APPENDIX A
TEST HOLE LOGS

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

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The City of Winnipeg
Public Works Department
104-1155 Pacific Avenue
Winnipeg, Manitoba
R3E 3P1

June 5, 2003

Project: Waverley Yard
(WIN-305)

Attention: Brian Lacey

1.0 SUMMARY

The National Testing Laboratories Limited were retained to undertake a geotechnical investigation and provide foundation recommendations for the proposed building to be located in the City of Winnipeg Waverley yard on the southwest corner of Waverley Street and Chevrier Boulevard, Winnipeg, Manitoba.

Two deep boreholes, BH4 and BH5, were drilled at locations selected by the client to refusal at depths of 16.6 and 16.8 m below grade respectively. Six shallow boreholes, BH1 to BH3 and BH6 to BH8, were drilled on the site to a maximum depth of 4.6 m below grade. The investigation revealed a general soil profile of granular fill, clay fill, clay, silt, clay and silt till to the depths explored. Groundwater seepage was observed originating in the silt till in borehole BH4 and after completion of drilling water level rose to 7.6 m below grade. Soil sloughing was observed in the silt layer in borehole BH5.

It was reported by the client that the building will be composed of an 2.4 m stud wall supported on a system of cast-in-place (CIP) concrete friction piles, it will be fabric covered and used for the storage of salt and sand piles. Based upon the subsurface conditions encountered, this is a feasible foundation option.

2.0 INTRODUCTION

2.1 Terms of Reference

The National Testing Laboratories Limited (NTL) were retained to conduct a site investigation and provide geotechnical recommendations for the proposed building to be located in the City of Winnipeg Waverley yard on the southwest corner of Waverley Street and Chevrier Boulevard, Winnipeg, Manitoba. Authorization to proceed with the work was provided by Brian Lacey of The City of Winnipeg Public Works Department.

The scope of work included:

- A subsurface investigation consisting of borehole drilling and soil sampling.
- Laboratory testing on selected soil samples to establish soil strengths.
- A report outlining the subsurface conditions, field and laboratory test results, recommendations for skin friction values for the building foundation, unusual site conditions or potential problems during construction.

2.2 Existing Site Conditions and Proposed Building

The property is rectangular in shape with approximate dimensions of 85 m x 135 m. The site is currently used to stockpile salt and sand, is relatively flat and is gravel surfaced. The compound is fenced and situated west of the City of Winnipeg office building (1539 Waverley Street). The proposed building is to be located in the approximate centre of the site.

3.0 FIELD AND LABORATORY INVESTIGATION

3.1 Borehole Drilling/Soil Sampling and Testing

The subsurface drilling and sampling program was conducted on May 16, 2003 with drilling services provided by Maple Leaf Drilling of Winnipeg under the direction of NTL geotechnical field personnel. Two boreholes, BH4 and BH5, were drilled at locations selected by the client to auger refusal at depths of 16.6 and 16.8 m below grade respectively. Six shallow boreholes, BH1 to BH3 and BH6 to BH8, were drilled to a maximum depth of 4.6 m below grade at locations selected by the client. Borehole BH2 was terminated at a depth of 1.8 m due to hard drilling caused by the presence of concrete rubble at that depth. The borehole location was moved 3 m east and borehole BH2a was drilled to 3.0 m below grade. The boreholes were drilled using a drill rig equipped with 150 mm diameter solid stem augers and their locations are shown on the Borehole Location Plan, Figure 1.

Representative soil samples were obtained directly off the augers at depth intervals ranging from 0.8 to 1.5 m or at changes in soil strata. Samples were visually classified in the field and returned to our soils testing laboratory.

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3.2 Laboratory Testing

Water content tests were performed on all soil samples recovered from the boreholes and the results are shown on the attached borehole logs.

Unconfined compressive strength (UCS) testing was conducted on four samples of the clay in borehole BH5 at varying depths and results are shown in the following table.

Depth, m	UCS, kPa	Shear Strength, kPa
4.8 - 4.95	54.4	27.2
7.9 - 8.06	77.0	38.5
10.9 - 11.06	79.3	39.7
14.0 - 14.16	57.9	28.9

Miniature vane tests were conducted to assess the shear strength of the clay. The measured undrained shear strength values ranged from 8 to 76 kPa, with an overall average of 35 kPa. Test results are shown on the attached borehole logs.

4.0 SUBSURFACE CONDITIONS

4.1 Soil Profile

The general site stratigraphy, as interpreted from the borehole logs, consisted of granular fill, clay fill, clay, silt, clay and silt till to the depths explored.

