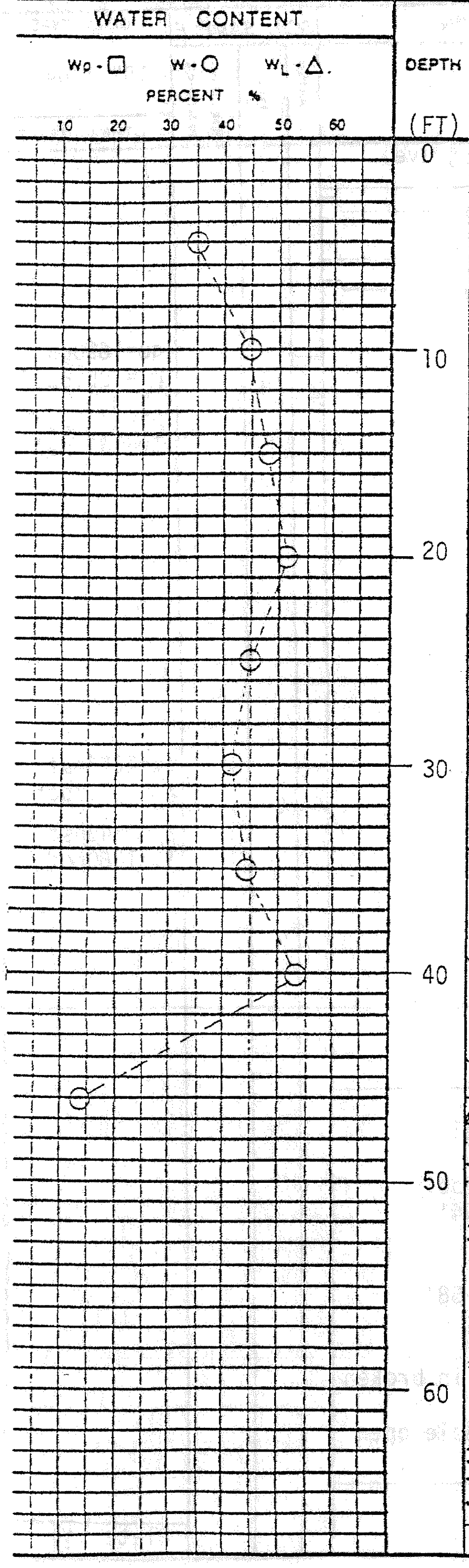
DYREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
SDG	NCB	8/03/88	88528	10

DRILL TYPE 18" Auger



SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 762.94'

Fill -gravel, some clay

Silt -tan, moist

Clay -mottled brown
-highly plastic
-stiff to firm

- - -grey

Glacial Till
-silty, sandy, gravelly
-tan, saturated, soft
-seepage at 52'
-dense from 55 to 58'
-medium dense below 58'

Notes:
1. Auger refusal at 66.5' on probable bedrock.
2. Water at 39' from grade upon completion of drilling.

SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE

U

U

OTHER TESTS

qu=2595psf
γ_w=108.7pcf
pp=3500psf
Tv=1650psf

qu=2750psf
γ_w=108.9pcf
pp=2240psf
Tv=950psf

Plate12

DYREGROV & BURGESS

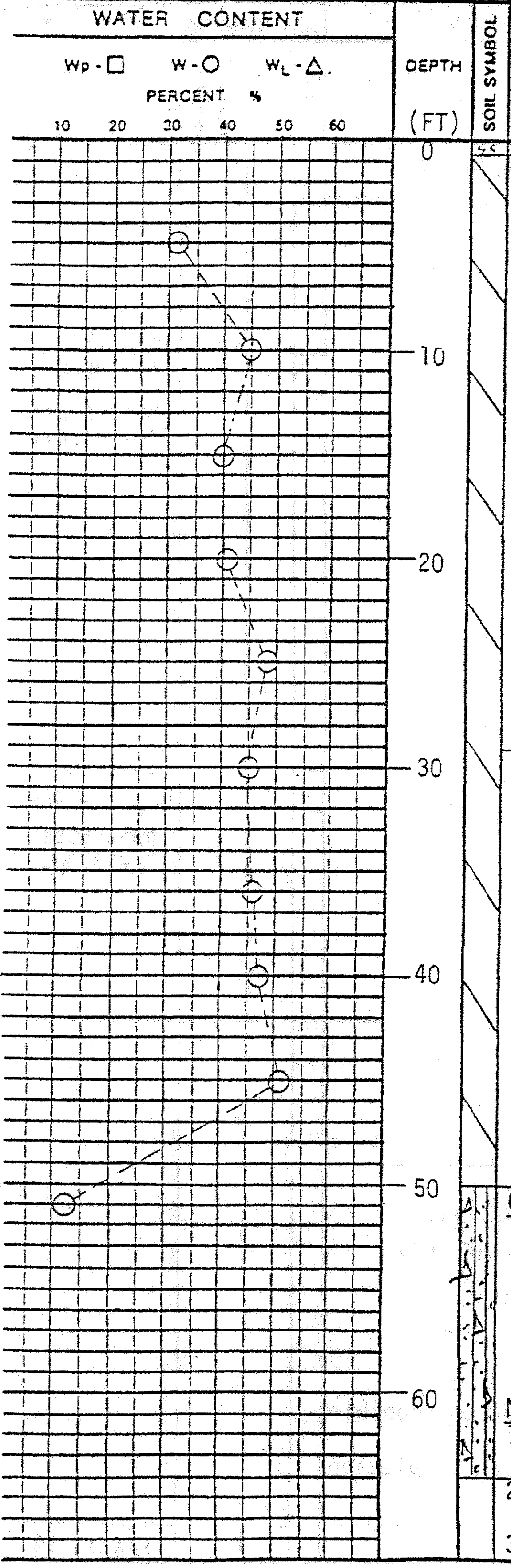
BOREHOLE LOG

PROJECT
South End Water Pollution Control Centre

LOGGED/DWN. SDG
CKD. NCB
DATE OF INVEST. 8/03/88
JOB NO. 88528
HOLE NO. 11

DRILL TYPE
18" Auger

DATUM
SURFACE ELEVATION 762.81'



SOIL DESCRIPTION

Topsoil -black

Clay -mottled brown
-highly plastic
-stiff to firm
-gypsum inclusions

---grey

Glacial Till
-silty, sandy, gravelly
-tan, saturated, soft
-seepage at 52'
-bouldery at 54'
-dense from 54 to 56'

Notes:
1. Auger refusal at 64' on probable bedrock.
2. Hole open to 45' upon completion of drilling.
3. Placed sealed standpipe at 55'.

SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE

Depth (ft)	Type	OTHER TESTS
20	U	qu=3435psf γ_w=110.0pcf pp=4880psf Tv=1940psf
35	U	qu=1835psf γ_w=113.2pcf pp=1760psf Tv=1000psf

Notes:(Cont'd)
4. Water level at 30' from grade on March 16/88.

Plate 13

DYREGROV & BURGESS

BOREHOLE LOG

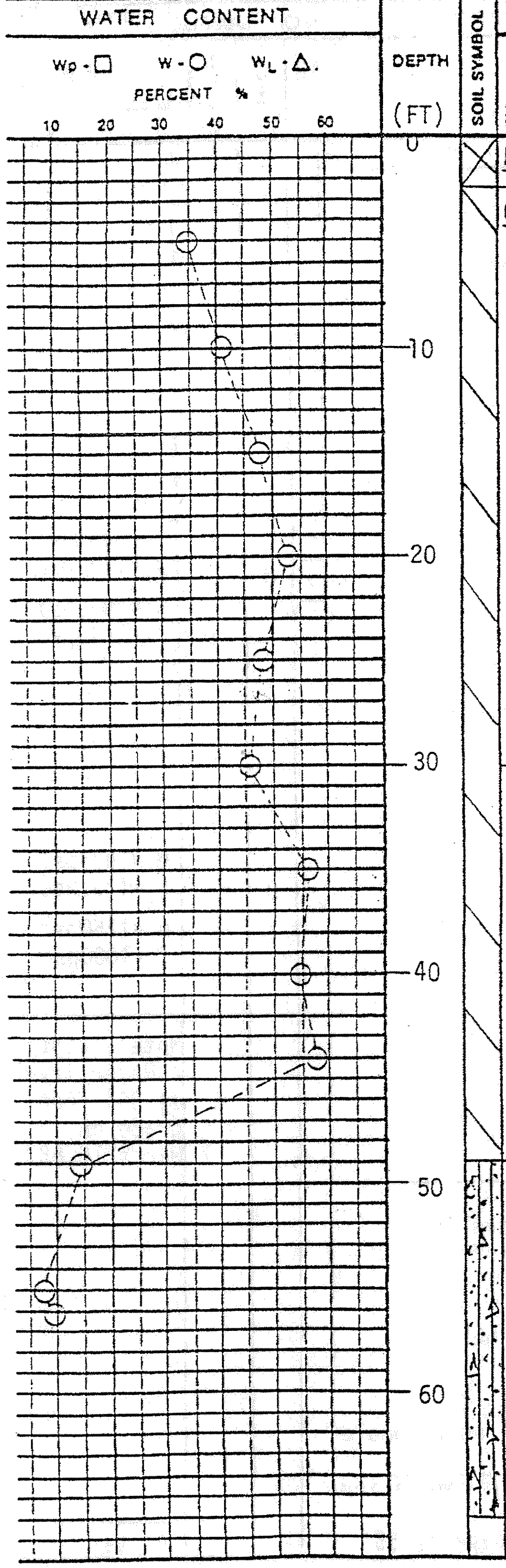
PROJECT South End Water Pollution Control Centre

LOGGED/DWN. SDG	CKD. NCB	DATE OF INVEST. 8/03/88	JOB NO. 88528	HOLE NO. 12

DRILL TYPE 18" Auger

DATUM

SURFACE ELEVATION 762.59'



SOIL DESCRIPTION

Fill -gravel, clay, concrete

Clay -mottled brown
-highly plastic
-stiff to firm

--- grey

Glacial Till
-silty, sandy, gravelly
-tan, soft to medium dense
-dense at 55'
-very sandy at 56'
-seepage at 56'

Notes:
1.Auger refusal at 66' on probable bedrock.
2.Hole open to 48' upon completion

SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE

TYPE	OTHER TESTS
U	qu=1180psf γ_w=106.9pcf pp=3200psf Tv=1640psf
U	qu=2390psf γ_w=110.5pcf pp=3080psf Tv=1570psf

Plate 14

GEOTECHNICAL REPORT

PROPOSED DISINFECTION BUILDING

SOUTH END WATER POLLUTION CONTROL CENTRE

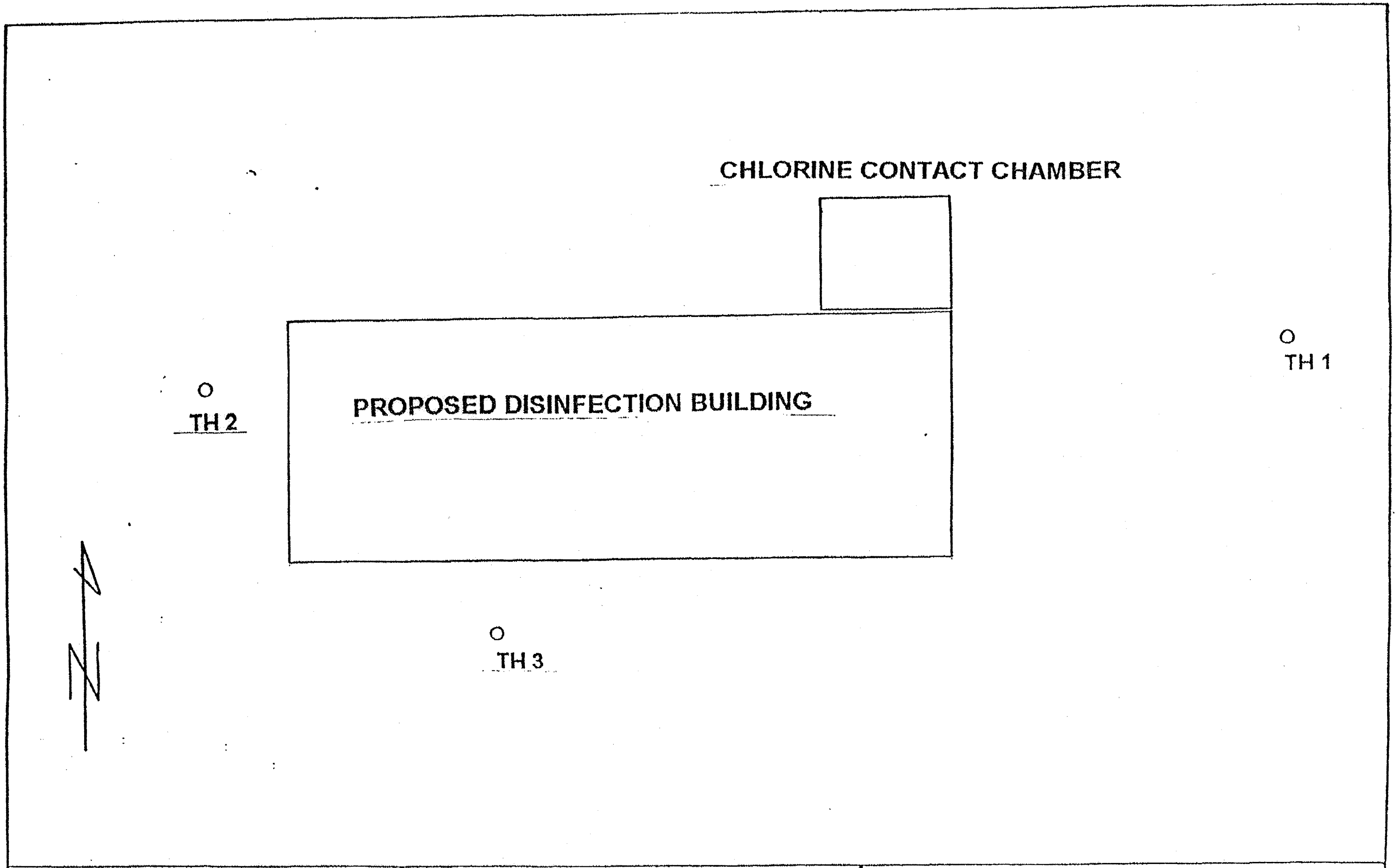
CITY OF WINNIPEG

PREPARED FOR

REID CROWTHER & PARTNERS LTD.

February 1998

Project 981754



DYREGROV CONSULTANTS

CONSULTING GEOTECHNICAL ENGINEERS

TEST HOLE LOCATION PLAN
PROPOSED DISINFECTION BUILDING
SEWPCC

DYREGROV CONSULTANTS	Logged / Dwn. : TH Checked: AOD	Test Hole No. 1	Project No. 981754
PROJECT:	SEWPCC DISINFECTION BUILDING	DATE OF INVEST.	January 29, 1998
CLIENT:	REID CROWTHER & PARTNERS LTD.	DRILL:	Subterranean 400 mm auger

SAMPLE NO.	DEPTH (m)	ELEV. (m)	SYM	SOIL DESCRIPTION	
	0.00	232.58		0.00-7.32 FILL GRANULAR WITH SOME CLAY TO .40 BELOW .4 IS A MIX OF CLAY WITH SOME TOPSOIL AND SILT WITH IN THE MATRIX	
	0.50	232.08			
	1.00	231.58			
	1.50	231.08			Qu-55 kPa Pp-144 kPa Tv-108 kPa W-18.90 Kn/M
	2.00	230.58			
	2.50	230.08			
	3.00	229.58		BECOMING SOFTER TOWARDS 2.59 TRACE OF TOPSOIL	Qu-29.3 KPa Pp-107 kPa Tv-63 kPa W-18.63 Kn/M
	3.50	229.08			
	4.00	228.58			
	4.50	228.08			**Qu-58 kPa** Pp-115 kPa Tv-78 kPa W-17.83 Kn/M
	5.00	227.58		CLAY WITH A MIX OF SOME SILT GRANULAR, STONES TO 100 mm DIA TRACE OF TOPSOIL	
	5.50	227.08			
	6.00	226.58			
	6.50	226.08			Pp-67 kPa Tv-48 kPa
	7.00	225.58			
	7.50	225.08		7.32-13.72 CLAY GREY, SOME SILT, STIFF TRACE TILL INCLUSIONS (SILT)	
	8.00	224.58			
	8.50	224.08			
	9.00	223.58		TILL INCLUSIONS BECOMING LARGER AND MORE FREQENT WITH DEPTH BECOMING MED TO FIRM	
	9.50	223.08			
	10.00	222.58			
	10.50	222.08			
	11.00	221.58			
	11.50	221.08			
	12.00	220.58			
	12.50	220.08			
	13.00	219.58			
	13.50	219.08			
	14.00	218.58		13.72-16.82 TILL SILT WITH A MIXTURE OF GRANULAR AND A TRACE OF CLAY **SOFT**	
	14.50	218.08			
	15.00	217.58			
	15.50	217.08		BECOMING DENSE AT 15.5	
	16.00	216.58			
	16.50	216.08			
	17.00	215.58		END OF TEST HOLE AT 16.82 INDENSE TILL	

MOISTURE CONTENT (%)

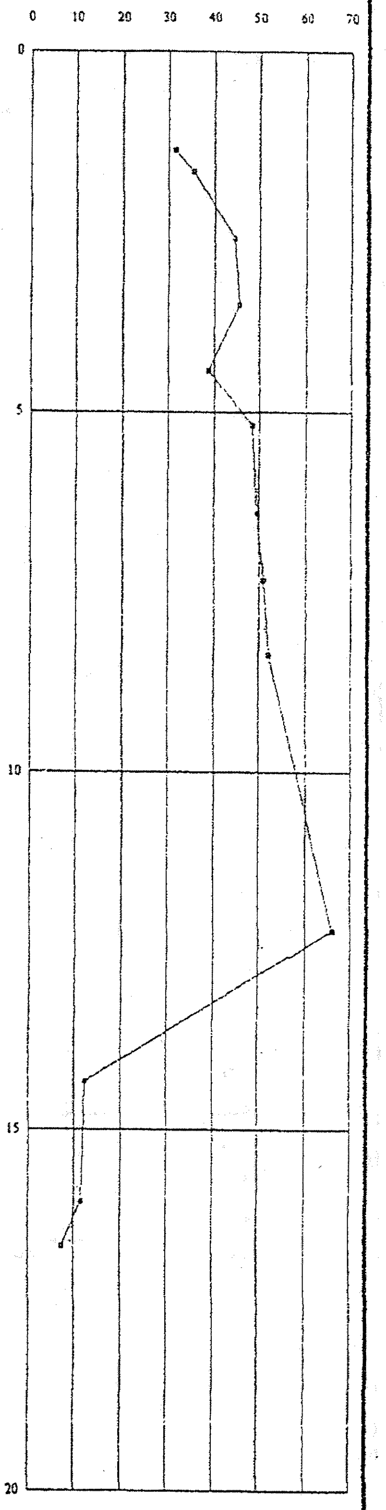


FIGURE 2

DYREGROV CONSULTANTS	Logged / Dwn. : TH Checked: AOD	Test Hole No. 2	Project No. 981754

PROJECT: SEWPCC DISINFECTION BUILDING
CLIENT: REID CROWTHER & PARTNERS LTD.
DATE OF INVEST. January 29, 1998
DRILL: Subterranean 400 mm auger

SAMPLE NO.	DEPTH (m)	ELEV. (m)	SYM	SOIL DESCRIPTION	
	0.00	231.91			
	0.50	231.41		0.00-2.90 FILL CLAY WITH A MIXTURE OF SILT, SOME GRANULAR, SOME TOPSOIL	
	1.00	230.91			
	1.50	230.41			
	2.00	229.91			
	2.50	229.41			
	3.00	228.91		2.90-13.11 CLAY BROWN, STIFF, SOME SILT TRACE OF SULPHATES (+)	Qu-53 kPa Pp-129 kPa Tv-89 kPa W -16.88 Kn/M
	3.50	228.41			
	4.00	227.91			
	4.50	227.41			
	5.00	226.91		TILL INCLUSIONS , SILT, BECOMING LARGER WITH DEPTH AND MORE FREQUENT STIFF TO FIRM	
	5.50	226.41			
	6.00	225.91			
	6.50	225.41		TRANSITION TO GREY CLAY TILL INCLUSIONS FIRM	
	7.00	224.91			
	7.50	224.41			
	8.00	223.91			
	8.50	223.41			
	9.00	222.91			
	9.50	222.41		CLAY BECOMING FIRM TO MED	
	10.00	221.91			
	10.50	221.41			
	11.00	220.91			
	11.50	220.41			
	12.00	219.91			
	12.50	219.41			
	13.00	218.91		13.11-16.31 TILL	
	13.50	218.41		SILTY, SOME GRANULAR, SOME STONES SOFT, TRACE OF CLAY	
	14.00	217.91			
	14.50	217.41			
	15.00	216.91			
	15.50	216.41		BECOMING MORE DENSE WITH DEPTH	
	16.00	215.91			
	16.50	215.41		END OF TEST HOLE AT 16.31 IN DENSE TILL	
	17.00	214.91			

MOISTURE CONTENT (%)

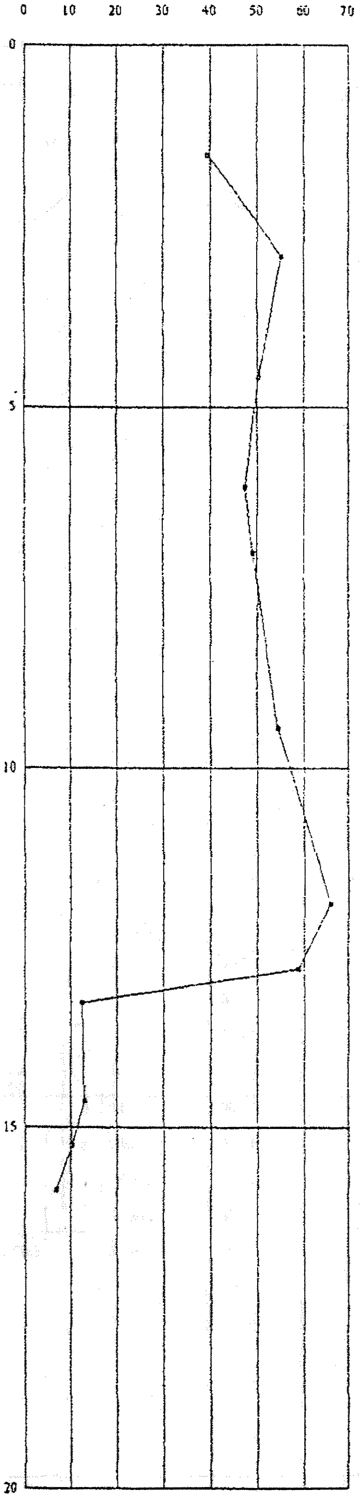
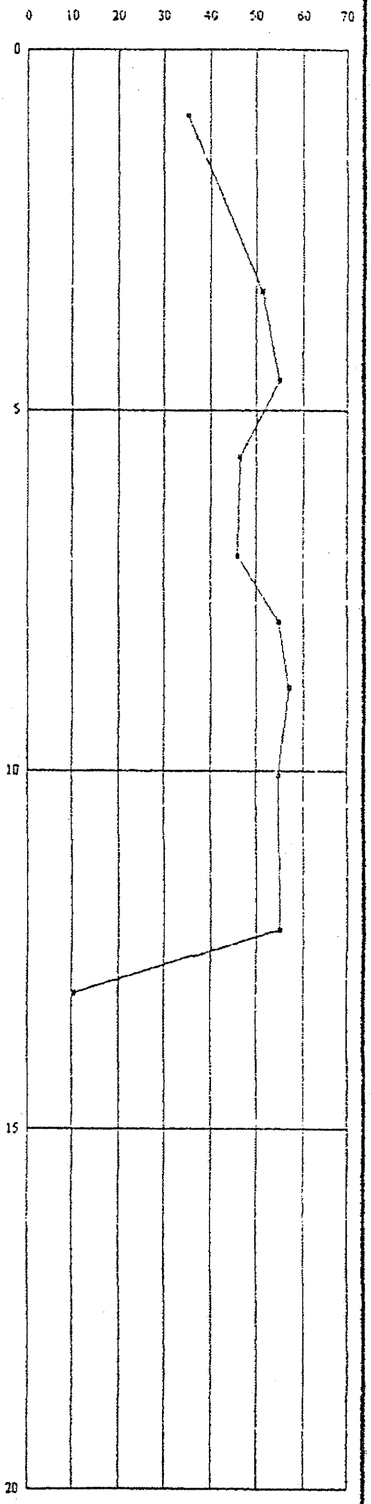


