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GEOTECHNICAL INVESTIGATION
PROPOSED COMMERCIAL BUILDING
FAITHFULL AVENUE AND 51ST STREET
LOT 5, BLOCK 638, PLAN 98-SA-17027
SASKATOON, SASKATCHEWAN
PMEL FILE NO. S10-7420
JULY 20, 2010

PREPARED FOR:

942252 ALBERTA LTD./VISIONS REALTY
UNIT 129, 10555-48TH STREET SE
CALGARY, ALBERTA
T2C 2B7

ATTENTION: MR. RICK WENAUS, CONSTRUCTION MANAGER

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1.0 INTRODUCTION

The following report has been prepared on the subsurface soil conditions existing at the site of the proposed Commercial Building to be constructed at Faithfull Avenue and 51st Street on Lot 5, Block 683, Plan 98-SA-17027 in Saskatoon, Saskatchewan.

The Terms of Reference for this investigation were presented in P. Machibroda Engineering Ltd. (PMEL) Proposal No. 0625-6180, dated June 25, 2010. Written authorization to proceed with this investigation was provided on June 28, 2010.

The field test drilling and soil sampling were conducted on July 5, 2010.

PMEL conducted a geotechnical investigation at the subject site in June, 1999 (PMEL Report No. S99-3395, dated July 16, 1999). Three of the test holes (99-4, 99-5 and 99-6) were drilled within the proposed Development Area. The test hole drill logs for the three test holes have been included in Appendix B. The test holes are located approximately as shown on the site plan, Drawing No. S10-7420-1.

2.0 FIELD INVESTIGATION

Five test holes, located as shown on the Site Plan, Drawing No. S10-7420-1, were dry drilled using our truck-mounted, continuous flight, solid stem auger drill rig. The test holes were 150 mm in diameter and extended to depths of 2.0 to 10.5 metres below the existing ground surface.

Test hole drill logs were compiled during test drilling to record the soil stratification, the groundwater conditions, the position of unstable sloughing soils and the depths at which cobblestones and/or boulders were encountered.

Disturbed samples of auger cuttings were collected during test drilling and sealed in plastic bags to minimize moisture loss. The soil samples were taken to our laboratory for analysis.

Standard penetration tests (N-index), utilizing a safety hammer with automatic trip, were performed during test drilling.

3.0 FIELD DRILL LOGS

The field drill logs recorded during test drilling have been shown plotted on Drawing Nos. S10-7420-2 to 6, inclusive. Field drill logs from a geotechnical investigation conducted at the subject site in 1999 have been included in Appendix B.

The ground surface elevation at each Test Hole location was referenced to the top bolt of the fire hydrant, located approximately as shown on the Site Plan, Drawing No. S10-7420-1. A datum elevation of 497.4 metres was provided for the top bolt of the fire hydrant.

3.1 Soil Profile

The general soil profile consisted of granular and/or clay fill (to a depth of about 0.1 to 1.0 metre) overlying variable deposits of clay, silt and sand (to a depth of about 1.8 to 3.2 metres), followed by glacial till, which extended to a depth of at least 10.5 metres, the maximum depth drilled at this site.

3.2 Groundwater Conditions, Sloughing

Groundwater seepage and sloughing conditions were encountered during test drilling. The depths at which groundwater seepage and sloughing conditions were encountered have been shown on Drawing Nos. S10-7420-2 to 6, inclusive. Based on the depths at which groundwater seepage was encountered, the groundwater table at this site is anticipated to be situated at about 1.3 metres (approximately at Elevation 494.5 metres) below existing ground surface. It should be noted that groundwater levels may not have stabilized at the time of test drilling, and that higher groundwater levels should be expected during or following spring thaw or periods of precipitation.

3.3 Cobblestones and Boulders

The glacial till consisted of a heterogeneous mixture of gravel, sand, silt and clay-sized particles. The glacial till strata also contained sorted deposits of the above particle sizes. In addition to the sorted deposits, a random distribution of larger particle sizes in the cobblestone range (60 to 200 mm) and boulder-sized range (larger than 200 mm) should be expected at the subject site.

It should be recognized that the statistical probability of encountering cobblestones and/or boulders in the five small diameter Test Holes drilled at the site was low. Intertill deposits of cobblestones, boulders, boulder pavements and isolated deposits of saturated sand or gravel should be anticipated. The frequency of encountering such deposits will increase proportionately with the number of piles installed.

4.0 LABORATORY ANALYSIS

The soil classification and index tests performed during this investigation consisted of a visual classification of the soil, water contents, unit weights and Atterberg limits.

The results of the soil classification and index tests conducted on representative samples of soil have been plotted on the drill logs alongside the corresponding depths at which the samples were recovered, as shown on Drawing Nos. S10-7420-2 to 6, inclusive.

5.0 DESIGN RECOMMENDATIONS

Based on the foregoing outline of soil test results, the following foundation design considerations and recommendations have been presented.

5.1 Design Considerations

It is understood that the proposed Building will have a footprint area of approximately 1,250 square metres and will have adjacent paved parking.

The subsurface soil conditions consisted of granular and/or clay fill overlying variable deposits of clay, silt and sand followed by glacial till. Groundwater seepage and sloughing conditions were encountered during test drilling. The groundwater table is anticipated to be situated about 1.3 metres (approximately at Elevation 494.5 metres) below existing ground surface. The subgrade soils are considered frost susceptible and the average depth of frost penetration for the Saskatoon area is about 2.0 metres.

A deep foundation system consisting of drilled, cast-in-place concrete piles and/or caissons or helical screw piles should perform satisfactorily. Construction difficulties should be anticipated in some pile holes due to groundwater seepage and sloughing conditions. Casing may be required to complete the installation of conventional drilled piles at this site.

Recommendations have been prepared for site preparation; drilled, cast-in-place concrete piles and/or caissons; helical screw piles; grade supported floor slab; grade beams; foundation concrete; and, asphalt concrete pavement structures.

5.2 Site Preparation

All topsoil, organics, loose fill and other deleterious materials should be removed from the construction area. The surface of the subgrade should be levelled and compacted to the following minimum density requirements.

Building Areas	-	96 percent of standard Proctor density at optimum moisture content;
Roadway Areas	-	96 percent of standard Proctor density at optimum moisture content;
Landscape Areas	-	90 percent of standard Proctor density at optimum moisture content.