Granular Fill - A 0.15 to 1.2 m thick layer of granular fill was encountered at the surface of all boreholes and consisted of compact sand and gravel.

Clay Fill - Clay fill was found below the granular fill in all the boreholes and extended to a depth of 1.7 m in all the boreholes with the exception of borehole BH2 where it extended to 3.0 m below grade. The clay fill contained large amounts of gravel in the upper approximate 0.6 m and trace amounts below. It was dark brown to black, moist, firm and of low plasticity.

Silt - Silt was found below the clay fill in boreholes BH3, BH4, BH5, BH7 and BH8 and within the clay

layer in boreholes BH1 and BH6. The silt ranged in thickness from 0.15 to 1.2 m and was tan, moist to wet, soft and of low plasticity.

Clay - A clay layer was found below the clay fill in boreholes BH1 and BH6 and below the silt layer in all other boreholes with the exception of borehole BH2a where no native clay was encountered. The clay extended to depths of 15.5 m and 14.6 m in boreholes BH4 and BH5 respectively and to the depths explored in the shallow boreholes. It was brown to grey, moist, stiff to soft, of high plasticity and contained trace silt inclusions and trace sand with depth.

Silt Till - Silt till was encountered below the clay in BH4 and BH5 and extended to the depths explored. The till was grey, damp, dense and contained trace clay and some sand and gravel. Auger refusal was encountered on suspected bedrock at depths of 16.6 and 16.8 m below grade in BH4 and BH5 respectively.

4.2 Ground Water

Ground water seepage originating in the silt till was observed in borehole BH4. The water level was measured at 7.6 m below grade in the boreholes after completion of drilling. Sloughing of the silt layer was observed in borehole BH5 during drilling. No other inference related to the ground water elevation can be made; levels will normally fluctuate during the year and will be dependent upon precipitation and surface drainage.

5.0 DESIGN RECOMMENDATIONS AND COMMENTS

5.1 Foundation

It was reported by the client that the preferred foundation system for the proposed building is a system of cast-in-place (CIP) concrete friction piles. Based upon the subsurface conditions encountered, this is a feasible foundation option.

CIP (Cast-In-Place) Concrete Friction Piles

A system of CIP concrete friction piles may be utilized to support the proposed building. Temporary steel sleeves should be available in the event that ground water seepage or sloughing of the pile holes is encountered. It is recommended that the pile depth not exceed 14 m to avoid penetration of the till and

potential water seepage. Pile holes should be poured with concrete as soon as they are drilled to minimize any potential problems of soil sloughing and/or ground water infiltration. Water, if encountered in the pile holes, should be removed prior to concrete placement.

The CIP concrete piles may be designed based upon the allowable skin friction values (shaft adhesion) shown in the following table.

Pile Depth Below Existing Grade, m	Allowable Skin Friction, kPa
6.0	14
7.5	13
9.0	12
10.5	12
12.0	11
13.5	11

The allowable skin friction value is applied to the pile circumference within the clay stratum only. Due to the potential for drying and shrinkage of the clay soil near the ground surface, the upper 1.5 and 3 m of the pile must be neglected in the calculation of the pile capacity for interior and exterior piles respectively. End bearing of the piles should also be ignored in pile capacity calculations. Minimum pile spacing should be three pile diameters, centre to centre. Since the piles will be located in an unheated area they should have a minimum pile length of 7.5 m and should be provided with full length reinforcement.

5.2 Site Drainage

All roof downspouts should be directed away from the building and the ground surface around the building should be graded to prevent water from ponding adjacent it. Final site grading should ensure that all surface runoff is directed away from the foundation using minimum gradients of 1% and 2% for paved and landscaped areas, respectively. To compensate for settlement of backfill materials adjacent to the structure, the grade should be increased to 10% for the first 2 m from the building.

5.3 Foundation Concrete

Sulphate resistant (Type 50) cement should be used at this location for concrete in contact with the soil. To meet the requirements of CSA A23.1, foundation concrete should be air entrained, have a maximum

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water to cementitious ratio of 0.45 and a minimum compressive strength of 32 MPa. Concrete subject to periodic cycles of freezing and thawing should be air entrained in accordance with CSA A23.1.

6.0 CLOSURE

The findings and recommendations provided in this report were prepared in accordance with generally accepted professional engineering principles and practices. The recommendations are based on the results of field and laboratory investigations. If conditions encountered during construction appear to be different than those shown by the boreholes drilled at this site, this office should be notified immediately in order that the recommendations can be reviewed.

