Appendix C
860198-0087(1.0)

GEOTECHNICAL REPORT
WINNIPEG TRANSIT GARAGE ADDITION
WINNIPEG, MANITOBA

Prepared for:
Colliers Project Leaders
Suite 960-363 Broadway
Winnipeg, MB
R3C 3N9

Project No: 161-09427-00
July 21, 2016

1600 BUFFALO PLACE
WINNIPEG, MB R3T 6B8

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1.0 SUMMARY

A geotechnical investigation was conducted for the proposed Winnipeg Transit Garage Addition at 421 Osborne Street, Winnipeg to assess the general subsurface conditions. It was requested that foundation and pavement recommendations for the proposed addition with access road and parking lot be provided. A total of 8 testholes (5 deep testholes between 12.2m and auger refusal depth, 16.5m (SUSPECTED BOULDER/BEDROCK), and three testholes between 3m and 12.2m depth across Brandon Avenue) revealed a general soil profile consisting of a layer of fill underlain by a thin upper clay layer followed by a thin silt layer. This thin silt layer is followed by a thick clay layer followed a till layer, which extended to the depth explored. The moist to wet SILT layer encountered in the upper layer (between 1.2m and 2.1m) is present in testholes, TH1 to TH5. Although not observed, seepage and caving conditions will be anticipated from the top of TILL layer and from the SILT layer during pile installation.

Based upon the subsurface conditions encountered, the preferred foundation for the proposed addition is a system of precast, prestressed driven concrete piles end-bearing on the native undisturbed dense till or suspected bedrock/boulder. Alternatively, cast-in-place (CIP) friction piles may be used for the proposed addition. Temporary sleeves should be used to seal off any seepage and caving conditions from the SILT layer. A combination of these foundation systems may be used provided that our recommendations are followed. Note that the existing buildings' foundation is a combination of driven piles and CIP friction piles.

2.0 INTRODUCTION

2.1 SCOPE OF WORK

WSP was retained to undertake a soils investigation for the proposed facilities (an addition to existing Winnipeg Transit Garage and a parking lot across Brandon Avenue) at 421 Osborne Street in Winnipeg, Manitoba. The purpose of this work was to establish the soil and groundwater conditions at the site and provide foundation and pavement recommendations for the proposed structures as well as comment on potential problems. Authorization to proceed with the work was provided by Mr. Kevin Sim of Colliers Project

Leaders.

2.2 PROPOSED FACILITIES

The proposed structure will be a one storey addition including a clear span structure for the bus areas. Other key features of the addition are bus hoists with pits, drainage pits, bus garage, shop and storage areas, structural slab for non-bus bay areas, possible slab-on-grade for bus bay areas, heavy duty access roads, fencing and bollards and car parking across Brandon Avenue.

2.3 EXISTING SITE

The proposed addition site is an existing gravel and paved parking lot west of the existing building. The proposed parking lot is an empty lot across Brandon Avenue as shown in the attached Figure in Appendix A.

3.0 FIELD METHODOLOGY

The subsoils encountered were visually classified to the full extent in the testhole and representative soil samples were recovered at regular depth intervals. Pocket penetrometer tests were conducted on cohesive soil to determine the approximate unconfined compressive strength and random Standard Penetration Testing (SPT) was conducted on the till layer to determine the relative density. Groundwater seepage and sloughing encountered in the testholes were noted.

4.0 LABORATORY AND FIELD TESTING

The field investigation was undertaken on July 4, 2016. A truck-mounted drill rig with a continuous flight auger was used to drill a total of 8 testholes, five deep(between 12.2m and auger refusal, 16.4m depth) and three shallow testholes (between 3 and 12.2m depth). The testhole locations are shown on the site plan in Appendix A.

Random pocket penetrometer and SPT testing were conducted in the testholes to determine the strength and relative density of the soil. Detailed descriptions of the soil profiles in each testhole are shown on the attached testhole logs, TH 1 to TH 8 in Appendix B.

5.0 SUBSURFACE CONDITIONS

5.1 SOIL PROFILE/GROUNDWATER

A total of 8 testholes (5 deep testholes between 12.2m and auger refusal depth, 16.5m (SUSPECTED BOULDER/BEDROCK), and three testholes between 3m and 12.2m depth across Brandon Avenue) revealed a general soil profile consisting of a layer of fill underlain by a thin upper clay layer followed by a thin silt layer. This thin silt layer is followed by a thick clay layer followed a till layer, which extended to the depth explored. The moist to wet SILT layer encountered in the upper layer (between 1.2m and 2.1m) is present in testholes TH1 to TH5. Although not observed, seepage and caving conditions will be anticipated from top of the TILL layer and from the SILT layer during pile installation.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 GENERAL

The foundation recommendations are made on our understanding that the proposed addition is a medium-loaded to heavily-loaded structure without a basement. The anticipated floor for the proposed structure will be a combination of structural slab for non-bus areas and possible slab-on-grade for bus bay areas.

6.2 FOUNDATIONS

Foundation alternatives, which were considered, include conventional footings, cast-in-place (CIP) concrete friction piles and precast concrete driven piles; end-bearing on the native undisturbed dense till or suspected bedrock.

Due to swelling, shrinkage and long-term settlement, a conventional footing on clay is not recommended.

The preferred foundation, which may be utilized for the addition which includes the hoists, hoist pits and drainage pits, is a system of precast concrete driven piles end-bearing on the native undisturbed dense till or suspected bedrock. Alternatively, CIP concrete friction piles maybe used for the proposed building, hoists, hoist pits and drainage pits. *Temporary sleeves should be used since seepage from the SILT layer is anticipated during pile installation.*

6.2.1 Precast, Prestressed Driven Concrete Piles

The preferred foundation for the proposed addition is a system of driven, prestressed, precast concrete piles. These units, when driven to practical refusal in the dense till or suspected bedrock with a heavy hammer capable of delivering a rated energy of 40672.4 N-m(30,000 ft-lbs) per blow, may be assigned the following allowable loads.

Pile Size mm (in)	Allowable Loads kN (tons)
300(12) hex	443 (50)
350(14) hex	620 (70)
400(16) hex	797 (90)

With Limit State Design, the following loads at Serviceability Limit State (SLS) and Factored Ultimate Limit State (ULS) are tabled below. *Factored ULS was determined by applying the appropriate resistance factor (0.4) to the Unfactored ULS.*

Table 1

Pile Size, mm(in)	SLS, kN (tons)	Factored ULS, kN (tons)
300 (12)	443 (50)	532 (60)
350 (14)	620 (70)	744 (84)
400 (16)	797 (90)	956 (108)

For driven piles uplift resistance, the SLS and Factored ULS is 13.6 kPa and 16.4 kPa.

Pile spacing should not be less than 3 pile diameters, centre to centre. Pile heaving at groups should be monitored and redriving done where pile heaving is found to be significant. The pile driving may induce some vibration and subsoil displacements. To avoid unjustified damage claims, a preconstruction survey of adjacent buildings in the form of inspection and taking photographic documentation should be undertaken prior to the pile installation.

To reduce the effects of pile driving upon adjacent buildings and buried services, preboring to at least 3m below grade should be considered for all driven pile locations. The prebore hole should be equal to the nominal pile diameter.

To ensure that all piles can be driven adequately to a safe bearing stratum and to develop the recommended loads, full time pile inspection by qualified geotechnical personnel is recommended. Practical refusal can be defined as the final penetration resistance of 5, 8, and 12 blows per 25mm for the 300, 350 and 400mm sizes respectively. The final penetration resistances should be achieved at least 3 times for the final resistance. *Pile installation may also be adversely affected by loose backfill (concrete remnants), numerous silt seams inclusions, cobbles and boulders*. Thus, contract documents should properly cover these potential obstacles during pile installation.

The estimated pile refusal depths at this location are approximately 15.2m (52 ft) to 18.2m (60 ft) below grade on dense till or suspected bedrock. *Precautions should be taken in determining the pile refusal depth as the dense till or suspected bedrock/boulder depth may vary from our testhole locations.*

6.2.2 Cast-In-Place Friction Piles

Alternatively, CIP concrete friction piles may be used for the proposed addition. *Temporary sleeves should be used since seepage from the SILT layer is anticipated during pile installation.*

Using pile lengths of 12.2m (40 ft) below grade, an allowable shaft adhesion value of 13.6 kPa(285 psf) applied to the pile circumference within the native clay may be used for the pile design.