Subgrade fill, if required, should preferably consist of imported granular material or non-expansive (i.e., low plastic) fine grained soils. The fill should be placed in thin lifts (maximum 150 mm loose) and compacted to 96 percent of standard Proctor density at optimum moisture content. The subgrade fill should be approved by the Geotechnical Consultant prior to placement.

The site should be graded to ensure positive site drainage away from the structure.

5.3 Drilled, Cast-In-Place Concrete Piles and/or Caissons

Construction difficulties should be anticipated in some pile holes due to groundwater seepage and sloughing conditions. Casing may be required to complete the installation of drilled, cast-in-place concrete piles.

Drilled, straight shaft, cast-in-place, reinforced concrete piles may be designed on the basis of skin friction only. Belled caissons may be designed on the basis of skin friction and end bearing capacity.

The allowable skin friction bearing pressures of the undisturbed soil are as follows:

TABLE I. SKIN FRICTION BEARING PRESSURES (DRILLED PILES)

Zone (metres)	Allowable Skin Friction Bearing Pressure (kPa)
0 to 2	0
2 to 7	30
Below 7	50

Notes:

1. To minimize frost heave potential, skin friction piles should be extended to and reinforced to a minimum depth of 6 metres below finished ground surface.

2. Piles should be reinforced.

3. A minimum pile diameter of 400 mm is recommended for the primary structural loads. Larger pile diameters may be required to allow for the removal of cobbles and boulders in some pile holes, if encountered.

4. The pile holes should be filled with concrete as soon as practical after drilling.

5. Groundwater seepage and sloughing conditions were encountered during test drilling. Casing will be required where groundwater seepage and sloughing conditions are encountered to maintain the pile holes open for placing of the reinforcing steel and concrete. The annular space between the casing and drilled hole must be filled with concrete. As casing is extracted, concrete in casing must have adequate head to displace all water in the annular space.

6. A minimum centre-to-centre pile spacing of not less than three pile diameters is recommended.

7. A representative of the Geotechnical Consultant should inspect and document the installation of the drilled, cast-in-place concrete piles.

TABLE II. END BEARING PRESSURE (BELLED CAISSONS)

*Depth (metres)	Allowable End Bearing Pressure (kPa)
6 to 8 (machine cleaned)	350
Below 8	500

*Bells should be formed a minimum of two bell diameters into very stiff glacial till. Belling depth will have to be adjusted depending on the position of seepage, sloughing, cobbles and boulders. Bells must be constructed an adequate depth below the underside of any saturated sand or silt deposits (if encountered).

<u>Notes:</u>

1. End bearing caissons designed on the basis of 350 kPa must bear on undisturbed, naturally deposited, very stiff glacial till. End bearing caissons designed on the basis of 500 kPa must bear on undisturbed, naturally deposited, hard glacial till.

2. For determination of skin friction capacity, the effective shaft length for belled caissons may be taken as the depth of embedment of the straight sided portion of the pile shaft, minus a length equal to the pile diameter (i.e., the bottom-most portion of the pile shaft is neglected to account for interaction with the bell).

3. End bearing caissons should be inspected to confirm the removal of loose, disturbed soil prior to placing concrete and steel.

4. Caisson shafts should be reinforced.

5. Concrete should be placed as soon as practical after cleaning the bell.

6. To prevent softening of the bearing strata, water should not be allowed to accumulate at the base of the caisson hole. Groundwater seepage and sloughing conditions were encountered during test drilling. Casing will be required where groundwater seepage and sloughing conditions are encountered to maintain the pile holes open for placing of the reinforcing steel and concrete. The annular space between the casing and drilled hole must be filled with concrete. As casing is extracted, concrete in casing must have adequate head to displace all water in the annular space.

7. End bearing caissons may be belled at the base to a maximum of three times the shaft diameter.

8. The height of the bell should be designed to provide adequate concrete to distribute the unit stresses into the concrete without over-stressing the outer, non-reinforced concrete within the bell.

9. Full time inspection by a representative of the Geotechnical Consultant, employed directly by the Owner, is required to confirm allowable bearing pressures and to document the installation of each end bearing caisson.

5.4 Helical Screw Piles

Helical screw piles are installed by rotating a steel pipe, equipped with one or more helix flightings, into the ground. For single helix screw piles, pile capacity is derived from shearing resistance along the pile shaft (i.e., skin friction) as well as end bearing capacity of the helix.

For multi-helix piles, cylindrical shear theory or individual plate bearing theory may be utilized to estimate pile capacity. Cylindrical shear theory assumes that pile capacity is derived from shearing resistance along the pile shaft and shearing resistance along the cylindrical soil surface between the helixes (i.e., soil shear strength), as well as end bearing capacity of the lower most helix. Individual plate bearing theory assumes that pile capacity is derived from shearing resistance along the pile shaft and the sum of the end bearing capacities of each helix. The actual capacity of multi-helix screw piles bearing in cohesive soils and the most appropriate design method (i.e. cylindrical shear or individual plate bearing) depends on many factors, primarily helix spacing and surrounding soil conditions. For multi-helix screw piles, the capacity utilized for design should be the lesser capacity as determined using the two methods.

The allowable shear resistance parameters of the undisturbed soil are as follows.

TABLE III. SHEAR RESISTANCE PARAMETERS (SCREW PILES)

Zone (metres)	Allowable Skin Friction Bearing Pressure Along Pile Shaft (kPa)	Allowable Soil Shear Strength Along Cylindrical Soil Surface (kPa)
0 to 2	0	0
2 to 7	30	100
Below 7	50	175

The screw piles should be extended to a minimum depth of 5 metres. For determination of skin friction capacity, the effective shaft length may be taken as the depth of embedment of the pile shaft (to the top of the uppermost helix) minus the diameter of the uppermost helix.

When using cylindrical shear theory for multi-helix screw piles, the shear capacity of the cylindrical soil surface between the helixes can be calculated on the basis of the projected surface area of the soil column between the helixes and the allowable soil shear strength values presented in Table III.

The allowable end bearing pressure for screw piles have been presented below.