FIGURE 3

DYREGROV CONSULTANTS	Logged / Dwn. : TH Checked: AOD	Test Hole No. 3	Project No. 981754
PROJECT:	SEWPCC DISINFECTION BUILDING	DATE OF INVEST.	January 29, 1998
CLIENT:	REID CROWTHER & PARTNERS LTD.	DRILL:	Subterranean 400 mm auger

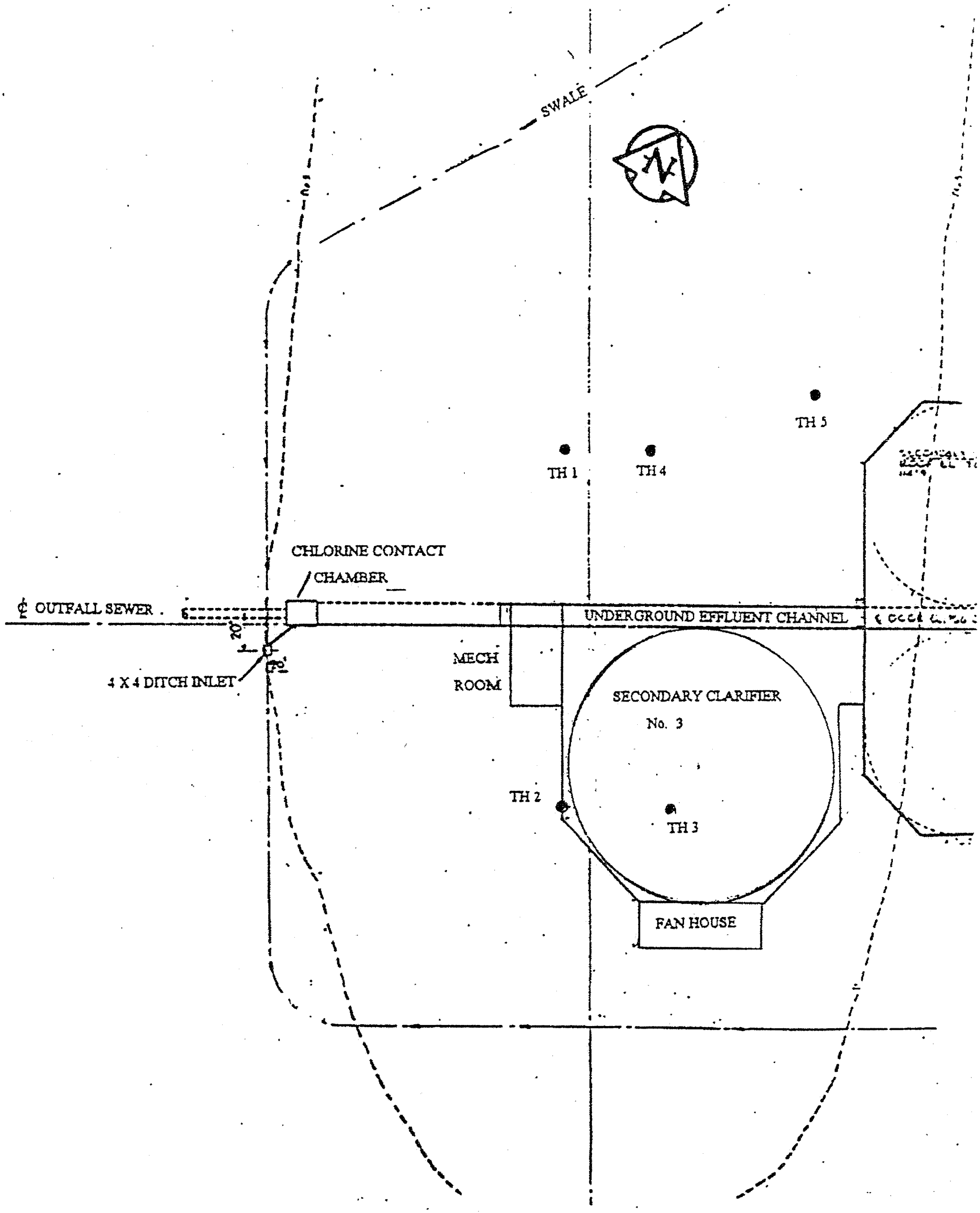
SAMPLE NO.	DEPTH (m)	ELEV. (m)	SYM	SOIL DESCRIPTION
	0.00	232.09		0.00-0.25 TOPSOIL
	0.50	231.59		0.25-1.22 CLAY BLACK TO BROWN, SOME SILT, FROZE
	1.00	231.09		1.22-1.45 SILT
	1.50	230.59		TAN, DAMP TO WET, SLOUGHING 1.45-13.11 CLAY
	2.00	230.09		BROWN,STIFF, SOME SILT TRACE OF SULPHATES
	2.50	229.59		
	3.00	229.09		
	3.50	228.59		
	4.00	228.09		LAYERING OF GREY AND BROWN CLAY STIFF, SOME SILT
	4.50	227.59		
	5.00	227.09		
	5.50	226.59		Qu-254 kPa Pp-163 kPa Tv-73 kPa W-17.26 Kn/M
	6.00	226.09		
	6.50	225.59		
	7.00	225.09		
	7.50	224.59		TRANSITION TO GREY CLAY TRACE (+) TILL INCLUSIONS, HIGH PLASTIC
	8.00	224.09		
	8.50	223.59		Qu-59 kPa Pp-124 kPa Tv-65 kPa W-18.48 Kn/M
	9.00	223.09		
	9.50	222.59		
	10.00	222.09		
	10.50	221.59		
	11.00	221.09		
	11.50	220.59		
	12.00	220.09		
	12.50	219.59		
	13.00	219.09		13.11-18.75 TILL
	13.50	218.59		SILT WITH SOME GRANULAR AND SAND SILT FIRM AT 13.2 AND BECAME SOFT BELOW
	14.00	218.09		NO SAMPLING BELOW 13.1 DUE TO SLOUGHING AUGER WAS SCREWED TO REFUSAL AT 18.75
	14.50	217.59		BELOW GROUND SURFACE
	15.00	217.09		
	15.50	216.59		
	16.00	216.09		
	16.50	215.59		
	17.00	215.09		
	17.50	214.59		
	18.00	214.09		
	18.50	213.59		
	19.00	213.09		END OF TEST HOLE AT 18.75 IN DENSE TO VERY DENSE TILL

MOISTURE CONTENT (%)



NOTE: WATER AT 7.5 BELOW SURFACE AFTER 20 MINUTES

FIGURE 4



DYREGROV CONSULTANTS

CONSULTING GEOTECHNICAL ENGINEERS

CONTROL CENTRE
SITE PLAN

SCALE NTS	DATE 12/02/98	MADE TH	CHKD AOD	JOB 981754	FIGURE 5

GEOTECHNICAL ENGINEERING REPORT
SOUTH END WATER POLLUTION CONTROL CENTRE

Prepared For

WARDROP ENGINEERING INC.

MACLAREN ENGINEERS INC.

On Behalf of

THE CITY OF WINNIPEG

April 15, 1988

Project No. 88528

1.0 INTRODUCTION

This report summarizes the results of a geotechnical investigation undertaken by Dyregrov and Burgess for the proposed expansion of the South End Water Pollution Control Centre. The work was done at the request of Wardrop Engineering Inc. and MacLaren Engineers Inc. as authorized in their letter of January 13, 1988. The work was done in accordance with our proposal of January 6, 1988.

2.0 DESCRIPTION OF THE FIELDWORK

A total of 12 boreholes were put down within the period of February 29 to March 8, 1988 at the locations shown in Figures 1 and 2. Truck mounted caisson drilling equipment (LDH 80) was supplied by Subterranean (Manitoba) Ltd. Eighteen inch diameter augers were used and all borings were taken to auger refusal. The soil profile was examined, classified on a continuous basis as drilling progressed and sampled at regular depth intervals. Disturbed samples from auger cuttings and relatively undisturbed, three inch diameter Shelby tube samples were obtained for laboratory strength and moisture content testing.

Observations were made during drilling concerning groundwater, seepage and caving conditions within the boreholes and the effect these factors may have on foundation selection and design. Sealed standpipe piezometers were installed within the glacial till materials at boreholes 1, 6 and 11.

All boreholes were backfilled on completion and ground elevations were referenced to the benchmark indicated in Drawing No. 1.

3.0 THE SOIL PROFILE

A thick deposit of highly plastic Agassiz clay is the predominant component of the soil profile and extends from about the ground surface to depths varying from 42 to 50 feet. The average thickness is 45 feet. The clay is common to the Winnipeg area and can be described as firm to stiff in terms of its relative consistency. Moisture contents are typically within the range of 40 to 60 percent and are relatively uniform with depth. Moisture depletion appears to be restricted to about the upper 10 feet of the soil profile. Plastic and liquid limits for the clays are typically 30 and 100 percent, respectively, and liquidity indices at this location are estimated to be in the range of 0.3 to 0.4. It should be noted that specific tests were not undertaken for the determination of the above index properties.

Undrained shear strengths were determined from unconfined compression, pocket penetrometer and Torvane tests in the laboratory. The results are shown in Plate 15. The lower strengths from unconfined compression tests within about the upper 12 feet of the profile are probably related to fissuring that has accompanied periodic moisture depletion within these depths.

The clays are underlain by glacial silt till which is a mixture of sand, gravel and boulder sized materials within a predominantly silt matrix. The relative density of the till has been evaluated on the basis of its moisture content and a visual examination of the auger cuttings. The depths at which the till can be described as loose, medium dense, dense and very dense are noted on the logs. Penetration tests for density evaluation in the till are not representative, because of boulders, for which reason these were not done. The elevation of the till surface varies from about 713 to 720. The average elevation is 717.6. The till is typically loose or soft near its surface and it becomes progressively more dense with depth. This is not always the case, however, and stronger layers are often underlain by weaker ones.

Of primary intest to the design of driven piles are the depths to power auger refusal across the site and these are summarized below:

Hole No.	Ground Elev.	Depth to Refusal (ft.)	Refusal Elev.
1	762.2	59	703.2
2	763.1	67	696.1
3	763.3	63	700.3
4	764.2	62.5	701.7
5	763.4	63.5	699.9
6	762.1	63	699.1
7	762.9	66	696.9
8	764.8	68	696.8
9	763.4	64.5	698.9
10	762.9	66.5	696.4
11	762.8	64	698.8
12	762.6	66	696.6

The mean auger refusal elevation is 698.7. Refusal occurred on boulders within the till in most cases and possibly on bedrock at boreholes 7 to 12. Refusal on bedrock at these locations was suspected primarily on the basis of drill performance and the rapid inflow of groundwater, however, coring was not done and the depth to bedrock was not confirmed.

A detailed description of the soil profile and the results of field and laboratory testing are summarized on the borehole logs, Plates 3 to 14.

4.0 GROUNDWATER CONDITIONS

The groundwater regime at the site consists essentially of groundwater perched within the relatively pervious silt strata that are within the top

10 feet of the soil profile, a nearly hydrostatic condition within the clays and a subartesian condition within the underlying glacial till and bedrock. Groundwater conditions within the upper silt deposits are likely to vary over short horizontal distances, to the extent that the deposits amount to pervious strata that vary in thickness and are not contiguous across the site. Piezometric pressures within the glacial till originate in the underlying bedrock, which is the carbonate aquifer that is common to Winnipeg, and these are the most relevant to the construction of relatively deep or large excavations. Standpipe piezometers were sealed in glacial till at depths of 47, 45 and 55 feet from grade at borings 1, 6 and 11 respectively. These were installed to determine the elevation of the piezometric surface of the till and bedrock. The water table within the piezometers at borings 1, 6 and 11 was at elevations 732.7, 756.1 and 732.8 respectively on March 16, 1988, some two weeks after drilling. The piezometric elevations of 732.7 and 732.8 are considered representative of the head in the till and bedrock. The piezometer at borehole 6 is not completely sealed and is considered to be recording the water table within the upper silt deposits which is probably high, temporarily, because of flooding of the area that occurred this winter (water main break).

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Foundations

Conditions are best suited to the use of prestressed, precast concrete piles that are driven to refusal. We understand that this has been the primary type of foundation system for the existing plant. The variable condition of the glacial till and the potential for problems related to water seepage and bell instability are factors that render the site unsuitable for the widespread use of high capacity caissons and this foundation type is not recommended. Precast concrete piles can be assigned capacities of 60, 85 and 110 tons for 12, 14 and 16 inch diameter sizes respectively. The piles must be driven with a diesel hammer rated at 30,000 foot-pounds or more. Link Belt 520 and Delmag D22 hammers are used routinely within Winnipeg and these are rated at 30,000 and 39,000 foot-pounds respectively. Practical refusal can be defined as final penetration resistance values of 5, 8 and 12 blows per inch for 12, 14 and 16 inch pile diameters respectively, for piles driven with a Link Belt 520 hammer. Final penetration resistance can be reduced to 4, 7 and 10 blows per inch for 12, 14 and 16 inch pile sizes driven with a Delmag D22 hammer. Preboring should be done at all pile locations, to minimize heave and vibration and to enhance pile plumbness. All piles in groups must be restruck, to counter the effects of heave, and pile spacing should not be closer than 2.5 diameters, centre to centre. In view of the large number of piles that will be required and the potential for ground heave under these circumstances, heave should be monitored, at least at the start of construction, to determine that this behaviour is counteracted. Precast, prestressed concrete piles driven to practical refusal will derive virtually all of their capacity from end-bearing and no reduction in individual pile capacity within groups is necessary for reasons related to group action. A pile concrete age of at least one week should be specified and piles in large groups or those concentrated within a relatively small area should be driven progressively outwards from the centre.

The depth to power auger refusal varied from about 59 to 68 feet.

This variation is likely to be consistent with the variation in the depth to practical refusal that may occur during pile driving.

Lightly loaded structures can be supported on cast-in-place concrete friction piles and these can be designed on the basis of an allowable skin friction of 400 psf. This value is applicable to piles in compression or tension. The top 5 and 10 feet of pile shaft should be ignored for interior and exterior piles respectively. A minimum pile diameter of 16 inches should be specified. Piles subject to frost action or uplift should contain full depth reinforcing and a minimum length of 20 feet should be specified in these cases, regardless of design loads. Temporary casing should be used on an as-required basis, to prevent caving and seepage into the pile borings. Casing was not required at the time of the test drilling but this condition may not apply at the time of construction. A mixture of friction piles and precast concrete piles is not recommended for the support of important structures, not do we recommend the use of groups of friction piles for large loads.

5.2 Excavations

Excavations will be required for the proposed primary clarifiers, aeration tanks and secondary clarifiers. These are expected to not exceed depths of about 20 feet at the primary clarifiers and aeration tanks and 25 feet at the secondary clarifiers. The piezometric surface within the glacial till and bedrock is nominally 30 feet below average grade at the site and this determines that the factor of safety against bottom heave is at least 2.5 for a 25 foot excavation. An allowance for a ten foot increase in the head in the till reduces the safety factor to about 2.0 and this also is satisfactory.

For the most part, it is expected that the excavations can be open cut. An average undrained shear strength of about 920 psf is required for a safety factor of 2.0 against slope instability for the case of a 25 foot cut with 2:1 side slopes, on the basis of a total stress analysis. This is a minimum safety factor for this condition and we recommend that cut slopes not be steeper than 2:1 (H:V) for excavations that are 20 feet deep or greater. Sloughing and seepage from the upper silt strata may occur, depending on environmental conditions at the time of construction. Sloughing of the silt should be expected during wet periods but it should be of a localized nature and of little significance to construction. Seepage from the clays will be insignificant. Particular care should be paid to excavation slopes where the new excavations will encroach upon or expose the existing structures. The transition in slopes in these areas must ensure that instability is prevented. Significant slides could adversely affect the existing structures or their foundations.

Temporary shoring may be necessary where the excavations will encroach on structures that have to be protected. The shoring can be designed on the basis of the earth pressure distribution shown in Plate 16. Cantilevered shoring can be employed for vertical cuts that are limited to about 13 feet. Bracing or a combination of sloped and shored cuts is necessary for cuts in excess of 13 feet.

5.3 Other

Basement, tank and rigid retaining walls should be designed to resist earth pressures equal to full hydrostatic pressure (equivalent fluid density of 62.4 pcf). This applies to walls that are drained. Where drainage is not provided, the equivalent fluid density should be increased to 93 pcf. The water table for undrained walls and for buoyancy/uplift calculations should be assumed to be at the ground surface. An allowance for surface live load should be included if significant load is applied within a distance from the wall equal to the height of the wall. The lateral pressure due to live load should be presumed equal to 50 percent of the vertical pressure due to the live load.

The clarifiers and aeration tanks should have structurally supported floors and these should be isolated from the underlying subgrade by a 12 inch void. We presume that these structures are not provided with underdrainage and that water can collect below them. This is conducive to swelling and a generous allowance for this is recommended. A smaller void can be used if it can be justified on the basis of experience with the existing clarifiers and aeration tanks.

The on-site clays are suitable for backfill purposes. The backfill should be free of topsoil and organic materials. The silt soils can be used as backfill provided they are mixed with the clays. The backfill should be compacted in thin lifts to at least 95 percent of Standard Proctor maximum dry density at moisture contents that are within 2 percent of optimum.

All concrete in contact with the soils at this location should be made with sulphate resistant cement.

5.4 Field Inspection

The potential for problems related to ground heave are significant for this project, assuming that a large number of piles will be driven within relatively confined areas. In addition, the piling is likely to penetrate most of the till deposit. These factors are conducive to heave and it may be necessary to prebore to greater depths than usual or to adopt other measures to counter this problem if it develops. Conditions at this location are amenable to the use of pile capacities that are higher than historical values and we have recommended the use of allowable loads that exceed the historical by about 20 percent. It is essential that the interpretation of practical refusal during pile driving be consistent with good engineering practice and it is important that extra attention be paid to this aspect of the work. Primarily for these reasons we would suggest that the requirement for inspection by geotechnical personnel is pronounced. We recommend that the pile driving be done under the full time inspection of the geotechnical consultant.

Respectfully submitted,

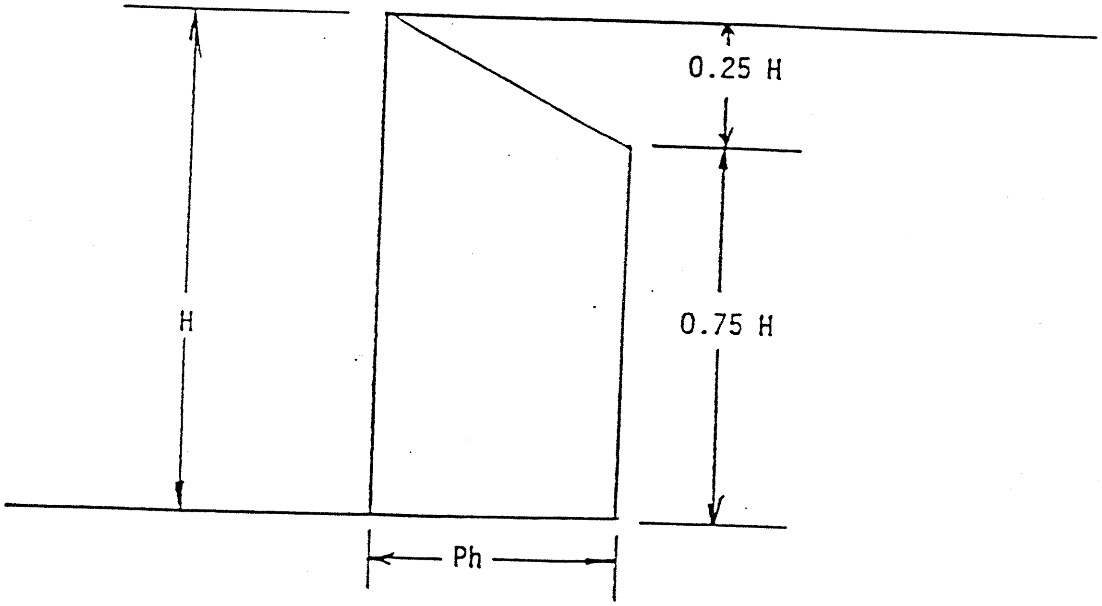
DYREGROV & BURGESS

Per: NCBurgess

N.C. Burgess, P.Eng.