With Limit State Design (LSD), the following shaft adhesion values for Factored Ultimate Limit State (ULS) and Serviceability Limit State (SLS) are recommended for this foundation system and shown in Table 2 below. For a factored ULS, the unfactored ULS was multiplied with the appropriate resistance factor (0.4).

TABLE 2

PILE LENGTH, m	SLS, kPa	FACTORED ULS, kPa
3 to 9.1m (10 to 30 ft)	15.0 (315 psf)	18.0 (378 psf)
9.1 to 12.2m (30 to 40 ft)	9.9 (206 psf)	11.8(248 psf)
12.2 to 15.2m (40 to 50 ft)	5.2 (108 psf)	6.2 (129 psf)
1.5 to 3m (interior)	13.5 (283 psf)	16.2 (338 psf)

For the exterior piles, the upper 3.0m (10 ft) of the piles should be ignored. *If heavier loads are used, the utilization of a single, larger diameter friction pile is preferred. Slight seepage and caving conditions are anticipated from the SILT layer and probably from the end of FILL layer. Thus, a temporary sleeve should be on hand and used as required during pile installation.*

Pile spacing should be at least three pile diameters, centre to centre. To minimize pile construction difficulties, the total number of pile holes left open at any given time should not be more than four and the pile holes should be poured with concrete as soon as they are drilled to the design diameters and depths.

Piles located in unheated areas should be provided with full-length reinforcements, a minimum pile length of 7.62m (25 ft) and the top 2.1m (7 ft) of the pile should be poly-wrapped with greased sonotube or equivalent to reduce the potential for frost jacking.

Pile installation may be adversely affected by seepage. Thus, contract documents should properly cover this potential obstacle during pile installation.

Pile inspection by a Manitoba registered geotechnical engineer should be employed to confirm a satisfactory foundation installation.

If any piles are subjected to highly repetitive or vibratory loads, the above capacities should be reduced by 50%. The allowable uplift capacities of piles may be assumed to be approximately 40% of the allowable pile capacity.

6.2.3 Combination of Driven Piles to Refusal and CIP Friction Piles

Since the existing building at the site consisted of mixed foundation system (CIP piles and driven piles) and there were no reported issues with this building with respect to differential movements, the differential movement between these piles should be minimal and is acceptable provided that the actual spacings are sufficient and based on the actual performance of the existing building.

In addition, the structural designer should advise the foundation builder to install the driven piles prior to installing the CIP friction piles. This is to protect the integrity of the CIP friction piles.

6.2.4 Floor Slab

Hoist, Hoist Pits/Ditch and Drainage Pits

Excavation for the proposed hoist components and drainage pits may require dewatering (wet SILT) and a much flatter slope (say 2H to 1V) to ensure safety and reduce the potential for caving. The anticipated depth is between 1.5m (sump pits) and 4.1m (hoist pit).

A silt layer was measured between 1.2m and 1.7m depth. Since the anticipated depth of pits is between 1.5m and 4.1m below grade, the subgrade will be either SILT or CLAY subgrade. Due to soft and wet conditions of the SILT soil, the preferred depth of the pits should be below1.7m depth. Otherwise, removal of the SILT from 1.2m to 1.7m is suggested and then be covered with non-woven geotextile, replaced with 300mm of 100mm down of crushed limestone followed by 150mm of base course material compacted to 98% STD Proctor Density. *Note that dewatering of the SILT layer using perimeter ditching or a temporary sump pit is suggested prior to construction of the slab and should be directed away from the proposed structure using permanent subdrains connected to a catch basin.*

Structural Floor

The anticipated floor is combination of a structural floor and slab-on-grade floor. Due to significant fill (750mm to 1.5m depth) and for this reason, the recommended flooring for the entire addition is the use of a structural floor supported on piles and separated from the *underlying subsoils with a minimum 150mm void space. A similar void should be provided under grade beams and pile caps.*

Slab-on-Grade Floor

However, if the owner wants to use slab-on-grade floor in some areas (bus bay areas) for cost reasons, it could be done provided that a construction joint between the two flooring system is installed to accommodate any differential movement and suitable subgrade and base materials are incorporated.

At this site, the amount of stripping and thickness of granular fill required below the main floor of the addition is dependent upon the degree of risk that the owner is willing to take in terms of rate and magnitude of long term floor movement.

In this regard, fill materials may be exposed at the subgrade and should be proof-rolled with a non-vibratory sheepsfoot roller to detect soft spots. These spots should be excavated an additional 300mm depth, covered with non-woven geotextile and replaced with the preferred subbase material. *The thickness of the granular fill (which includes the recommended structure) at the soft areas should be a total of 900mm thick*. The base course and subbase materials should conform to City of Winnipeg grading limit specifications.

To minimize floor movement, the floor may be supported on the native undisturbed clay if some long term floor movement, perhaps as much as 25mm and related to the swelling and shrinkage of the clay, can be tolerated to the owner. Subgrade preparation for the floor slab in this case should include *complete* removal upon approval of the in-situ fill, silt, ponded water, softened, disturbed soils; perhaps as much as 1.7m as shown by TH1 to TH5 soil conditions. The exposed clay subgrade should be compacted to 95% Standard Proctor using heavy sheepsfoot equipment. The slab should be underlain by at least 300 mm of well graded 19 mm crushed limestone compacted to 100% maximum dry density. *Additional fill, as required below the slab, should include a well graded 50 mm crushed limestone material compacted maximum 150mm lifts to 100% standard Proctor density.*

Due to the significant depth of fill at the site, and if potential floor movements perhaps as much as 50mm can be tolerated, the total granular thickness below the slab-on-grade may be reduced to 600mm. In this case, the slab should be underlain by 150mm of base course and

450mm of subbase. *The recommended subbase material for stability purposes is 100mm to 150mm crushed clean limestone. The subbase material should be statically placed while the base course material should be compacted in maximum 150mm lifts to 100% standard Proctor density.*

Perimeter weeping tiles and internal subdrains should be provided and encased with filter cloth and surrounded with a minimum of 150 mm of pea gravel. *The bottom of the weeping tile and subdrain should be placed at the bottom of the subbase material.*

If construction takes place during the heating season, problems of freezing weather, frozen soils and difficulty in achieving satisfactory compaction may be encountered. For all-year construction requirements beneath the slab-on-grade, it would be advisable to use well-graded 20mm crushed limestone and 100mm down crushed limestone for replacing the recommended base course and subbase, respectively.

The pit walls should be designed to resist lateral earth stresses using the equivalent fluid method (equivalent fluid weight 9.45 kN/m^3 or 60 pcf) and a triangular pressure distribution. This assumes that the walls are backfilled with free draining pit run gravel materials and that there is no "build-up" of hydrostatic pressure behind the walls. The pit walls should be properly damp-proofed.

The base course and subbase materials should conform to City of Winnipeg grading limit specifications.

Where heavier loading is anticipated at any given floor area, proper construction joints between the heavier loaded floor area and the lightly loaded floor area should be constructed to accommodate possible relative movements between the two. Proper construction joints between heated and unheated structure should also be constructed to accommodate possible movements caused by thermal differentiation. The floor slab should have a minimum thickness of 225mm at the heavier loaded areas underlain by the recommended granular fill.

6.3 PAVEMENT RECOMMENDATIONS

The anticipated subgrade for the access road and parking lot is a clay fill subgrade. Based on this assumption, (i.e. mostly a clay fill subgrade), the recommended asphaltic concrete pavement construction at this site, based on the assumption of using an Equivalent Single Axle Load (ESAL) of about 22,000 for light duty and 261,000 for heavy duty traffic with asphalt, should be as follows:

Pavement Structure

	Light Duty	**Heavy Duty**	**% Compaction**
Asphalt	75mm	100 mm	98% Marshall
Base Course	150 mm	300 mm	98% STD
Subbase	300 mm	400 mm	98% STD

The above pavement sections should be constructed on a prepared clay fill subgrade; note that the CBR equivalence of the existing clay fill over thin clay followed by a SILT subgrade, based on SPT number, is approximately 1. The anticipated site stripping at the proposed access road and parking lot depending on the traffic is the depth of the recommended pavement structure. *The recommended base course material and subbase material are well-graded 20mm crushed limestone and 100mm to 150mm down crushed limestone, respectively.* The prepared subgrade should be proof rolled with a heavy sheepsfoot roller (min. 20 passes) which translates to at least 95% STD Proctor.