TABLE IV. END BEARING PRESSURE (SCREW PILES)

Depth (metres)	Allowable End Bearing Pressure (kPa)
6 to 8	400
Below 8	600

End bearing capacity may be calculated utilizing the effective soil contact area of the helix (i.e., overall cross-sectional area for the lowest helix, helix area minus shaft area for upper helixes). The helical plate shall be normal to the central shaft (within 3 degrees) over its entire length. Multiple helixes (if applicable) should be spaced at increments of the helix pitch to ensure that all helixes travel the same path during installation.

Continuous monitoring of the installation torque should be undertaken during installation to determine whether the screw pile has been damaged during installation and to monitor the consistency of the subsurface soils. Screw piles should be designed on the basis of appropriate Geotechnical Engineering principals pertaining to helical pile foundations. A representative of the Geotechnical Consultant should inspect and document the installation of each steel pipe screw pile on a continuous basis.

5.5 Grade Supported Floor Slab

The subgrade soils encountered at the design subgrade elevation consisted of granular and/or clay fill. Grade-supported floor slabs based on the clay fill soils could potentially undergo excessive differential movements associated with moisture fluctuations in the soil profile and due to consolidation of the fill. The magnitude of differential movement can be minimized by reinforcing the floor slab and providing a uniform layer of compacted structural fill below the floor slab.

The following minimum provisions should be incorporated into the design of a heated, grade-supported, cast-in-place, reinforced concrete slab.

1. Prepare the site in accordance with Section 5.2, Site Preparation. Over-excavate, as required, to allow for placement of a minimum of 600 mm of compacted granular fill. The uppermost 150 mm of fill should consist of crushed granular base course material.

2. Level and compact the upper 150 mm of subgrade soil to 96 percent of standard Proctor density at optimum moisture content. Do not allow the subgrade soil to dry out. Cover the prepared subgrade soil with non-expansive fill as soon as practical after preparation.

3. Proof roll the prepared subgrade with heavy wheeled equipment to detect soft areas. Excavate soft subgrade areas and replace with suitable, non-expansive fill, placed and compacted to 96 percent of standard Proctor density at optimum moisture content.

4. Subgrade fill, if required, should consist of granular material or non-expansive (i.e., low plastic), fine grained soils, placed in thin lifts (maximum 150 mm loose) and compacted to 96 percent of standard Proctor density at optimum moisture content.

5. All fill placed above the design subgrade elevation should be placed in thin lifts (150 mm loose, maximum) and compacted to 98 percent of standard Proctor density at optimum moisture content.

6. Isolate the slab from foundation walls, columns, etc., by means of separation joints.

7. Reinforce the concrete slab and articulate the slab at regular intervals to provide for controlled cracking.

8. Provide positive site drainage away from the proposed Building.

9. Floor slabs should not be constructed on desiccated, wet, or frozen subgrade soil or base.

10. Frost should not be allowed to penetrate beneath the floor slab just prior to, during or after construction.

The above recommended floor system should minimize potential differential floor movements and cracking, depending on the initial soil moisture conditions, the magnitude of moisture variation under the floor slab and the condition of the placed fill.

If some differential movements/floor cracking cannot be tolerated, then a structural floor on a compressible void filler should be constructed. A continuous sheet of polyethylene plastic should be placed between the compressible void filler and the concrete floor. The compressible void filler should be installed in accordance with the manufacturer's specifications.

5.6 Grade Beams

The grade beams should be reinforced at both top and bottom throughout their entire length. Grade beams should be constructed to allow for a minimum of 100 mm of net void space between the underside of the grade beam and the subgrade soil.

5.7 Foundation Concrete

Water-soluble sulphate salts (gypsum crystals) are known to exist in the geological deposits in this area. Sulphate resistant cement should be used for all concrete in contact with the subgrade soil. All concrete at this site should be manufactured in accordance with current CSA standards. It should be recognized that water soluble sulphate salts combined with moist soil conditions or low pH soils, could render the soil highly corrosive to some types of metal water lines, elbows, connectors, etc., in contact with the soil.

5.8 Site Classification For Seismic Site Response

Based on the consistency of the subgrade soils encountered at this site and Table 4.1.8.4A of the 2005 National Building code, the site classification for seismic site response falls within Class D.

5.9 Asphalt Concrete Pavement Structures

The following minimum recommendations should be incorporated into the design of the asphalt concrete pavement structures.

1. Prepare the site in accordance with Section 5.2, Site Preparation.

2. Proof roll the prepared subgrade with heavy wheeled equipment to detect soft areas. Soft subgrade areas should be excavated and replaced with suitable soil compacted to 96 percent of standard Proctor density at optimum moisture content.

3. As a subgrade support, the CBR (California Bearing Ratio) rating of the compacted subgrade soil should be in the order of 3. Based on the CBR rating the following pavement structures have been presented.

TABLE V. THICKNESS DESIGN FOR PAVEMENT STRUCTURES

Pavement Structure	Heavy Truck Traffic Wheel Loading (5,400 kg) (mm)	Medium Truck Traffic Wheel Loading (3,180 kg) (mm)	Light Truck/Passenger Vehicle Traffic Wheel Loading (1,830 kg) (mm)
*Asphalt Concrete	100	80	65
Granular Base (Min CBR = 65)	150	150	150
Granular Sub-Base (Min CBR =20)	350	245	150
Prepared Subgrade	(150)	(150)	(150)
**Geotextile	As Required	As Required	As Required
Total Thickness	**600**	**475**	**365**

* Use 2:1 equivalency for granular substitution of asphalt concrete.
** Geotextile is recommended for all areas where soft/wet subgrade soil conditions are encountered [woven geotextile with a minimum grab tensile strength of 1100 N (ASTMD-4632)].

4. Subgrade fill, if required, should preferably consist of granular material or non-expansive fined grained soils. Subgrade fill should be placed in thin lifts (150 mm loose, maximum) and compacted to 96 percent of standard Proctor density at optimum moisture content.

5. If utilizing a geotextile, place a continuous layer of geotextile over the prepared subgrade surface. The geotextile should have a minimum overlap of 600 mm and should be placed in accordance with the manufacturer's recommendations.

6. All granular fill placed above the subgrade elevation should be placed in thin lifts (150 mm loose) and compacted to 98 percent of standard Proctor density. The granular base and sub-base course material should meet the following aggregate gradation requirements.