PROVINCE OF MANITOBA
N. C.
BURGESS
REGISTERED PROFESSIONAL ENGINEER

NCB/pf



$Ph = 0.4 \gamma H$

Where: Ph = Lateral earth pressure on shoring (psf)

γ = Soil unit weight (110 pcf)

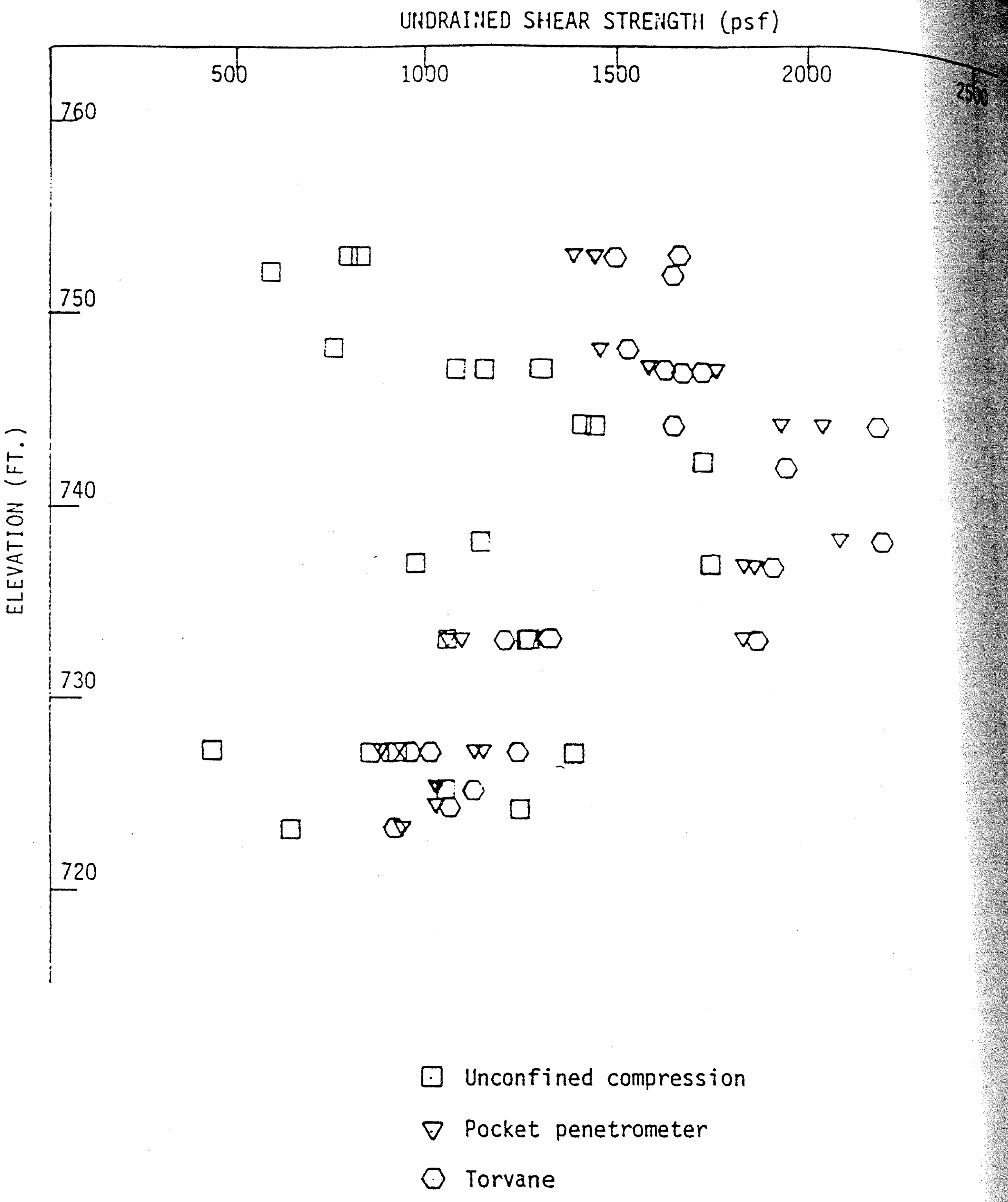
H = Wall height (ft.)

Note: Add surface load surcharge where applicable

DYREGROV & BURGESS
CONSULTING GEOTECHNICAL ENGINEERS

EARTH PRESSURES, TEMPORARY SHORING

CALE NTS
DATE
MADE
CHKD
JOB 88528
FIGURE 16



DYREGROV & BURGESS
CONSULTING GEOTECHNICAL ENGINEERS

SHEAR STRENGTH DATA

SCALE
DATE
MADE
CHKD
JOB 88528
FIGURE 15

YREGROV & BURGESS

BOREHOLE LOG

PROJECT: South End Water Pollution Control Centre

GED/DWN. SDG

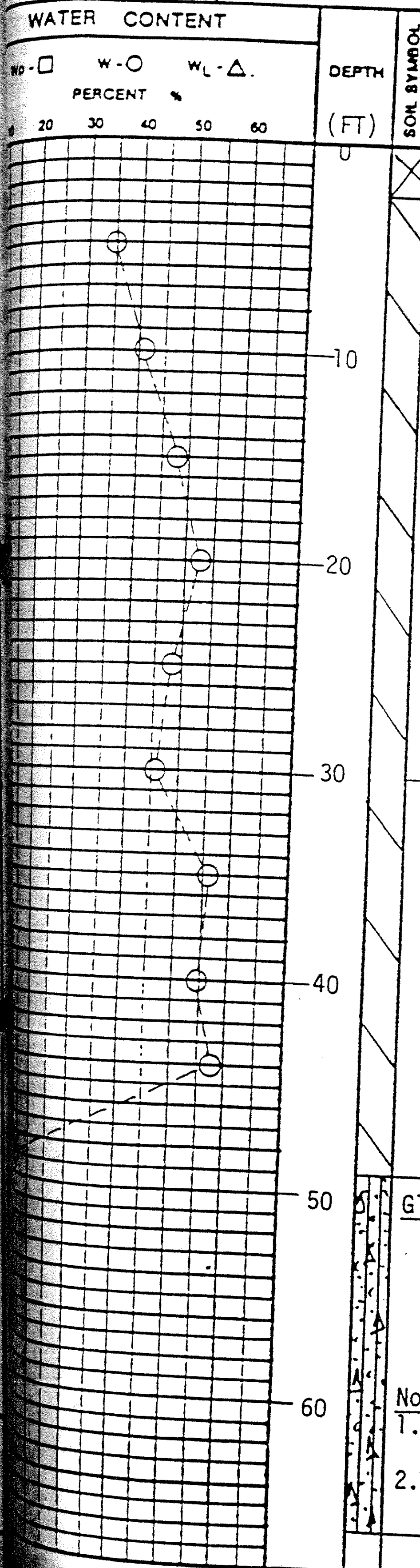
CKD. NCB

DATE OF INVEST. 8/03/88

JOB NO. 88528

HOLE NO. 12

DRILL TYPE: 18" Auger



SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 762.59'

SOIL DESCRIPTION	CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
Fill -gravel, clay, concrete				
Clay -mottled brown -highly plastic -stiff to firm				
		U		qu=1180psf γ_W=106.9pcf pp=3200psf Tv=1640psf
--- grey				
		U		qu=2390psf γ_W=110.5pcf pp=3080psf Tv=1570psf
Glacial Till -silty, sandy, gravelly -tan, soft to medium dense -dense at 55' -very sandy at 56' -seepage at 56'				

Notes:

1. Auger refusal at 66' on probable bedrock.
2. Hole open to 48' upon completion

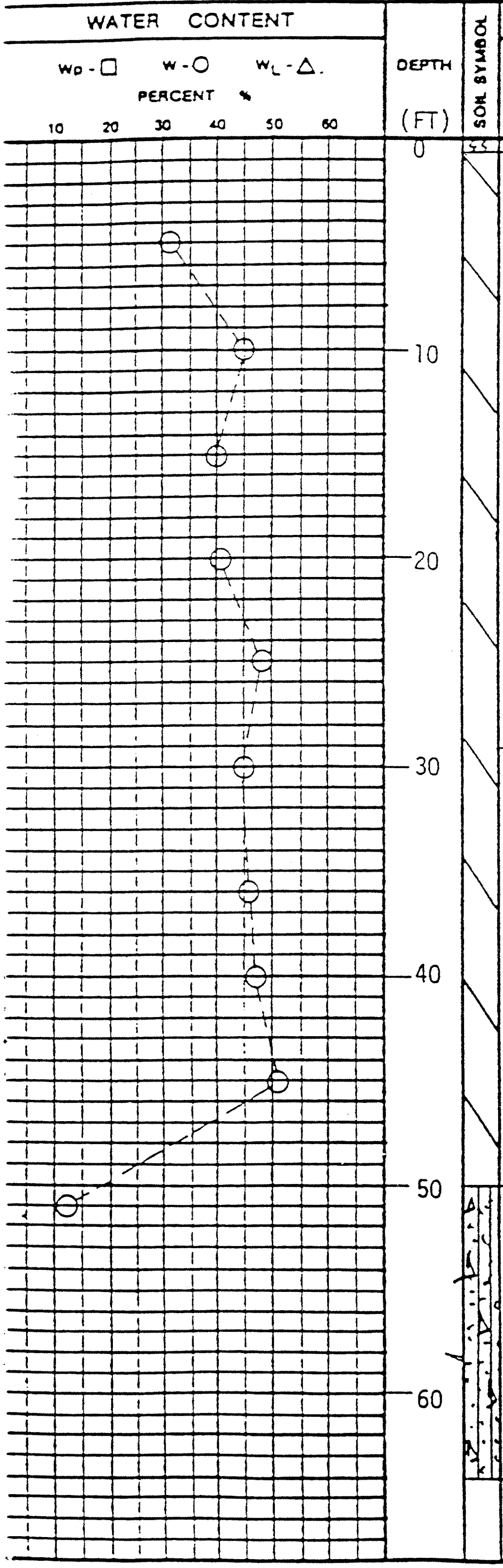
Plate 14

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

LOGGED/DWN. SDG
CKD. NCB
DATE OF INVEST. 8/03/88
JOB NO. 88528
HOLE NO. 11
DRILL TYPE 18" Auger



SOIL DESCRIPTION

DATUM
SURFACE ELEVATION 762.81'

Topsoil -black

Clay -mottled brown
-highly plastic
-stiff to firm
-gypsum inclusions

---grey

712.8 Refusal Elev. 700.3

Glacial Till
-silty, sandy, gravelly
-tan, saturated, soft
-seepage at 52'
-bouldery at 54'
-dense from 54 to 56'

Notes:
1. Auger refusal at 64' on probable bedrock.
2. Hole open to 45' upon completion of drilling.
3. Placed sealed standpipe at 55'.

SOIL SAMPLE

CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
	U		qu=3435psf γ_W=110.0pcf pp=4880psf Tv=1940psf
	U		qu=1835psf γ_W=113.2pcf pp=1760psf Tv=1000psf

Notes: (Cont'd)
4. Water level at 30' from grade on March 16/88.

Plate 13

1 Centre

OLE NO. 11

DRILL TYPE

18" Auger

OTHER TESTS

ju=3435psf
'w=110.0pcf
pp=4880psf
Tv=1940psf

qu=1835psf
γ_w=113.2pcf
pp=1760psf
Tv=1000psf

lotes:(Cont'd
!.Water level
it 30' from
grade on
March 16/88.

Plate 13

REGROV & BURGESS

BOREHOLE LOG

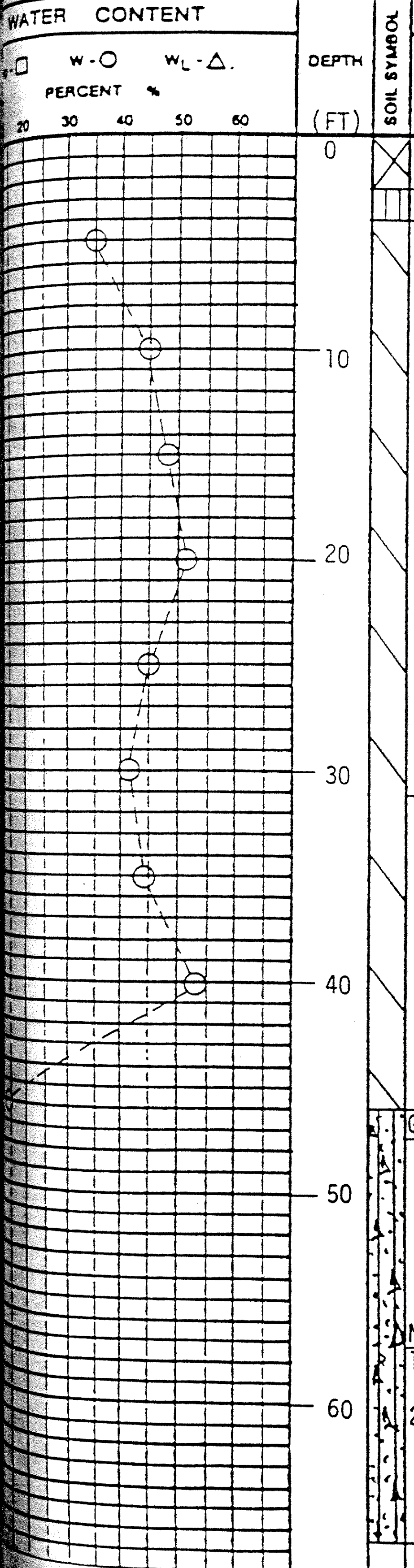
PROJECT South End Water Pollution Control Centre

DWN.	SDG	CKD.	NCB	DATE OF INVEST.	8/03/88	JOB NO.	88528	HOLE NO.	10

DRILL TYPE: 18" Auger

DATUM

SURFACE ELEVATION 762.94'



SOIL DESCRIPTION	SOIL SAMPLE CONDITION	TYPE	PENETRATION RESISTANCE	OTHER TESTS
Fill -gravel, some clay				
Silt -tan, moist				
Clay -mottled brown -highly plastic -stiff to firm				
	▨	U		qu=2595psf γ_w=108.7pcf pp=3500psf Tv=1650psf
---grey				
	▨	U		qu=2750psf γ_w=108.9pcf pp=2240psf Tv=950psf
Glacial Till -silty, sandy, gravelly -tan, saturated, soft -seepage at 52' -dense from 55 to 58' -medium dense below 58'				

Notes:
1. Auger refusal at 66.5' on probable bedrock.
2. Water at 39' from grade upon completion of drilling.

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

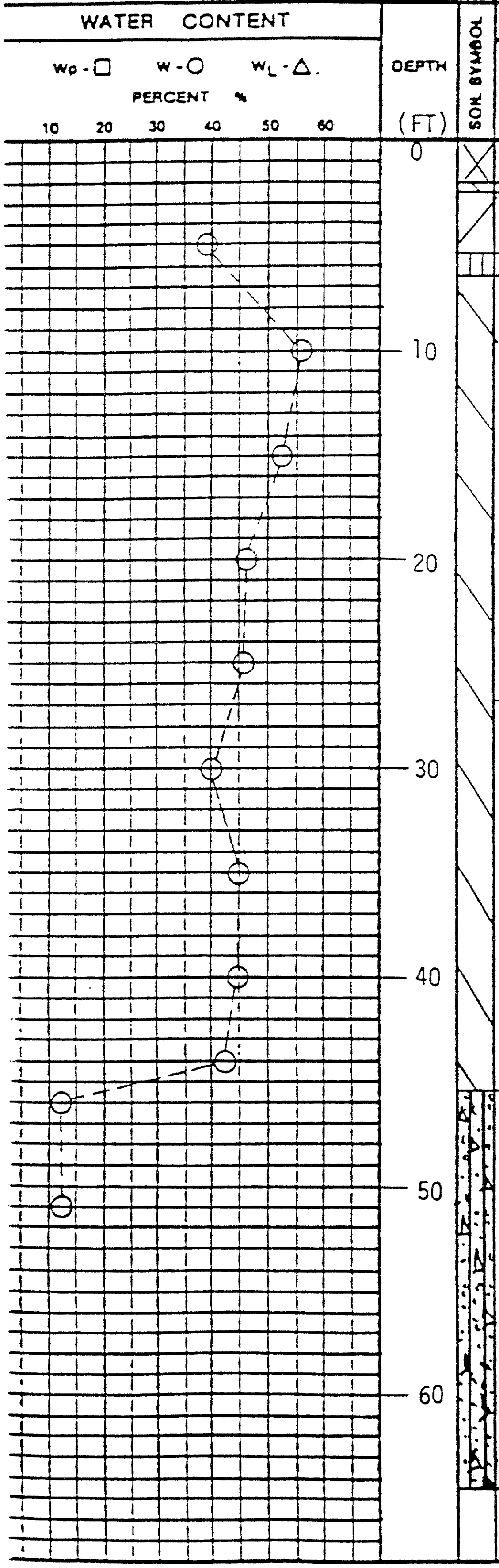
LOGGED/DWN.	SDG	CKD.	NCB	DATE OF INVEST.	2/03/88	JOB NO.	88528

HOLE NO. 9

DRILL TYPE 18" Auger

DATUM

SURFACE ELEVATION 763.38'



SOIL DESCRIPTION

Fill -clay, silt, trace gravel

Clay -black

Clay -silty
-brown

Silt -tan, moist

Clay -mottled brown
-highly plastic
-stiff to firm

--- grey

Glacial Till
-sitly, sandy, gravelly
-tan, clayey to 48'
-saturated, soft, cobbly
-slight seepage at 54'
-bouldery below 56'
dense from 56 to 58'
-medium dense below 58'

Notes:
1. Auger refusal at 64.5' in broken bedrock.
2. Water level at 43 and hole open to 44' upon completion.

SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE

Depth (ft)	Type	Other Tests
~11	U	qu=1620psf γ_W=105.8pcf pp=2785psf Tv=1490psf
~31	U	qu=2525psf γ_W=108.0pcf pp=3640psf Tv=1860psf

OTHER TESTS

Plate 11

Centre

NO. 9

DRILL TYPE

3" Auger

THER TESTS

=1620psf
=105.8pcf

=2785psf
=1490psf

=2525psf
=108.0pcf

=3640psf
=1860psf

Plate 11

YREGROV & BURGESS

BOREHOLE LOG

PROJECT

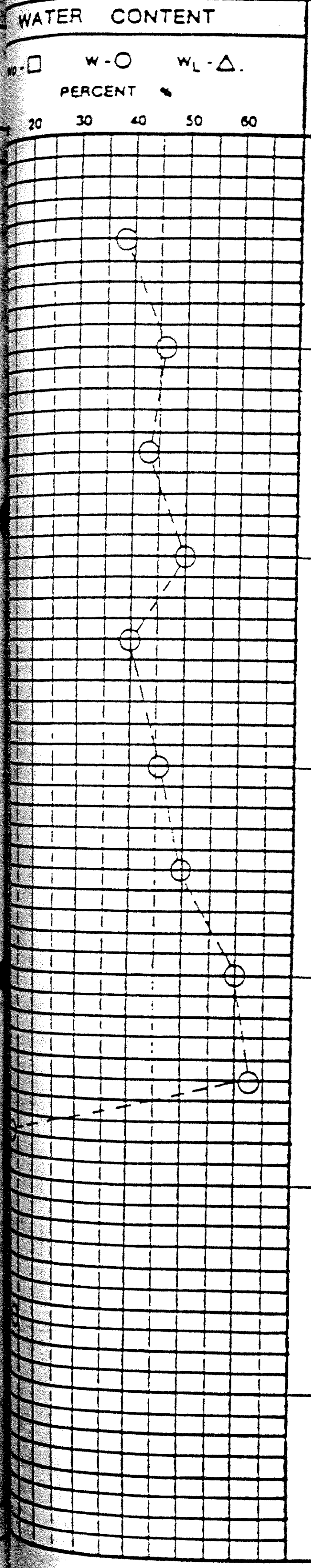
South End Water Pollution Control Centre

/DWN.	SDG	CKD.	NCB	DATE OF INVEST.	1/03/88	JOB NO.	88528	HOLE NO.	8

DRILL TYPE: 18" Auger

DATUM

SURFACE ELEVATION 764.81'



DEPTH (FT)	SOIL DESCRIPTION	SOIL SAMPLE TYPE	OTHER TESTS
0	Fill -clay, trace gravel		
	Clay -mottled brown -highly plastic -stiff to firm		
10			
20		U	qu=2795psf γ_w=110.0pcf pp=4265psf Tv>2000psf
	--- grey		
30			
40		U	qu=2500psf γ_w=103.8pcf pp=2025psf Tv=1050psf
	Glacial Till -silty, sandy, gravelly -tan, soft to medium dense -cobbly -dense at 54' -very sandy below 55' -bouldery at 56' -slight seepage at 57'		
50			
60			

Notes:
1. Auger refusal at 68' on bedrock.
2. Slight seepage. No measurable amount of water.

Plate 10

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

LOGGED/DWN. SDG

CKD. NCB

DATE OF INVEST. 1/03/88

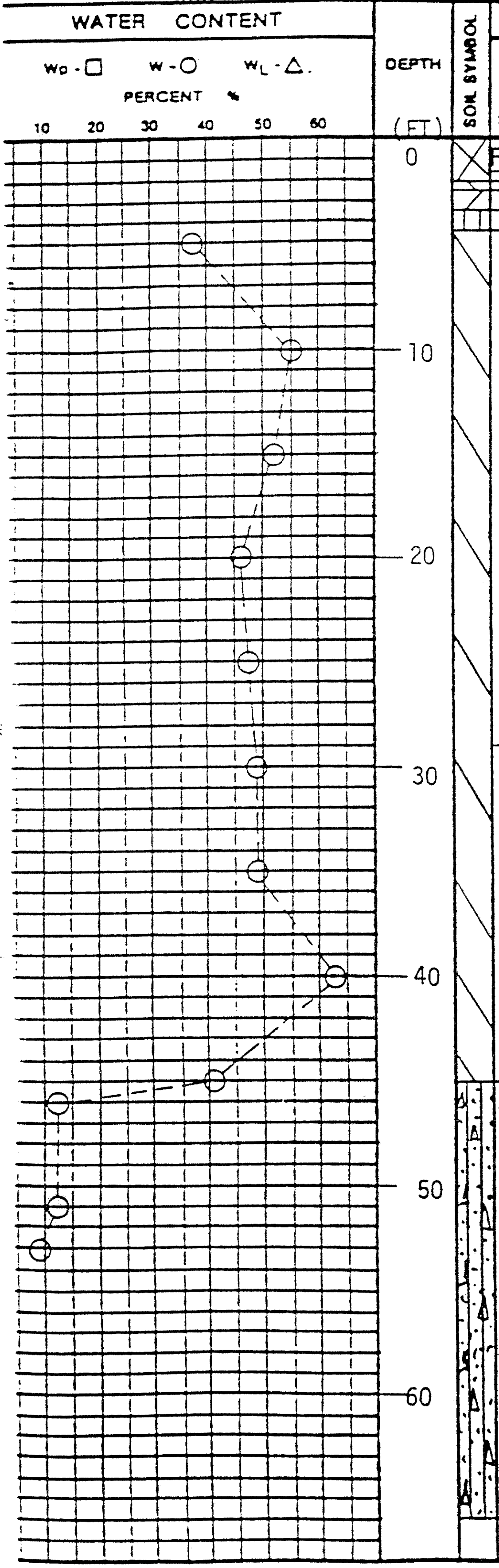
JOB NO. 88528

HOLE NO. 7

DRILL TYPE 18" Auger

DATUM

SURFACE ELEVATION 762.90'



SOIL DESCRIPTION

Fill -clay, some gravel, cobbly

Clay -black

Clay -silty, brown

Silt -tan, moist

Clay -mottled brown
-highly plastic
-stiff to firm

- - -grey

Glacial Till
-silty, sandy, gravelly
-tan, soft to medium dense
-bouldery
-very sandy at 53'
-dense at 53'
-seepage at 53'
-medium dense below 54'

Notes:
1.Auger refusal at 66' on possible bedrock.
2.Water level at 40' from grade upon completion of drilling.

SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE

U

U

OTHER TESTS

qu=2305psf
γ_w=106.7pcf
pp=3235psf
Tv=1720psf

qu=1935psf
γ_w=107.5pcf
pp=3700psf
Tv=1900psf

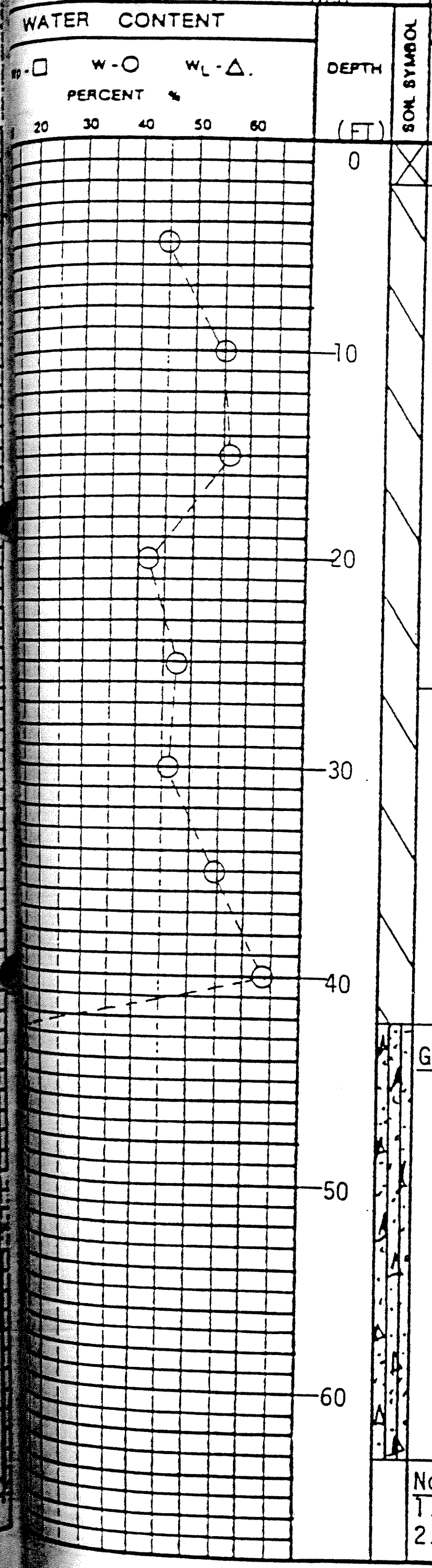
Plate 9

YREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

DRN./DWN. SDG
CKD. NCB
DATE OF INVEST. 1/03/88
JOB NO. 88528
HOLE NO. 6
DRILL TYPE 18" Auger
DATUM
SURFACE ELEVATION 762.06'



SOIL DESCRIPTION

SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE

OTHER TESTS

Fill -clay, some gravel

Clay -mottled brown
-highly plastic
-stiff to firm

--- grey

U
qu=3500psf
γ_W=112.8pcf
pp=3640psf
Tv=1870psf

U
qu=1700psf
γ_W=103.4pcf
pp=2300psf
Tv=1240psf

Glacial Till
-silty, sandy , gravelly
-tan, soft
-wet to saturated
-medium dense at 51'
dense and bouldery at 52'
-slight seepage upon drilling to 54'
-medium dense below 55'

Notes: (Cont'd)
3.Installed sealed stand-pipe at 45'.
4.Water level at 6' from grade on Marc 16/88.

Notes:
1.Auger refusal at 63'.
2.Water level at 50' from grade
~~upon completion of drilling.~~

Plate 8

---

ntre
7
TYPE
Auger
TESTS
305psf
06.7pcf
235psf
720psf
935psf
07.5pcf
700psf
900psf
ate 9

DYREGROV & BURGESS

BOREHOLE LOG

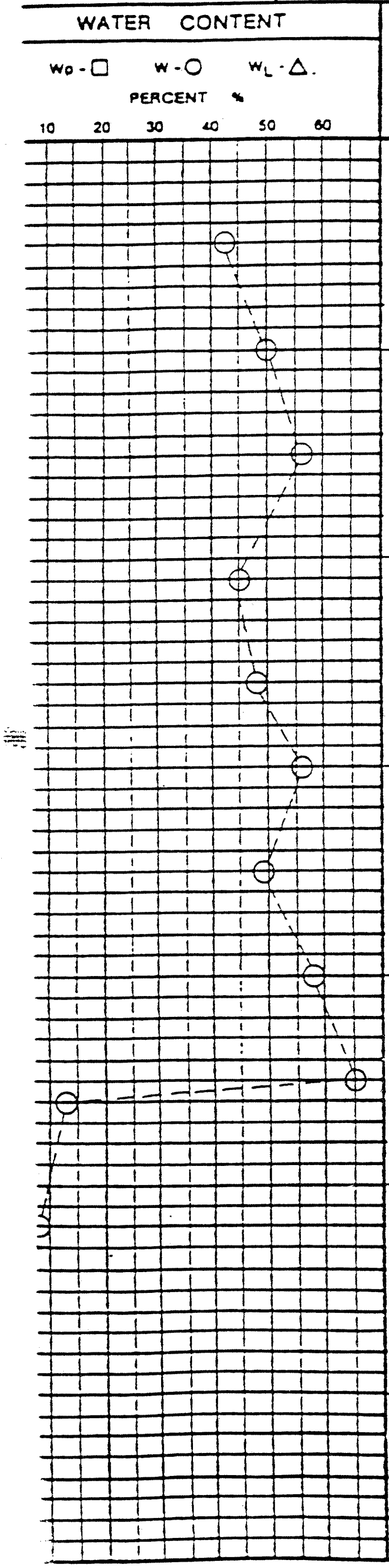
PROJECT
South End WAter Pollution Control Centre

GGED/DWN. SDG | CKD. NCB | DATE OF INVEST. 1/03/88 | JOB NO. 88528 | HOLE NO. 5

DRILL TYPE 18" Auger

DATUM

SURFACE ELEVATION 763.35'



DEPTH (FT): 0, 10, 20, 30, 40, 50, 60

SOIL SYMBOL

SOIL DESCRIPTION

Fill -clay
-trace gravel
-organic clay

Silt -tan, moist, trace sand

Clay -mottled brown
-highly plastic
-stiff to firm

SOIL SAMPLE — CONDITION, TYPE, PENETRATION RESISTANCE

U

OTHER TESTS
qu=1450psf
γ_W=104.6pcf
pp=2850psf
Tv=1510psf

--- grey

U

qu=2530psf
γ_W=109.2pcf
pp=2100psf
Tv=1200psf

Glacial Till
-silty, sandy gravelly
-tan, soft to medium dense
-dense at 52'
-very dense and bouldery at 53'
-slight seepage at 56'
-medium dense below 57'

Notes:

1. Auger refusal at 63.5'.
2. Water level at 42' upon completion of drilling.

Plate 7

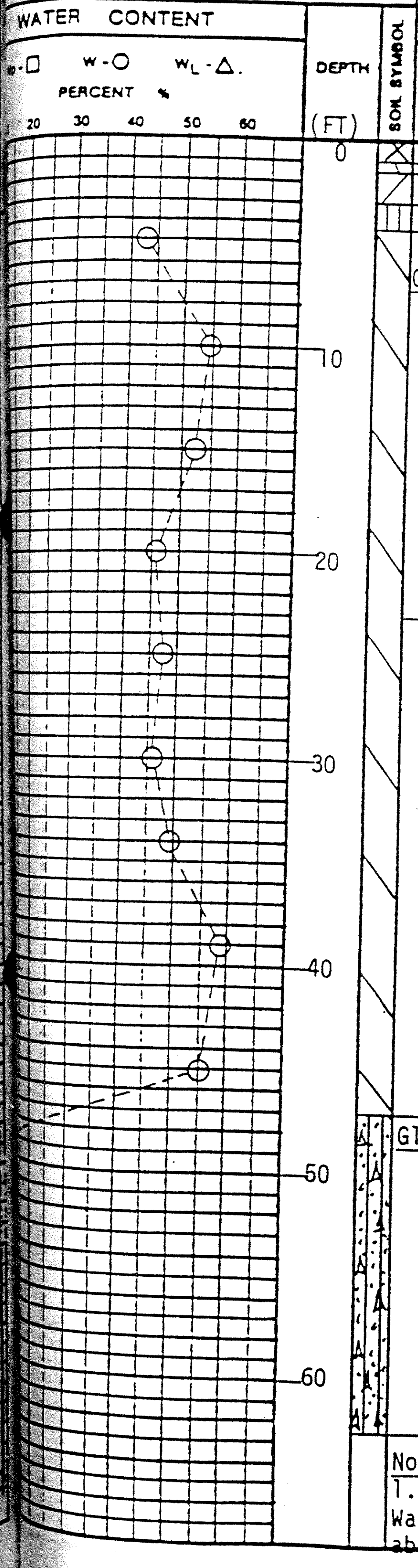
ntre
NO. 5
ILL TYPE
Auger
IER TESTS
450psf
04.6pcf
2850psf
1510psf
2530psf
109.2pcf
2100psf
1200psf
Plate 7

YREGROV & BURGESS

BOREHOLE LOG

PROJECT South End Water Pollution Control Centre

DRAWN. SDG
CKD. NCB
DATE OF INVEST. 1/03/88
JOB NO. 88528
HOLE NO. 4
DRILL TYPE 18" Auger



SOIL DESCRIPTION
SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE
OTHER TESTS

DATUM
SURFACE ELEVATION 764.18'

Fill -clay, trace gravel

Clay -black

Clay -silty, brown

Silt -tan, clayey, moist

Clay -mottled brown
-highly plastic
-stiff to firm

---grey

U
qu=2865psf
γ_w=109.9pcf
pp=3750psf
Tv=1640psf

U
qu=2080psf
γ_w=101.0pcf
pp=2050psf
Tv=1120psf

Glacial Till
-silty, sandy, gravelly
-tan, medium dense
-6" thick clay seams to 49'
-dense to very dense at 52'
-bouldery below 51'
-slight seepage upon drilling to 53'

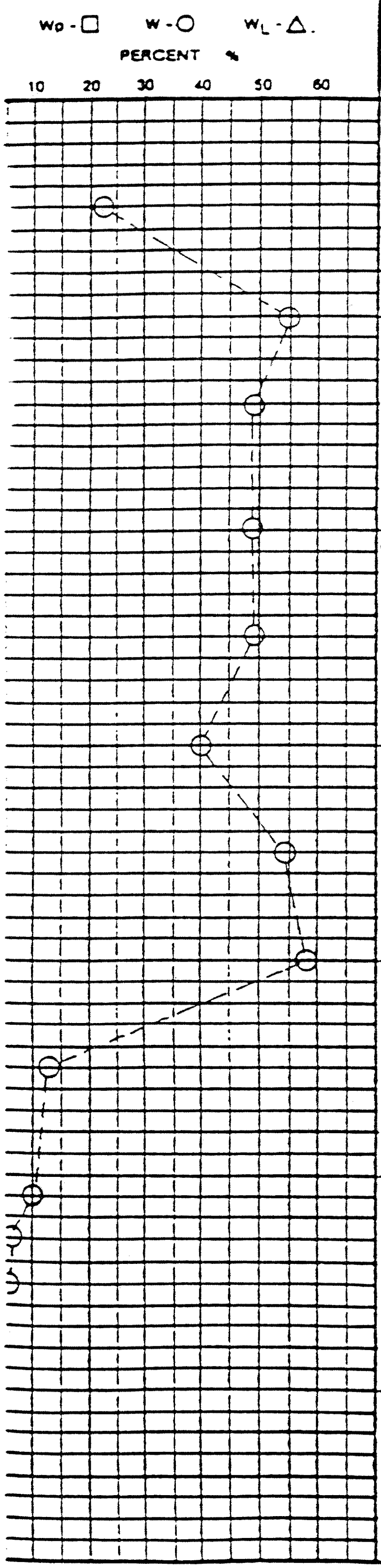
Notes:
1.Auger refusal at 62.5'
Water level at 44' from grade in about 5 minutes.

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT
South End Water Pollution Control Centre

OGGED/DWN. SDG
CKD. NCB
DATE OF INVEST. 29/02/88
JOB NO. 88528
HOLE NO. 3
DRILL TYPE 18" Auger



DEPTH (FT): 0, 10, 20, 30, 40, 50, 60

SOIL SYMBOL

SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 763.27'

Topsoil

Clay -silty, brown

Silt -tan
-moist, firm

Clay -mottled brown
-highly plastic
-stiff to firm

--- grey

Glacial Till
-silty, sandy, gravelly
-tan, soft
-dense to very dense at 52'
-bouldery below 54'
-medium dense below 56'

Notes:
1.Auger refusal at 63'.
2.Water level at 47' from grade in about 5 minutes.

SOIL SAMPLE: CONDITION, TYPE, PENETRATION RESISTANCE

OTHER TESTS

TYPE	OTHER TESTS
U	qu=1595psf γ_w=106.7pcf pp=2880psf Tv=1660psf
U	qu=2115psf γ_w=110.5pcf pp=2200psf Tv=1320psf

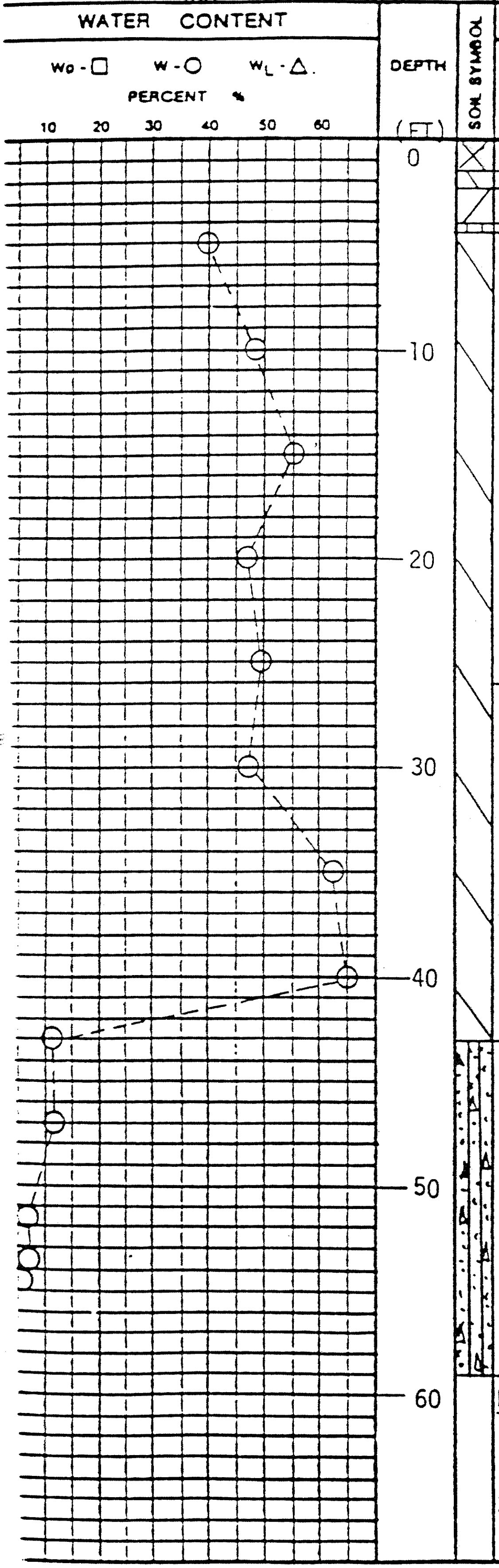
Plate 5

DYREGROV & BURGESS

BOREHOLE LOG

PROJECT
South End Water Pollution Control Centre

LOGGED/DWN. SDG
CKD. NCB
DATE OF INVEST. 29/02/88
JOB NO. 88528
HOLE NO. 1
DRILL TYPE 18" Auger



SOIL DESCRIPTION

DATUM

SURFACE ELEVATION 762.17'

Fill -clay, trace gravel

Clay -black

Clay -silty, brown

Silt -tan, moist

Clay -mottled brown
-highly plastic
-stiff to firm
-gypsum inclusions to 17'

--- grey

Glacial Till
-silty, sandy, gravelly
-tan, medium dense to soft
-wet to saturated
-cobbly and/or bouldery
-dense to very dense at 51'
-slight seepage at 56'
-medium dense below 56'

Notes:
1.Auger refusal at 59'.
2.Installed sealed standpipe at 47'.
Bottom 3' of standpipe slotted.
3.Water level at 29.5' from grade
on March 16/88.

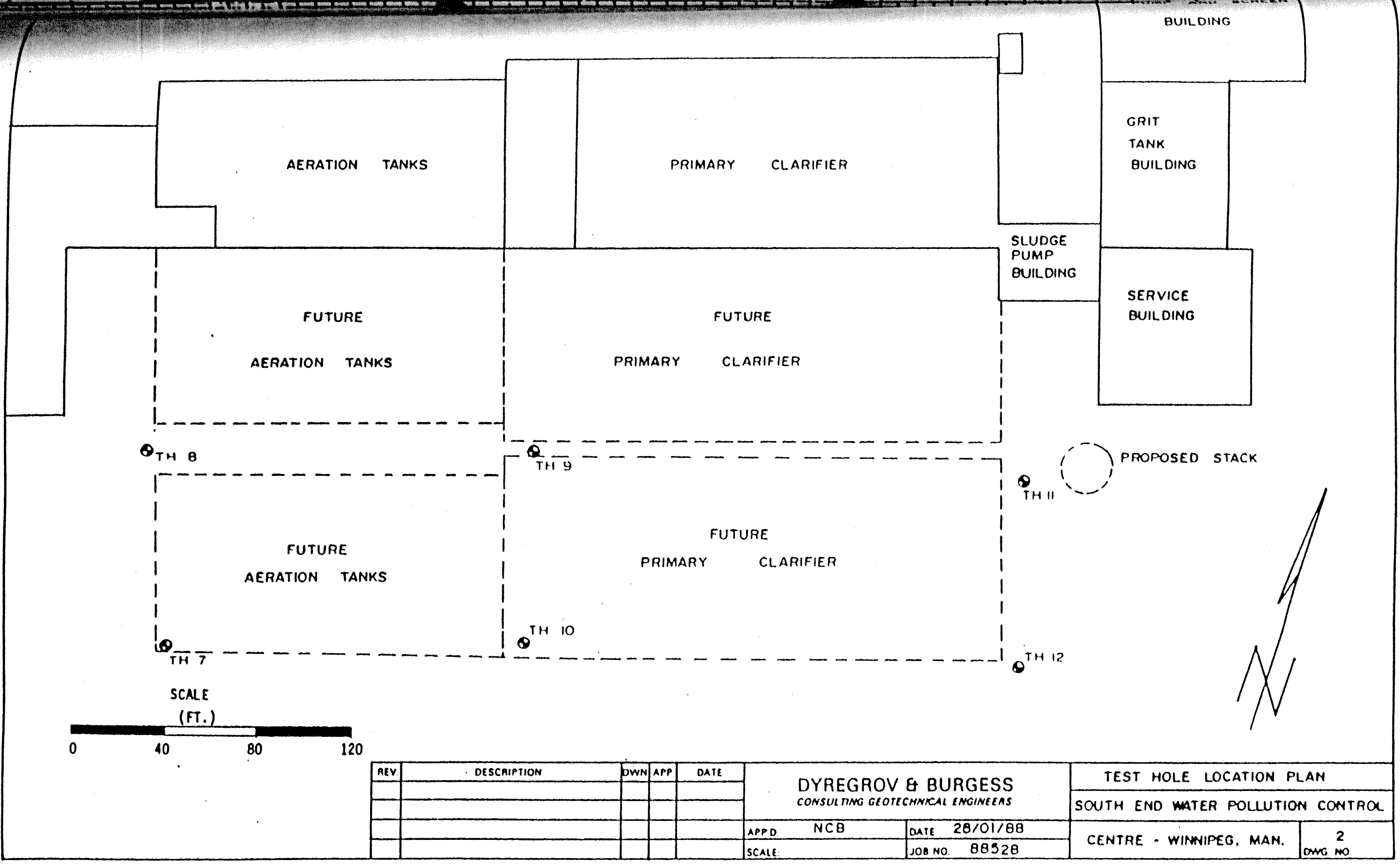
SOIL SAMPLE: CONDITION | TYPE | PENETRATION RESISTANCE

OTHER TESTS

U
qu=2170psf
γ_W=105.6pcf
pp=3165psf
Tv=1620psf

U
qu=855psf
γ_W=102.2pcf
pp=1750psf
Tv=890psf

Plate 3

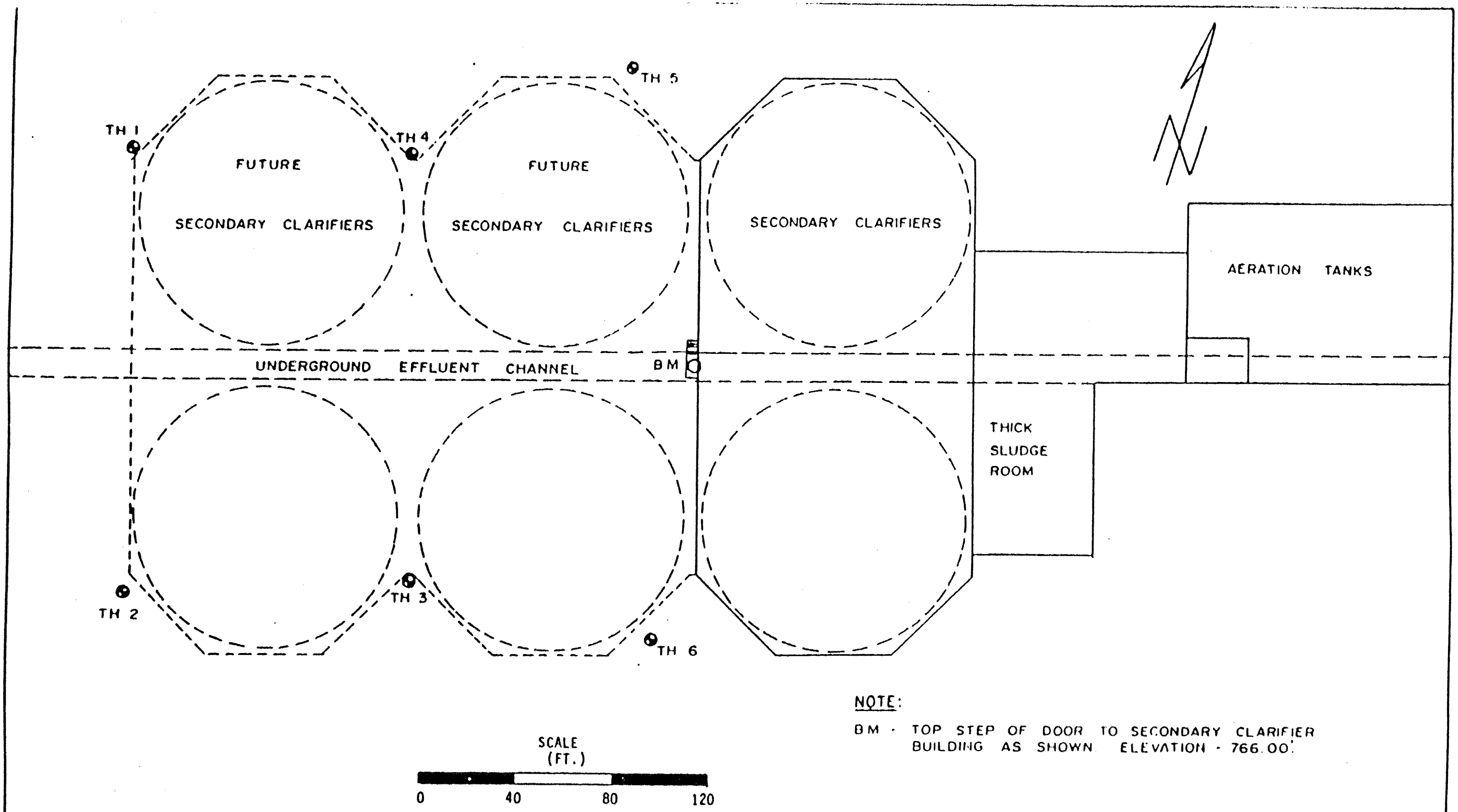


REV	DESCRIPTION	DWN	APP	DATE

DYREGROV & BURGESS
CONSULTING GEOTECHNICAL ENGINEERS

APP'D NCB
DATE 28/01/88
SCALE
JOB NO. 88528

TEST HOLE LOCATION PLAN
SOUTH END WATER POLLUTION CONTROL
CENTRE - WINNIPEG, MAN.
DWG NO 2



NOTE:

BM - TOP STEP OF DOOR TO SECONDARY CLARIFIER BUILDING AS SHOWN ELEVATION - 766.00'

REV	DESCRIPTION	DWN	APP	DATE

DYREGROV & BURGESS
CONSULTING GEOTECHNICAL ENGINEERS

APP'D NCB
DATE 22/01/88
SCALE:
JOB NO 88528

TEST HOLE LOCATION PLAN
SOUTH END WATER POLLUTION CONTROL
CENTRE - WINNIPEG, MAN.
DWG NO 1

66303-Dis - 8

DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

GEOTECHNICAL REPORT
NORTH END WATER POLLUTION CONTROL CENTRE
DISINFECTION FACILITY

Prepared for

EARTH TECH (CANADA) INC.

on behalf of

THE CITY OF WINNIPEG

December, 2004

Project 242663

GEOTECHNICAL REPORT
NORTH END WATER POLLUTION CONTROL CENTRE
DISINFECTION FACILITY

Prepared for

EARTH TECH (CANADA) INC.

on behalf of

THE CITY OF WINNIPEG

December, 2004

Project 242663

1.0 INTRODUCTION

This report summarizes the results of a geotechnical investigation undertaken by Dyregrov Consultants for the proposed Disinfection Facility at the North End Water Pollution Control Centre. The work was undertaken at the request of Earth Tech (Canada) Inc., on behalf of The City of Winnipeg, and as authorized by the Earth Tech facsimile of October 18, 2004 from their Mr. Eric Hutchinson, P.Eng. The work was done in accordance with our proposal of September 24, 2004.