Where soft but dry spots are encountered, construction traffic should be restricted. Soft but dry spots should be excavated an additional 300mm depth, covered with non-woven geotextile and a total of 750mm (450mm+300 mm) of granular fill should be placed underneath the 75mm asphalt (light duty); *the subbase material about 300mm thick should comprised of 100 to 150mm clean crushed limestone.*

For better pavement performance and drainage purposes, installation of permanent subdrains (600mm below the subgrade level) connected to positive outlet (catch basin) is recommended.

The granular base course and subbase materials should include organic-free, non-frozen, aggregate conforming to City of Winnipeg gradation limits. Sieve analysis and compaction testing of the granular base and subgrade materials should be conducted by qualified geotechnical personnel to ensure that the materials supplied and percent compactions are in accordance with design specifications

For the hot mix asphaltic concrete, gradation analysis of the aggregates (i.e. stone, fines and additive), compaction testing and sampling of at least one representative hot mix asphalt mixture (during construction) for laboratory Marshall testing should be undertaken. This will provide data to confirm that the asphaltic concrete pavement complies with the project specification. Hot mix asphaltic concrete should not be placed at ambient temperatures lower than +4^{0}C. During placement, the temperature of the paving mix should be in the range of +120^{0}C to +150^{0}C and compaction should not take place at paving mix temperatures lower than +85^{0}C. The combined aggregate gradation limits and physical requirements of the asphaltic concrete should be in accordance with the City of Winnipeg specifications.

For any concrete apron, sidewalk, curbs, the pavement structure should consist of 150mm reinforced concrete followed by 300mm of compacted (98% Standard Proctor Density) base course over the compacted subgrade. If a silt layer is encountered as a subgrade, the application of non-woven geotextile over the silt layer is recommended. Exterior, grade supported concrete slabs will be subjected to some seasonal vertical movements related to frost. Exterior concrete slabs should not be tied into rigid structures such as grade beams, pile caps or interior slabs. If it is required, provide a rigid insulation underneath the granular fill extending at least 1.2m horizontally.

7.0 ADDITIONAL CONSIDERATIONS

Traces of sulphate inclusions were observed in some of the testholes. All concrete should be manufactured with sulphate-resistant (Type 50) cement, minimum compressive strength of 32 mPa and air content between 4% and 7%. Any concrete subject to cycles of freezing and thawing should be air entrained in accordance with the latest edition of CSA A23.1, Concrete Materials and Methods of Concrete Construction.

8.0 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 testholes at this site, this office should be notified immediately in order that the recommendations can be reviewed.

This report has been prepared by WSP for the benefit of the client to whom it is addressed. The information and data contained herein represent WSP best professional judgment in light of the knowledge and information available to WSP at the time of preparation. Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by the client, its officers and employees. WSP denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents without the express written consent of WSP and the client.

The report is provided to the proponent for general information only. The proponent shall engage its own Geotechnical Engineer to provide actual design direction and site confirmation and inspections.

Prepared by: Silvestre S. Urbano Jr., P.Eng.
Reviewed by: Ross Webster, P.Eng.

PROVINCE OF MANITOBA
S. S.
URBANO
JULY 21, 2016
REGISTERED PROFESSIONAL ENGINEER

APEGM
Certificate of Authorization
WSP Canada Inc.
No. 5750 Date: JULY 21, 2016

APPENDIX A

Site Plan

421 Osborne St North

161-09427-00

APPENDIX B

Testhole Logs

Project No: 161-09427-00

Client: Colliers Project Leaders

TH1

Project: Winnipeg Transit Garage Addition

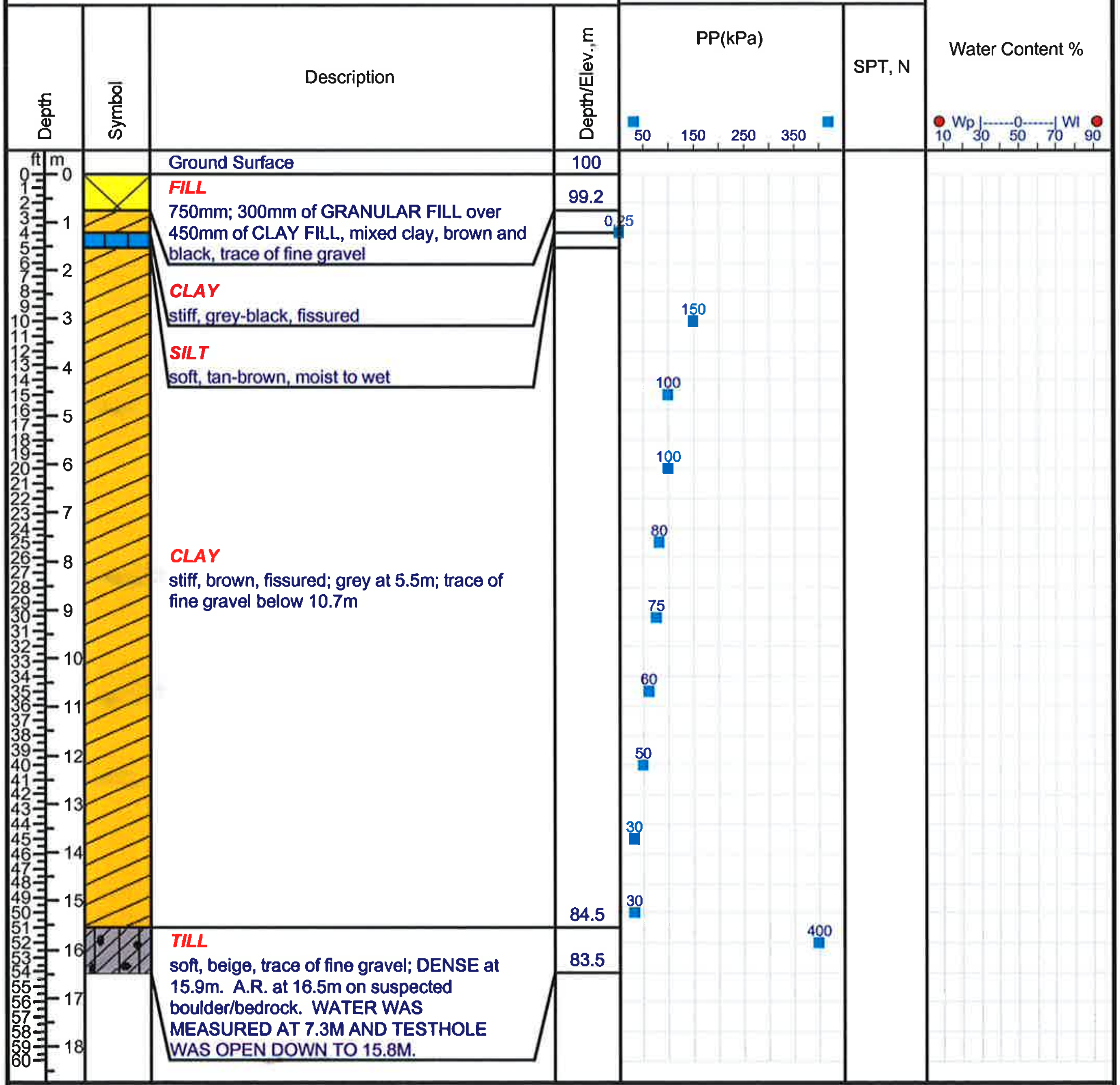
Location: 421 Osborne St., Winnipeg

Enclosure:

Engineer: SSU

SUBSURFACE PROFILE

SAMPLE



Description	Depth/Elev.,m
Ground Surface	100
FILL 750mm; 300mm of GRANULAR FILL over 450mm of CLAY FILL, mixed clay, brown and black, trace of fine gravel	99.2
CLAY stiff, grey-black, fissured	
SILT soft, tan-brown, moist to wet	
CLAY stiff, brown, fissured; grey at 5.5m; trace of fine gravel below 10.7m	84.5
TILL soft, beige, trace of fine gravel; DENSE at 15.9m. A.R. at 16.5m on suspected boulder/bedrock. WATER WAS MEASURED AT 7.3M AND TESTHOLE WAS OPEN DOWN TO 15.8M.	83.5

Drill Method: S/S Auger

Drill Date: 08/04/16

Hole Size: 125mm

WSP Canada Inc.
1600 Buffalo Place
Winnipeg, MB.
R3T 6B8

Elevation: Assumed 100.0 M

Checked by: SSU

Sheet: 1 of 1

Project No: 161-09427-00

Client: Colliers Project Leaders

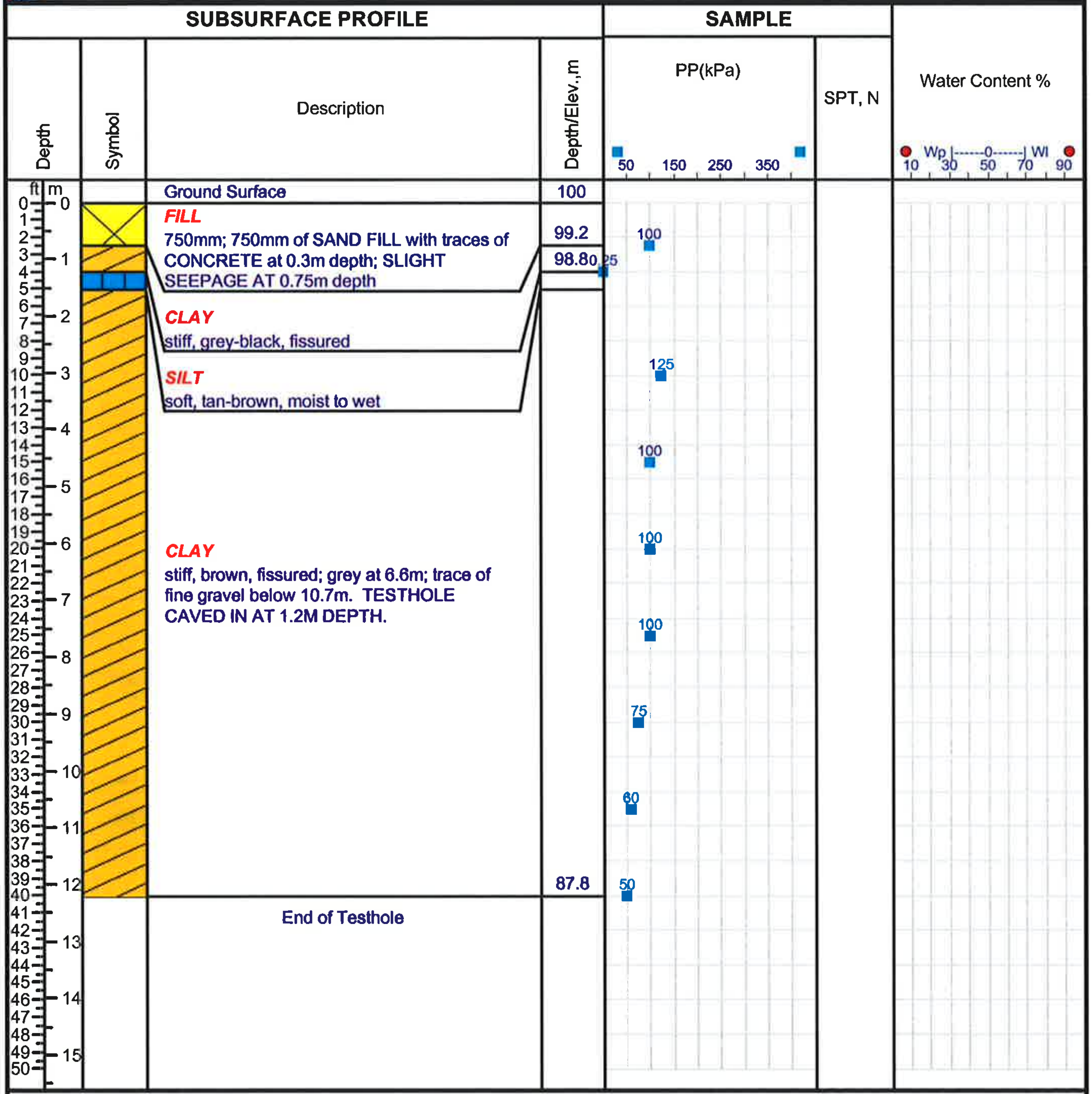
TH2

Project: Winnipeg Transit Garage Addition

Location: 421 Osborne St., Winnipeg

Enclosure:

Engineer: SSU



Depth/Elev.,m	Description
100	Ground Surface
99.2	**FILL** 750mm; 750mm of SAND FILL with traces of CONCRETE at 0.3m depth; SLIGHT SEEPAGE AT 0.75m depth
98.80	**CLAY** stiff, grey-black, fissured
	SILT soft, tan-brown, moist to wet
	CLAY stiff, brown, fissured; grey at 6.6m; trace of fine gravel below 10.7m. TESTHOLE CAVED IN AT 1.2M DEPTH.
87.8	End of Testhole

Drill Method: S/S Auger

Drill Date: 08/04/16

Hole Size: 125mm

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Elevation: Assumed 100.0 M

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Sheet: 1 of 1

Project No: 161-09427-00

Client: Colliers Project Leaders

TH3

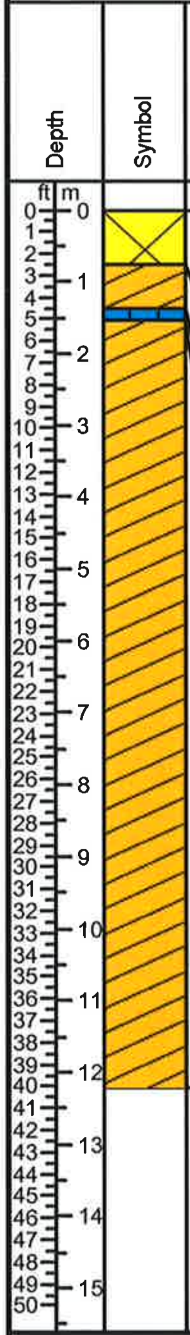
Project: Winnipeg Transit Garage Addition

Location: 421 Osborne St., Winnipeg

Enclosure:

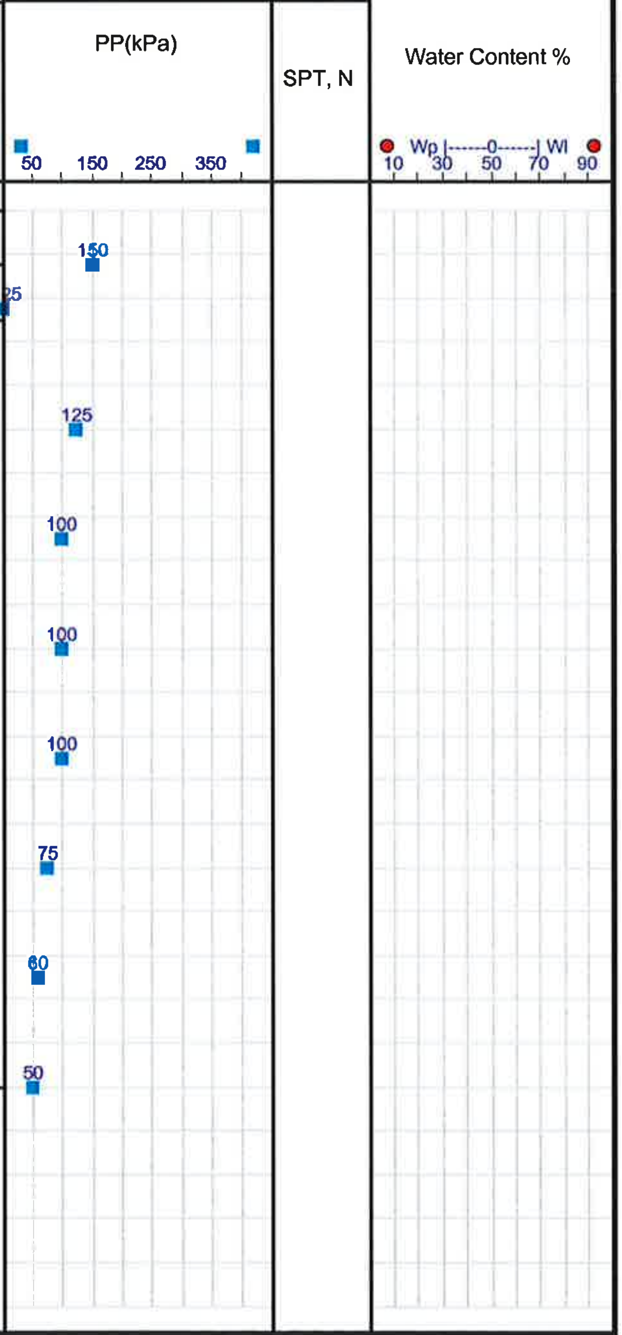
Engineer: SSU

SUBSURFACE PROFILE



Description	Depth/Elev.,m
Ground Surface	100
FILL 750mm; 100mm of ASPHALT over 300mm of GRANULAR FILL over 350mm of CLAY FILL with traces of fine gravel	99.2
CLAY stiff, grey-black, fissured	98.6
SILT soft, tan-brown, moist to wet	
CLAY stiff, brown, fissured; grey at 6.9m; trace of fine gravel below 10.7m. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING.	87.8
End of Testhole	

SAMPLE



Drill Method: S/S Auger

Drill Date: 08/04/16

Hole Size: 125mm

WSP Canada Inc.
1600 Buffalo Place
Winnipeg, MB.
R3T 6B8

Elevation: Assumed 100.0 M

Checked by: SSU

Sheet: 1 of 1

Project No: 161-09427-00

Project: Winnipeg Transit Garage Addition

Client: Colliers Project Leaders

TH4

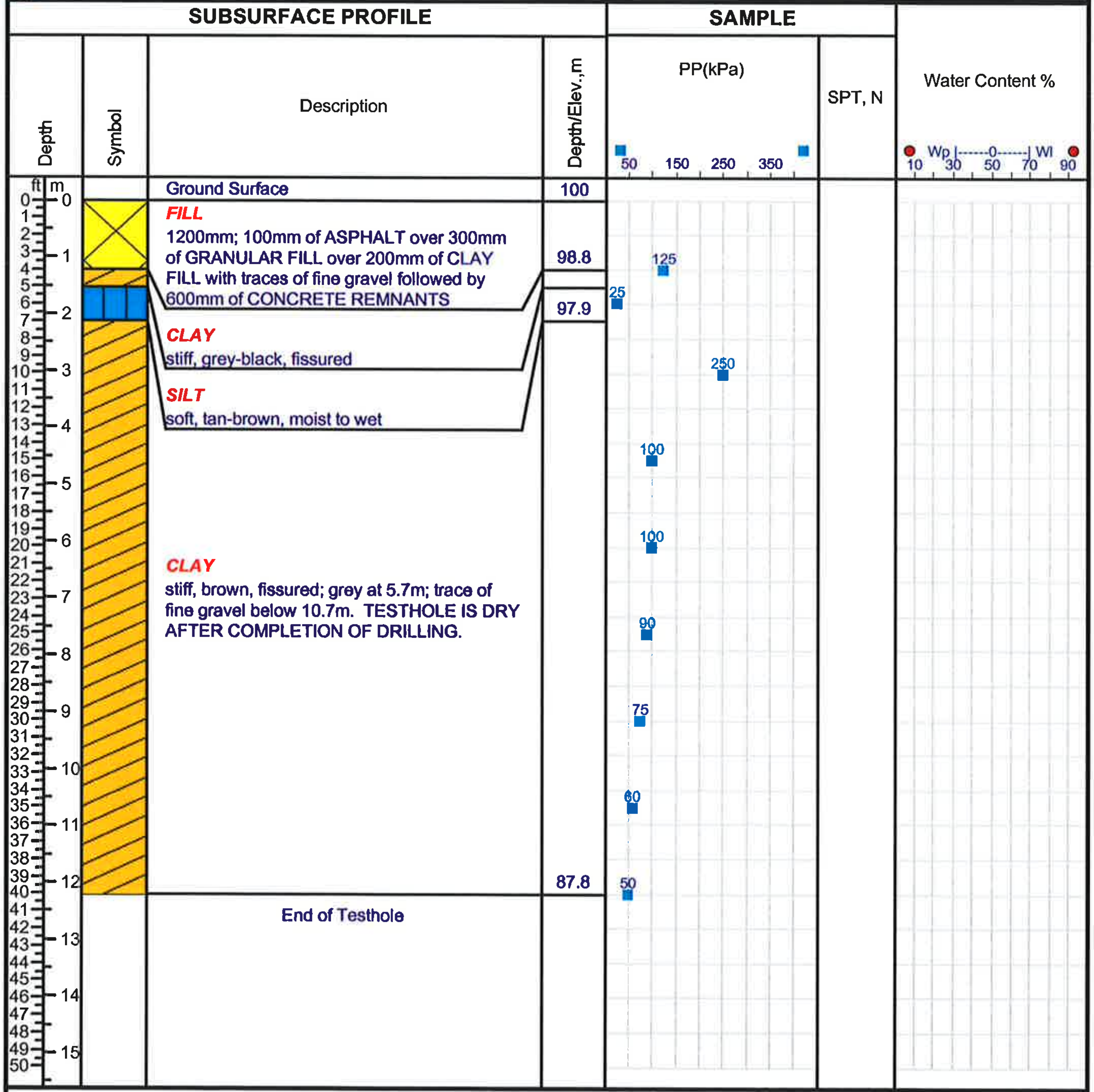
Location: 421 Osborne St., Winnipeg

Enclosure:

Engineer: SSU

SUBSURFACE PROFILE

SAMPLE



Description	Depth/Elev.,m
Ground Surface	100
FILL 1200mm; 100mm of ASPHALT over 300mm of GRANULAR FILL over 200mm of CLAY FILL with traces of fine gravel followed by 600mm of CONCRETE REMNANTS	98.8
CLAY stiff, grey-black, fissured	97.9
SILT soft, tan-brown, moist to wet	
CLAY stiff, brown, fissured; grey at 5.7m; trace of fine gravel below 10.7m. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING.	87.8
End of Testhole	

