CITY OF WINNIPEG

Deck and Patio Areas of Bill and Helen Norrie Library – Geotechnical Assessment Report

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STATEMENT OF LIMITATIONS AND CONDITIONS

Limitations

This report has been prepared for City of Winnipeg in accordance with the agreement between KGS Group and City of Winnipeg (the "Agreement"). This report represents KGS Group's professional judgment and exercising due care consistent with the preparation of similar reports. The information, data, recommendations and conclusions in this report are subject to the constraints and limitations in the Agreement and the qualifications in this report. This report must be read as a whole, and sections or parts should not be read out of context.

This report is based on information made available to KGS Group by City of Winnipeg. Unless stated otherwise, KGS Group has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of its work. The information and conclusions provided in this report apply only as they existed at the time of KGS Group's work.

Third Party Use of Report

Any use a third party makes of this report or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

Geotechnical Investigation Statement of Limitations

The geotechnical investigation findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practice. The findings and recommendations are based on the results of field and laboratory investigations, combined with an interpolation of soil and groundwater conditions found at and within the depth of the test holes drilled by KGS Group at the site at the time of drilling. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS Group or if the assumptions stated herein are not in keeping with the design, KGS Group should be notified in order that the recommendations can be reviewed and modified if necessary.

1.0 INTRODUCTION

Kontzamanis Graumann Smith MacMillan Inc. (KGS Group) was authorized by City of Winnipeg to complete a geotechnical investigation and assessment report for heaving issues affecting the paved patio and wooden deck areas of Bill and Helen Norrie library located at 15 Poseidon Bay, Winnipeg, Manitoba. KGS Group's scope of services for this project was outlined in our Proposal No. 24-000-1397 titled "Geotechnical and Structural Investigation – 15 Poseidon Bay", dated August 8, 2024.

2.0 BACKGROUND INFORMATION

Background information that has been reviewed as part of this project include:

- Geotechnical report titled “Geotechnical Investigation for the Proposed One-storey, Steel-frame, 14,000 FT^2 Bill & Helen Norrie Library to be Located at 25 Poseidon Bay in Winnipeg, Manitoba”, dated November 8, 2018, attached in Appendix A.
- Tower Engineering’s Observation Report dated May 31, 2023, prepared for the City of Winnipeg, included as Appendix B.

3.0 PROJECT UNDERSTANDING

A concrete paver surfaced patio and wooden deck were built off the southeast corner of the library building. It has been noted that the patio surface and wooden deck have moved differentially at various locations upwards of approximately 100 mm.

The wooden deck was visual inspected by Tower Engineering on May 10, 2023. The results of their inspection are summarized in their Observation Report dated May 31, 2023, attached in Appendix B. The following deficiencies were indicated in the report:

- The connections between the piles and beams are not securely bolted at various locations of the wooden deck;
- A gap was observed under the beam, indicating it was not bearing on anything. According to the shop drawings, the connection between the beam and pile was to have one anchor bolt on each side to connect the angle and pile. However, it was noted that only one angle was connected to the pile, and the other angle was not connected at all. This allows for the beam to rotate and lift if uplift soil pressure is applied;
- Gaps were noted between the pile and the underside of the angle, as well as between the angle and beam. Additionally, it appeared that a square pile cap was poured on top of the pile, which did not allow the beam-to-pile connection as per the shop drawings;
- The subgrade below the deck did not appear to have a slope indicated in the HTFC drawings, and the beam was sitting directly on the subgrade in some locations; and
- The compacted subgrade beneath the patio stone area was observed to have settled below the plywood protection board and extended under the deck.

4.0 GEOTECHNICAL INVESTIGATIONS PROGRAM

4.1 Test Hole Drilling and Sampling

A drilling and sampling program was completed on November 15, 2024, under continuous supervision by KGS Group, while drilling services were provided by Paddock Drilling Ltd. of Brandon, Manitoba. Drilling was performed using an Acker MP8 truck mounted geotechnical drill rig equipped with 125 mm diameter solid stem auger, and a Standard Penetration Test (SPT) auto-hammer.

A total of two (2) test holes (TH24-01 and TH24-02) were drilled to refusal at a depth of 15.2 m. TH24-01 was drilled south side of library's building adjacent to wood decking area and TH24-02 was drilled near southeast building corner, approximately 1.5 m east of wood deck at concrete paver patio.

Test hole locations are shown on Figure 1. Test hole summary and UTM coordinates are provided in Table 1.

FIGURE 1: TEST HOLE LOCATION PLAN

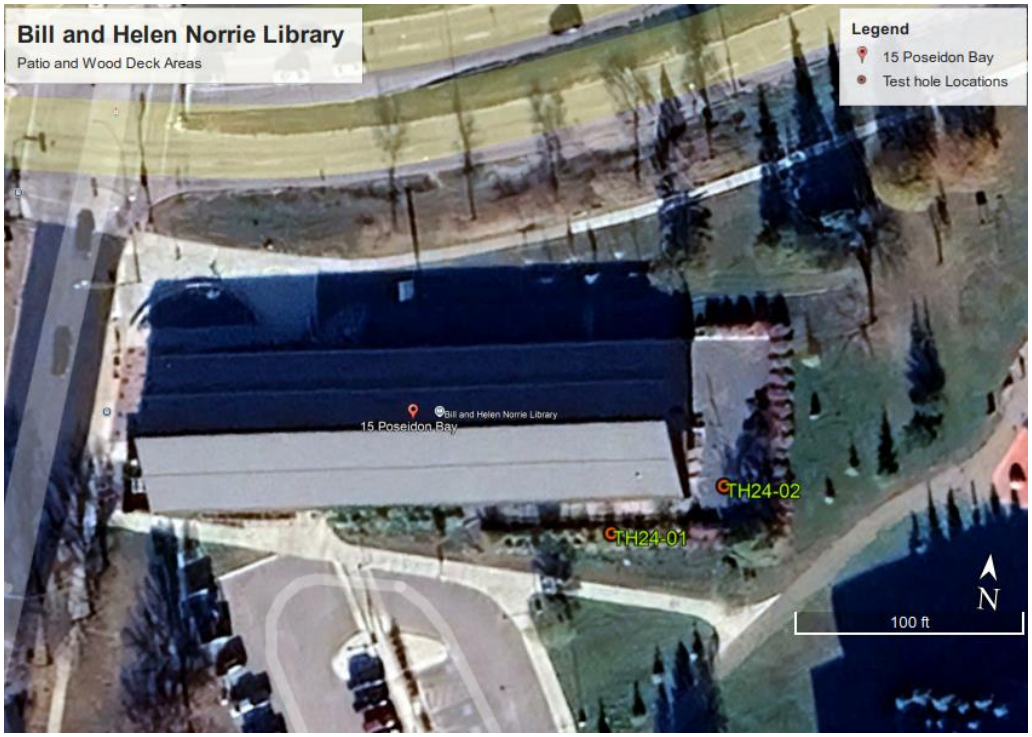


TABLE 1: SUMMARY OF TEST HOLE LOCATIONS

Test Hole ID	Location	Surface Elevation (m)	UTM Coordinates[1,2]		Test Hole Depth (m)
			Northing (m)	Easting (m)	
TH24-01	South side of library building, adjacent to wooden deck area	233.25	5,524,175	631,215	15.2
TH24-02	Southeast building corner, approximately 1.5 m east of wooden deck at concrete blocks patio	233.23	5,524,183	631,229	15.2
Notes	1. Test hole coordinates presented above were collected using a handheld GPS with an accuracy of ±3 m. 2. All UTM coordinates located in zone 14U.				

Representative soil samples were obtained from the test holes (TH24-01 and TH24-02) at the intervals of 1.5 m or at any changes in soil strata. Soil samples were collected directly off the auger or from the split spoon sampler and visually classified in the field in general accordance with the modified Unified Soil Classification System (USCS). The SPT's were advanced at the intervals of 1.5 m in till materials, while clay samples were tested using a handheld Torvane to assess the undrained shear strengths. Test holes were backfilled with auger cuttings and bentonite chips to existing grade. Excess auger cutting were placed in a large soil bag and removed from the site.