2.0 PROPOSED DEVELOPMENT

It is our understanding that the proposed facility will be located in the general area between the existing Main Building at the North End Water Pollution Control Centre and Main Street as shown on Figure 1. The proposed Disinfection Facility will parallel the existing 2.286 mm outfall pipe to the Red River and will extend from an existing gate chamber on the west some 80 to 90 metres where the new facility will tie back into the outfall pipe. From the existing gate chamber, a channel bypass will be constructed which will be founded at a depth of about 7.5 metres and will extend to a pump area. The bottom of the pump wells will be about 11 metres below existing grade. The effluent will be passed through a series of U/V channels before returning to the existing outfall pipe. The general founding elevation for the balance of the facility will be some 6.5 metres below grade.

3.0 DESCRIPTION OF THE FIELDWORK

A total of 4 test holes were put down on November 18, 2004 at the locations shown on Figure 1. Truck-mounted caisson drilling equipment (LDH 80) was supplied by Subterranean Ltd. A 400 mm diameter auger was used to advance the borings with three of the test holes being carried to auger refusal and a fourth to 4.88 metres. The soil profile was examined and classified on a continuous basis as the drilling progressed and sampled at regular intervals. Disturbed samples from the auger cuttings and relatively undisturbed samples (three inch diameter Shelby tube samples) were obtained for laboratory strength and moisture content testing.

Observations were made during drilling concerning groundwater, seepage and caving conditions within the borings and the effect these factors may have on foundation selection and design. A temporary steel casing was required to advance the borings through a silt deposit which was encountered in each of the test holes.

All test holes were backfilled with the auger cuttings on completion. Ground elevations at the test holes and their locations were determined by Earth Tech (Canada) Ltd.

A test pit was put down to examine the soil conditions around the existing outfall pipe at the location illustrated on Figure 1. A description of the conditions is included on Figure 6.

4.0 THE SOIL PROFILE

A thick deposit of highly plastic Lake Agassiz silty clay is the predominate component of the soil profile and extends from about the ground surface to depths varying from 19.66 to 20.73 metres or elevations between 210.06 to 211.42 metres. (Existing ground elevations are approximately 230.8 metres.) The clay is common to the Winnipeg area and can be described as firm to stiff in terms of its relative consistency. Moisture contents are generally within the 45 to 55 percent range and are relatively uniform with depth. Plastic and Liquid limits for the clays were determined to be in the order of 65 and 100 percent respectively which would indicate Liquidity Indices in the order of 65 percent.

Undrained shear strengths were determined from unconfined compression, pocket penetrometer and Torvane tests in the laboratory. The results are shown on Figure 7 and indicate that the undrained shear strengths, based on the unconfined compression tests, are basically in the range between 43 and 55 kPa.

Near the upper part of the clay profile, a water-bearing tan silt was noted in each of the test holes at depths ranging from 2.44 to 3.05 metres. The thickness of the silt ranged from 1.06 to 1.37 metres with the bottom being at depths ranging from 3.81 to 4.27 metres. The silt was wet and sloughing which required the use of temporary steel sleeves to cut off the silt which enabled the advancement of the test holes.

The clays are underlain by a glacial silt till at depths between 19.66 and 20.73 metres (elevations between 210.06 and 211.42 metres). The glacial till is known to be a mixture of sand, gravel, cobbles and boulder materials within a predominately silt matrix. At the locations of the test holes, auger refusal was reached between elevations 209.60 and 210.10 metres. The thickness of the glacial till varied from 0.46 to 1.82 metres. The action of the drill suggested that the auger refusal could be on bedrock. The consistency of the glacial till was visually classified as soft and was confirmed by moisture contents in excess of 10 percent.

At the location of the test pit, which was carried to the spring line on one side, a hand-augered hole was drilled beside and beneath the existing outfall pipe. The top of the pipe was at a depth of 2.29 metres (elevation 228.29 metres). Immediately above the pipe was a silt and clay fill which appeared to be well compacted. Its lateral limits were vertical which would suggest that it was placed within a wide trench or within a shored excavation. The hand-augered test hole indicated the presence of the silt below the spring line which in turn was underlain by the silty clay. Some seepage was noted from the silt.

5.0 GROUNDWATER CONDITIONS

A perched groundwater table is evident in the tan silt which is within the upper four metres of the soil profile. When auger refusal was reached in the glacial till/bedrock, the water level rose to a depth of 6.78 metres (elevation 224.01 metres) in Test Hole 1, a trace of water noted in both Test Holes 2 and 3. The water level of 224.01 metres is consistent with the piezometric conditions in the underlying bedrock.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

It is our understanding that the proposed development will include a connection to an existing gate chamber on the existing outfall pipe to the Red River. The connection will connect to a bypass channel that will parallel the existing outfall pipe which will connect to a pump well for transfer into the Disinfection Facility structure. The treated effluent will then be connected back to the existing outfall pipe by a new tie-in chamber. The bypass channels and treatment building structure will be structurally supported on a pile foundation system. Deep excavations are required throughout the facility.

6.2 Foundations

The two principal foundation options for the support of the structural aspects of the project are driven precast prestressed end-bearing concrete piles and cast-in-place concrete friction piles. The preferred foundation alternative is the driven precast concrete piles which would be end bearing in the underlying glacial till. However, actions will have to be taken to minimize the impacts of vibrations induced by the pile driving operations.

Driven precast concrete piles have been used extensively at the NEWPCC and are considered appropriate for this project if the loads can be distributed to take full advantage of the relatively high capacities of these piles. These piles, if driven to practical refusal, may be assigned conventional supporting capacities of 445, 625 and 800 kN for nominal 300, 350 and 400 mm sizes respectively. The piles should be driven with a diesel hammer with a rated energy of not less than 40 kilojoules. Practical refusal may be defined as final penetration resistance sets of 5, 8 and 12 blows per less than 25 mm for the 300, 350 and 400 mm sizes respectively. At least three sets should be obtained. If followers are used, the final penetration resistance criteria should be increased by 50 percent. No reduction in individual pile capacity is necessary for reasons related to group action provided that pile heave is monitored, measures undertaken to minimize it (by preboring) and redriving is done as necessary in pile groups. Pile spacing should not be less than 2.5 pile diameters centre to centre. Pile concrete should be at least 7 days old.

Inspections of the driven pile installation should be undertaken by technologists experienced with their installation. The lack of large thicknesses of the glacial till and the presence of cobbles and boulders may result in pile installation problems which should be monitored.

Preboring should be done at the driven pile locations with diameters that are 50 mm larger than the pile size. The preboring is effective in reducing ground vibrations and pile heave and contributes positively to pile verticality. When driving within 3 metres of existing underground facilities, deeper prebore to within 1.5 metres of the glacial till (approximately elevation 213.0

metres) should be considered. If followers are required for driving the piles, the size of the prebore should be 50 mm larger than the follower and for a depth equal to the length of the follower.

It is understood that pile loads may be suitable for the use of the cast-in-place concrete friction piles. These piles should have a minimum diameter of 400 mm and may be sized on the basis of an allowable shaft adhesion of 16.7 kPa. The upper 5 feet of shaft support should be discounted and the piles should not penetrate the glacial silt till to avoid problems with the groundwater conditions which exist in the underlying bedrock, such as was encountered in Test Hole 1. In this regard, it is recommended that the pile tips should not extend closer than 1.5 metres to the glacial till surface or approximately 213.0 metres. Pile spacing should not be closer than 3 pile diameters centre to centre. If pile groups are required, group action should be considered. Temporary steel sleeves should be on hand and used on an as-required basis to prevent seepage and caving into the borings, particularly from the water-bearing silt.

The friction piles potentially subject to frost heave and uplift should contain full-length reinforcement and should be a minimum length of 7.6 metres. Alternatively, the piles could be protected by the use of flat-lying, rigid, high-density insulation around the pile at least 300 mm below the finished grade.

It is understood that a number of piles may be installed in areas where significant amounts of fill may be placed. Conventional down-drag forces on these piles are not of any consequence as fill will only be carried up to near the original grade such that the stresses in the underlying clay will not be significantly different than the original stresses with the result that consolidation of the clay will not occur. The self-consolidation of the fill around the piles is not expected to transmit any consequential loads to the pile due to the relatively loose condition that the fill will be placed around the piles.

6.3 Slabs

It is understood that structurally supported floor slabs will be used throughout. The floors (and grade beams) should be separated from the underlying soil subgrade by a 300 mm void. It is presumed that these slabs will have no underdrainage and that water could collect below them. This is conducive to swelling and generous allowance for this is recommended.

6.4 Excavations

Excavations are required throughout the project, some of which are quite deep, as well as adjacent to existing underground facilities such as the 2.286 metre diameter existing outfall to the Red River. The deep excavations will have to be shored or will require relatively flat excavation slopes. These slopes may require unloading of the overburden above the existing outfall to achieve satisfactory safety factors for the temporary slopes. Excavated materials should not be stockpiled immediately adjacent to the work as their presence may negatively impact the stability of the excavation slopes, shoring or the underground facilities.

The design of the excavation slopes should recognize the presence of the water-bearing silt which was noted in the test holes. The bottom of the silt was below the top of the existing outfall pipe. It may be necessary to control seepage from the silt during construction.

The excavated slopes should be protected from weathering by suitable temporary coverings.

Temporary shoring may be designed on the basis of the earth pressure distribution illustrated in Figure 8. Ground movements behind the shoring will occur and it is largely unavoidable. The amount that will occur cannot be predicted with much accuracy, mainly because the movement is as much a function of excavation procedures and workmanship as it is a function of theoretical considerations. The impact of these movements should be assessed.

It is recommended that toe support for soldier piles be provided by concrete plugs within the clay deposit immediately below the excavation surface. It is recommended that the toe support not be provided from driving the soldier piles and/or sheet piles into the underlying glacial till/bedrock. This will minimize the potential for a long-term groundwater connection between the bedrock aquifer and the proposed facility.

Where shoring is provided at the base of any excavated slopes, the effects of sloping ground above the shoring, on the shoring, must be considered.

6.5 <u>Below-Grade Walls</u>

The below-grade walls should be designed to resist lateral earth pressures that are derived on the basis of the following conventional relationship:

$$P = K \gamma D$$

where P = lateral earth pressure at depth below final grade D (kN/m^2)
K = earth pressure coefficient (0.5)
γ = soil backfill unit weight (17.5 kN/m^3)
D = depth from final grade to point of pressure calculation (m)

The base of the wall should be provided with a filter-protected positive drainage system to prevent the buildup of hydrostatic pressure against the wall. Where drainage is not provided, the lateral pressure should be increased by 9.81 kN/m^3. An allowance for surface live loads should be included if significant load is applied within a distance from the wall equal to the height of the wall. The lateral pressure due to the live load should be presumed equal to 50 percent of the vertical pressure due to the live load.

The selection of backfill materials should be reviewed during the design and their impact on the foregoing pressures assessed.

6.6 Backfill Over Structures

The backfill over structures can be undertaken with the clayey materials from the excavations. These materials should receive nominal compaction to about 90 percent of Standard Proctor Density. Due to the extensive areas of backfill, compaction equipment will have to be used. A unit weight of about 17.5 kN/m^3 can be used for the clayey materials for design of the roofs of the structures. Also, the loads induced by the compaction equipment on the roofs should be checked. If materials, other than the clayey materials are used, the design unit weights should be increased.

6.7 Pavements

It is recommended that for the relocation of the existing driveway and access to the facility, the pavement section should consist of 75 mm of asphaltic concrete placed on 380 mm of crushed granular base course or an equivalent section. Some consideration could be given to using 200 mm of reinforced concrete on 75 mm of a crushed granular base course service area adjacent to the facility.

The pavement sections should be placed on a prepared subgrade which should be compacted to a uniform density of at least 95 percent of Standard Proctor density at optimum moisture content. The subgrade should be "proof rolled" and any soft spots should be removed and replaced with suitable materials and compacted to this standard.

Although silt was encountered in all of the test holes, it is not expected that it will affect the subgrade preparation because it is relatively deep. It may, however, generate some frost heave in particularly cold winters.

6.8 Other

All concrete in contact with the soil should be manufactured with sulphate-resistant cement and should be of high quality.

Site drainage should be away from the facility site at a gradient of at least 2 percent.

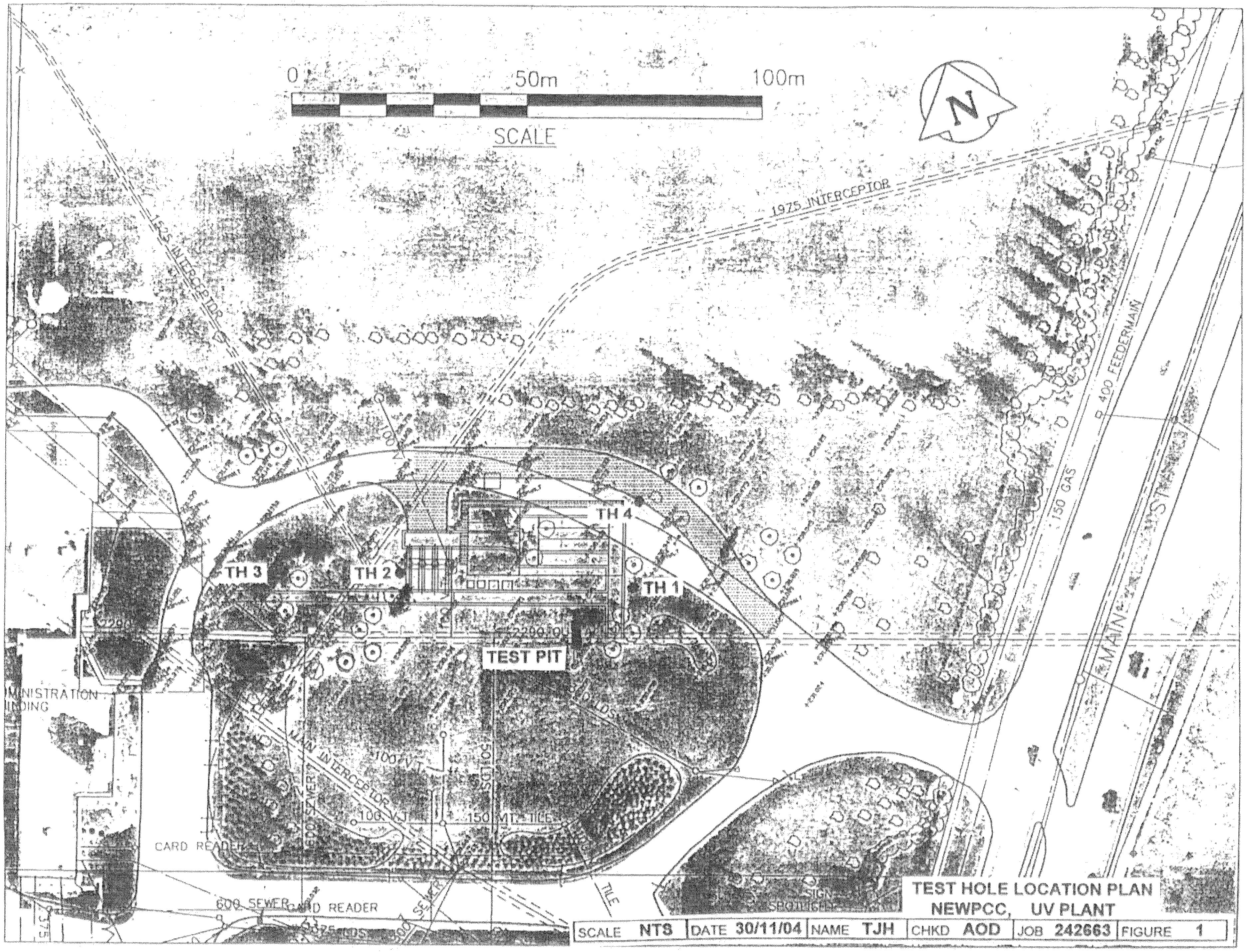
Respectfully submitted,

DYREGROV CONSULTANTS

Per: Al Dyregrov

A.O. Dyregrov, P.Eng.

PROVINCE OF MANITOBA
A. O.
DYREGROV
91/12/04
REGISTERED PROFESSIONAL ENGINEER



TEST HOLE LOCATION PLAN
NEWPCC, UV PLANT

SCALE NTS	DATE 30/11/04	NAME TJH	CHKD AOD	JOB 242663	FIGURE 1

CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 1	Project No. 242663
PROJECT: NEWPCC		DATE OF INVEST. NOVEMBER 18, 2004	
CLIENT: EARTH TECH		DRILL : SUBTERRANEAN, 16 INCH AUGER	

SAMPLE NO.	DEPTH (m)	ELEV. (m)	SYM	SOIL DESCRIPTION	
	0.00	230.79			
				0.00-0.15 SOD OVER TOPSOIL	
1S1	0.75	230.04		0.15-0.90- CLAY, BLACK, MOIST, ORGANIC	
1S2				0.90-2.59 CLAY	
	1.50	229.29		BROWN, SILTY, STIFF, BLOCKY TO 1.5	
1S3					
	2.25	228.54			
1S4				2.59-3.81 SILT	
	3.00	227.79		TAN, MOIST,	
1S5				MOIST TO WET AT 3.1, SLOUGHING, WATER	
	3.75	227.04			
				3.81-20.73 CLAY	
	4.50	226.29		BROWN, SILTY, MOTTLED, STIFF, HIGH PLASTIC	
1S6					Qu-92.3 KPa
1T7	5.25	225.54			Pp-95.8 KPa
1S8					Tv-70.9 KPa
	6.00	224.79			W -16.67 KN/M
				AT 6.4 GREY, SILTY,	
	6.75	224.04			
1T9	7.50	223.29			Qu-106.6 KPa
					Pp-86.1 KPa
	8.25	222.54			Tv-67.0 KPa
					W -16.69 KN/M
1S10	9.00	221.79			
	9.75	221.04			
	10.50	220.29			Qu-96.7 KPa
1T11					Pp-71.8 KPa
	11.25	219.54			Tv-57.5 KPa
					W -17.07 KN/M
1S12	12.00	218.79			
	12.75	218.04			
	13.50	217.29			
1T13				VERY TILLY BETWEEN 13.71 AND 16.77	Qu-107.1 KPa
	14.25	216.54			Pp-76.6 KPa
					Tv-51.7 KPa
	15.00	215.79			W -17.14 KN/M
1S14					
	15.75	215.04			
					Qu-90.1 KPa
	16.50	214.29			Pp-64.6 KPa
				MORE HOMOGENEOUS BETWEEN 13.77 AND 19.50	Tv-53.6 KPa
	17.25	213.54			W -19.75 KN/M
1T15					
	18.00	212.79			
1S16					
	18.75	212.04			
	19.50	211.29			
				AT 19.50 MANY TILL INCLUSIONS	
1S17	20.25	210.54			
1S18					
	21.00	209.79		20.73- 21.19 GLACIAL SILT TILL	
	21.75	209.04			
	22.50	208.29		END OF TEST HOLE AT 21.19 ON POSSIBLE BEDROCK	
	23.25	207.54		NOTE: WATER ROSE QUICKLY IN FIVE MINUTES TO 6.78 BELOW GROUD SURFACE	

MOISTURE CONTENT (%)