Drill Method: S/S Auger

Drill Date: 08/04/16

Hole Size: 125mm

WSP Canada Inc.
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R3T 6B8

Elevation: Assumed 100.0 M

Checked by: SSU

Sheet: 1 of 1

Project No: 161-09427-00

Client: Colliers Project Leaders

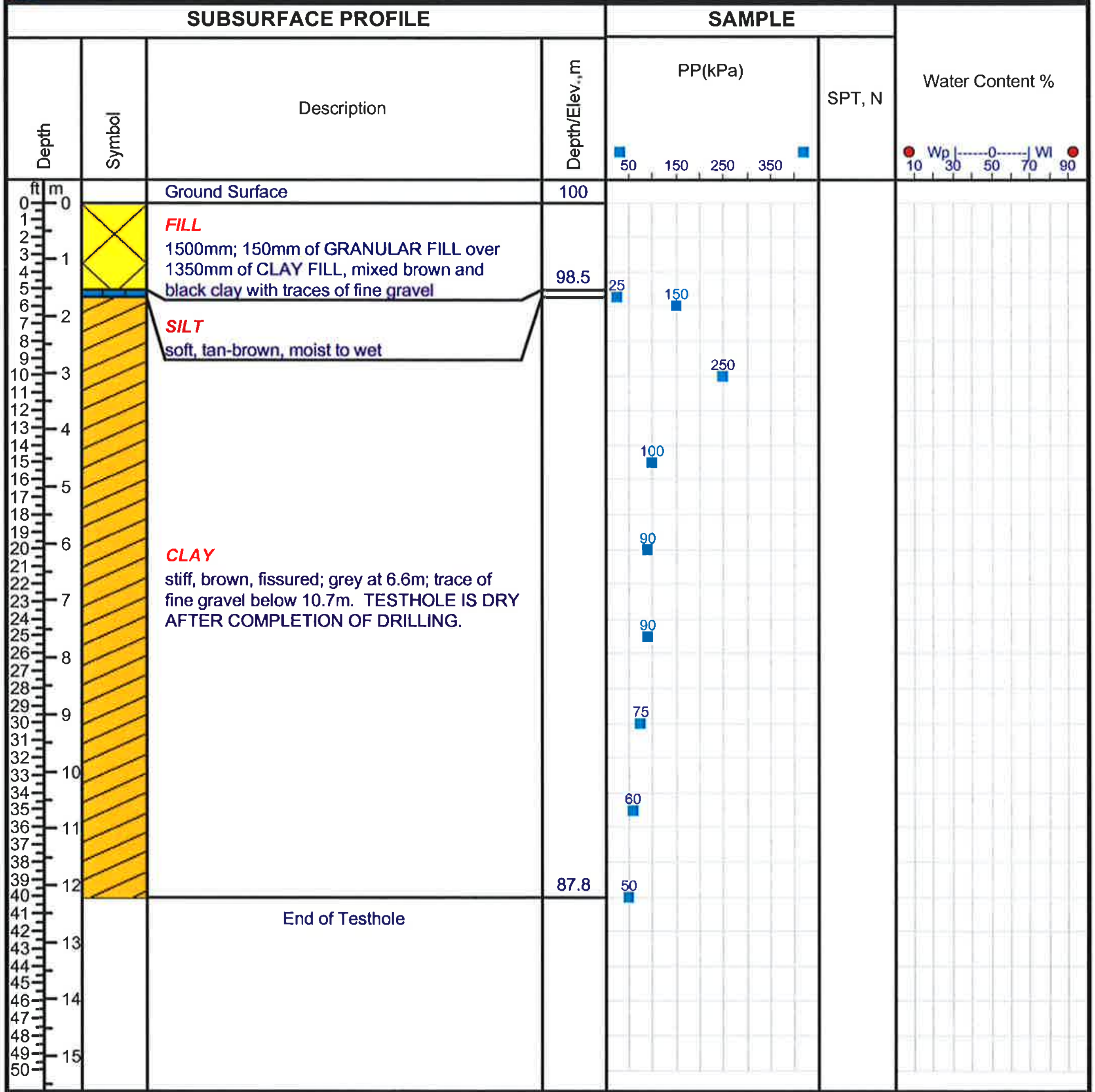
TH5

Project: Winnipeg Transit Garage Addition

Location: 421 Osborne St., Winnipeg

Enclosure:

Engineer: SSU



Depth	Symbol	Description	Depth/Elev.,m	PP(kPa)	SPT, N	Water Content %
0		Ground Surface	100			
		FILL 1500mm; 150mm of GRANULAR FILL over 1350mm of CLAY FILL, mixed brown and black clay with traces of fine gravel	98.5			
		SILT soft, tan-brown, moist to wet				
		CLAY stiff, brown, fissured; grey at 6.6m; trace of fine gravel below 10.7m. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING.	87.8			
		End of Testhole				

Drill Method: S/S Auger

Drill Date: 08/04/16

Hole Size: 125mm

WSP Canada Inc.
1600 Buffalo Place
Winnipeg, MB.
R3T 6B8

Elevation: Assumed 100.0 M

Checked by: SSU

Sheet: 1 of 1

Project No: 161-09427-00

Client: Colliers Project Leaders

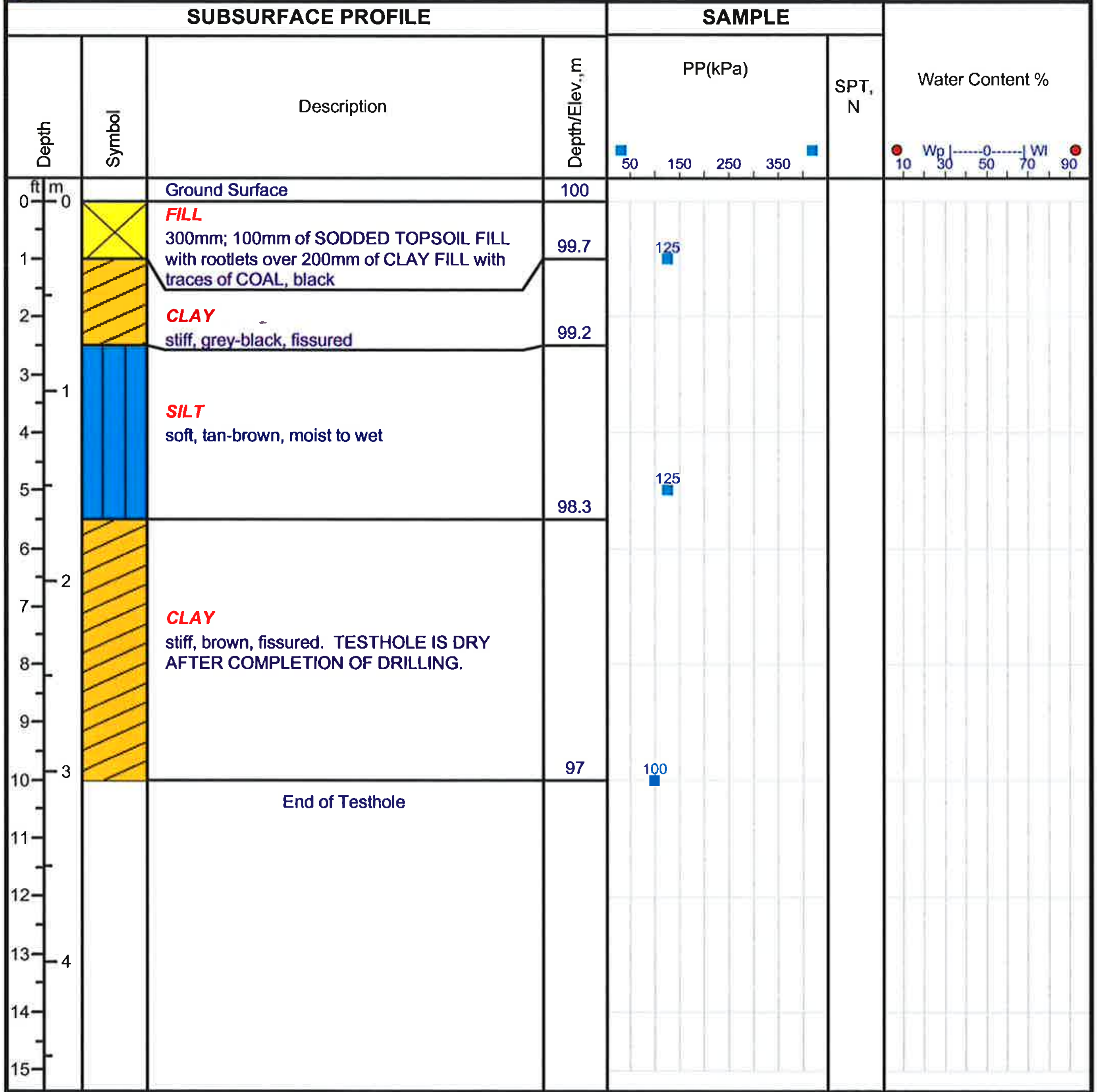
TH6

Project: Winnipeg Transit Garage Parking Lot

Location: 421 Osborne St., Winnipeg

Enclosure:

Engineer: SSU



Ground Surface

FILL
300mm; 100mm of SODDED TOPSOIL FILL with rootlets over 200mm of CLAY FILL with traces of COAL, black

CLAY
stiff, grey-black, fissured

SILT
soft, tan-brown, moist to wet

CLAY
stiff, brown, fissured. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING.