Detailed descriptions of the soil, groundwater and sloughing conditions encountered in test holes (TH24-01 and TH24-02) can be found on the test hole logs provided in the Appendix C, and laboratory test results provided in Appendix D.

4.2 Laboratory Testing

Laboratory tests were completed on representative soil samples to determine index properties for correlation to relevant engineering properties. Testing was completed at a laboratory certified by the Canadian Council of Independent Laboratories (CCiL) in Winnipeg, Manitoba. Testing included 33 moisture contents and one (1) Atterberg limits, and two (2) one dimensional swell tests. Laboratory test results are included on the summary test hole logs provided in Appendix C and laboratory test reports provided in Appendix D.

4.3 Stratigraphy

The general stratigraphy at the site was interpreted by KGS Group to consist of three (3) general layers: fill materials consisted of various layer such as topsoil, gravel with sand, and clay, overlying a clay, overlaying high plastic clay, overlying clay and silt till. A detailed description of each stratigraphic layer is provided below as well as on the test hole log reports included in Appendix C.

Topsoil – A layer of topsoil was encountered at the surface of test hole (TH24-01) and was approximately 305 mm (12 in) in thickness.

Gravel with Sand Fill – A layer of well graded gravel with sand fill was encountered in test hole (TH24-02) and was approximately 213 mm (8.4 in) in thickness.

Clay Fill – A layer of clay fill was encountered in both test holes (TH24-01 and TH24-02) and was approximately 204 mm (8 in) and 445 mm (18 in) in thickness, respectively.

Organic Soil – A thin layer of organic fill was encountered beneath the clay fill in test hole (TH24-02) and was black, damp, stiff and approximately 34 mm (1.5 in) in thickness.

Fat Clay (CH) – High to intermediate plasticity clay was encountered below the clay fill in both test holes, ranging in thickness from 10.1 and 9.4 m (33 ft and 31 ft) below ground surface (BGS), respectively. The clay was generally greyish brown to grey in color, moist, firm to stiff, contained trace gypsum nodules, trace fine gravel. Moisture contents ranged from 25 to 52%, as measured from 16 tests.

The undrained shear strength of the clay was measured using a field Torvane, with values ranging from 100 to 15 kPa, generally decreasing with depth, classifying the soil as stiff to soft.

Two (2) Atterberg limits were completed on samples of the clay from depths of 0.9 m in TH23-01, and 1.8 m in TH24-02 indicating liquid limits of 81 and 91, plastic limits of 37 and 39, and plasticity indices of 44 and 52, classifying it of high plasticity (CH).

In test hole TH24-01, a 150 mm (6 in) thick silt layer was encountered within the clay at approximately 1.5 m below grade. The silt was noted to be light brown, moist, firm and of low plasticity.

Clay till – A layer of clay till 0.85 m in thickness was encountered underlying the clay strata in test hole TH24-01, and was grey, moist, soft, and contained some medium to coarse sand, trace fine gravel.

Silt Till – Silt till ranging in thickness from 4.6 to 5.0 m was encountered underlying the clay strata in test holes TH24-01, and TH24-02 and was light grey, damp to moist, loose to dense, and contained trace to some sand, gravel, and clay. The moisture content of the silt till ranged from 7 to 19% as measured from 12 tests. Standard Penetration Tests completed on the silt till resulted in uncorrected N values of 8 to 31, indicating the material to being loose to dense.

One (1) Atterberg limits were completed on a sample of the silt till in TH24-02, indicating liquid limits of 37, plastic limits of 14, and plasticity indices of 23.

Stratigraphic conditions observed in the 2024 investigation program is consistent with those conditions observed in the original 2018 investigation program conducted by M. Block & Associates Ltd., the report including test hole logs are provided in Appendix A.

4.4 Seepage, Sloughing and Groundwater Conditions

Groundwater and sloughing observations were recorded during and upon completion of drilling in open test holes (TH24-01 and TH24-02) as summarized in Table 2 below.

TABLE 2: OBSERVED GROUNDWATER AND SLOUGHING CONDITIONS

Test Hole ID	Depth of Test Hole (m)	Seepage Layer	Water Level During Drilling (m)	Water Level Upon Completion (m)	Cave-in Depth (m)
TH24-01	15.2	None	None	None	13.0
TH24-02	15.2				8.5

Groundwater levels will fluctuate seasonally and following precipitation and snow melt events. As such, the actual groundwater level at various times of the year could differ from the conditions observed during test hole drilling.

5.0 DISCUSSION AND RECOMMENDATIONS

KGS Group reviewed laboratory test results including Atterberg limits, moisture contents, grain size distribution, and swell tests completed on select soil samples. Based on the test results, it is estimated that the high plasticity clay soil across the deck and patio areas could heave up to an additional 200 to 300 mm with ongoing exposure to elevated moisture contents. Laboratory test results are provided in Appendix D.

The following recommendations can be considered and implemented to reduce the potential for damage with ongoing movement due to swell and/or frost related movements.

5.1 Surface Drainage

- Surface grades should be re-established around the perimeter of the building to create positive drainage away from structures.
- Ensure gutters are free of debris and draining properly to downspouts.
- Downspouts should discharge to swales that extend beyond the deck areas to reduce infiltration of runoff water and continued excess saturation of the subgrade soils.
- Grading / drainage swales beyond the patio areas should be directed to catch basins to discharge water off-site. Swales can consist of concrete or be lined with a minimum of 200 mm of compacted high plasticity clay (Fat Clay, CH).
- Inspect both exterior and interior weeping tile systems, including sump pits and discharge lines, to ensure that they are operating as intended.

5.2 Wood Deck

- KGS Group observed that the subgrade soils are displaced upward due to swelling soil and/or frost heave, resulting on pressure and damage to the wood beams and steel brackets. In some cases, the brackets are pulled out of the pile caps and/or the pile caps have lifted off of the piles.
- According to project plans, it is understood that the cast-in-place piles that support the deck extend 8 m below grade.
- Observations to date, do not suggest that the piles have displaced upward due to jacking from either swelling soil or frost heave.
- Based on the observations and specified pile lengths, we do not suspect that pile movement has occurred. It is our opinion that the piles can be reused to support the new deck. For additional protection from future potential movements, consideration can be given to adding an adjustable connection between the top of pile and deck support beams.
- Laboratory tests indicated between 5 and 12% swell for samples loaded to between 15 and 25 kPa prior to wetting. Based on the test results, void space below the patio support beams and subgrade soil should be a minimum of 300 mm.

5.3 Patio Stone Surfaced Deck Area

It is KGS Groups opinion, that the upward displacement and movement/shifting of the paver blocks is due to a combination of swelling of the underlying high plasticity clay soil and frost heave. Non-uniform wetting and/or accumulations of water in the underlying granular materials and subgrade, results in non-uniform movement and displacement at the surface. Additionally, where underlying soil is saturated and water accumulates, movement due to frost heave will be more prevalent. For uniform performance of the paving stone surfacing, we recommend they be supported on a minimum of 300 mm (12 in) of granular base over a reinforcing geotextile at the interface with the underlying clay soil. Subgrade preparations across the area of the paver stones should be completed as follows:

- Remove pavers and existing surfacing materials and excavate soil down to design subgrade elevation. All existing fill or organically enriched soil should be removed in their entirety down to native high plasticity clay (fat clay, CH).
- The exposed clay subgrade should be proof rolled using available wheeled equipment with a loaded bucket, such as a skid steer or loader, under the supervision of an experienced geotechnical professional or qualified designate. Proof rolling will be completed to identify unsuitable or soft areas that exhibit deflection. KGS Group can contacted to provide direction to address unsuitable/unstable areas identified during proof rolling.
- The final exposed clay subgrade should be compacted to a smooth any loose or disturbed soil and be graded to drain to a collection point or existing weeping tile system to remove any water accumulations.
- A geotextile comprised of a reinforcing biaxial geogrid (Mirafi BXG 120 or Tensar BX1200, or approved equivalent) and non-woven separation fabric, or combi-grid, should be placed at the interface between the approved subgrade and base course. The geotextile(s) should extend up the vertical sidewalls of the sub-excavation, the full depth of granular base course, with adjacent edges/seams overlapped according to the manufacturer's recommendations.
- Granular A, Base Course (minus 25 mm) should be well-graded and be free of organics and frozen material and meet the requirements of City of Winnipeg Specification CW 3110 dated November 15, 2022.
- Sieve analysis and compaction testing of the granular base should be conducted by qualified geotechnical personnel to ensure that the materials supplied, and percent compactions are in accordance with design specifications.
- Place base materials in approximate 200 mm (8 in) loose lifts and compact to 100% of the SPMDD, within 3% of optimum moisture content.