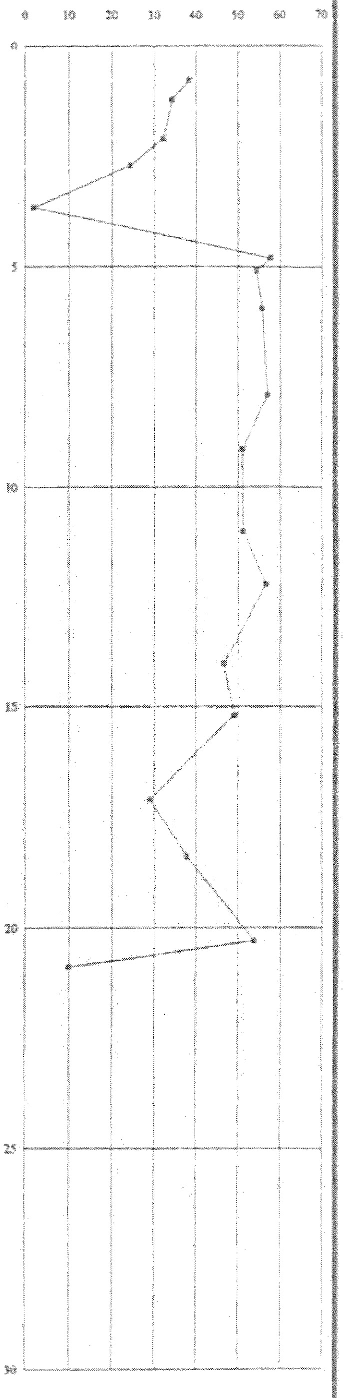


FIGURE 2

DYREGROV CONSULTANTS

Logged/Dwn.: TH
Checked: AOD

Test Hole No. 2
Project No. 242663

PROJECT: NEWPCC
CLIENT: EARTH TECH

DATE OF INVEST. NOVEMBER 18, 2004
DRILL : SUBTERRANEAN, 16 INCH AUGER

SAMPLE NO.	DEPTH (m)	ELEV. (m)	SYM	SOIL DESCRIPTION	
	0.00	230.83		0.00-0.15 SOD OVER TOPSOIL	
	0.75	230.08		0.15-0.76 CLAY, BLACK, ORGANIC, FIRM	
2S1	1.50	229.33		0.76-2.44 CLAY BROWN, SILTY, STIFF, WEATHERED	
2S2	2.25	228.58			
2S3 2S4	3.00	227.83		2.44-3.81 SILT TAN TO LIGHT BROWN, MOIST, TRACE FINE SAND MOIST TO WET AT 3.1, SLOUGHING, WATER	
	3.75	227.08			
2T5	4.50	226.33		3.81-19.82 CLAY BROWN GREY, SILTY, MOTTLED, TRACE SILT INCLUSIONS FIRM, MEDIUM TO HIGH PLASTIC	Qu-80.0 KPa Pp-95.8 KPa Tv-77.6 KPa W -16.74 KN/M
	5.25	225.58			
	6.00	224.83			
2T6	6.75	224.08		AT 6.4 GREY CLAY, TRACE SILT INCLUISIONS	Qu-95.7 KPa Pp-71.8 KPa Tv-68.9 KPa W -16.83
2S7	7.50	223.33			
	8.25	222.58			
	9.00	221.83			
2T8	9.75	221.08			Qu-10.1 KPa PP-67.0 KPa Tv-56.5 KPa W -17 12
2S9	10.50	220.33			
	11.25	219.58			
	12.00	218.83			
2T10	12.75	218.08		TRACE OF TILL POCKETS BELOW 12.2	Qu-99.1 KPa Pp-67.0 KPa Tv-47.9 KPA W -16.42 KN/M
	13.50	217.33			
1S11	14.25	216.58			
	15.00	215.83			
2T12	15.75	215.08			Qu-97.6 KPa Pp-47.9 KPa Tv-43.0 KPa W -16.88 KN/M
	16.50	214.33			
	17.25	213.58			
2S13	18.00	212.83			
2T14	18.75	212.08			
2S15	19.50	211.33			
2S16	20.25	210.58		19.82-20.73 GLACIAL SILT TILL SILT MATRIX WITH SOME PEBBLES AND STONES, TAN	
	21.00	209.83		END OF TEST HOLE AT 20.73 IN GLACIAL SILT TILL	
	21.75	209.08		NOTE: TRACE OF WATER AT COMPLETEION OF DRILLING	

MOISTURE CONTENT (%)

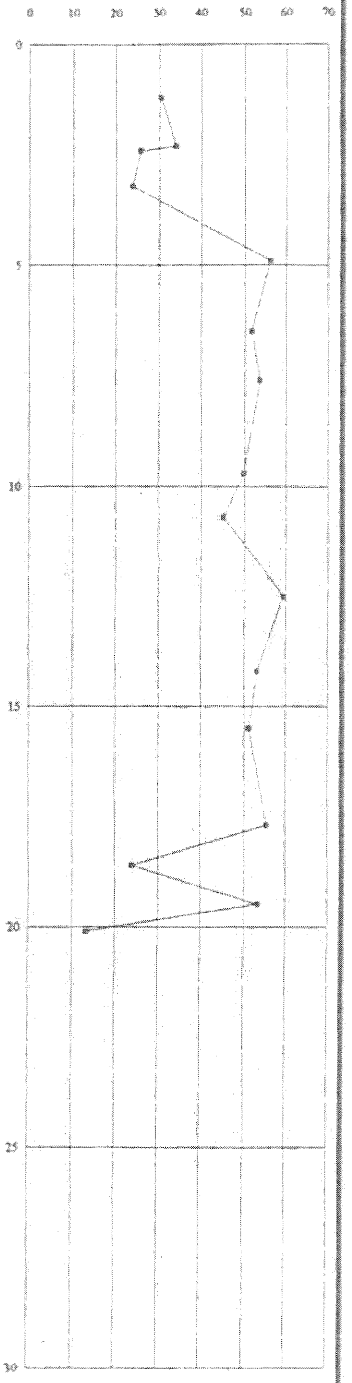


FIGURE 3

CONSULTANTS
Logged/Dwn.: TH
Checked: AOD

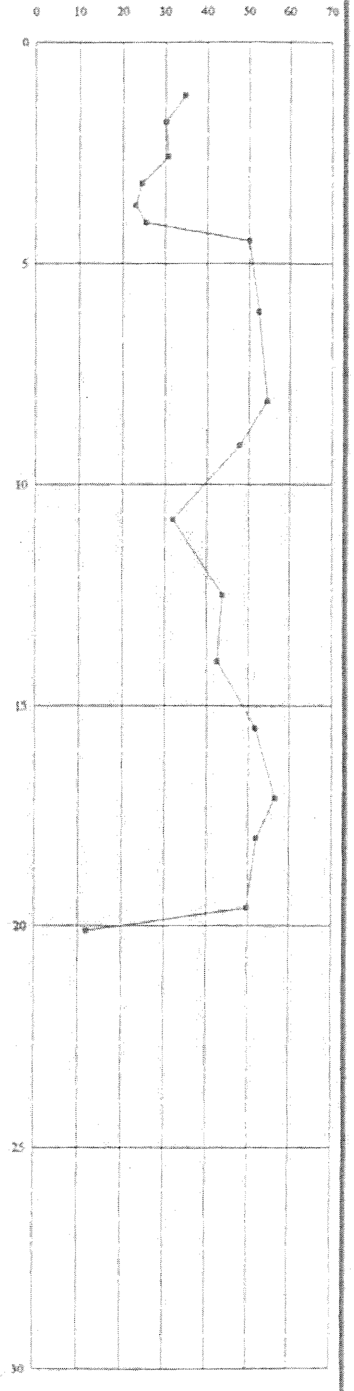
Test Hole No. 3
Project No. 242663

PROJECT: NEWPCC
CLIENT: EARTH TECH

DATE OF INVEST. NOVEMBER 18, 2004
DRILL : SUBTERRANEAN, 16 INCH AUGER

SAMPLE NO.	DEPTH (m)	ELEV. (m)	SYM	SOIL DESCRIPTION	
	0.00	231.08			
				0.00-0.15 SOD OVER TOPSOIL	
	0.75	230.33		0.15-2.44 FILL,	
3S1				TO 0.61 CLAY MATRIX WITH POCKET OF PIT RUN	
	1.50	229.58			
3S2				AT 1.8 SAME WITH TRACE BLACK POCKET,	
	2.25	228.83		TRACE STONES	
3S3				2.44-2.90 CLAY, BROWN, SILTY, STIFF	
	3.00	228.08		2.90-3.96 SILT	
3S4				TAN, MOIST TO WET AT 3.1, SLOUGHING, WATER	
3S5	3.75	227.33			
3S6					
3T7	4.50	226.58		3.96-19.66 CLAY	Qu-79.8 KPa
				BROWN, SILTY/GREY, MOTTLED, TRACE TAN SILT	Pp-129.3 KPa
	5.25	225.83		INCLUSIONS, MEDIUM TO STIFF, MEDIUM TO HIGH PLAST	Tv-119.7 KPa
				VERTICAL FISSURE FILLED WITH GREY SILT	W -17.23 KN/M
3S8	6.00	225.08			
	6.75	224.33			
	7.50	223.58			
3T9				GREY, STIFF, TRACE SILT AND FINE SAND INCLUSIONS	Qu-93.7 KPa
	8.25	222.83			Pp-95.7 KPa
					Tv-70.9 KPa
3S10	9.00	222.08			W -16.88 KN/M
	9.75	221.33			
	10.50	220.58			
3T11				SAME, MEDIUM TO STIFF, PLUS TRACE FINE	Qu-84.7 KPa
	11.25	219.83		GRAVEL INCLUSIONS	Pp-95.7 KPa
					Tv-67.0 KPa
	12.00	219.08			W -18.1 KN/M
3S12					
	12.75	218.33			
	13.50	217.58			
3T13	14.25	216.83		SAME, SOME FINE SILT AND FINE SAND LAYERING	Qu-91.7 KPa
					Pp-47.9 KPa
	15.00	216.08			Tv-47.9 KPa
					W -17.97 KN/M
3S14	15.75	215.33			
	16.50	214.58			
3T15				SAME, MEDIUM, TRACE SILT, FINE SAND, AND FINE	Qu-77.9 KPa
	17.25	213.83		GRAVEL INCLUSIONS	Pp-35.9 KPa
					Tv-38.3 KPa
3S16	18.00	213.08			W -17.05 KN/M
	18.75	212.33			
3S17					
	19.50	211.58			
				19.66-21.48 GLACIAL SILT TILL	
3S18	20.25	210.83		SILT MATRIX WITH SAND, TRACE CLAY, SOME GRAVEL	
				SOME COBBLES AND BOULDERS	
	21.00	210.08			
	21.75	209.33		END OF TEST HOLE AT 21.48	
				AUGER REFUSAL ON ASSUMED BEDROCK	
				NOTE: APPROXIMATELY 25mm OF WATER IN HOLE AT OMPLETION OF DRILLING	

MOISTURE CONTENT (%)



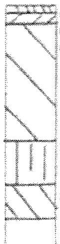
DYREGROV CONSULTANTS

Logged/Dwn.: TH
Checked: AOD

Test Hole No. 4
Project No. 242663

PROJECT: NEWPCC
CLIENT: EARTH TECH

DATE OF INVEST. NOVEMBER 18, 2004
DRILL : SUBTERRANEAN, 16 INCH AUGER



SAMPLE NO.	DEPTH (m)	ELEV (m)	SYM	SOIL DESCRIPTION
	0.00	230.66		0.00-0.15 SOD OVER TOPSOIL
	0.75	229.91		0.15-0.53 CLAY, BLACK, ORGANIC, MOIST, FIRM, LOW PLASTIC, 0.53-3.05 CLAY
	1.50	229.16		BROWN, SILTY, TRACE SILT INCLUSIONS TO 1.5 SOME SILT VARVES TO 3.0, BLOCKY, WEATHERED,
	2.25	228.41		FIRM, MEDIUM TO HIGH PLASTIC
	3.00	227.66		3.05-4.27 SILT
	3.75	226.91		TAN TO LIGHT BROWN, MOIST TO WET BELOW 3.3 SOFT, VERY LOW TO NON PLASTIC, SLOUGHING AND WATER BELOW 3.3
	4.50	226.16		4.27-4.88 CLAY BROWN, SILTY, MOTTLED, TRACE TINY SILT AND
	5.25	225.41		FINE SAND INCLUSIOND
	6.00	224.66		END OF TEST HOLE AT 4.88 IN BROWN SILTY CLAY

MOISTURE CONTENT (%)

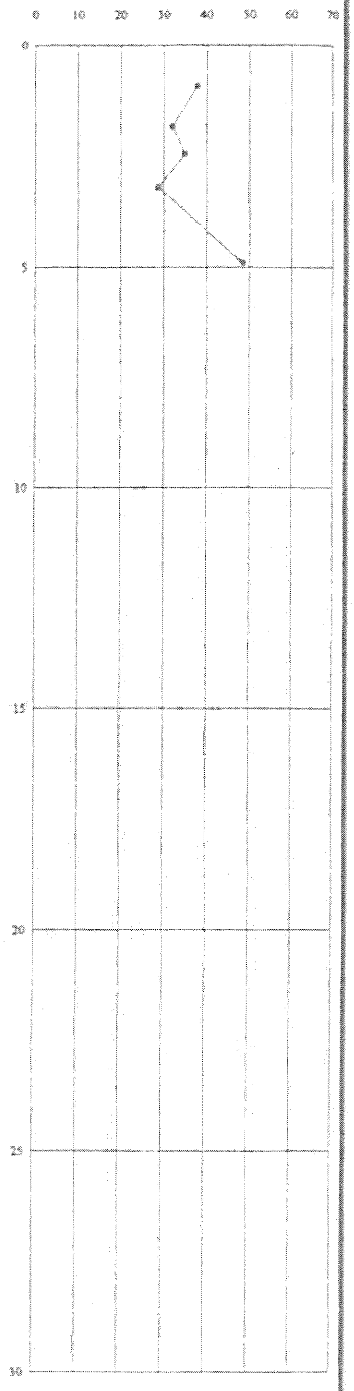
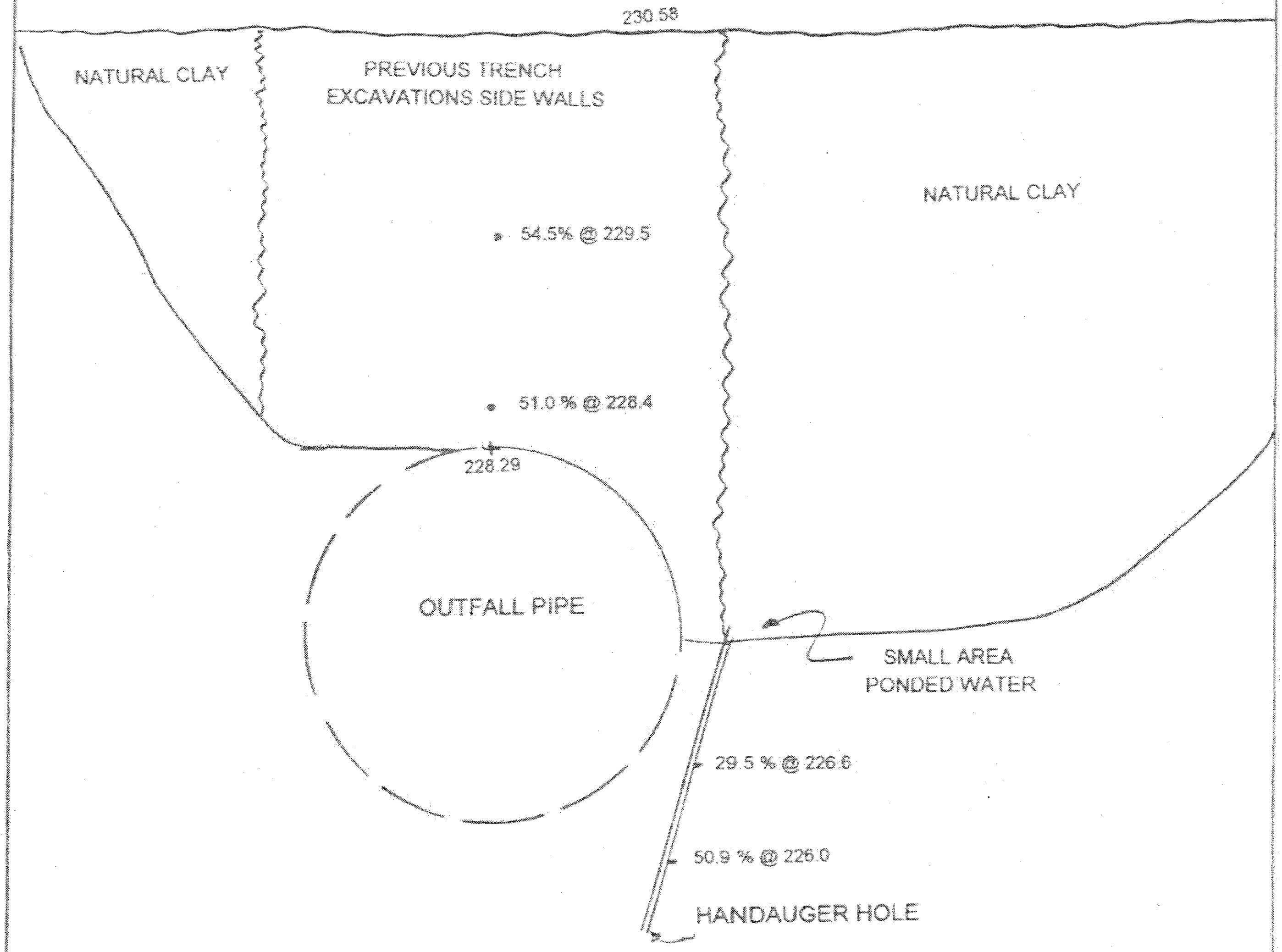


FIGURE 5



NOTE: The small area of poned water came from the silt and from around the pipe

The outfall pipe was exposed with a large backhoe to approximately 300 above the pipe and the remainder of the fill was removed by shovell .

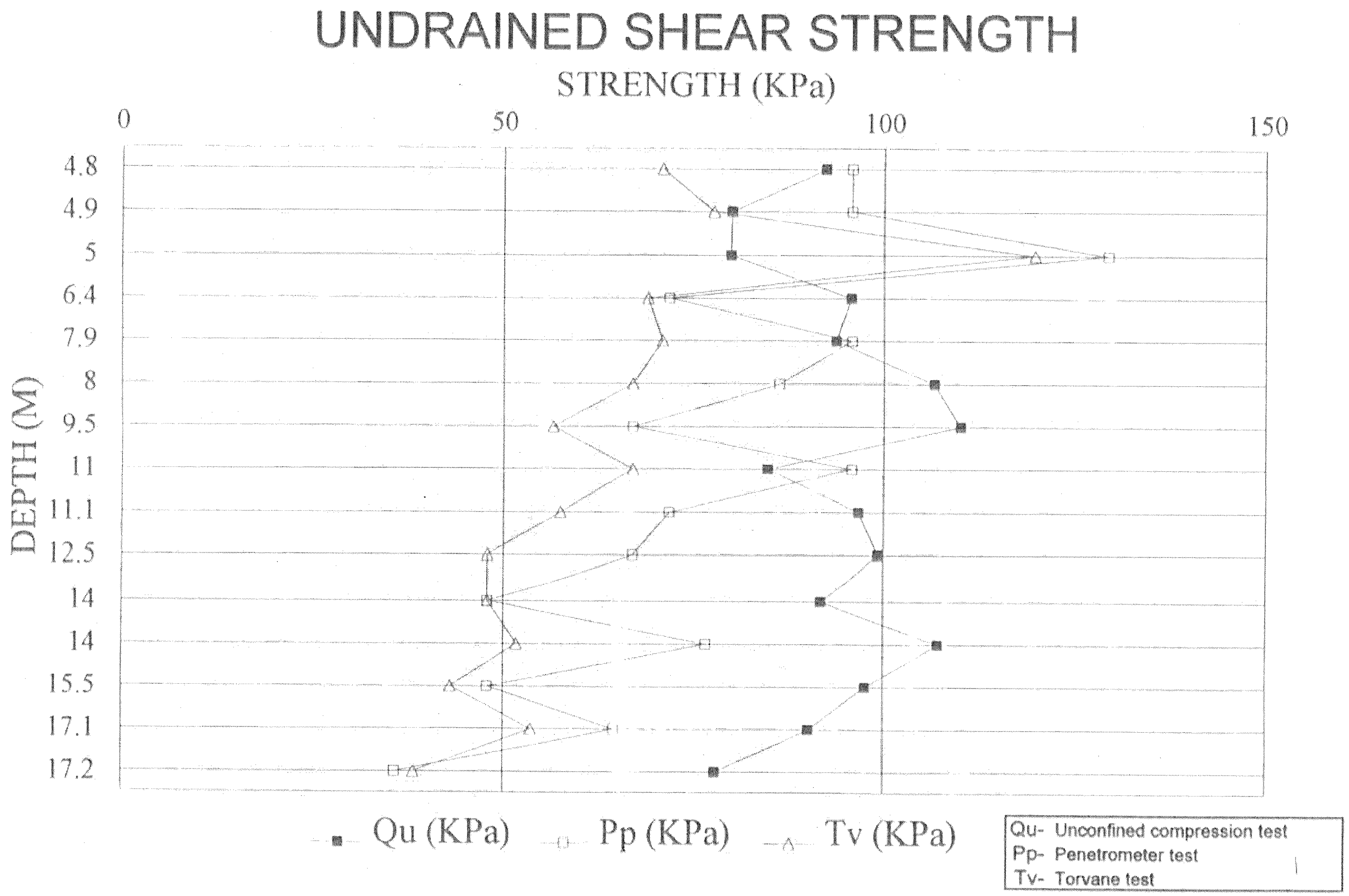
The outfall pipe was exposed only to the string line.

The previous excavated trench was +/- 3.0 m wide

DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

TEST PIT EXPOSING OUTFALL PIPE
NEWPCC, PROPOSED U V PLANT

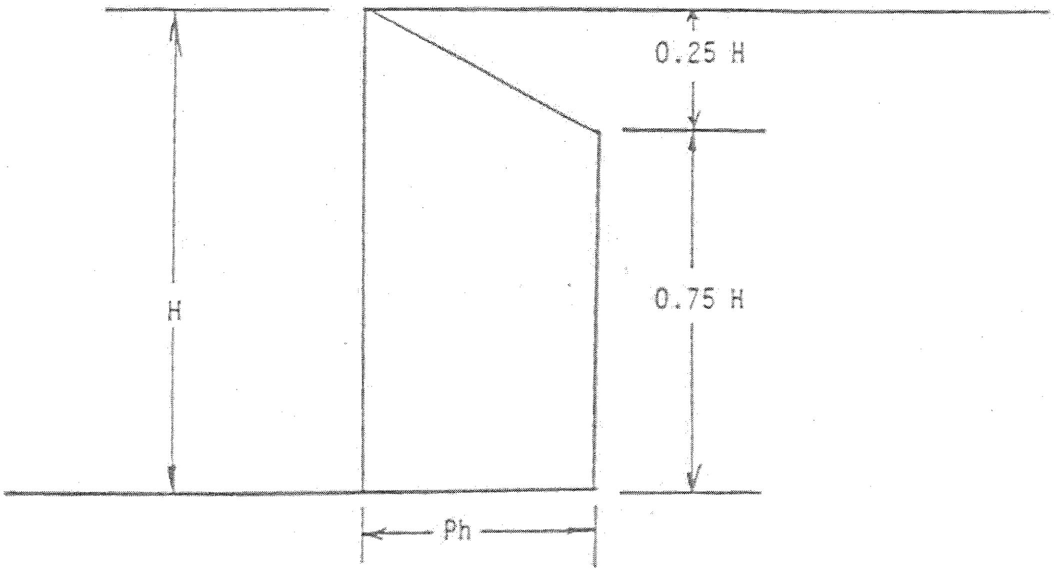
SCALE NTS	DATE 07/12/04	MADE TJH	CHKD AOD	JOB 242663	FIGURE 6



DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

UNDRAINED SHEAR STRENGTH
NEWPCC, PROPOSED U V PLANT

SCALE NTS	DATE 08/12/04	MADE TJH	CHKD AOD	JOB 242663	FIGURE 7



Ph = 0.4γ H

Where: Ph = Lateral earth pressure on shoring (kPa)

γ = Soil unit weight (17.28 KN/M^3)

H = Wall height (M)

Note: Add surface load surcharge where applicable

DYREGROV CONSULTANTS

CONSULTING GEOTECHNICAL ENGINEERS

EARTH PRESSURE DISTRIBUTION
TEMPORARY SHORING
NEWPCC DISINFECTION FACILITY

SCALE NTS	DATE 07/12/04	MADE TJH	CHKD AOD	JOB 242663	FIGURE 8

66303-Dis - 8

DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

GEOTECHNICAL REPORT

NORTH END WATER POLLUTION CONTROL CENTRE

DISINFECTION FACILITY

Prepared for

EARTH TECH (CANADA) INC.

on behalf of

THE CITY OF WINNIPEG

December, 2004

Project 242663

GEOTECHNICAL REPORT

NORTH END WATER POLLUTION CONTROL CENTRE

DISINFECTION FACILITY

Prepared for

EARTH TECH (CANADA) INC.

on behalf of

THE CITY OF WINNIPEG

December, 2004

Project 242663

1.0 INTRODUCTION

This report summarizes the results of a geotechnical investigation undertaken by Dyregrov Consultants for the proposed Disinfection Facility at the North End Water Pollution Control Centre. The work was undertaken at the request of Earth Tech (Canada) Inc., on behalf of The City of Winnipeg, and as authorized by the Earth Tech facsimile of October 18, 2004 from their Mr. Eric Hutchinson, P.Eng. The work was done in accordance with our proposal of September 24, 2004.