Prepared by:

Ines Alguacil, B.Sc., E.I.T.,
Environmental and Geotechnical
Engineering Services

Reviewed by:

Peter Giesbrecht, P. Eng., Manager,
Environmental and Geotechnical
Engineering Services

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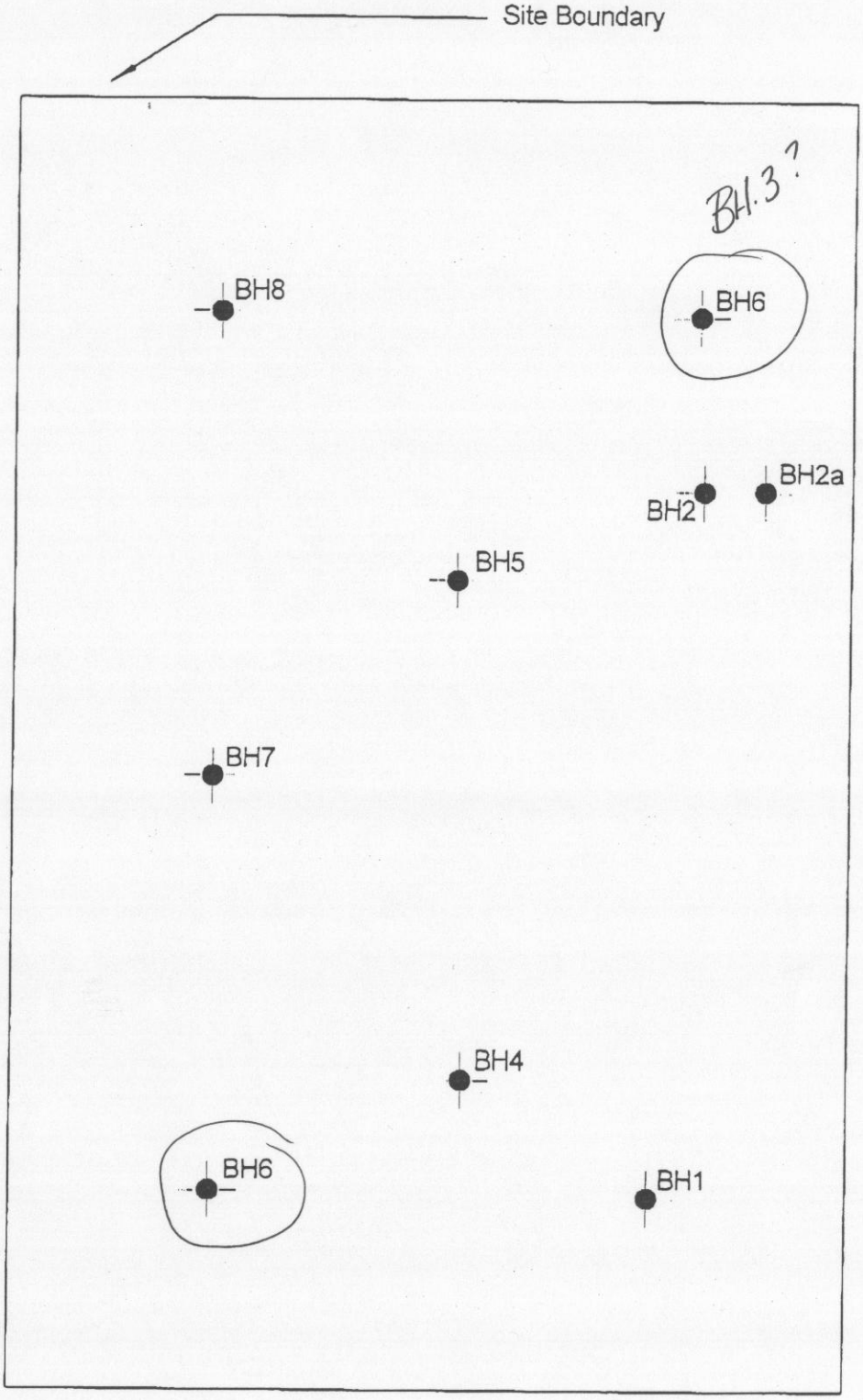

THE NATIONAL TESTING LABORATORIES LIMITED Established in 1923	Borehole Location Plan	SW Corner of Waverley St. & Chevrier Blvd. Winnipeg, Manitoba	
	Project No.: WIN-305	Drawn by: I.A.	Figure: 1
	Date: June 5, 2003	Checked By: P.G.	Scale: 1:720