End of Testhole

Drill Method: S/S Auger

Drill Date: 08/04/16

Hole Size: 125mm

WSP Canada Inc.
1600 Buffalo Place
Winnipeg, MB.
R3T 6B8

Elevation: Assumed 100.0 M

Checked by: SSU

Sheet: 1 of 1

Project No: 161-09427-00

Project: Winnipeg Transit Garage Addition

Client: Colliers Project Leaders

TH7

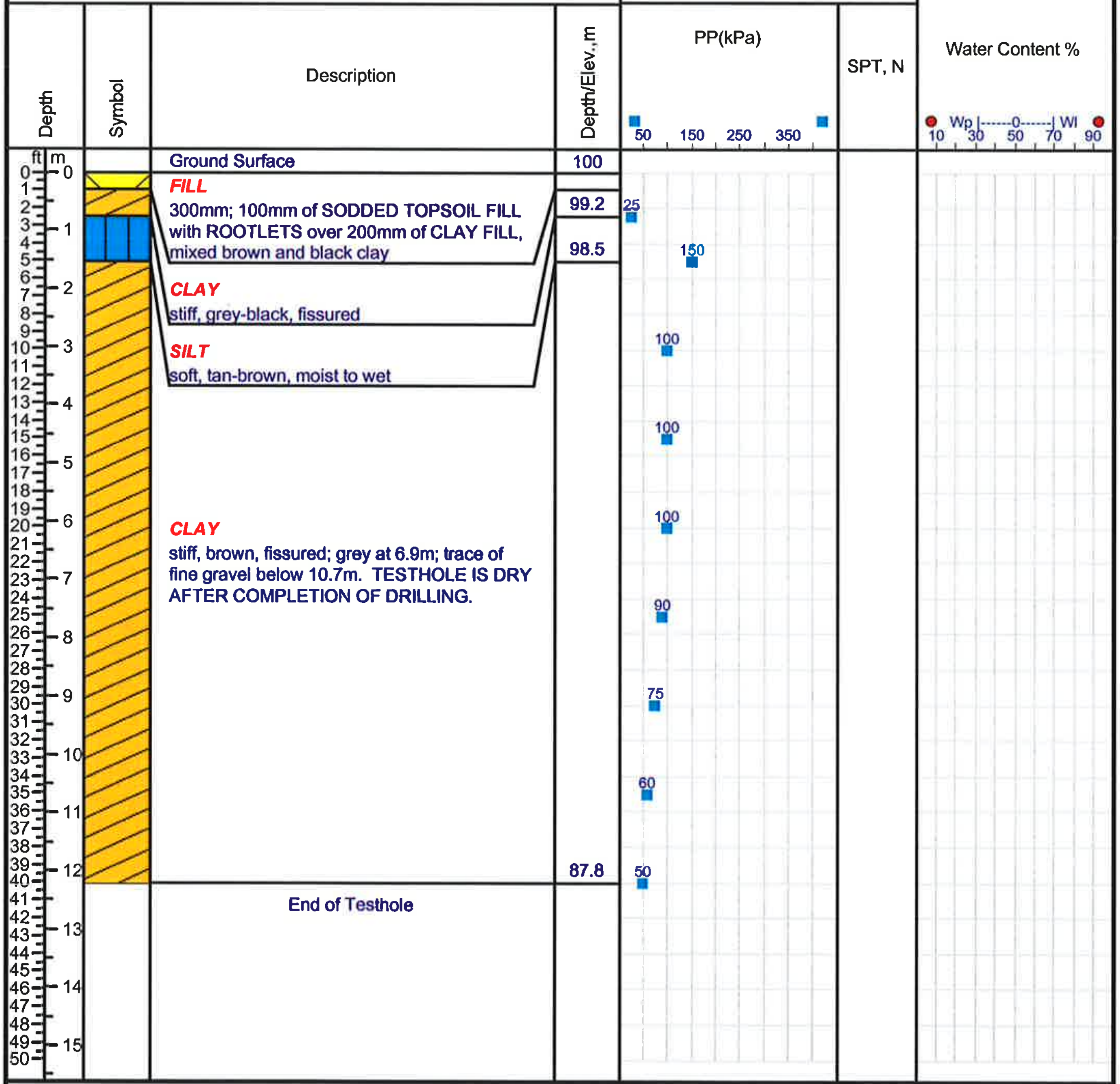
Location: 421 Osborne St., Winnipeg

Enclosure:

Engineer: SSU

SUBSURFACE PROFILE

SAMPLE



Ground Surface — 100

FILL
300mm; 100mm of SODDED TOPSOIL FILL with ROOTLETS over 200mm of CLAY FILL, mixed brown and black clay — 99.2

CLAY
stiff, grey-black, fissured — 98.5

SILT
soft, tan-brown, moist to wet

CLAY
stiff, brown, fissured; grey at 6.9m; trace of fine gravel below 10.7m. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING. — 87.8