TABLE VI. AGGREGATE GRADATION REQUIREMENTS

Grain Size (mm)	Percent Passing	
	Base Course	Sub-Base Course
50.0	–	100
25.0	100	85 – 100
18.0	87 – 100	80 – 100
12.5	72 – 93	70 – 100
5.0	45 – 77	50 – 85
2.0	26 – 56	35 – 75
0.900	18 – 39	25 – 50
0.400	13 – 26	15 – 35
0.160	7 – 16	8 – 22
0.071	6 – 11	0 – 13
Plasticity Index (%)	0 – 6	0 – 6
CBR (min.)	65	20
% Fracture (min.)	50	–

7. Positive surface drainage is recommended to reduce the potential for moisture infiltration through the pavement structure.

8. Surface water should be prevented from seeping back under the outer edges of the pavement structure.

9. Periodic maintenance such as crack sealing will be required

6.0 LIMITATIONS

The presentation of the summary of the field drill log and foundation design recommendations has been completed as authorized. Five, 150 mm diameter test holes were dry drilled using our continuous flight auger drill rig. Field drill logs were compiled for the Test Holes during test drilling which, we believe, was representative of the subsurface conditions at the Test Hole locations at the time of test drilling. Variations in the subsurface conditions from that shown on the drill logs at locations other than the exact test locations should be anticipated. If conditions should differ from those reported here, then we should be notified immediately in order that we may examine the conditions in the field and reassess our recommendations in the light of any new findings.

No detectable evidence (visual or odor) of environmentally sensitive materials were detected during the actual time of the field test drilling program. If, on the basis of any knowledge, other than that formally communicated to us, there is reason to suspect that environmentally sensitive materials may exist, then additional test holes should be drilled and samples recovered for chemical analysis.

The subsurface investigation necessitated the drilling of deep test holes. The test holes were backfilled at the completion of test drilling. Please be advised that some settlement of the backfill materials will occur which may leave a depression or an open hole. It is the responsibility of the client to inspect the site and backfill, as required, to ensure that the ground surface at each Test Hole location is maintained level with the existing grade.

This report has been prepared for the exclusive use of 942252 Alberta Ltd., Visions Realty and their agents for specific application to the proposed Commercial Building to be constructed at Faithfull Avenue and 51st Street on Lot 5, Block 638, Plan 98-SA-17027 in Saskatoon, Saskatchewan. It has been prepared in accordance with generally accepted geotechnical engineering practices and no other warranty, express or implied, is made.

Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, are the responsibility of such Third Parties. PMEL accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

The acceptance of responsibility for the design/construction recommendations presented in this report are contingent on adequate and/or full time inspection (as required, based on site conditions at the time of construction) by a representative of the Geotechnical Consultant. PMEL will not accept any responsibility on this project for any unsatisfactory performance if adequate and/or full time inspection is not performed by a representative of PMEL.

If this report has been transmitted electronically, it has been digitally signed and secured with personal passwords to lock the document. Due to the possibility of digital modification, only originally signed reports and those reports sent directly by PMEL can be relied upon without fault.

We trust that this report fulfils your requirements for this project. Should you require additional information, please contact us.

P. MACHIBRODA ENGINEERING LTD.

Kelly Pardoe, P.Eng.

FOR Jennifer Krasowski, Engineer-In-Training

Terry Werbovetski, P. Eng.

JK/TW:zz:clb

Association of Professional Engineers & Geoscientists of Saskatchewan
CERTIFICATE OF AUTHORIZATION
P. MACHIBRODA ENGINEERING LTD.
Number 172
Permission to Consult held by:

Discipline	Sk. Reg. No.	Signature
Geotechnical	4955	10-07-20

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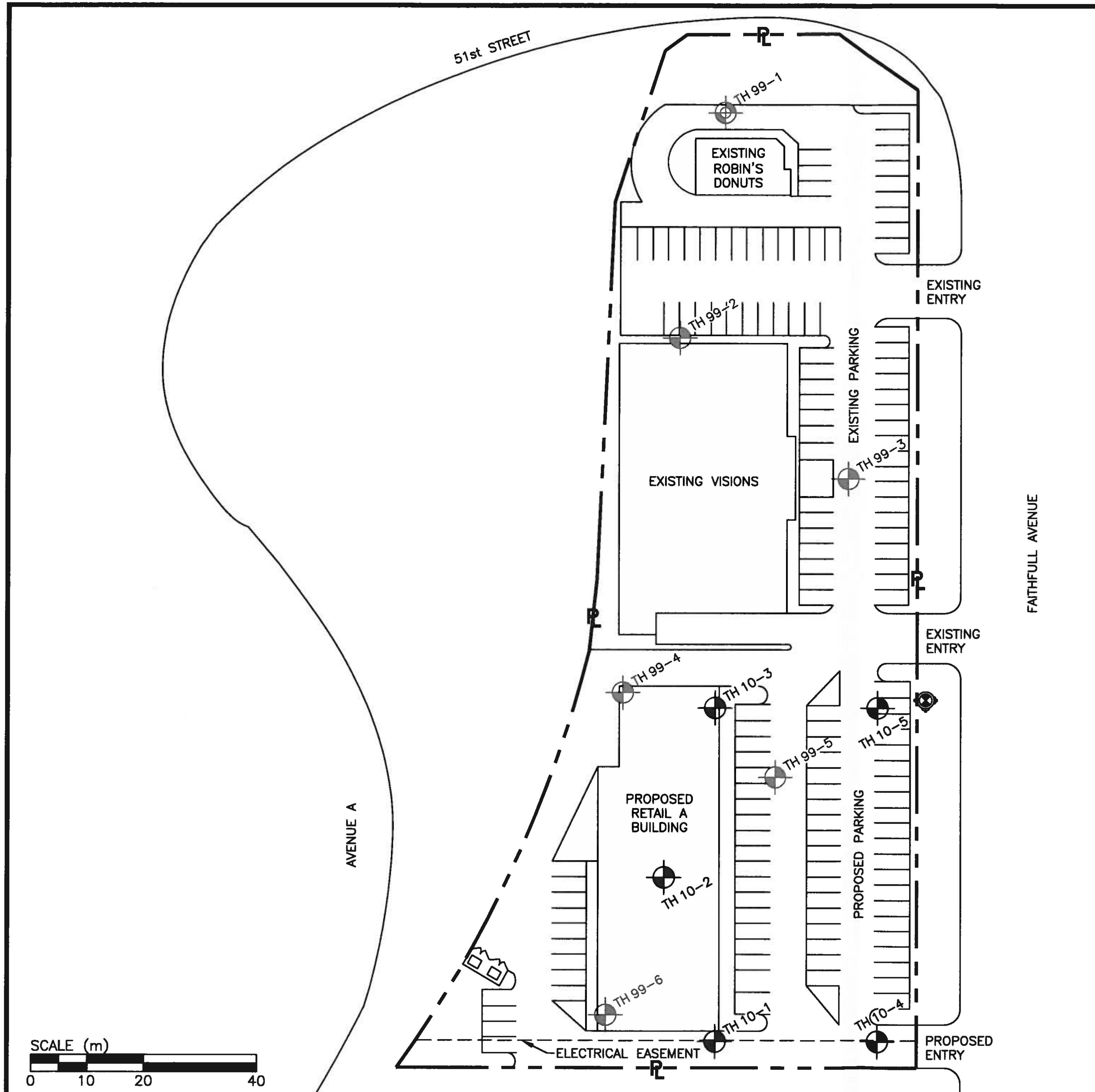
DRAWINGS