BOREHOLE BH1

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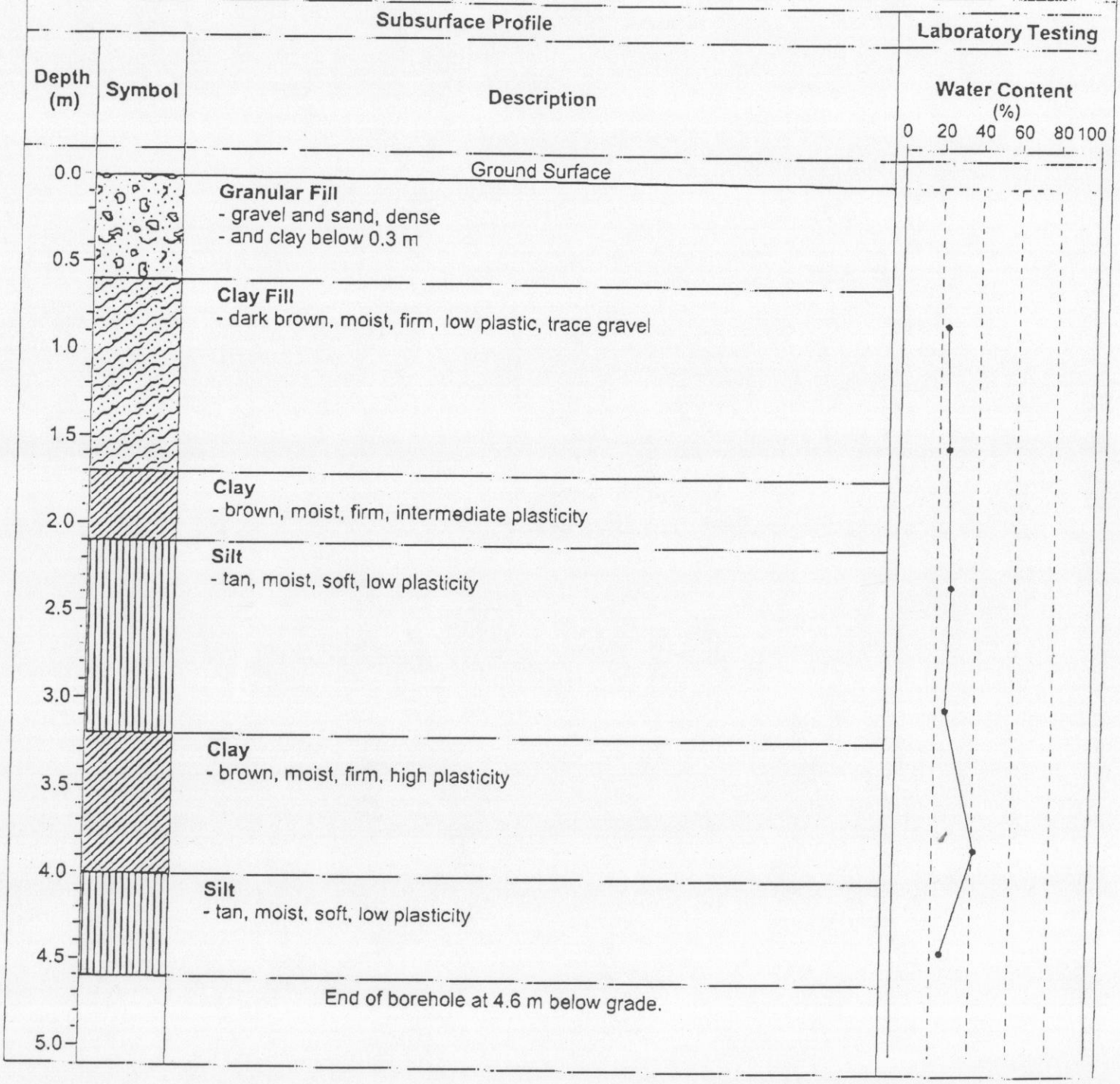
Established in 1933

Project Name: Waverley Yard
Client: City of Winnipeg
Project Number: WIN-305
Site Location: SW corner of Waverley St. & Chevrier Blvd.

Date Drilled: May 16, 2003
Depth of Borehole: 4.6 m
Logged by: Robert Hochkievich
Reviewed by: Ines Alguacil



BOREHOLE BH2

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1973

Project Name: Waverley Yard
Client: City of Winnipeg
Project Number: WIN-305
Site Location: SW corner of Waverley St. & Chevrier Blvd.