2.0 PROPOSED DEVELOPMENT

It is our understanding that the proposed facility will be located in the general area between the existing Main Building at the North End Water Pollution Control Centre and Main Street as shown on Figure 1. The proposed Disinfection Facility will parallel the existing 2.286 mm outfall pipe to the Red River and will extend from an existing gate chamber on the west some 80 to 90 metres where the new facility will tie back into the outfall pipe. From the existing gate chamber, a channel bypass will be constructed which will be founded at a depth of about 7.5 metres and will extend to a pump area. The bottom of the pump wells will be about 11 metres below existing grade. The effluent will be passed through a series of U/V channels before returning to the existing outfall pipe. The general founding elevation for the balance of the facility will be some 6.5 metres below grade.

3.0 DESCRIPTION OF THE FIELDWORK

A total of 4 test holes were put down on November 18, 2004 at the locations shown on Figure 1. Truck-mounted caisson drilling equipment (LDH 80) was supplied by Subterranean Ltd. A 400 mm diameter auger was used to advance the borings with three of the test holes being carried to auger refusal and a fourth to 4.88 metres. The soil profile was examined and classified on a continuous basis as the drilling progressed and sampled at regular intervals. Disturbed samples from the auger cuttings and relatively undisturbed samples (three inch diameter Shelby tube samples) were obtained for laboratory strength and moisture content testing.

Observations were made during drilling concerning groundwater, seepage and caving conditions within the borings and the effect these factors may have on foundation selection and design. A temporary steel casing was required to advance the borings through a silt deposit which was encountered in each of the test holes.

All test holes were backfilled with the auger cuttings on completion. Ground elevations at the test holes and their locations were determined by Earth Tech (Canada) Ltd.

A test pit was put down to examine the soil conditions around the existing outfall pipe at the location illustrated on Figure 1. A description of the conditions is included on Figure 6.

4.0 THE SOIL PROFILE

A thick deposit of highly plastic Lake Agassiz silty clay is the predominate component of the soil profile and extends from about the ground surface to depths varying from 19.66 to 20.73 metres or elevations between 210.06 to 211.42 metres. (Existing ground elevations are approximately 230.8 metres.) The clay is common to the Winnipeg area and can be described as firm to stiff in terms of its relative consistency. Moisture contents are generally within the 45 to 55 percent range and are relatively uniform with depth. Plastic and Liquid limits for the clays were determined to be in the order of 65 and 100 percent respectively which would indicate Liquidity Indices in the order of 65 percent.

Undrained shear strengths were determined from unconfined compression, pocket penetrometer and Torvane tests in the laboratory. The results are shown on Figure 7 and indicate that the undrained shear strengths, based on the unconfined compression tests, are basically in the range between 43 and 55 kPa.

Near the upper part of the clay profile, a water-bearing tan silt was noted in each of the test holes at depths ranging from 2.44 to 3.05 metres. The thickness of the silt ranged from 1.06 to 1.37 metres with the bottom being at depths ranging from 3.81 to 4.27 metres. The silt was wet and sloughing which required the use of temporary steel sleeves to cut off the silt which enabled the advancement of the test holes.

The clays are underlain by a glacial silt till at depths between 19.66 and 20.73 metres (elevations between 210.06 and 211.42 metres). The glacial till is known to be a mixture of sand, gravel, cobbles and boulder materials within a predominately silt matrix. At the locations of the test holes, auger refusal was reached between elevations 209.60 and 210.10 metres. The thickness of the glacial till varied from 0.46 to 1.82 metres. The action of the drill suggested that the auger refusal could be on bedrock. The consistency of the glacial till was visually classified as soft and was confirmed by moisture contents in excess of 10 percent.

At the location of the test pit, which was carried to the spring line on one side, a hand-augered hole was drilled beside and beneath the existing outfall pipe. The top of the pipe was at a depth of 2.29 metres (elevation 228.29 metres). Immediately above the pipe was a silt and clay fill which appeared to be well compacted. Its lateral limits were vertical which would suggest that it was placed within a wide trench or within a shored excavation. The hand-augered test hole indicated the presence of the silt below the spring line which in turn was underlain by the silty clay. Some seepage was noted from the silt.

5.0 GROUNDWATER CONDITIONS

A perched groundwater table is evident in the tan silt which is within the upper four metres of the soil profile. When auger refusal was reached in the glacial till/bedrock, the water level rose to a depth of 6.78 metres (elevation 224.01 metres) in Test Hole 1, a trace of water noted in both Test Holes 2 and 3. The water level of 224.01 metres is consistent with the piezometric conditions in the underlying bedrock.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

It is our understanding that the proposed development will include a connection to an existing gate chamber on the existing outfall pipe to the Red River. The connection will connect to a bypass channel that will parallel the existing outfall pipe which will connect to a pump well for transfer into the Disinfection Facility structure. The treated effluent will then be connected back to the existing outfall pipe by a new tie-in chamber. The bypass channels and treatment building structure will be structurally supported on a pile foundation system. Deep excavations are required throughout the facility.

6.2 Foundations

The two principal foundation options for the support of the structural aspects of the project are driven precast prestressed end-bearing concrete piles and cast-in-place concrete friction piles. The preferred foundation alternative is the driven precast concrete piles which would be end bearing in the underlying glacial till. However, actions will have to be taken to minimize the impacts of vibrations induced by the pile driving operations.

Driven precast concrete piles have been used extensively at the NEWPCC and are considered appropriate for this project if the loads can be distributed to take full advantage of the relatively high capacities of these piles. These piles, if driven to practical refusal, may be assigned conventional supporting capacities of 445, 625 and 800 kN for nominal 300, 350 and 400 mm sizes respectively. The piles should be driven with a diesel hammer with a rated energy of not less than 40 kilojoules. Practical refusal may be defined as final penetration resistance sets of 5, 8 and 12 blows per less than 25 mm for the 300, 350 and 400 mm sizes respectively. At least three sets should be obtained. If followers are used, the final penetration resistance criteria should be increased by 50 percent. No reduction in individual pile capacity is necessary for reasons related to group action provided that pile heave is monitored, measures undertaken to minimize it (by preboring) and redriving is done as necessary in pile groups. Pile spacing should not be less than 2.5 pile diameters centre to centre. Pile concrete should be at least 7 days old.

Inspections of the driven pile installation should be undertaken by technologists experienced with their installation. The lack of large thicknesses of the glacial till and the presence of cobbles and boulders may result in pile installation problems which should be monitored.

Preboring should be done at the driven pile locations with diameters that are 50 mm larger than the pile size. The preboring is effective in reducing ground vibrations and pile heave and contributes positively to pile verticality. When driving within 3 metres of existing underground facilities, deeper prebore to within 1.5 metres of the glacial till (approximately elevation 213.0

metres) should be considered. If followers are required for driving the piles, the size of the prebore should be 50 mm larger than the follower and for a depth equal to the length of the follower.

It is understood that pile loads may be suitable for the use of the cast-in-place concrete friction piles. These piles should have a minimum diameter of 400 mm and may be sized on the basis of an allowable shaft adhesion of 16.7 kPa. The upper 5 feet of shaft support should be discounted and the piles should not penetrate the glacial silt till to avoid problems with the groundwater conditions which exist in the underlying bedrock, such as was encountered in Test Hole 1. In this regard, it is recommended that the pile tips should not extend closer than 1.5 metres to the glacial till surface or approximately 213.0 metres. Pile spacing should not be closer than 3 pile diameters centre to centre. If pile groups are required, group action should be considered. Temporary steel sleeves should be on hand and used on an as-required basis to prevent seepage and caving into the borings, particularly from the water-bearing silt.

The friction piles potentially subject to frost heave and uplift should contain full-length reinforcement and should be a minimum length of 7.6 metres. Alternatively, the piles could be protected by the use of flat-lying, rigid, high-density insulation around the pile at least 300 mm below the finished grade.

It is understood that a number of piles may be installed in areas where significant amounts of fill may be placed. Conventional down-drag forces on these piles are not of any consequence as fill will only be carried up to near the original grade such that the stresses in the underlying clay will not be significantly different than the original stresses with the result that consolidation of the clay will not occur. The self-consolidation of the fill around the piles is not expected to transmit any consequential loads to the pile due to the relatively loose condition that the fill will be placed around the piles.

6.3 Slabs

It is understood that structurally supported floor slabs will be used throughout. The floors (and grade beams) should be separated from the underlying soil subgrade by a 300 mm void. It is presumed that these slabs will have no underdrainage and that water could collect below them. This is conducive to swelling and generous allowance for this is recommended.

6.4 Excavations

Excavations are required throughout the project, some of which are quite deep, as well as adjacent to existing underground facilities such as the 2.286 metre diameter existing outfall to the Red River. The deep excavations will have to be shored or will require relatively flat excavation slopes. These slopes may require unloading of the overburden above the existing outfall to achieve satisfactory safety factors for the temporary slopes. Excavated materials should not be stockpiled immediately adjacent to the work as their presence may negatively impact the stability of the excavation slopes, shoring or the underground facilities.

The design of the excavation slopes should recognize the presence of the water-bearing silt which was noted in the test holes. The bottom of the silt was below the top of the existing outfall pipe. It may be necessary to control seepage from the silt during construction.

The excavated slopes should be protected from weathering by suitable temporary coverings.

Temporary shoring may be designed on the basis of the earth pressure distribution illustrated in Figure 8. Ground movements behind the shoring will occur and it is largely unavoidable. The amount that will occur cannot be predicted with much accuracy, mainly because the movement is as much a function of excavation procedures and workmanship as it is a function of theoretical considerations. The impact of these movements should be assessed.

It is recommended that toe support for soldier piles be provided by concrete plugs within the clay deposit immediately below the excavation surface. It is recommended that the toe support not be provided from driving the soldier piles and/or sheet piles into the underlying glacial till/bedrock. This will minimize the potential for a long-term groundwater connection between the bedrock aquifer and the proposed facility.

Where shoring is provided at the base of any excavated slopes, the effects of sloping ground above the shoring, on the shoring, must be considered.

6.5 Below-Grade Walls

The below-grade walls should be designed to resist lateral earth pressures that are derived on the basis of the following conventional relationship:

$$P = K \gamma D$$

where P = lateral earth pressure at depth below final grade D (kN/m^2)
K = earth pressure coefficient (0.5)
γ = soil backfill unit weight (17.5 kN/m^3)
D = depth from final grade to point of pressure calculation (m)

The base of the wall should be provided with a filter-protected positive drainage system to prevent the buildup of hydrostatic pressure against the wall. Where drainage is not provided, the lateral pressure should be increased by 9.81 kN/m^3. An allowance for surface live loads should be included if significant load is applied within a distance from the wall equal to the height of the wall. The lateral pressure due to the live load should be presumed equal to 50 percent of the vertical pressure due to the live load.

The selection of backfill materials should be reviewed during the design and their impact on the foregoing pressures assessed.

6.6 Backfill Over Structures

The backfill over structures can be undertaken with the clayey materials from the excavations. These materials should receive nominal compaction to about 90 percent of Standard Proctor Density. Due to the extensive areas of backfill, compaction equipment will have to be used. A unit weight of about 17.5 kN/m^3 can be used for the clayey materials for design of the roofs of the structures. Also, the loads induced by the compaction equipment on the roofs should be checked. If materials, other than the clayey materials are used, the design unit weights should be increased.

6.7 Pavements

It is recommended that for the relocation of the existing driveway and access to the facility, the pavement section should consist of 75 mm of asphaltic concrete placed on 380 mm of crushed granular base course or an equivalent section. Some consideration could be given to using 200 mm of reinforced concrete on 75 mm of a crushed granular base course service area adjacent to the facility.

The pavement sections should be placed on a prepared subgrade which should be compacted to a uniform density of at least 95 percent of Standard Proctor density at optimum moisture content. The subgrade should be "proof rolled" and any soft spots should be removed and replaced with suitable materials and compacted to this standard.

Although silt was encountered in all of the test holes, it is not expected that it will affect the subgrade preparation because it is relatively deep. It may, however, generate some frost heave in particularly cold winters.

6.8 Other

All concrete in contact with the soil should be manufactured with sulphate-resistant cement and should be of high quality.

Site drainage should be away from the facility site at a gradient of at least 2 percent.

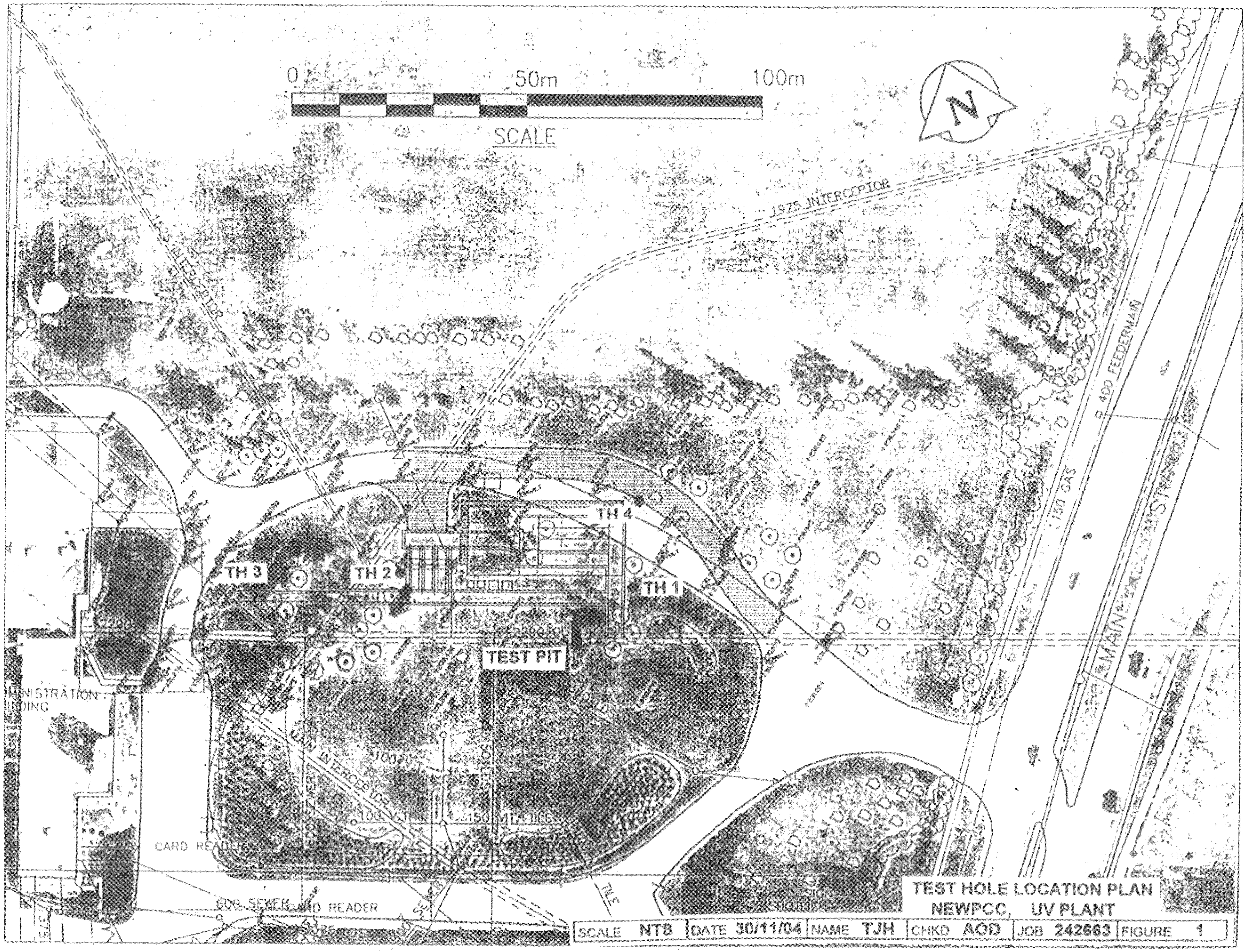
Respectfully submitted,

DYREGROV CONSULTANTS

Per: AO Dyregrov

A.O. Dyregrov, P.Eng.

PROVINCE OF MANITOBA
A. O.
DYREGROV
01/12/04
REGISTERED PROFESSIONAL ENGINEER



TEST HOLE LOCATION PLAN
NEWPCC, UV PLANT

SCALE **NTS**	DATE **30/11/04**	NAME **TJH**	CHKD **AOD**	JOB **242663**	FIGURE **1**

CONSULTANTS

Logged/Dwn.: TH
Checked: AOD

Test Hole No. 1
Project No. 242663

PROJECT: NEWPCC
CLIENT: EARTH TECH

DATE OF INVEST. NOVEMBER 18, 2004
DRILL : SUBTERRANEAN, 16 INCH AUGER

SAMPLE NO.	DEPTH (m)	ELEV. (m)	SYM	SOIL DESCRIPTION	
	0.00	230.79			
				0.00-0.15 SOD OVER TOPSOIL	
1S1	0.75	230.04		0.15-0.90- CLAY, BLACK, MOIST, ORGANIC	
1S2				0.90-2.59 CLAY	
	1.50	229.29		BROWN, SILTY, STIFF, BLOCKY TO 1.5	
1S3					
	2.25	228.54			
1S4				2.59-3.81 SILT	
	3.00	227.79		TAN, MOIST,	
1S5				MOIST TO WET AT 3.1, SLOUGHING, WATER	
	3.75	227.04			
				3.81-20.73 CLAY	
	4.50	226.29		BROWN, SILTY, MOTTLED, STIFF, HIGH PLASTIC	
1S6					Qu-92.3 KPa
1T7	5.25	225.54			Pp-95.8 KPa
1S8					Tv-70.9 KPa
	6.00	224.79			W -16.67 KN/M
				AT 6.4 GREY, SILTY,	
	6.75	224.04			
1T9	7.50	223.29			Qu-106.6 KPa
					Pp-86.1 KPa
	8.25	222.54			Tv-67.0 KPa
					W -16.69 KN/M
1S10	9.00	221.79			
	9.75	221.04			
	10.50	220.29			Qu-96.7 KPa
1T11					Pp-71.8 KPa
	11.25	219.54			Tv-57.5 KPa
					W -17.07 KN/M
1S12	12.00	218.79			
	12.75	218.04			
	13.50	217.29			
1T13				VERY TILLY BETWEEN 13.71 AND 16.77	Qu-107.1 KPa
	14.25	216.54			Pp-76.6 KPa
					Tv-51.7 KPa
	15.00	215.79			W -17.14 KN/M
1S14					
	15.75	215.04			
					Qu-90.1 KPa
	16.50	214.29			Pp-64.6 KPa
				MORE HOMOGENEOUS BETWEEN 13.77 AND 19.50	Tv-53.6 KPa
	17.25	213.54			W -19.75 KN/M
1T15					
	18.00	212.79			
1S16					
	18.75	212.04			
	19.50	211.29			
				AT 19.50 MANY TILL INCLUSIONS	
1S17	20.25	210.54			
1S18					
	21.00	209.79		20.73- 21.19 GLACIAL SILT TILL	
	21.75	209.04			
	22.50	208.29		END OF TEST HOLE AT 21.19 ON POSSIBLE BEDROCK	
	23.25	207.54		NOTE: WATER ROSE QUICKLY IN FIVE MINUTES TO 6.78 BELOW GROUD SURFACE	

MOISTURE CONTENT (%)

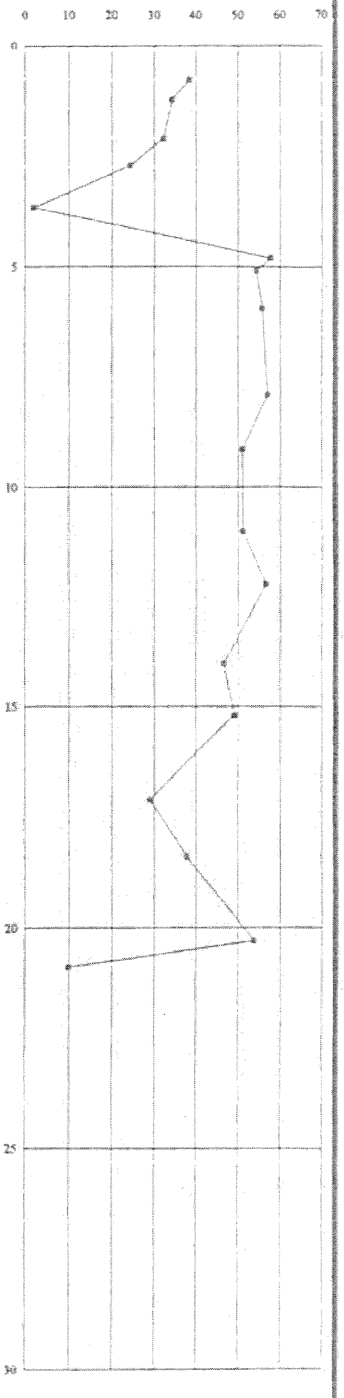


FIGURE 2

DYREGROV CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 2	Project No. 242663
PROJECT: NEWPCC CLIENT: EARTH TECH		DATE OF INVEST. NOVEMBER 18, 2004 DRILL : SUBTERRANEAN, 16 INCH AUGER	