NOTE:
1. THIS DRAWING IS FOR CONCEPTUAL PURPOSES ONLY. ACTUAL LOCATIONS MAY VARY AND NOT ALL STRUCTURES ARE SHOWN.
2. THIS DRAWING WAS COMPILED USING SITE PLAN PROVIDED BY TURNER FLEISCHER. – PROJECT #09166/01, DRAWING #A1-9, (JANUARY 29, 2010).
3. BENCHMARK DESCRIPTION: FIRE HYDRANT, EAST OF SITE. ELEVATION = 497.400 m.

LEGEND

- –PMEL TEST HOLE
- –PMEL TEST HOLE (PREVIOUSLY DRILLED S99-3395)
- –PMEL TEST HOLE (PIEZOMETER INSTALLED) (PREVIOUSLY DRILLED S99-3395)
- –BENCHMARK
- PL –PROPERTY LINE
- –FIRE HYDRANT

P. MACHIBRODA ENGINEERING LTD.

CONSULTING
GEOENVIRONMENTAL
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806 – 48th STREET EAST
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DRAWING TITLE:

SITE PLAN - TEST HOLE LOCATIONS

PROJECT:
PROPOSED COMMERCIAL BUILDING
51st STREET & FAITHFULL AVE, SASKATOON, SK

APPROVED BY: TW	DRAWN BY: RO
DATE: JULY, 2010	DRAWING NUMBER: S10-7420-1
SCALE: 1:750	

TEST HOLE 10-1

ELEV: 495.8 m

DEPTH (m)	N	U (pp)	γ_w	Pw	Lw	w	Description
0		1.3		12	29	23.9	**FILL,** sand, some silt, some gravel, compact, well graded, fine to coarse grained, moist, light brown.
							FILL, clay, some silt, trace gravel, stiff, low to medium plastic, moist, brown.
1		0.8				24.4	**CLAY,** silty, firm, medium plastic, moist, olive brown.
	494.2 m I.A.D.						**SAND,** silty, compact, poorly graded, fine grained, wet, light brown, seepage, sloughing.
2		0.5				33.9	**CLAY,** trace silt, firm, highly plastic, moist, olive brown.
3		0.5				34.8	
							GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, brown, oxide stained.
4		2.0				18.8	
5							
6		2.3				13.7	
							–sandy, hard below 6.8 m.
7		3.5				10.1	
8							
9		4.5				11.4	
10							–grey below 10.1 m.
						11.2	
11							

NOTE:
1. Test Hole sloughed to 1.6 m I.A.D.

LEGEND:

TOPSOIL, FILL, GRAVEL, SAND, SILT, CLAY, GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m³)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm²)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE — SPLIT SPOON — CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED COMMERCIAL BUILDING

LOCATION: 51st STREET & FAITHFULL AVENUE SASKATOON, SK

NORTHING: **EASTING:**

DATE DRILLED:	DRAWING NUMBER:
JUL 5/10	S10-7420-2

TEST HOLE 10-2

ELEV: 495.1 m

DEPTH (m)	N	U	γ_w	Pw	Lw	w	Description
0		pp		19	38	23.3	**FILL,** clay, some silt, trace gravel, stiff, medium plastic, moist, brown.
		2.0					
1						28.8	
		2.0					
2						21.7	**GLACIAL TILL,** clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, olive brown, oxide stained.
		1.5					
3	11		22.0			13.3	
4							–hard below 4.2 m.
	29		22.2			11.1	
5							
6							–sand lense, wet, seepage, sloughing at 6.0 m.
	53		22.7			12.0	
	488.6 m I.A.D.						
7							–sandy below 6.8 m.
	27		21.8			11.5	
8							–grey below 8.6 m.
9	68		23.3			11.0	
10						10.4	
		4.5					
11							

NOTE:
1. Test Hole sloughed to 9.2 m I.A.D.

LEGEND:

TOPSOIL, FILL, GRAVEL, SAND, SILT, CLAY, GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γw...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE — SPLIT SPOON — CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED COMMERCIAL BUILDING

LOCATION: 51st STREET & FAITHFULL AVENUE SASKATOON, SK

NORTHING: **EASTING:**

DATE DRILLED: JUL 5/10

DRAWING NUMBER: S10-7420-3

TEST HOLE 10-3

DEPTH (m)

ELEV: 495.2 m

N	U	γ_w	Pw	Lw	w
	pp				
	2.8		17	42	15.9
					21.5
493.9 m I.A.D.					
11					24.5
	2.0				16.9
	1.5				13.8
	4.5				9.5
	4.0				11.3
	4.5				11.9
	4.5				13.4

FILL, sand, some silt, some gravel, compact, well graded, fine to coarse grained, moist, light brown.

FILL, clay, some silt, trace gravel, very stiff, medium plastic, moist, brown.

—black stained, slight organic odour at 900 mm.

SAND AND SILT, trace clay, compact, poorly graded, fine grained, wet, light brown, seepage, sloughing.

GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff to very stiff, medium plastic, moist, brown, oxide stained.

—sandy, hard below 5.6 m.

—grey below 9.4 m.

NOTE:
1. Test Hole sloughed to 1.3 m I.A.D.