Date Drilled: May 16, 2003
Depth of Borehole: 1.8 m
Logged by: Robert Hochkievich
Reviewed by: Ines Alguacil

Subsurface Profile

Depth (m)	Symbol	Description
0.0		Ground Surface
		Granular Fill - gravel and sand, compact
1.0		
		Clay Fill - black, moist, firm, low plastic, some gravel
1.5		
2.0		Refusal at 1.8 m on suspected concrete rubble.
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		

BOREHOLE BH2a

THE NATIONAL TESTING LABORATORIES LIMITED

Project Name: Waverley Yard
Client: City of Winnipeg
Project Number: WIN-305
Site Location: SW corner of Waverley St. & Chevrier Blvd.

Date Drilled: May 16, 2003
Depth of Borehole: 3.0 m
Logged by: Robert Hochkievich
Reviewed by: Ines Alguacil

Subsurface Profile

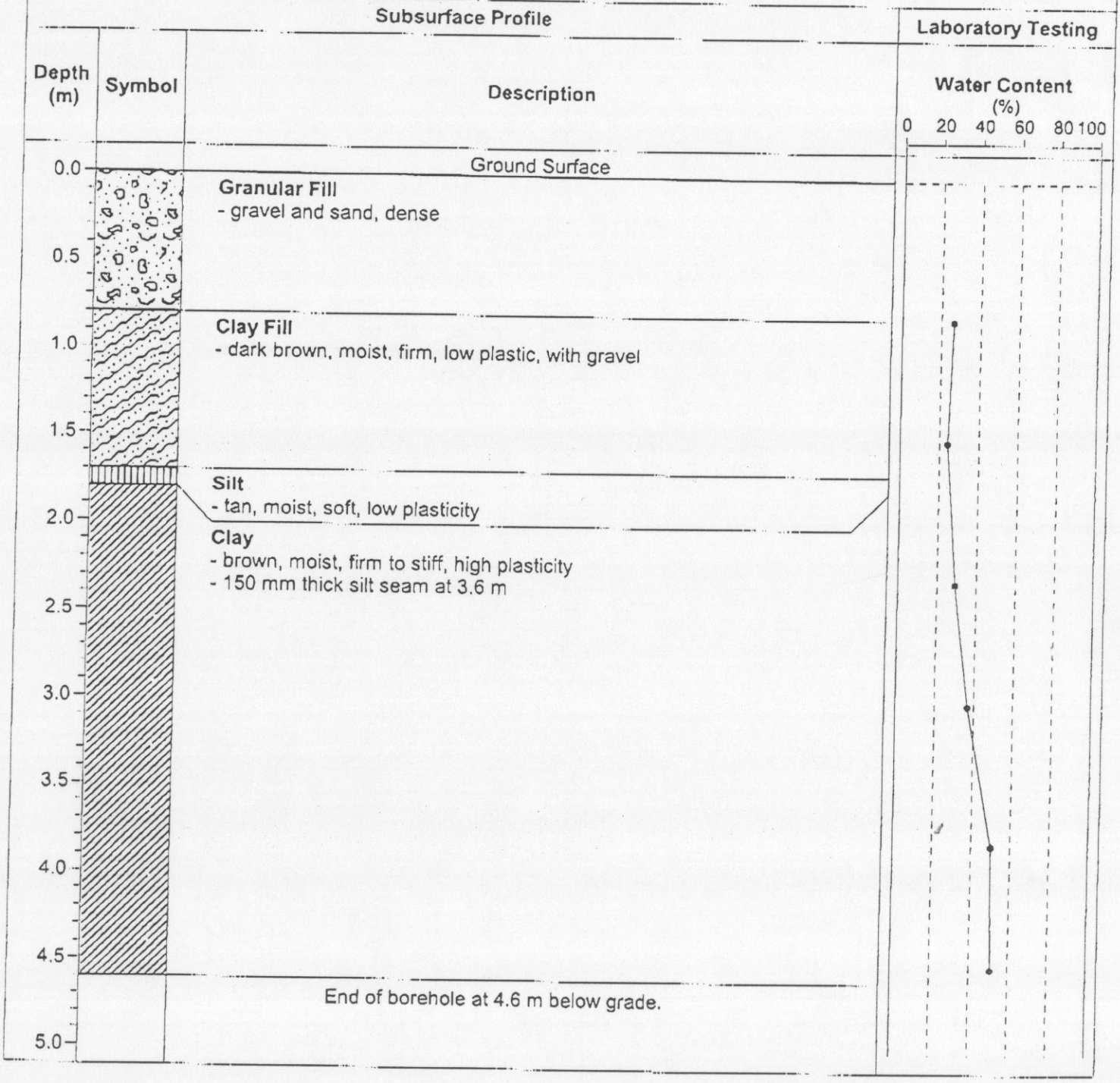
Depth (m)	Symbol	Description
0.0		Ground Surface
		Granular Fill - gravel and sand, compact
1.0		
		Clay Fill - black, moist, firm, low plastic, some gravel - trace gravel below 1.8 m
3.0		End of borehole at 3.0 m below grade.
5.0		