APPENDIX A

Geotechnical Report by M. Block & Associates Ltd., dated November 8, 2018

M. Block & Associates Ltd.
Consulting Engineers
CSA CERTIFIED CONCRETE LABORATORY

▪ Geotechnical Investigations ▪ Environmental Assessments ▪ C.S.A. Certified Material Testing

November 8th, 2018

The City of Winnipeg
3rd Floor – 65 Garry Street
Winnipeg, Manitoba
R3C 4K4
Attention: Ms. Maria Petsa, EIT, M.Sc. (Eng.), PMP

Dear Madam:

RE: GEOTECHNICAL INVESTIGATION FOR THE PROPOSED ONE-STOREY, STEEL-FRAME, 14,000 FT^2 BILL & HELEN NORRIE LIBRARY TO BE LOCATED AT 25 POSEIDON BAY IN WINNIPEG, MANITOBA

1.0 TERMS OF REFERENCE

On October 17th, 2018, M. Block & Associates Ltd. (MBA) received e-mailed authorization from Mr. Peter Wertepny, P. Eng., representing Tower Engineering Group Limited Partnership, to proceed with the geotechnical investigation for the proposed one-storey, steel-frame, 14,000 ft^2 Bill & Helen Norrie Library to be located at 25 Poseidon Bay in Winnipeg, Manitoba. Therefore, on October 30th, 2018, nine test holes in total were bored implementing a track-mounted Acker MP-5, using interconnected 5' long x 5" diameter continuous flight solid stem augers, supplied by Maple leaf Drilling Ltd. of Winnipeg, Manitoba. Representative “disturbed” soil samples were retrieved from the test holes and brought back to MBA’s CSA certified materials testing laboratory in Winnipeg for moisture content testing and verification of the field soil classifications. Alternatively, during the field investigation, the fine grained soils’ respective ‘disturbed’ undrained shear strengths were measured implementing a hand-held calibrated Pocket Geotester and torque shear vane. Upon the completion of this investigation, the test holes’ elevations and the groundwater elevations in them, if any, were measured and referenced to their respective surfaces and also the top of the fire hydrant situated immediately to the north of the subject property, as illustrated on pages 18 – 30 of this report. In addition, the test holes were completely backfilled with bentonite and the soil cuttings.

2.0 SOIL LITHOLOGY AND GROUNDWATER CONDITIONS

Test holes #1, #2, #3, #4, #5, #6, #7, #8 and #9 were covered with, approximately, 1'6", 1'6", 1', 2', 2', 2', 1'6", 6" and 1'6", respectively, of black/grey/brown, very stiff, damp, silty clay fill. Black, becoming grey and then brown in colour with increasing depth, alluvially deposited, very stiff, damp, silty clay was then traversed in test holes #1, #2, #3, #4, #5, #6, #7, #8 and #9 down to the 5'6", 5'6", 4', 4'6", 5'6", 5'6", 4'6", 6' and 5'6" depths, respectively. Next, brown, alluvially deposited, powdery dry to wet, silt was observed in, only, test holes #8 and #9 down to the 8' and 7' depths, respectively. Brown, becoming grey in colour below the 24' depth, glaciolacustrine, very stiff to firm, damp to moist, silty clay with silt and gypsum inclusions was then noted in test holes #4, #7, #8 and the shallow probe holes down to the 31', 32', 31' and 10' depths, respectively. Grey, soft, wet, sandy clayey silt with potential cobbles and boulders (glacial till) was next recorded in the deep test holes, #4, #7 and #8, down to the 33', 34' and 33' depths, respectively. Finally, brown, compact to very dense, practically non-plastic, gravelly sandy silt with cobbles and boulders (glacial till) that varied in stiffness and relative porosity from soft and saturated to hard and dry, respectively, was encountered in test holes #4, #7 and #8 down to the 51'6", 45' and 40'6" depths, respectively, where the auger refused on suspected fractured limestone bedrock (TH #4) or boulders. As such, the deep test holes were terminated at the aforementioned depths. Alternatively, the shallow probe holes were discontinued at the 10' depth. Upon penetrating the possible fractured limestone bedrock's aquifer, groundwater flowed into test hole #4 at a very high inflow rate. In addition, within ten minutes of obtaining auger refusal, the groundwater elevations in test hole #4 was measured 24' below its current ground elevation. Furthermore, it is anticipated that this phreatic surface could rise by an additional 14' during wet spring runoffs and/or heavy rainfall runoff events. As such, that contingency will be incorporated into the project's geotechnical designs presented in this report. The soil lithology in the test holes and their specific locations were appended to this report on pages 18 – 30.

3.0 SUMMARY OF FIELD AND LABORATORY TESTS

DEPTH	UNCONFINED COMPRESSION	MOISTURE CONTENT
10'	1921 psf	53.2 %
20'	1911 psf	58.0 %

The soils' measured torque shear vane strengths are located on the test holes' log sheets.
The soils' measured Pocket Geotester strengths are located on the test holes' log sheets.
Moisture content vs. Depth graphs are located on the test holes' log sheets.
A summary of the laboratory data is appended to this report on pages 34 – 36.

4.0 FOUNDATION DESIGN ALTERNATIVES

4.1 CONCRETE FOOTINGS AND SURFACE SLABS ON GRADE

Predicated upon the well-documented, volumetrically sensitive, glaciolacustrine silty clay deposition in the former Lake Agassiz that has caused significant structural distresses in typical below grade footings and surface slabs on grade in similarly constructed structures in the Red River Basin and the alluvial and upper glaciolacustrine depositions' very stiff unconfined compressive strengths, its estimated extremely high liquid limit and plasticity index, and/or "far below normal" moisture content on this site above or at the 9' depth, it is the writer's professional opinion that a concrete footing foundation system and a surface slab on grade, constructed on the glaciolacustrine soil above or at the 9' depth, is still extremely susceptible to significant soil swelling, shrinkage and/or rebound, and, as such, strongly not recommended as feasible foundation and/or surface floor support systems for this project.

However, one must question how relevant is the soil's current moisture content, porosity and swell potential, since these will obviously vary, possibly substantially, from the time the excavation is opened until the concrete main floor slab is placed. As such, it is the writer's professional opinion that, predicated upon the distinct possibility of the soil situated at the proposed surface slab on grade elevation drying out significantly, from the time it is

excavated until it is concreted, and events beyond the writer's and consultants' control, the maximum soil swelling and rebound potential would be, approximately, 450 mm.