LEGEND:

TOPSOIL, FILL, GRAVEL, SAND, SILT, CLAY, GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE — SPLIT SPOON — CUTTINGS

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P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED COMMERCIAL BUILDING

LOCATION: 51st STREET & FAITHFULL AVENUE SASKATOON, SK

NORTHING:

EASTING:

DATE DRILLED: JUL 5/10

DRAWING NUMBER: S10-7420-4

TEST HOLE 10-4

ELEV: 496.2 m

DEPTH (m)	N	U	γ_w	Pw	Lw	w
0		pp		16	34	24.3
						28.9
1						
						29.9
2						32.1
3						
4						
5						
6						
7						
8						
9						
10						
11						

FILL, sand, some silt, some gravel, compact, well graded, fine to coarse grained, moist, light brown.
CLAY, some silt, stiff, medium plastic, moist, olive brown.

NOTE:
1. Test Hole open to 2.0 m and dry I.A.D.

LEGEND:

TOPSOIL, FILL, GRAVEL, SAND, SILT, CLAY, GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE | SPLIT SPOON | CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE SUBSURFACE CONDITIONS ENCOUNTERED AT THE SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND, IN TIME, MAY CHANGE AT THIS SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED COMMERCIAL BUILDING

LOCATION: 51st STREET & FAITHFULL AVENUE SASKATOON, SK

NORTHING:

EASTING:

DATE DRILLED: JUL 5/10

DRAWING NUMBER: S10-7420-5

TEST HOLE 10-5

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

ELEV: 495.8 m

N	U (pp)	γ_w	Pw	Lw	w
					15.8
			16	48	34.4
					35.4
					22.3

FILL, sand, some silt, some gravel, compact, well graded, fine to coarse grained, moist, light brown.

FILL, clay, some silt, trace gravel, stiff, medium to highly plastic, moist, brown.

CLAY, some silt, stiff, medium plastic, moist, olive brown.

GLACIAL TILL, clay, some silt, some sand, trace gravel, stiff, medium plastic, moist, brown, oxide stained.

NOTE:
1. Test Hole open to 2.0 m and dry I.A.D.

LEGEND:

TOPSOIL, FILL, GRAVEL, SAND, SILT, CLAY, GLACIAL TILL

w.....WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw...LIQUID LIMIT

Pw...PLASTIC LIMIT

γ_w...WET UNIT WEIGHT (kN/m^3)

U.....UNCONFINED COMPRESSIVE STRENGTH (kPa)

pp...POCKET PENETROMETER (kg/cm^2)

N.....STANDARD PENETRATION TEST (SAFETY HAMMER w/AUTOMATIC TRIP) (50/125 = BLOWS/SAMPLER PENETRATION [mm])

SO_4 .....SULPHATE CONTENT (PERCENT OF DRY SOIL WEIGHT)

P200...% PASSING No. 200 SIEVE

I.A.D.....IMMEDIATELY AFTER DRILLING

▽...RECORDED WATER LEVEL (TEST HOLE I.A.D.)

▼...RECORDED WATER LEVEL (PIEZO)

SHELBY TUBE | SPLIT SPOON | CUTTINGS

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P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED COMMERCIAL BUILDING

LOCATION: 51st STREET & FAITHFULL AVENUE SASKATOON, SK

NORTHING:

EASTING:

DATE DRILLED: JUL 5/10

DRAWING NUMBER: S10-7420-6

APPENDIX A

EXPLANATION OF TERMS ON TEST HOLE LOGS

P. MACHIBRODA ENGINEERING LTD.

CLASSIFICATION OF SOILS

Coarse-Grained Soils: Soils containing particles that are visible to the naked eye. They include gravels and sands and are generally referred to as cohesionless or non-cohesive soils. Coarse-grained soils are soils having more than 50 percent of the dry weight larger than particle size 0.080 mm.

Fine-Grained Soils: Soils containing particles that are not visible to the naked eye. They include silts and clays. Fine-grained soils are soils having more than 50 percent of the dry weight smaller than particle size 0.080 mm.

Organic Soils: Soils containing a high natural organic content.

Soil Classification By Particle Size

Clay – particles of size	< 0.002 mm
Silt – particles of size	0.002 – 0.060 mm
Sand – particles of size	0.06 – 2.0 mm
Gravel – particles of size	2.0 – 60 mm
Cobbles – particles of size	60 – 200 mm
Boulders – particles of size	>200 mm

TERMS DESCRIBING CONSISTENCY OR CONDITION

Coarse-grained soils: Described in terms of compactness condition and are often interpreted from the results of a Standard Penetration Test (SPT). The standard penetration test is described as the number of blows, N, required to drive a 51 mm outside diameter (O.D.) split barrel sampler into the soil a distance of 0.3 m (from 0.15 m to 0.45 m) with a 63.5 kg weight having a free fall of 0.76 m.

Compactness Condition	SPT N-Index (blows per 0.3 m)
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	Over 50

Fine-Grained Soils: Classified in relation to undrained shear strength.

Consistency	Undrained Shear Strength (kPa)	N Value (Approximate)	Field Identification
Very Soft	<12	0-2	Easily penetrated several centimetres by the fist.
Soft	12-25	2-4	Easily penetrated several centimetres by the thumb.
Firm	25-50	4-8	Can be penetrated several centimetres by the thumb with moderate effort.
Stiff	50-100	8-15	Readily indented by the thumb, but penetrated only with great effort.
Very Stiff	100-200	15-30	Readily indented by the thumb nail.
Hard	>200	>30	Indented with difficulty by the thumbnail.