BOREHOLE BH3

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

Project Name: Waverley Yard
Client: City of Winnipeg
Project Number: WIN-305
Site Location: SW corner of Waverley St. & Chevrier Blvd.

Date Drilled: May 16, 2003
Depth of Borehole: 4.6 m
Logged by: Robert Hochkievich
Reviewed by: Ines Alguacil



BOREHOLE BH4

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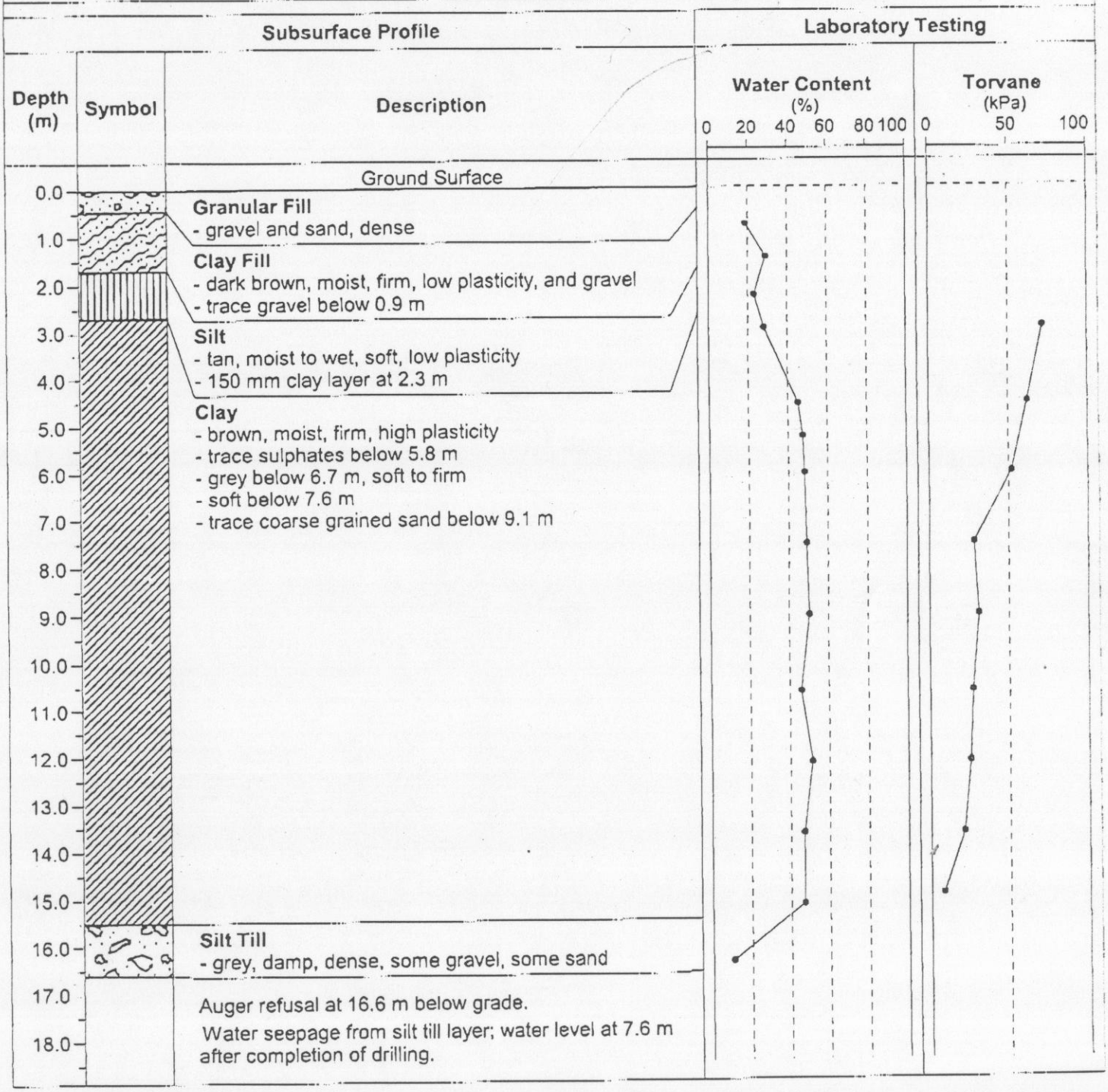
Established in 1923

Project Name: Waverley Yard
Client: City of Winnipeg
Project Number: WIN-305
Site Location: SW corner of Waverley St. & Chevrier Blvd.