4.2 DRILLED CAST IN PLACE CONCRETE FRICTION PILES

Alternatively, drilled cast in place concrete friction piles could be implemented as the foundation design for the proposed one-storey, steel-frame, 14,000 ft^2 Bill & Helen Norrie Library to be located at 25 Poseidon Bay in Winnipeg, Manitoba. Predicated upon the neutral plane of this pile type modeled near the 8' depth around the proposed structure and the risk of basal instability occurring in this foundation type below the 28' depth, the allowable effective functional friction length of glaciolacustrine silty clay at this site, **from the present grade of test hole #4**, is **28' – 8' = 20'.** The laboratory data indicates that the factored geotechnical resistance (FGR), using ultimate limit states (ULS) where $\Phi = 0.4$, of the soil/concrete interface from the 8' to 28' depths, only, is 385 psf (350 psf in the SLS analysis for 1" deflection). Based upon these calculations, a 16" diameter friction pile drilled 28' deep, properly constructed, would safely transfer, using ULS, 30 kips of load down to the underlying glaciolacustrine deposition. The concrete, relative to the soil, has an additional net weight of, approximately, 40 pcf in the upper 28' of overburden. Therefore, the additional net weight of the concrete is included in the above analysis. In addition, in order to avoid reducing the piles' net efficiency, they must be spaced at least three pile diameters, on center. Furthermore, in order to resist potential soil swelling and frost jacking uplift stresses, these piles shall have minimum embedment lengths of 25' and 28' in heated and unheated areas of the site, respectively. Finally, full-length reinforcing steel shall also be installed in all the piles implemented in an unheated service condition. The modeled foundation displacement of this foundation type would be in the order of nil to 10 mm.

It is recommended that the geotechnical engineer's personnel inspect the installation of this foundation type in order to verify that it conforms to the contents of this report, the structural drawings and project's specifications.

The foundation contractor shall be fully cognizant that a saturated soil stratum may underlie untested areas of this site in the overburden and, as such, may slough and seep significantly into some or several of the piles' drilled open excavations during wet seasons and/or years. Therefore, should that situation transpire, steel casing through that entire deposition would then be required. Since soil sloughing during concreting may cause improper foundation performance, special care must be given when removing the steel sleeve not to cause sloughing soil from entering a pile's excavation from in behind it. As such, the foundation contractor should be diligent when removing the steel sleeve not to cause sloughing soil from entering the pile's excavation from in behind it. In addition, the top 8' of embedment length in every concrete pile should be mechanically vibrated.

The advantages of this piling system are its relatively fast rate of pile installation, frequency of being more economical than other piled foundation designs in this area, efficiency of installation in comparison with driven pre-cast concrete end-bearing piles, the many piling businesses located in the vicinity and minimal magnitude of modeled long-term foundation settlement. The disadvantages of this piling system are the limited functional depth of serviceable clay and, as such, frictional pile capacity on this site, the extra cost, if any, associated with temporary steel sleeving, and pile settlement, if constructed improperly.

4.3 DRILLED SPREAD BORE CONCRETE END-BEARING PILES

Similarly, drilled, cast in place, spread bore concrete end-bearing piles could also be implemented as the foundation design for the proposed one-storey, steel-frame, 14,000 ft^2 Bill & Helen Norrie Library to be located at 25 Poseidon Bay in Winnipeg, Manitoba. These piles shall only be mechanically constructed on the stiff glaciolacustrine silty clay 6 m below test hole #4's current elevation, where the FGR, using ULS where Φ = 0.4, and the piling installation supervised by qualified geotechnical personnel, would be 125 kPa (125 kPa in the SLS analysis for 1" deflection). In addition, in order to avoid reducing the piles' net efficiency, they must be spaced at least two-and-a-half bell and three shaft diameters, on center, from each other.

In order to protect these short piles from frost jacking stresses in unheated applications, only, they shall have sono-tube casings installed along their upper 3.0 m of embedment length. Furthermore, the sono-tube shall be wrapped in 6 mil poly and completely greased on its inside. In addition, full-length reinforcing steel shall also be installed in all the piles implemented in an unheated service condition.

The foundation contractor shall be fully cognizant that a saturated soil stratum may underlie untested areas of this site in the overburden and, as such, may slough and seep significantly into some or several of the piles' drilled open excavations during wet seasons and/or years. Therefore, should that situation transpire, steel casing through that entire deposition would then be required. Since soil sloughing during concreting may cause improper foundation performance, special care must be given when removing the steel sleeve not to cause sloughing soil from entering a pile's excavation from in behind it. As such, the foundation contractor should be diligent when removing the steel sleeve not to cause sloughing soil from entering the pile's excavation from in behind it. In addition, the top 2.4 m of embedment length in every concrete pile should be mechanically vibrated.

The advantages of this piling system are its anticipated relatively short pile embedment length, moderate allowable axial compressive, tensile and frost jacking resistances and minimal magnitude of modeled long-term foundation settlement. The disadvantages of this piling system are its higher cost and longer foundation installation time per pile associated with mechanically constructing the bell and temporary steel sleeving, if any, and the potential for pile settlement, if incorrectly constructed. The modeled foundation displacement of this foundation type would be in the order of nil to 10 mm.

4.4 DRIVEN PRE-CAST CONCRETE END BEARING PILES

Finally, driven pre-cast concrete end-bearing piles could also be implemented as the foundation design for the proposed one-storey, steel-frame, 14,000 ft^2 Bill & Helen Norrie Library to be located at 25 Poseidon Bay in Winnipeg, Manitoba. All driven pre-cast concrete

piles should be pre-drilled 5 m below present site grade, due to the proposed structure's proximity to the adjacent dwellings, possibly constructed on shallow foundations, prior to being driven to refusal onto a dense stratum, such as, a hard glacial till matrix, a dense granular stratum or bedrock. The estimated length of properly driven pre-cast concrete piles required at this location would be **in the order of 12 m – 17 m from the present ground elevation of test hole #4.** However, the foundation contractor should still verify the estimated length of pre-cast concrete piles required at this site and become fully cognizant with the contents of this report. Following their successful installation, in order to maximize their lateral support and minimize their adhesion and frictional capacity with the underlying volumetrically sensitive glaciolacustrine silty clay, all the piles' oversized pre-bores should then be backfilled with clean sand or another pre-approved equivalent substitute alternative. The modeled foundation displacement of this foundation type would be in the order of nil to 10 mm. Furthermore, the geotechnical engineer's personnel should inspect the foundation installation in order to verify the FGR, using ULS where Φ = 0.6, based upon the following pile driving criteria:

PILE DIAMETER	MIN. CONCRETE COMP. STRENGTH	DRIVING ENERGY	REFUSAL CRITERIA	ULS FGR	SLS
305 mm	40 mPa	30 foot * kips	5 blows / 1" (25 mm)	75 tons	65 tons
350 mm	40 mPa	30 foot * kips	10 blows / 1" (25 mm)	105 tons	90 tons
400 mm	40 mPa	30 foot * kips	15 blows / 1" (25 mm)	135 tons	115 tons

Note: Max 1" (25.4 mm) penetration per set, for 3 consecutive sets

MBA has performed many pile load tests in The City of Winnipeg during the 1960s. It was through these static pile load tests in The City of Winnipeg that the SLS criteria used by all the labs here were established for the geology underlying The Red River Valley and, as such, The City of Winnipeg. As such, when the new ULS criteria was mandated, MBA just reviewed those pile load tests and modified the pile driving criteria based upon the direct relationship between driving energy, deflection for a set number of blows at that energy and ultimate pile capacity to establish the ULS pile capacities based upon these static load tests inside The City of Winnipeg. Furthermore, based upon these static load tests, all design

work in the City of Winnipeg from the 1960s onwards was based upon a direct relationship between driving energy, deflection for a set number of blows at that energy and ultimate pile capacity. In the last few years, these pre-cast pile capacities have been also verified to be true through PDA testing. However, these static pile load test reports cannot be forwarded due to the privacy laws in Canada. However, they are on file at MBA. However, as critically mentioned previously though, all the design and construction work, previously implemented from the 1960s onwards, was using the data from these static load tests that did not require to be constantly re-proven from site to site in The City of Winnipeg from the 1960s to 2010.

In addition to the aforementioned specifications for driven pre-cast concrete piles, MBA offers the following recommendations:

- Pre-drilling through the zone of frost may be required for winter or early spring construction.
- If a drop hammer is to be used to install these piles, the mass of the hammer shall be 3 times greater than the mass of the pile.
- Pile spacing shall not be less than three pile diameters, on center.
- Piles driven within five pile diameters, on center, shall be monitored for heave. Where observed; the piles shall be re-driven to the aforementioned refusal criteria.
- Once pile driving is initiated, all piles shall be driven continuously to their respective refusal depth.