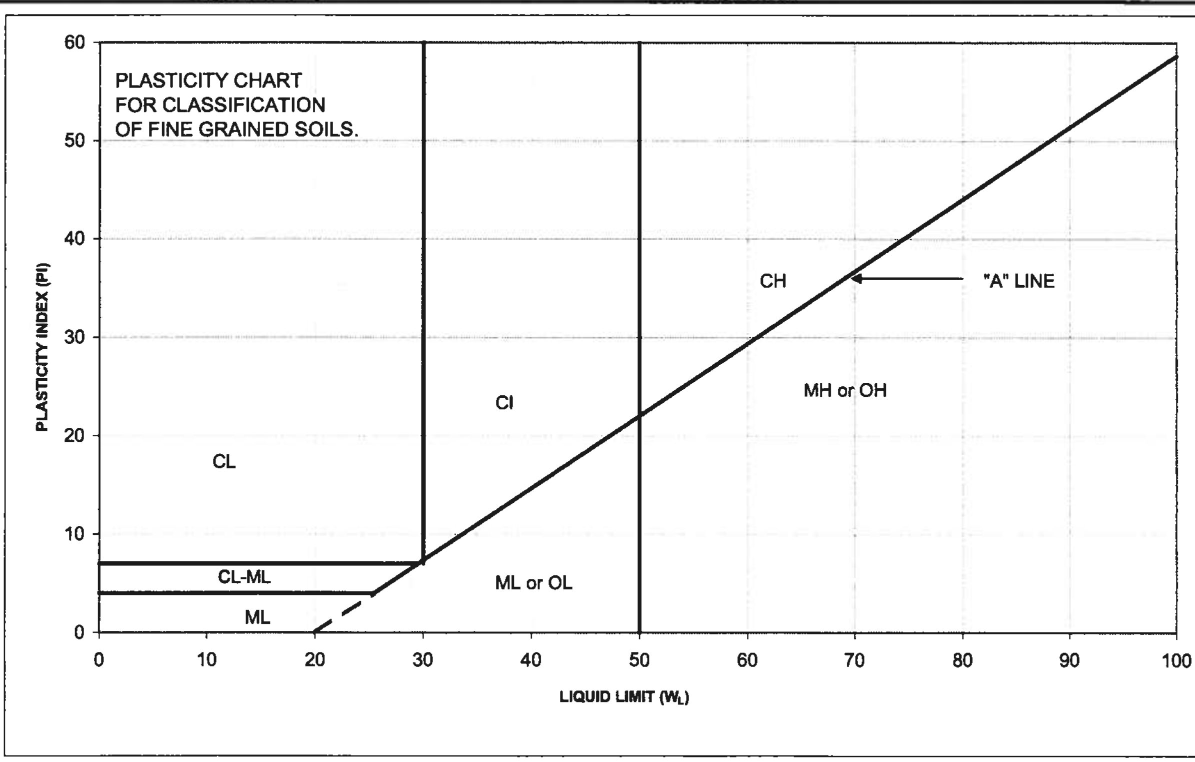
Organic Soils: Readily identified by colour, odour, spongy feel and frequently by fibrous texture.

DESCRIPTIVE TERMS COMMONLY USED TO CHARACTERIZE SOILS

Poorly Graded	- predominance of particles of one grain size.
Well Graded	- having no excess of particles in any size range with no intermediate sizes lacking.
Mottled	- marked with different coloured spots.
Nuggety	- structure consisting of small prismatic cubes.
Laminated	- structure consisting of thin layers of varying colour and texture.
Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks.
Fractured	- broken by randomly oriented interconnecting cracks in all 3 dimensions.

SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOUR OR ODOUR AND OFTEN FIBROUS TEXTURE
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS More than half coarse fraction larger than No. 4 sieve size	CLEAN GRAVELS	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 4$ $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}} = 1$ to 3
			GP	POORLY-GRADED GRAVELS AND GRAVEL-SAND MIXTURES <5% FINES	NOT MEETING ALL ABOVE REQUIREMENTS FOR GW
		DIRTY GRAVELS	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR PI < 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE WITH PI > 7
	SANDS More than half coarse fraction smaller than No. 4 sieve size	CLEAN SANDS	SW	WELL-GRADED SANDS, GRAVELLY SANDS MIXTURES <5% FINES	$C_u = \frac{D_{60}}{D_{10}} > 6$ $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}} = 1$ to 3
			SP	POORLY-GRADED SANDS OR GRAVELLY SANDS <5% FINES	NOT MEETING ALL GRADATION REQUIREMENTS FOR SW
		DIRTY SANDS	SM	SILTY SANDS, SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR PI < 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE WITH PI >7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSING NO. 200 SIEVE SIZE)	SILTS Below "A" line on plasticity chart; negligible organic content		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	$W_L < 50$
			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	$W_L > 50$
	CLAYS Above 'A" line on plasticity chart; negligible organic content		CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	$W_L < 30$
			CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS	$W_L > 30 < 50$
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	$W_L > 50$
	ORGANIC SILTS & ORGANIC CLAYS Below "A" line on plasticity chart		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	$W_L < 50$
			OH	ORGANIC CLAYS OF HIGH PLASTICITY	$W_L > 50$



APPENDIX B

FIELD DRILL LOGS AND SOIL TEST RESULTS
PMEL REPORT NO. S99-3395

TEST HOLE 99-4

DEPTH (m): 0 – 11

ELEV: 494.1 m

N	U (pp)	D	Pw	Lw	w
			14	33	13.5
					16.8
					17.4
					12.8
					11.2
					10.6
					10.8
					13.3
					11.4

TOPSOIL

GLACIAL TILL- Clay, silty, some sand, trace gravel, stiff, medium plastic, moist, olive brown, oxide stained, gypsum crystals.

SAND, silty, some clay, trace gravel, medium dense, poorly graded, medium grained, moist to wet, grey, sloughing.

GLACIAL TILL- Clay, silty, some sand, trace gravel, stiff, medium plastic, moist, olive brown, oxide stained, gypsum crystals.

–gravelly sand lense, wet at 7.6 m.
–grey below 7.9 m.

NOTE:
Test Hole sloughed in to 2.0 m after drilling.

LEGEND:

TOPSOIL, GRAVEL, SAND, SILT, CLAY, GLACIAL TILL, FILL

pp....POCKET PENETROMETER (kg/cm^2)

w......WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw....LIQUID LIMIT

Pw....PLASTIC LIMIT

D......DRY DENSITY (kg/m^3)

U......UNCONFINED COMPRESSIVE STRENGTH (kPa)

N......STANDARD PENETRATION TEST

SO_4 ...SULPHATE CONTENT (PERCENT OF DRY SOIL)

TR....TRACE

*......SULPHATE CONTENT WATER SAMPLE (ppm)

▼.....RECORDED WATER LEVEL

SHELBY TUBE, SPLIT SPOON, CUTTINGS

LIMITATIONS: THE FIELD DRILL LOG IS A SUMMARY OF THE FIELD CONDITIONS ENCOUNTERED AT A SPECIFIC TEST HOLE LOCATION AT THE TIME OF TEST DRILLING. SUBSURFACE CONDITIONS MAY VARY AT OTHER LOCATIONS OF THIS SITE AND IN TIME, MAY CHANGE AT THE SPECIFIC TEST HOLE LOCATION.