Date Drilled: May 16, 2003
Depth of Borehole: 16.6 m
Logged by: Robert Hochkievich
Reviewed by: Ines Alguacil



BOREHOLE BH5

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Established in 1933

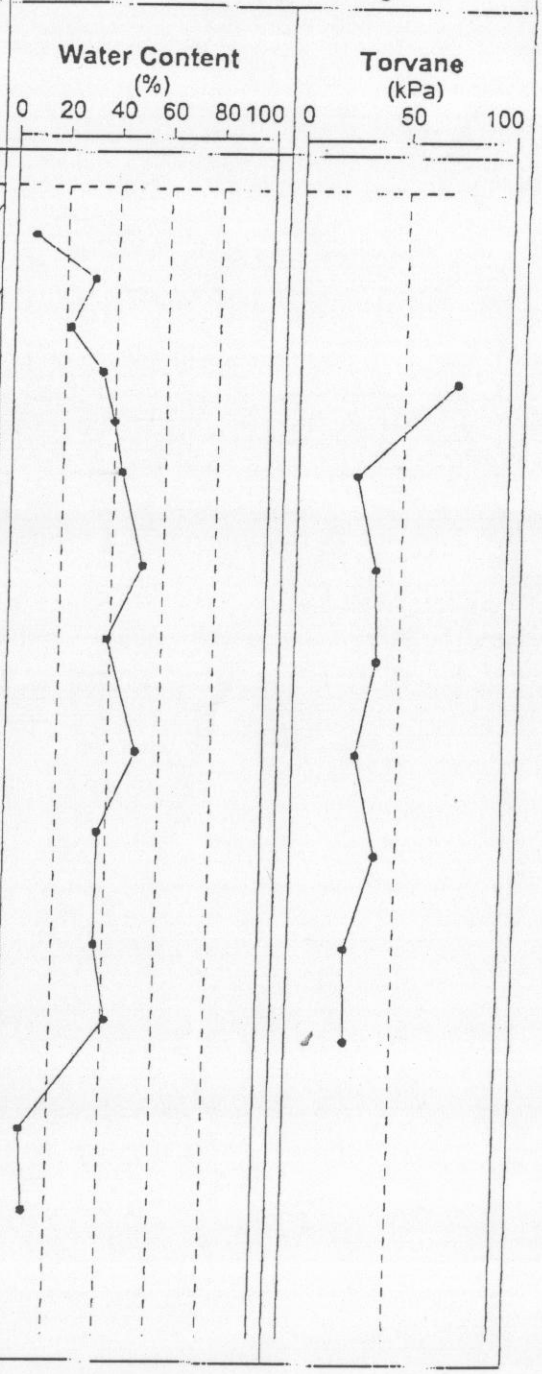
Project Name: Waverley Yard
Client: City of Winnipeg
Project Number: WIN-305
Site Location: SW corner of Waverley St. & Chevrier Blvd.

Date Drilled: May 16, 2003
Depth of Borehole: 16.8 m
Logged by: Robert Hochkievich
Reviewed by: Ines Alguacil

Subsurface Profile

Depth (m)	Symbol	Description
0.0		Ground Surface
		Granular Fill - gravel and sand, dense
1.0		
		Clay Fill - dark brown, moist, firm, low plasticity, and gravel - trace gravel below 0.9 m
2.0		
3.0		**Silt** - tan, moist to wet, soft, low plasticity
4.0		**Clay** - brown, moist, stiff, high plasticity, trace silt inclusions - firm below 3.4 m - grey below 7.9 m, soft
5.0		
6.0		
7.0		
8.0		
9.0		
10.0		
11.0		
12.0		
13.0		
14.0		
15.0		**Silt Till** - grey, damp, dense, some gravel, some sand
16.0		
17.0		Auger refusal at 16.8 m below grade. Sloughing of soil below 2.4 m.
18.0		