The advantages of this piling system are its very heavy allowable axial compressive capacities and minimal magnitude of modeled long-term foundation settlement. The disadvantages of this piling system are its frequently greater cost per foot of pile and the potentially variable depths to practical refusal across this site.

5.0 CONCRETE DESIGN

Due to the visibly high concentration of sulphate in the glaciolacustrine deposition at this site, Sulphate Resisting Cement shall be used in all the concrete implemented for the aforementioned concrete foundation systems. Its concrete shall have a minimum 28-Day laboratory compressive strength of 32 mPa. Furthermore, the concrete shall contain at least 550 pounds of cement per cubic yard, have a maximum water cement ratio, a plastic concrete air content and slump of 0.45, 4 to 6 percent and 60 mm to 100 mm, respectively.

Alternatively, due to the higher elevation of the proposed structure in relation to the elevations of these test holes and the likely low concentration of sulphate in the proposed filled layers, Normal Portland Cement could be used in all the concrete implemented for the structure's grade beams and floor slabs.

All other concrete exposed to freezing and thawing cycles shall contain an air entraining admixture that corresponds to the applicable class of exposure listed in tables 2-4 of the recent addition of CSA. Concrete poured in cold weather shall be heated and protected in accordance with CSA A23.1-04 clause 21.2.3.

In addition, all concrete poured shall be tested in accordance with CSA A23.1-04 every day and at least once every 50 m^3 per day by a CSA certified concrete testing laboratory.

6.0 PAVEMENT DESIGNS

All the soil depositions located above the pavements' designated working sub-grade elevation, as designated by the project's forthcoming civil engineering consultant, shall be stripped and then transported off of the site. In addition, all the deleterious soil encountered at or below the project's recommended working sub-grade elevation, if any, shall also be excavated and then transported off of the site. Next, prior to placing the proposed pavement structures' granular sub-base and base courses, the in-situ, primarily fine-grained silty clay

possibly fill, with a high plasticity index, located at or below the working sub-grade elevation, shall then be proof-rolled using a sheepsfoot roller until it has at least 95 % of its standard proctor density (SPD). Areas failing the aforementioned proof-roll test and any other deleterious material encountered at or below the working sub-grade elevation shall be verified and documented by the geotechnical engineer's personnel. Predicated upon this consultant's recommendations, the project's pavement sub-contractor shall then excavate and replace the documented failed proof-rolled soil and any other deleterious material encountered at or below the working sub-grade elevation with 100 mm or 50 mm down crushed limestone fill or another pre-approved equivalent bridging material placed in sufficient 200 mm deep lifts and compacted until each layer has at least 95 % of its SPD.

Next, any segments of the proposed pavement areas naturally lower than the proposed sub-grade elevation, if any, shall then be brought up to the working sub-grade elevation implementing either a highly plastic silty clay; 100 mm or 50 mm down crushed limestone fill; granular C-Base fill or another pre-approved equivalent bridging material, placed in sufficient 200 mm deep lifts and compacted until each layer has at least 95 % of its SPD.

In order to provide adequate structural support in areas designated for heavy truck traffic, concrete plaza's and sidewalks' concrete slabs, their sub-bases shall consist of at least two layers of 50 mm down crushed limestone fill, C-Base fill or another pre-approved equivalent material placed in 150 mm deep lifts and compacted until each layer has at least 98 % of its SPD. However, only one lift of granular sub-base is structurally required for the light car traffic's pavement construction. Alternatively, in all traffic areas, the granular base course shall be composed of a 150 mm deep layer of A-Base, compacted until it has at least 100 % of its SPD. Finally, the light car traffic's asphalt pavement shall be laid in two layers with each lift having a minimum thickness of 32 mm. Similarly, areas with heavier truck traffic shall have 2 - 45 mm lifts of asphalt pavement. Each asphalt pavement area shall be consolidated until it has at least 98 % of its respective laboratory Marshall Density. An elevation drawing of the car and heavy truck traffic's pavement structures is illustrated on page 31 of this report.

The plaza's and sidewalks' concrete slab shall have a design thickness of 150 mm, overlying its aforementioned granular base's structural support, and an air-entrainment, slump and water cement ratio in accordance with all the relevant CSA standards in A23.1-04.

The asphalt aggregate shall have a crushed count of >60%. The asphalt shall be placed at a temperature of 125°C to 155°C. The ambient temperature may be no less than 6°C when the asphalt is to be laid. The geotechnical engineer's personnel shall test the asphalt of the following aggregate gradation specifications and physical properties.

METRIC SIEVE SIZE (microns)	(% Passing)
16,000	100
10,000	70 – 85
5,000	55 – 70
2,500	40 – 60
1,250	25 – 50
630	15 – 40
315	5 – 20
160	4 – 11
80	3 – 7

Asphalt Cement, % total sample weight	5.0 % - 6.0 %
Voids in Mineral Aggregate	14% minimum
Air Voids	3.0% - 5.0%
Marshall Stability, N at 60° C	7 kN minimum
Flow Index, units of 250 µm	6.0 – 16.0

The pavement's slope and catch basin placement should be designed by the project's municipal engineering consultant. Currently, the writer has not been provided the proposed municipal site plan indicating the proposed cut and fill depths. Ultimately, however, this office should be contacted of any proposed change to the aforementioned range of working sub-grade elevations. Finally, the slope of the pavement, at a minimum, should be sufficiently graded at 2 % for expedient drainage into catch basins or towards the perimeter of the site.

7.0 LATERAL EARTH PRESSURE

Typically, new structures, such as, the one proposed for this site, have all of their below grade walls rigidly designed and constructed. Therefore, the "at-rest" earth pressures (K_o) will apply for all cases on this project. The distribution of the lateral earth pressures are dependent upon the following key factors; backfill type, compaction effort and drainage

conditions. As such, the following two equations should be used for the calculation of the lateral earth pressures where sub-drainage is provided and not provided, respectively.

Sub-drainage provided

$P_h = K_o \gamma H$

where:
P_h = lateral earth pressure at any depth (psf)
K_o = earth pressure coefficient
γ = unit weight of the soil (pcf)
H = height of the wall in (ft.)

Sub-drainage not provided

$P_h = K_o \gamma' H + \gamma_w H$

where:
P_h = lateral earth pressure at any depth (psf)
K_o = earth pressure coefficient
γ' = buoyant unit weight of the soil (pcf)
γ_w = unit weight of water (pcf)
H = height of the wall in (ft.)

If the sub-grade located adjacent to the structure is utilized to support a surface concrete slab on grade or any pavement structures, 98% - 100% of its SPD (well compacted) will be required and therefore the following K_o values listed in the table below should be used.

COMPACTION SPEC. & SOIL TYPE	K_o	TOTAL UNIT WEIGHT (pcf)
98% - 100% of its SPD (Sands & Gravels)	0.43	145
98% - 100% of its SPD (Silty Clays)	0.58	110

When the sub-grade soils compaction is required to be in the range of 90% - 95% of its SPD (moderate compaction) then the following table of K_o values should be implemented.

COMPACTION SPEC. & SOIL TYPE	K_o	TOTAL UNIT WEIGHT (pcf)
90% - 95% of its SPD (Sands & Gravels)	0.55	135
90% - 95% of its SPD (Silty Clays)	0.71	100

If surcharge loadings (i.e. line loads and point loads) are to be incorporated into this projects design then the figure located on page 32, obtained from the Canadian Engineering Foundation Manual, should be used to determine their associated respective lateral pressures on the rigidly structurally designed member. For a uniformly distributed surcharge load, the lateral earth pressure is simply determined by multiplying the load by the aforementioned applicable K_o factor. In addition, for the soils that require 98% - 100% of their SPD (well compacted), the size and type of compaction equipment used to compact the backfill induces additional lateral earth pressures. Therefore, in order to calculate the lateral earth pressures caused by the compaction equipment, a design chart has been provided on page 33 of this report. In addition, it still may also be necessary to provide temporary bracing of the wall during construction in order to resist those lateral earth pressures associated with the compaction equipment.