P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

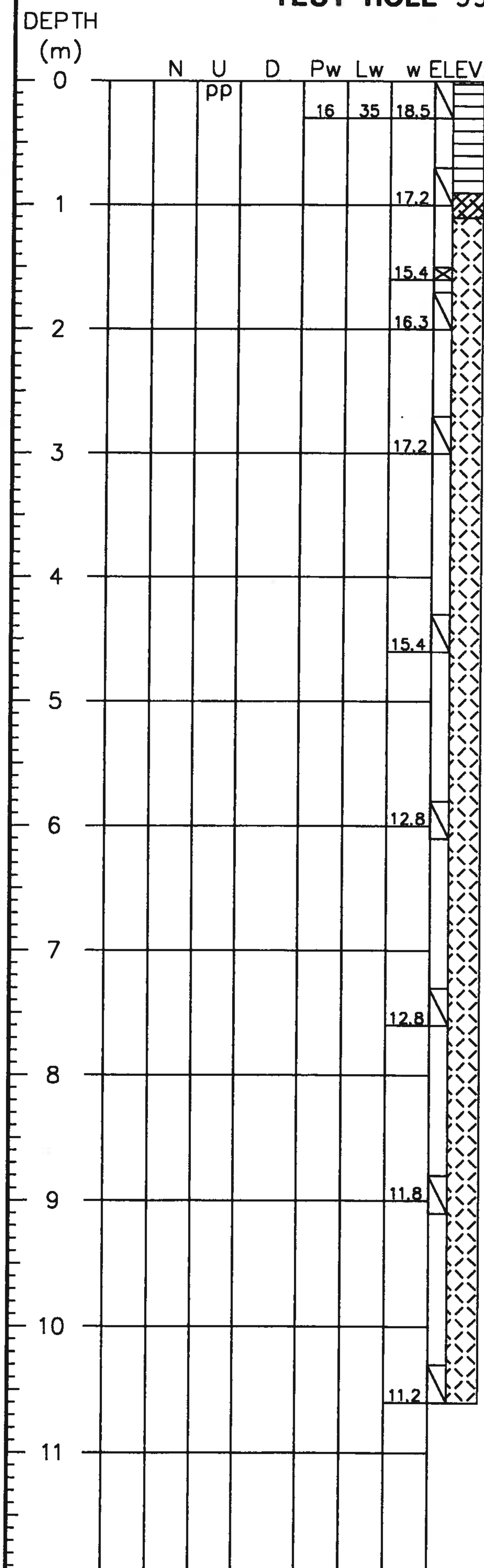
PROJECT: PROPOSED COMMMERCIAL DEVELOPMENT

LOCATION: SASKATOON, SK

DATE DRILLED: JUNE 26/99

DRAWING NUMBER: S99-3395-5

TEST HOLE 99-5



TOPSOIL

FILL- Clay, silty, firm, medium plastic, moist, olive brown, trace organics.

TOPSOIL- Clay, silty.

GLACIAL TILL- Clay, silty, some sand, trace gravel, stiff, medium plastic, moist, olive brown, oxide stained.

–sandy gravel, wet sloughing 5.0 to 5.3 m.
–cobbles at 5.2 m.
–hard below 5.2 m.

–grey below 9.5 m.

NOTE:
1. Test Hole open immediately after drilling.
2. Water Level at 9.5 m immediately after drilling.

LEGEND:

TOPSOIL GRAVEL SAND SILT CLAY GLACIAL TILL FILL

pp....POCKET PENETROMETER (kg/cm²)

w......WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw....LIQUID LIMIT

Pw....PLASTIC LIMIT

D......DRY DENSITY (kg/m³)

U......UNCONFINED COMPRESSIVE STRENGTH (kPa)

N......STANDARD PENETRATION TEST

SO_4 ...SULPHATE CONTENT (PERCENT OF DRY SOIL)

TR....TRACE

*......SULPHATE CONTENT WATER SAMPLE (ppm)

▼.....RECORDED WATER LEVEL

SHELBY TUBE SPLIT SPOON CUTTINGS

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P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED COMMMERCIAL DEVELOPMENT

LOCATION: SASKATOON, SK

DATE DRILLED: JUNE 26/99

DRAWING NUMBER: S99-3395-6

TEST HOLE 99-6

ELEV: 495.6 m

DEPTH (m)	N	U pp	D	Pw	Lw	w	Description
0				18	40	29.6	**TOPSOIL**
							CLAY, silty, firm, medium plastic, moist, olive brown.
1						33.9	**GLACIAL TILL-** Clay, silty, some sand, trace gravel, stiff, medium plastic, moist, olive brown, oxide stained, gypsum crystals.
2						17.7	
3						12.3	
4							—hard below 4.0 m.
						12.6	
6						11.9	
7						11.4	
9						11.5	
							—grey below 9.5 m.
						10.5	

NOTE:
Test Hole dry and open to 10.6 m immediately after drilling.

LEGEND:

TOPSOIL, GRAVEL, SAND, SILT, CLAY, GLACIAL TILL, FILL

pp....POCKET PENETROMETER (kg/cm²)

w......WATER CONTENT (PERCENT OF DRY SOIL WEIGHT)

Lw....LIQUID LIMIT

Pw....PLASTIC LIMIT

D......DRY DENSITY (kg/m³)

U......UNCONFINED COMPRESSIVE STRENGTH (kPa)

N......STANDARD PENETRATION TEST

SO_4 ...SULPHATE CONTENT (PERCENT OF DRY SOIL)

TR....TRACE

*......SULPHATE CONTENT WATER SAMPLE (ppm)

▼.....RECORDED WATER LEVEL

SHELBY TUBE · SPLIT SPOON · CUTTINGS

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P. MACHIBRODA ENGINEERING LTD.

FIELD DRILL LOG AND SOIL TEST RESULTS

PROJECT: PROPOSED COMMMERCIAL DEVELOPMENT

LOCATION: SASKATOON, SK

DATE DRILLED: JUNE 26/99

DRAWING NUMBER: S99-3395-7