SAMPLE NO.	DEPTH (m)	ELEV. (m)	S Y M	SOIL DESCRIPTION	
	0.00	230.83		0.00-0.15 SOD OVER TOPSOIL	
	0.75	230.08		0.15-0.76 CLAY, BLACK, ORGANIC, FIRM	
2S1				0.76-2.44 CLAY	
	1.50	229.33		BROWN, SILTY, STIFF, WEATHERED	
2S2	2.25	228.58			
2S3				2.44-3.81 SILT	
2S4	3.00	227.83		TAN TO LIGHT BROWN, MOIST, TRACE FINE SAND MOIST TO WET AT 3.1, SLOUGHING, WATER	
	3.75	227.08		3.81-19.82 CLAY	
2T5	4.50	226.33		BROWN GREY, SILTY, MOTTLED, TRACE SILT INCLUSIONS FIRM, MEDIUM TO HIGH PLASTIC	Qu-80.0 KPa Pp-95.8 KPa
	5.25	225.58			Tv-77.6 KPa W -16.74 KN/M
	6.00	224.83			
2T6				AT 6.4 GREY CLAY, TRACE SILT INCLUISIONS	Qu-95.7 KPa
	6.75	224.08			Pp-71.8 KPa Tv-68.9 KPa
2S7	7.50	223.33			W -16.83
	8.25	222.58			
	9.00	221.83			
2T8					Qu-10.1 KPa
	9.75	221.08			PP-67.0 KPa Tv-56.5 KPa
2S9	10.50	220.33			W -17 12
	11.25	219.58			
	12.00	218.83			
2T10				TRACE OF TILL POCKETS BELOW 12.2	Qu-99.1 KPa
	12.75	218.08			Pp-67.0 KPa Tv-47.9 KPA
	13.50	217.33			W -16.42 KN/M
1S11	14.25	216.58			
	15.00	215.83			
2T12	15.75	215.08			Qu-97.6 KPa Pp-47.9 KPa
	16.50	214.33			Tv-43.0 KPa W -16.88 KN/M
	17.25	213.58			
2S13					
	18.00	212.83			
2T14	18.75	212.08			
2S15	19.50	211.33		19.82-20.73 GLACIAL SILT TILL	
2S16	20.25	210.58		SILT MATRIX WITH SOME PEBBLES AND STONES, TAN	
	21.00	209.83		END OF TEST HOLE AT 20.73 IN GLACIAL SILT TILL	
	21.75	209.08		NOTE: TRACE OF WATER AT COMPLETEION OF DRILLING	

MOISTURE CONTENT (%)

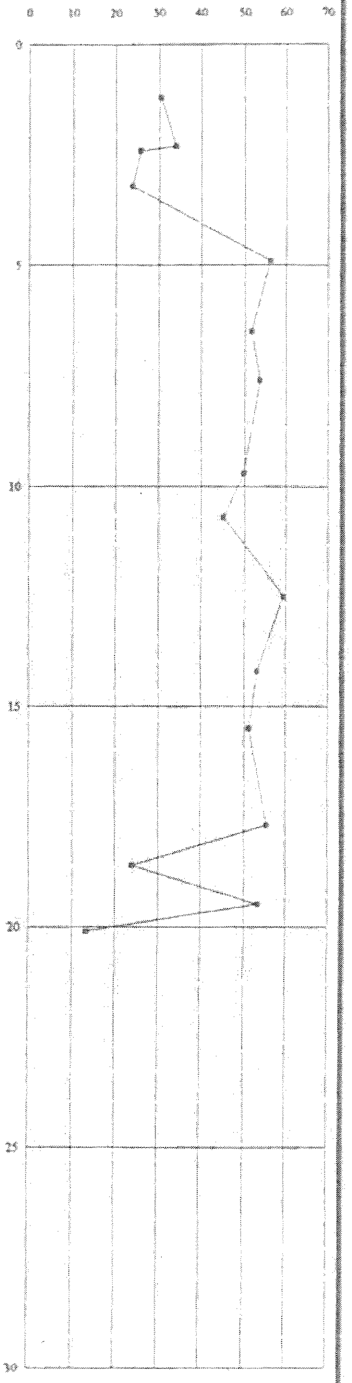


FIGURE 3

CONSULTANTS	Logged/Dwn.: TH Checked: AOD	Test Hole No. 3	Project No. 242663

PROJECT: NEWPCC
CLIENT: EARTH TECH
DATE OF INVEST. NOVEMBER 18, 2004
DRILL : SUBTERRANEAN, 16 INCH AUGER

SAMPLE NO.	DEPTH (m)	ELEV. (m)	SYM	SOIL DESCRIPTION	
	0.00	231.08			
				O DO-0.15 SOD OVER TOPSOIL	
	0.75	230.33		0.15-2.44 FILL,	
3S1				TO 0.61 CLAY MATRIX WITH POCKET OF PIT RUN	
	1.50	229.58			
3S2				AT 1.8 SAME WITH TRACE BLACK POCKET,	
	2.25	228.83		TRACE STONES	
3S3				2.44-2.90 CLAY, BROWN, SILTY, STIFF	
	3.00	228.08		2.90-3.96 SILT	
3S4				TAN, MOIST TO WET AT 3.1, SLOUGHING, WATER	
3S5	3.75	227.33			
3S6					
3T7	4.50	226.58		3.96-19.66 CLAY	Qu-79.8 KPa
				BROWN, SILTY/GREY, MOTTLED, TRACE TAN SILT	Pp-129.3 KPa
	5.25	225.83		INCLUSIONS, MEDIUM TO STIFF, MEDIUM TO HIGH PLAST	Tv-119.7 KPa
				VERTICAL FISSURE FILLED WITH GREY SILT	W -17.23 KN/M
3S8	6.00	225.08			
	6.75	224.33			
	7.50	223.58			
3T9				GREY, STIFF, TRACE SILT AND FINE SAND INCLUSIONS	Qu-93.7 KPa
	8.25	222.83			Pp-95.7 KPa
					Tv-70.9 KPa
3S10	9.00	222.08			W -16.88 KN/M
	9.75	221.33			
	10.50	220.58			
3T11				SAME, MEDIUM TO STIFF, PLUS TRACE FINE	Qu-84.7 KPa
	11.25	219.83		GRAVEL INCLUSIONS	Pp-95.7 KPa
					Tv-67.0 KPa
	12.00	219.08			W -18.1 KN/M
3S12					
	12.75	218.33			
	13.50	217.58			
3T13	14.25	216.83		SAME, SOME FINE SILT AND FINE SAND LAYERING	Qu-91.7 KPa
					Pp-47.9 KPa
	15.00	216.08			Tv-47.9 KPa
					W -17.97 KN/M
3S14	15.75	215.33			
	16.50	214.58			
3T15				SAME, MEDIUM, TRACE SILT, FINE SAND, AND FINE	Qu-77.9 KPa
	17.25	213.83		GRAVEL INCLUSIONS	Pp-35.9 KPa
					Tv-38.3 KPa
3S16	18.00	213.08			W -17.05 KN/M
	18.75	212.33			
3S17					
	19.50	211.58			
				19.66-21.48 GLACIAL SILT TILL	
3S18	20.25	210.83		SILT MATRIX WITH SAND, TRACE CLAY, SOME GRAVEL	
				SOME COBBLES AND BOULDERS	
	21.00	210.08			
	21.75	209.33		END OF TEST HOLE AT 21.48	

AUGER REFUSAL ON ASSUMED BEDROCK

NOTE: APPROXIMATELY 25mm OF WATER IN HOLE AT OMPLETION OF DRILLING

MOISTURE CONTENT (%)

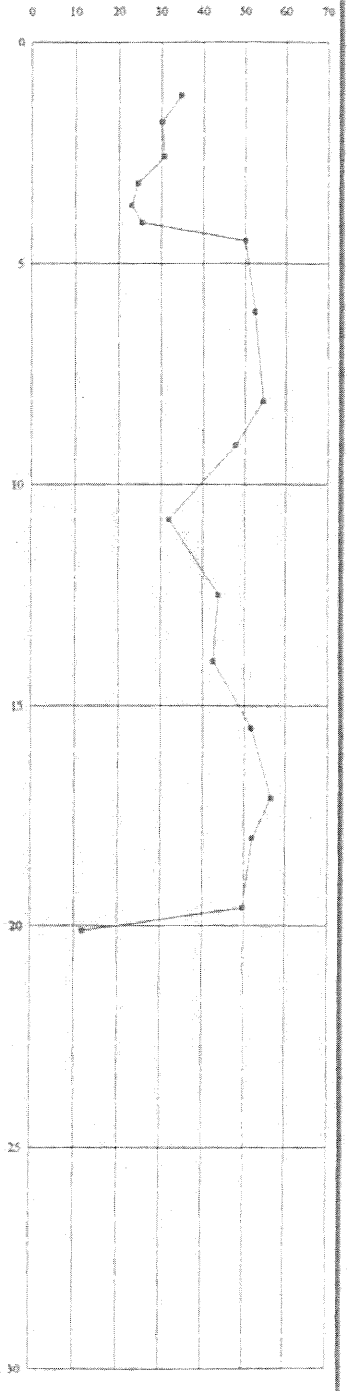


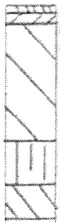
FIGURE 4

DYREGROV CONSULTANTS
Logged/Dwn.: TH
Checked: AOD
Test Hole No. 4
Project No. 242663

PROJECT: NEWPCC
CLIENT: EARTH TECH
DATE OF INVEST. NOVEMBER 18, 2004
DRILL : SUBTERRANEAN, 16 INCH AUGER

SAMPLE NO.	DEPTH (m)	ELEV (m)
	0.00	230.66
	0.75	229.91
	1.50	229.16
	2.25	228.41
	3.00	227.66
	3.75	226.91
	4.50	226.16
	5.25	225.41
	6.00	224.66

SYM



SOIL DESCRIPTION

0.00-0.15 SOD OVER TOPSOIL
0.15-0.53 CLAY, BLACK, ORGANIC, MOIST, FIRM, LOW PLASTIC,
0.53-3.05 CLAY
BROWN, SILTY, TRACE SILT INCLUSIONS TO 1.5
SOME SILT VARVES TO 3.0, BLOCKY, WEATHERED,
FIRM, MEDIUM TO HIGH PLASTIC

3.05-4.27 SILT
TAN TO LIGHT BROWN, MOIST TO WET BELOW 3.3
SOFT, VERY LOW TO NON PLASTIC, SLOUGHING AND WATER BELOW 3.3
4.27-4.88 CLAY
BROWN, SILTY, MOTTLED, TRACE TINY SILT AND
FINE SAND INCLUSIOND

END OF TEST HOLE AT 4.88 IN BROWN SILTY CLAY

MOISTURE CONTENT (%)

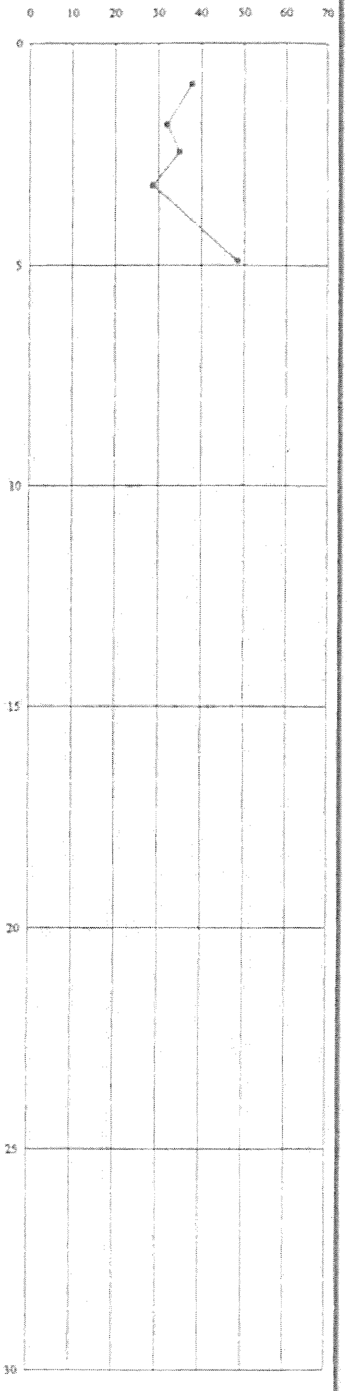
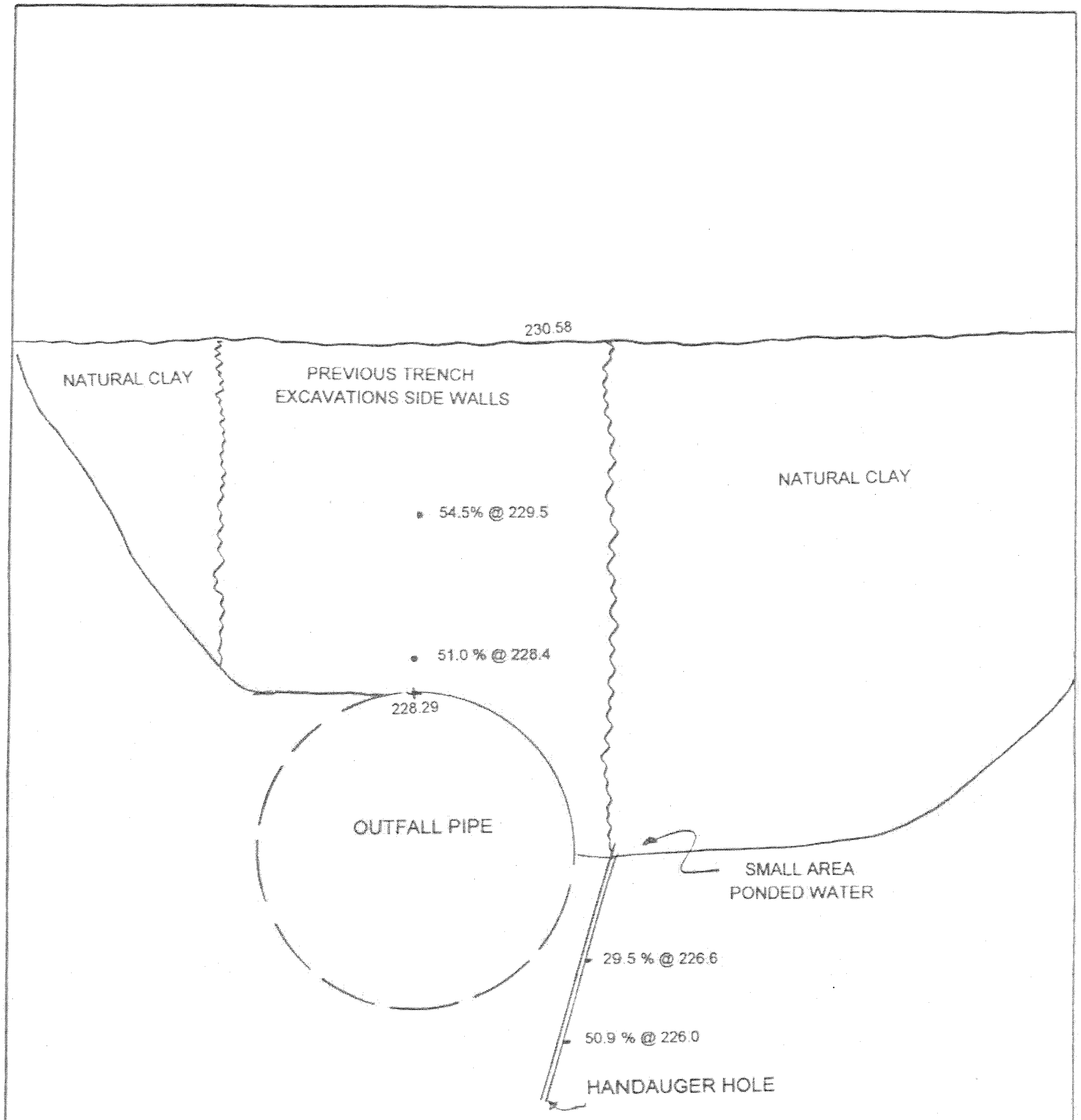


FIGURE 5



NOTE: The small area of poned water came from the silt and from around the pipe

The outfall pipe was exposed with a large backhoe to approximately 300 above the pipe and the remainder of the fill was removed by shovell .

The outfall pipe was exposed only to the string line.

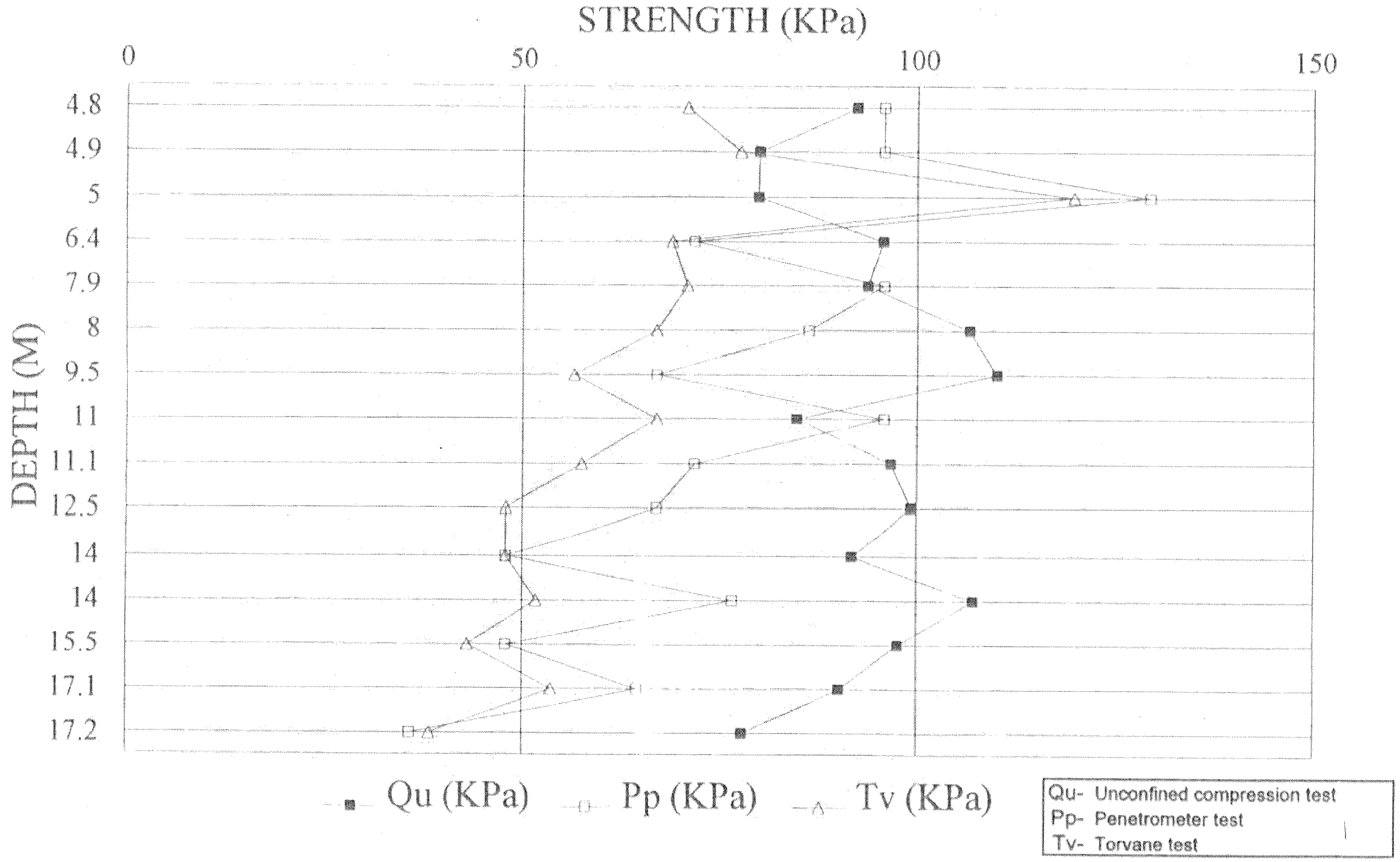
The previous excavated trench was +/- 3.0 m wide

DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

TEST PIT EXPOSING OUTFALL PIPE
NEWPCC, PROPOSED U V PLANT

SCALE NTS	DATE 07/12/04	MADE TJH	CHKD AOD	JOB 242663	FIGURE 6

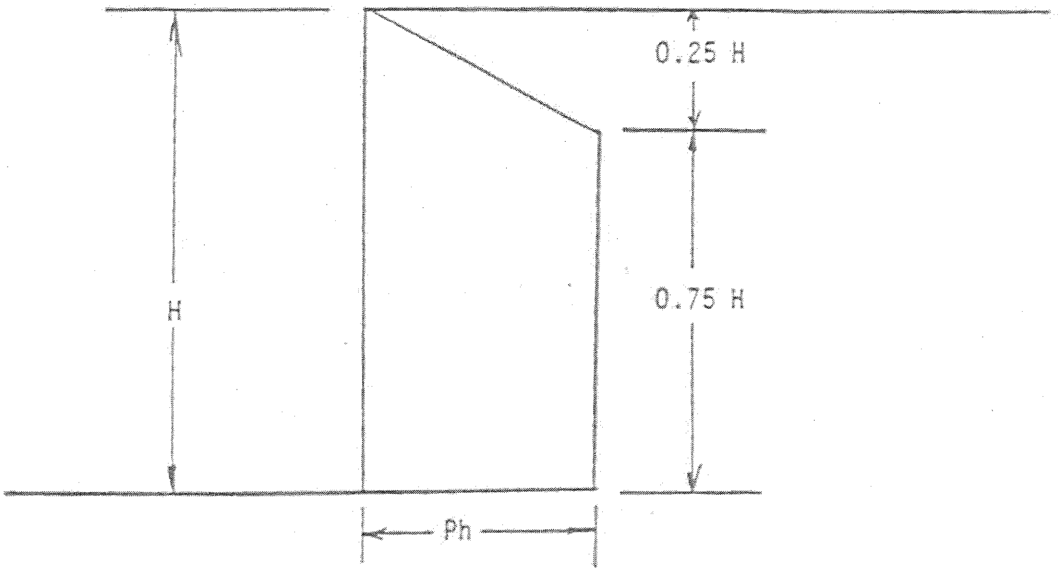
UNDRAINED SHEAR STRENGTH



DYREGROV CONSULTANTS
CONSULTING GEOTECHNICAL ENGINEERS

UNDRAINED SHEAR STRENGTH
NEWPCC, PROPOSED U V PLANT

SCALE NTS	DATE 08/12/04	MADE TJH	CHKD AOD	JOB 242663	FIGURE 7



Ph = $0.4 \gamma H$

Where: Ph = Lateral earth pressure on shoring (kPa)

γ = Soil unit weight (17.28 KN/M^3)

H = Wall height (M)

Note: Add surface load surcharge where applicable

DYREGROV CONSULTANTS

CONSULTING GEOTECHNICAL ENGINEERS

EARTH PRESSURE DISTRIBUTION
TEMPORARY SHORING
NEWPCC DISINFECTION FACILITY

SCALE NTS	DATE 07/12/04	MADE TJH	CHKD AOD	JOB 242663	FIGURE 8