Alternatively, if the sub-grade located adjacent to the crawlspace is not required to support surface concrete slab on grade or pavement structures, then the standard triangular earth pressure distribution should be used for design purposes.

8.0 RECOMMENDATIONS

Predicated upon the soils' aforementioned respective strength parameters, lithology and physical properties, the current and modeled groundwater elevations, the field and laboratory test data, and the proposed one-storey, steel-frame, 14,000 ft^2, structure's anticipated moderate applied foundation stresses, drilled cast in place concrete friction piles, drilled spread bore concrete end-bearing piles or driven pre-cast concrete end-bearing piles could be implemented as the foundation design for the proposed Bill & Helen Norrie Library to be located at 25 Poseidon Bay in Winnipeg, Manitoba. Based upon the aforementioned advantages and disadvantages of these foundation systems, a driven pre-cast concrete end-bearing piled foundation design would likely be a well performing, more economical and efficient one for the proposed one-storey, moderately-loaded, 14,000 ft^2, structure placed on a site with the aforementioned geotechnical design parameters and implemented in a heated

service condition. Alternatively, MBA recommends that the wooden deck's foundation type should be installed implementing a spread bore concrete piled foundation type. However, the choice of foundation type implemented for this project will ultimately depend upon their respective, previously described, advantages and disadvantages, estimated installation costs and the applied foundation loads that will be calculated by the project's structural engineering consultant.

It is recommended in the strongest of terms that the geotechnical engineer's personnel inspect the installation of all the foundation elements in order to verify that they all conform with the contents of this report, the structural drawings and the project's specifications.

Any areas of the yard naturally lower in elevation, if any, shall be brought up to its future grade implementing a highly plastic silty clay fill, 50 mm down limestone fill, granular C-Base fill or another pre-approved equivalent material, placed in sufficient 200 mm deep lifts and compacted until each layer has at least 95 % of its SPD.

The backfill material around the perimeter of the proposed structure shall be brought up to its future grade implementing either a 20 mm down limestone fill; granular C-Base fill; or another pre-approved equivalent material, placed in sufficient 150 mm deep lifts and compacted until each layer has densities in the range of 92 % to 97 % of its SPD.

All the various proposed concrete and asphalt pavement surfaces shall be constructed as per the recommendations outlined in section 6.0 of this report. Furthermore, the pavement contractor shall also take precautions to prevent the fine-grained sub-grade soil from the following conditions; freezing, excessive soil moisture loss or gain, water ponding and heavily loaded axle traffic. In addition, the granular fill placed for this project shall be free of frost, frozen material and placed at an ambient air temperature of at least 6° Celsius. In order to verify compliance with the aforementioned standard proctor and Marshall Density specifications, field compaction tests shall be taken on every lift of granular material and asphalt placed for this project, respectively. All concrete poured shall be tested in

accordance with CSA A23.1-04 every day and at least once every 50 m^3 per day by a CSA Certified concrete testing laboratory.

The selected 50 mm down and 20 mm down crushed limestone, A-Base and C-Base gravels implemented for this project shall all meet the following gradation specifications:

METRIC SIEVE SIZE (µm)	20 mm Limestone (% Passing)	50 mm Limestone (% Passing)	A-BASE (% Passing)	C-BASE (% Passing)
50,000		100		
25,000			100	100
20,000	100		80 – 100	
5,000	40 – 70	25 – 80	40 – 70	25 – 80
2,500	25 – 60		25 – 55	
315	8 - 25		13 – 30	
80	6 - 17	5 – 18	5 – 15	5 – 18

In order to minimize frost penetration under the building, 50 mm thick rigid horizontal insulation, or another pre-approved equivalent frost protection, shall be placed around the structure's entire exterior. This insulation shall be placed along the faces of the proposed building out to a distance 1200 mm away from it at a depth of 300 mm below future ground elevation and also along the outside faces of the structure's exterior concrete grade beams.

The proposed structure shall have properly designed and installed weeping tile drainage system connected to sump pit(s) with operational sump pump(s), in accordance with the National Building Code of Canada (NBCC) and the City of Winnipeg Building Code. In addition, the building's superstructure shall all be entirely structurally supported by only one of the aforementioned approved foundation systems. In all the aforementioned feasible piled foundation designs, a void space, of at least 300 mm in thickness, shall be constructed under the concrete walls, pile caps and grade beams to allow for the potential expansive and rebound capabilities of the alluvial and glaciolacustrine deposited, very stiff, silty clays underlying this site. The structurally supported concrete main floor shall overlay either a minimum 750 mm deep vented crawlspace or a minimum 300 mm thick biodegradable void

form. The surface of any crawlspace shall be covered by a minimum 100 mm deep layer of clean sand fill overlying a 6 mm thick impervious poly vapour barrier. Lastly, the writer understands that a crawl space is intended for the proposed structure.

Since an underground crawlspace is intended underlying the proposed structure, its associated lateral earth pressures should be calculated as per section 7.0 of this report. Furthermore, the proposed crawlspace's excavation and shoring should, at a minimum, comply with all the Manitoba Department's Workplace Health and Safety guidelines for confined underground work and be designed by the project's structural engineering consultant, respectively. Their respective constructions should then proceed as per those standards and the project's sealed drawings and specifications.

If any of the aforementioned design elements are modified or deleted, please contact the undersigned to determine if that course of action will be acceptable.

In addition, MBA respectfully requests an opportunity to review all the relevant finalized structural drawings and the project's foundation and materials testing specifications for this project in order to verify their conformance with the contents of this report.

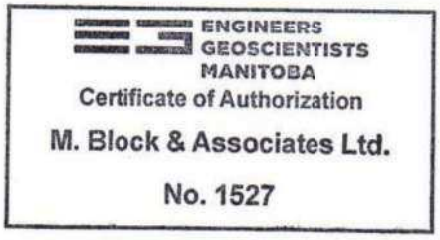
The test holes drilled during the investigation represent only those specific areas tested. The soil conditions on this site may vary from that described in this report. Should that situation occur, please contact this office for further instructions.

All the geotechnical engineering design recommendations presented in this report are predicated upon the assumption that a sufficient degree of inspection will be provided during the project's construction and that a qualified and experienced foundation contractor properly installs an aforementioned pre-approved, engineered and sealed foundation type.

Any uses which a third party makes of this report, or any reliance on decisions to be made based on it, are the sole responsibility of such third parties. MBA accepts no responsibility

for damages, if any, suffered by any third party as a result of decisions made or actions based upon this report.

Yours Truly,
M. Block & Associates Ltd.