End of Testhole

Drill Method: S/S Auger

Drill Date: 08/04/16

Hole Size: 125mm

WSP Canada Inc.
1600 Buffalo Place
Winnipeg, MB.
R3T 6B8

Elevation: Assumed 100.0 M

Checked by: SSU

Sheet: 1 of 1

Project No: 161-09427-00

Client: Colliers Project Leaders

TH8

Project: Winnipeg Transit Garage Parking Lot

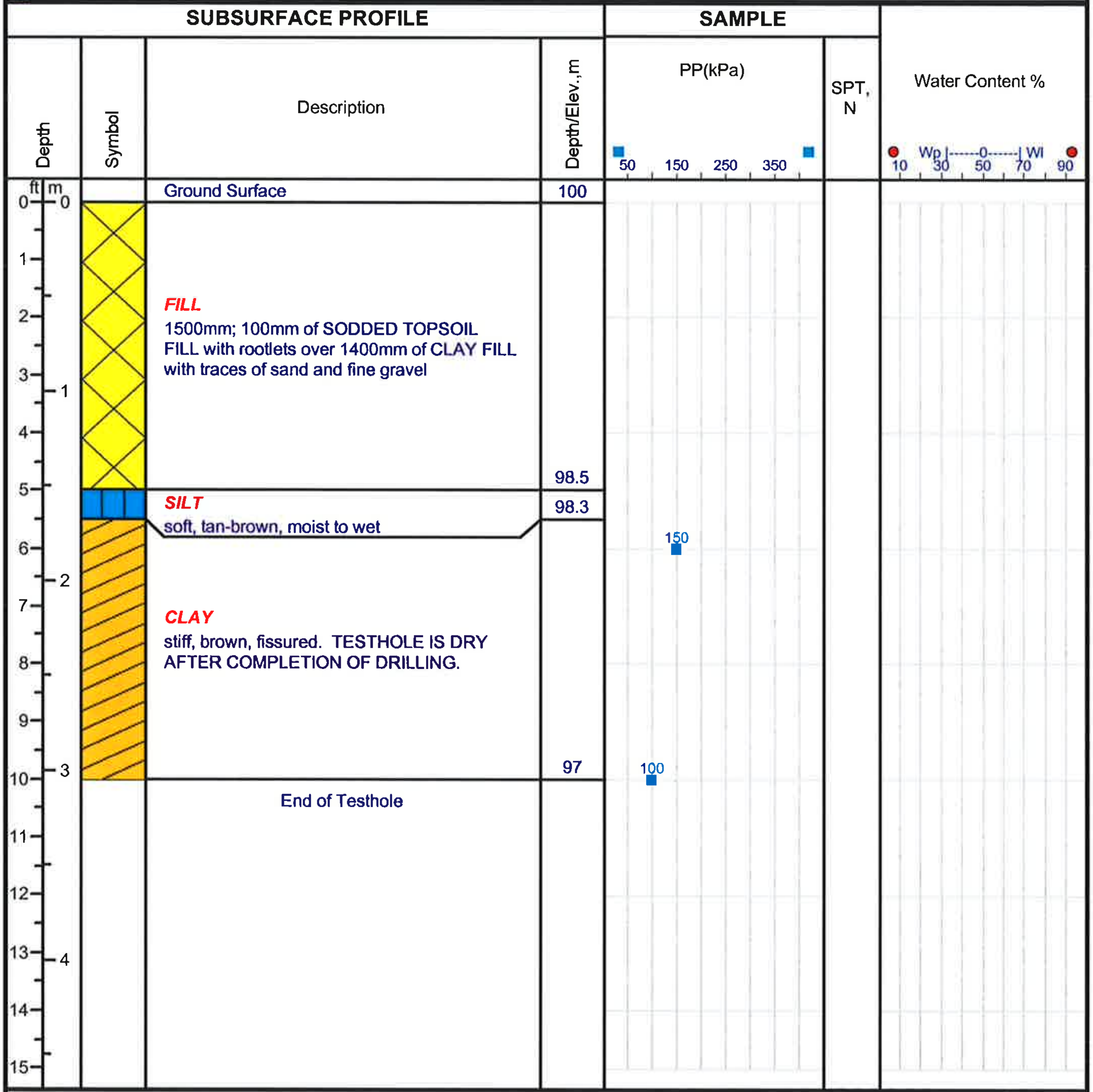
Location: 421 Osborne St., Winnipeg

Enclosure:

Engineer: SSU

SUBSURFACE PROFILE

SAMPLE



Ground Surface

FILL

1500mm; 100mm of SODDED TOPSOIL FILL with rootlets over 1400mm of CLAY FILL with traces of sand and fine gravel

SILT

soft, tan-brown, moist to wet

CLAY

stiff, brown, fissured. TESTHOLE IS DRY AFTER COMPLETION OF DRILLING.

End of Testhole

Drill Method: S/S Auger

Drill Date: 08/04/16

Hole Size: 125mm

WSP Canada Inc.
1600 Buffalo Place
Winnipeg, MB.
R3T 6B8

Elevation: Assumed 100.0 M

Checked by: SSU

Sheet: 1 of 1

APPENDIX C

Laboratory Test Results

H. MANALO
CONSULTING LTD.

1402 Notre Dame Avenue, Winnipeg, MB R3E 3G5
Phone: 204-697-3854 Cell: 204-997-1355
Email: hmanalo@mts.net

MOISTURE CONTENT OF SOIL (ASTM D2216)

CLIENT:	WSP	TEST NO:	1	PROJECT NO:	103-1606
PROJECT:	Winnipeg Bus Transit	DATE SAMPLED:		SAMPLED BY:	
PROJECT CONTACT:	Silvestre Urbano	DATE TESTED:	7/18/2016	TESTED BY:	Gladys Paciente

HoleDesc	TH 1	TH 1	TH 1	TH 1	TH 1
Depth (ft)	5.00	10.00	15.00	20.00	25.00
Tare No:					
Wt Wet Sample + Tare	56.30	113.70	104.60	116.60	106.30
Wt Dry Sample + Tare	46.10	80.60	72.50	83.10	75.00
Wt Water	10.20	33.10	32.10	33.50	31.30
Wt Tare	4.40	4.80	4.20	4.20	4.60
Wt Dry Sample	41.70	75.80	68.30	78.90	70.40
Moisture Content (%)	**24.5**	**43.7**	**47.0**	**42.5**	**44.5**
HoleDesc	TH 1	TH 1	TH 1	TH 1	TH 1
Depth (ft)	30.00	33.00	40.00	45.00	50.00
Tare No:					
Wt Wet Sample + Tare	129.90	107.80	123.40	146.30	141.30
Wt Dry Sample + Tare	94.40	76.60	87.30	123.00	113.40
Wt Water	35.50	31.20	36.10	23.30	27.90
Wt Tare	4.20	4.30	4.30	4.50	4.70
Wt Dry Sample	90.20	72.30	83.00	118.50	108.70
Moisture Content (%)	**39.4**	**43.2**	**43.5**	**19.7**	**25.7**
HoleDesc	TH 1				
Depth (ft)	54.00				
Tare No:					
Wt Wet Sample + Tare	34.80				
Wt Dry Sample + Tare	31.10				
Wt Water	3.70				
Wt Tare	4.30				
Wt Dry Sample	26.80				
Moisture Content (%)	**13.8**				
HoleDesc					
Depth (ft)					
Tare No:					
Wt Wet Sample + Tare					
Wt Dry Sample + Tare					
Wt Water					
Wt Tare					
Wt Dry Sample					
Moisture Content (%)					

APPENDIX D

Granular Specification

CW 3110 - SUB-GRADE, SUB-BASE AND BASE COURSE CONSTRUCTION

1. DESCRIPTION

1.1 General

.1 This specification covers pavement removal, excavation, preparation of sub-grade, supply and placement of sub-base and base course materials, ditch grading and boulevard grading for pavements, slab renewals, curbs, miscellaneous concrete slabs, sidewalks and other related works.

1.2 Definitions

.1 Sub-grade - the natural in-situ material.

.2 Sub-base - where required, the layer of material provided between the sub-grade and the base course.

.3 Base course – the layer of material immediately underlying the pavement.

1.3 Referenced Standard Construction Specifications

.1 CW 1130 – Work Site Requirements.
.2 CW 3130 – Supply and Installation of Geotextile Fabrics.
.3 CW 3450 – Planing of Pavement.

2. MATERIALS

2.1 Sub-Base Materials

.1 Sub-base material of the type(s) shown on the Drawings or indicated in the Specifications will be supplied in accordance with the following requirements:

.1 Suitable site sub-base material will be of a type approved by the Contract Administrator.

.2 Clay borrow sub-base material will be of a type approved by the Contract Administrator.

.3 Crushed sub-base material will be well-graded and conform to the following grading requirements:

TABLE CW 3110.1 - Crushed Sub-Base Material Grading Requirements

CANADIAN METRIC SIEVE SIZE	PERCENT OF TOTAL DRY WEIGHT PASSING EACH SIEVE	
	50 mm MAX. AGG.	150 mm MAX. AGG.
150 000		90% - 100%
100 000		75% - 90%
50 000	100%	
25 000		50% max.
5 000	25% - 80%	
80	5% - 18%	

150 millimetre crushed limestone material when subjected to the abrasion test will have a loss of not more than 40% when tested in accordance with grading 1 of ASTM C535, Test for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

50 millimetre crushed limestone material when subjected to the abrasion test will have a loss of not more than 40% when tested in accordance with grading A of ASTM C131, Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

Crushed pavement sub-base material will be a mixture of concrete, asphaltic concrete, granular material and clay. The mix will contain no more than 15% by weight passing the 80 µm sieve.

2.2 Base Course Material

.1 Base course material will be approved by the Contract Administrator.

.2 Base course material will consist of sound, hard, crushed rock or crushed gravel and will be free from organic or soft material that would disintegrate through decay or weathering.

.3 The base course material will be well graded and conform to the following grading requirements:

TABLE CW 3110.2 – Base Course Material Grading Requirements

CANADIAN METRIC SIEVE SIZE	PERCENT OF TOTAL DRY WEIGHT PASSING EACH SIEVE	
	Granular	Crushed Limestone
25 000	100%	
20 000	80% - 100%	100%
5 000	40% - 70%	40% - 70%
2 500	25% - 55%	25% - 60%
315	13% - 30%	8% - 25%
80	5% - 15%	6% - 17%

Base course material when subjected to the abrasion test will have a loss of not more than 35% when tested in accordance with grading B of ASTM C131, Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

The material passing the 315 sieve will have a liquid limit not greater than 25 and a plasticity index not greater than 6.

Where base course is being placed under an asphaltic concrete pavement, the aggregate retained on a No. 5 000 sieve will contain not less than 35% crushed aggregate as determined by actual particle count. Crushed aggregate will be considered as that aggregate having at least one fractured face.

2.3 Asphalt Cuttings for Base Course Material

.1 Asphalt cuttings produced from planing of asphalt pavements or overlays in accordance with CW 3450 may be used as a base course material where indicated in the Specifications or as approved by the Contract Administrator.

.2 Asphalt cuttings will be well graded and have a maximum particle size of 40 millimetres.