Laboratory Testing



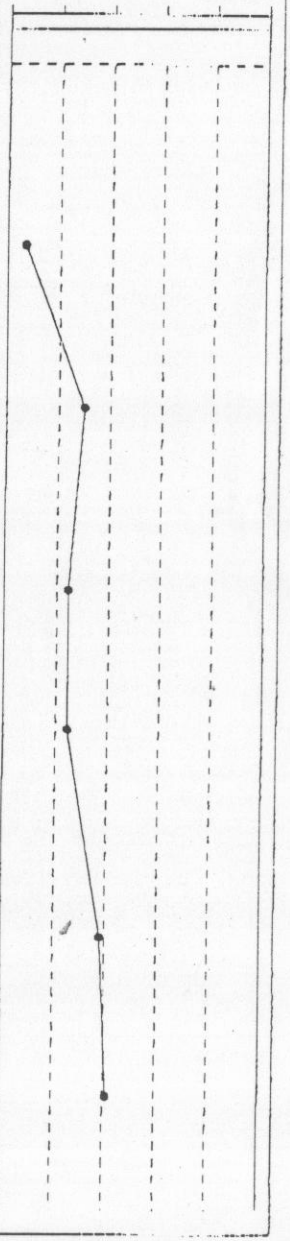
BOREHOLE BH6

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

Project Name: Waverley Yard
Client: City of Winnipeg
Project Number: WIN-305
Site Location: SW corner of Waverley St. & Chevrier Blvd.

Date Drilled: May 16, 2003
Depth of Borehole: 4.6 m
Logged by: Robert Hochkievich
Reviewed by: Ines Alguacil

Subsurface Profile			Laboratory Testing
Depth (m)	Symbol	Description	Water Content (%) 0 20 40 60 80 100
0.0		Ground Surface	
		Granular Fill - gravel and sand, dense	
0.5		**Clay Fill** - dark brown, moist, firm, low plastic, and gravel - trace gravel below 0.9 m, firm to stiff	
1.0			
1.5			
		Clay - brown, moist, firm, high plasticity, trace silt inclusions	
2.0		**Silt** - tan, moist to wet, soft, low plasticity, trace clay seams	
2.5			
3.0		**Clay** - brown, moist, firm, high plasticity	
3.5			
4.0			
4.5		End of borehole at 4.6 m below grade.	
5.0			



BOREHOLE BH7

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

Project Name: Waverley Yard
Client: City of Winnipeg
Project Number: WIN-305
Site Location: SW corner of Waverley St. & Chevrier Blvd.

Date Drilled: May 16, 2003
Depth of Borehole: 4.6 m
Logged by: Robert Hochkievich
Reviewed by: Ines Alguacil

Depth (m)	Symbol	Subsurface Profile: Description	Laboratory Testing: Water Content (%)
0.0		Ground Surface	
		Granular Fill - gravel and sand, dense	
0.5		**Clay Fill** - dark brown, moist, firm, low plastic, and gravel - trace gravel below 0.6 m, firm to stiff	
1.0			
1.5			
		Silt - tan, moist, soft, low plasticity	
2.0			
2.5		**Clay** - brown, moist, firm, high plasticity	
3.0			
3.5		**Silt** - tan, moist, soft, low plasticity	
4.0		**Clay** - brown, moist, firm, high plasticity	
4.5		End of borehole at 4.6 m below grade.	
5.0			

Water Content (%): 0 20 40 60 80 100

BOREHOLE BH8

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

Project Name: Waverley Yard
Client: City of Winnipeg
Project Number: WIN-305
Site Location: SW corner of Waverley St. & Chevrier Blvd.

Date Drilled: May 16, 2003
Depth of Borehole: 4.6 m
Logged by: Robert Hochkievich
Reviewed by: Ines Alguacil

Depth (m)	Symbol	Subsurface Profile: Description	Laboratory Testing: Water Content (%)
		Ground Surface	0 20 40 60 80 100
0.0		**Granular Fill** - gravel and sand, dense	
0.5		**Clay Fill** - dark brown, moist, firm, low plastic, and gravel - trace gravel below 0.6 m, firm to stiff	
1.0			
1.5			
2.0		**Silt** - tan, moist, soft, low plasticity	
2.5		**Clay** - brown, moist, firm to stiff, high plasticity	
3.0		**Silt** - tan, moist, soft, low plasticity	
3.5		**Clay** - brown, moist, firm, high plasticity - with silt from 3.8 m to 4.0 m	
4.0			
4.5		End of borehole at 4.6 m below grade.	
5.0			