Jeffrey Block, P. Eng., Senior Geotechnical Engineer

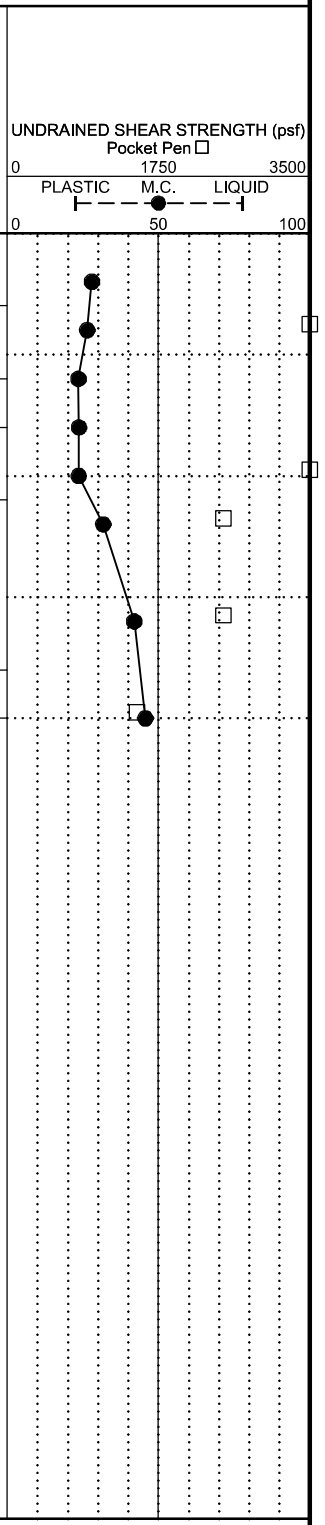
M. Block & Associates Ltd.
2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

TEST HOLE NO.: 1

Sheet 1 of 1

Client:	The City of Winnipeg	Job No.:	2018-1842	Logged By:	J. Block, P. Eng.
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library			Reviewed By:	J. Block, P. Eng.
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation:	99.05m	Drawing Number:	5883

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0		1	FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		2	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		3	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		4	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
5.0		5	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
		6			7' - Brown dry SILT lens
7.5		7	CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		8			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

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2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
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Fax: (204)-339-7976

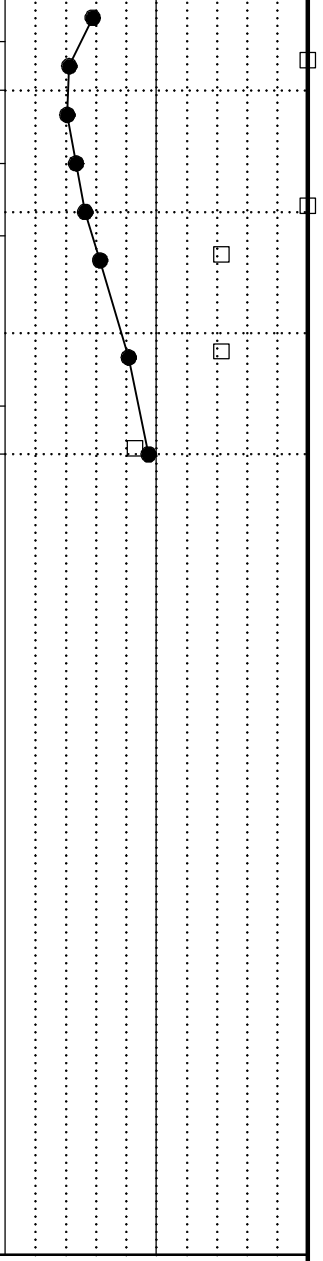
TEST HOLE NO.: 2

Sheet 1 of 1

Client:	The City of Winnipeg	Job No.:	2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library			Reviewed By: J. Block, P. Eng.	Time: 9:15 AM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation:	99.10m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0		9	FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		10	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		11	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		12	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
5.0		13			
		14	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions 6' - Brown dry SILT lens
7.5		15			
			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		16			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					

UNDRAINED SHEAR STRENGTH (psf)
Pocket Pen ☐
0 1750 3500
PLASTIC M.C. LIQUID
0 50 100



SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

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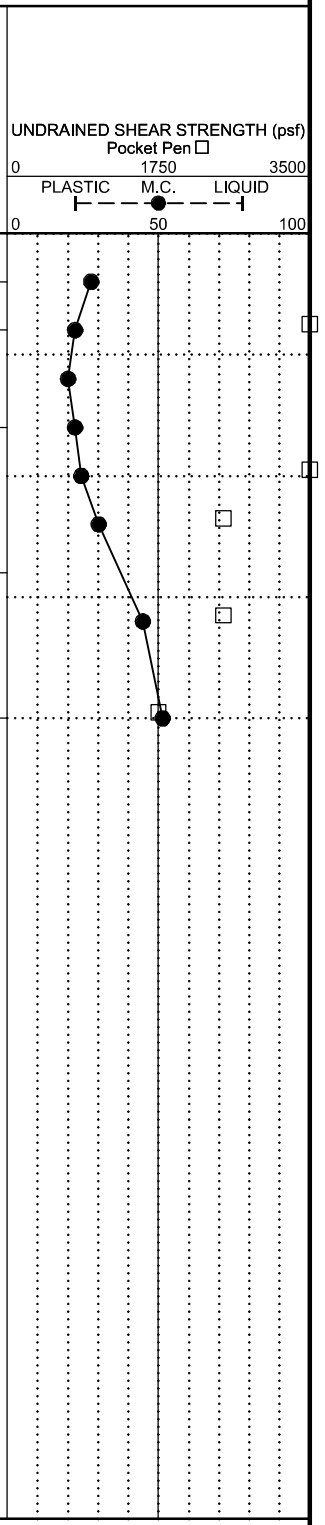
TEST HOLE NO.: 3

Sheet 1 of 1

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 9:30 AM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation: 99.13m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		17	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
		18			
2.5			CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		19			
		20	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
5.0		21			
		22			
7.5			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
		23			
10.0		24			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

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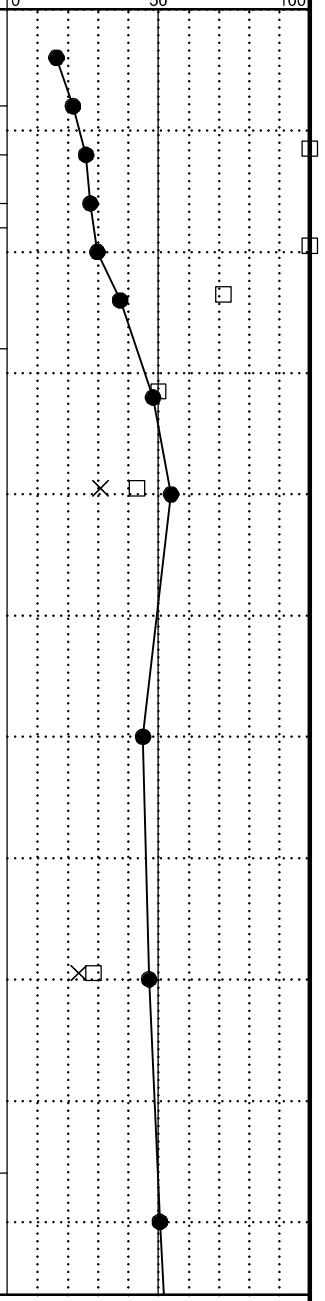
TEST HOLE NO.: 4

Sheet 1 of 2

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 9:45 AM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation: 99.11m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0		25	FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		26			
2.5		27	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
		28	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
			CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
5.0		29	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
		30			6' - Brown dry SILT lens
7.5		31	CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		32			
12.5					
15.0		33			
17.5					
20.0		34			
22.5					
	▽		CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions
25.0		35			

UNDRAINED SHEAR STRENGTH (psf)
Pocket Pen ☐ Vane Shear ✕
0 1750 3500
PLASTIC M.C. LIQUID
0 50 100



Continued Next Page

SAMPLE TYPE SYMBOLS

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- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

▽ Phreatic Surface #1: 24.0 ft

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

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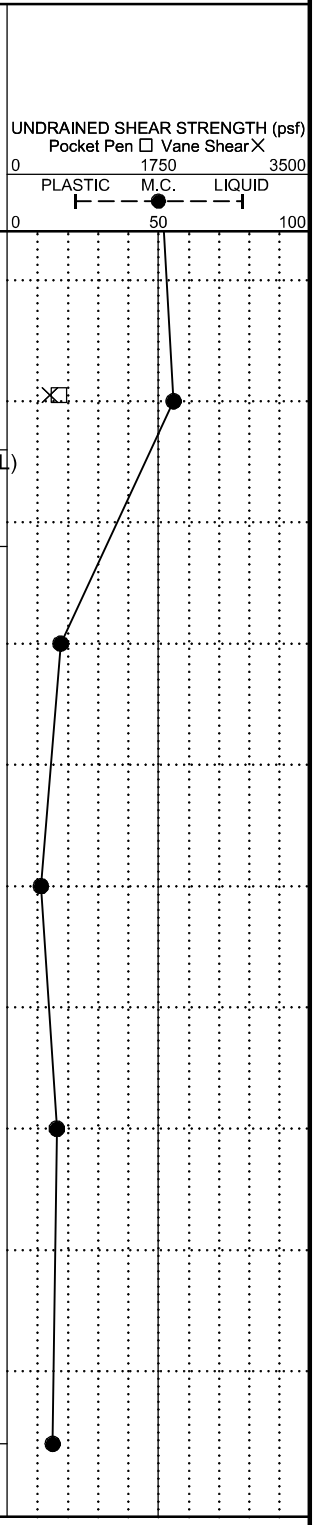
TEST HOLE NO.: 4

Sheet 2 of 2

Client:	The City of Winnipeg		Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date:	30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library			Reviewed By:	J. Block, P. Eng.	Time:	9:45 AM
Location:	25 Poseidon Bay, Winnipeg, Manitoba		Elevation: 99.11m	Drawing Number:	5883		

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
27.5			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions *(continued)*
30.0		36			
			CL		Grey, soft, wet, sandy clayey SILT with potential cobbles and boulders (GLACIAL TILL)
32.5			CL-ML		Grey, soft, saturated, compact, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
35.0		37			
37.5					
40.0		38			
42.5					
45.0		39			
47.5					
50.0					
		40			51'6" - Auger refusal on suspected fractured LIMESTONE BEDROCK;
52.5					- Upon completion, the groundwater & sloughed soil was measured at the 24' and 50' depths, respectively



SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

▽ Phreatic Surface #1: 24.0 ft

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

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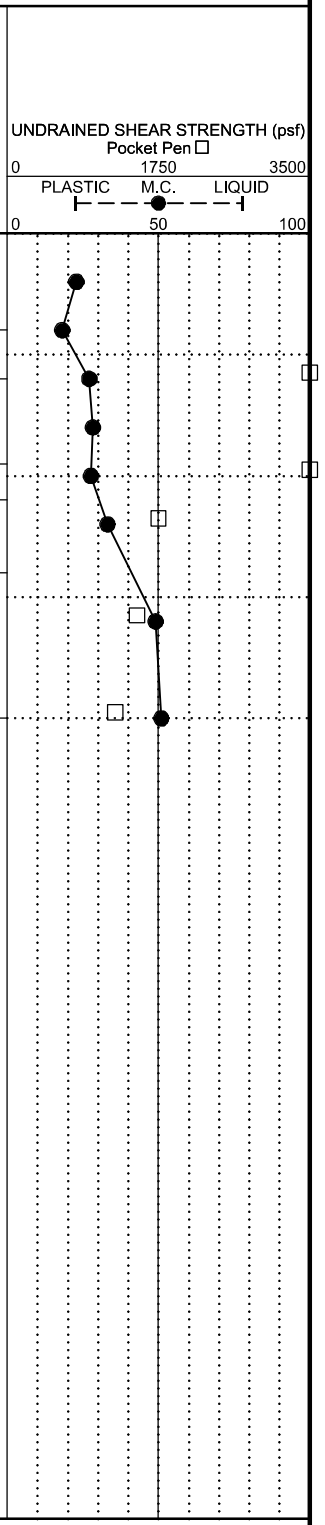
TEST HOLE NO.: 5

Sheet 1 of 1

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 11:00 AM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation: 99.12m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		41			
		42			
2.5			CH		Black, alluvially deposited, very stiff, damp, silty CLAY
		43			
			CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		44			
5.0		45	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
		46	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions 6' - Brown dry SILT lens
7.5			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
		47			
10.0		48			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

M. Block & Associates Ltd.
2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

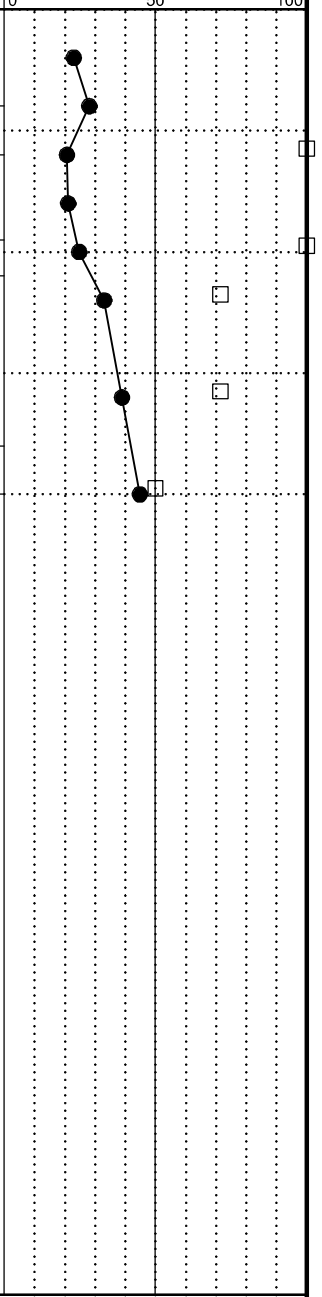
TEST HOLE NO.: 6

Sheet 1 of 1

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 11:15 AM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation: 99.18m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		49			
		50			
2.5			CH		Black, alluvially deposited, very stiff, damp, silty CLAY
		51			
			CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		52			
5.0		53	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
		54	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
7.5		55			
			CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		56			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					

UNDRAINED SHEAR STRENGTH (psf)
Pocket Pen ☐
0 1750 3500
PLASTIC M.C. LIQUID
0 50 100



SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

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Winnipeg, Manitoba, R2V 4P6
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Fax: (204)-339-7976

TEST HOLE NO.: 7

Sheet 1 of 2

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 11:30 AM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation: 99.19m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0		57	FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		58	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		59	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
		60	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
5.0		61	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
		62			
7.5		63			
		64	CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0					
12.5					
15.0		65			
17.5					
20.0		66			
22.5			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions
25.0		67			

UNDRAINED SHEAR STRENGTH (psf)
Pocket Pen ☐ Vane Shear ✕
0 1750 3500
PLASTIC M.C. LIQUID
0 50 100

Continued Next Page

SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

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Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

TEST HOLE NO.: 7

Sheet 2 of 2

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 11:30 AM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation: 99.19m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	USCS	Graphic Log	MATERIAL DESCRIPTION
27.5			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions *(continued)*
30.0		68			
32.5			CL		Grey, soft, wet, sandy clayey SILT with potential cobbles and boulders (GLACIAL TILL)
35.0		69	CL-ML		Grey, stiff, moist, compact, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
37.5					
40.0		70			
42.5					
45.0		71	CL-ML		Grey, hard, dry, very dense, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
47.5					45' - Auger refusal on suspected boulder; - No groundwater seepage and/or soil sloughing in test hole
50.0					
52.5					

UNDRAINED SHEAR STRENGTH (psf)
Pocket Pen ☐ Vane Shear ✕
0 1750 3500
PLASTIC M.C. LIQUID
0 50 100

SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

M. Block & Associates Ltd.
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Winnipeg, Manitoba, R2V 4P6
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Fax: (204)-339-7976

TEST HOLE NO.: 8

Sheet 1 of 2

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 12:45 PM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation: 99.19m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	USCS	Graphic Log	MATERIAL DESCRIPTION
0.0			FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		72	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
		73	ML		Brown, alluvially deposited, powdery dry, SILT
2.5		74			
		75			
5.0		76	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
		77	ML		Brown, alluvially deposited, soft, wet, SILT
7.5		78	CH		Brown, glaciolacustrine, stiff, moist, silty CLAY with silt and gypsum inclusions
10.0		79			
12.5					
15.0		80			
17.5					
20.0		81	CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions
22.5					
25.0		82			

UNDRAINED SHEAR STRENGTH (psf)
Pocket Pen □ Vane Shear ×
0 1750 3500
PLASTIC M.C. LIQUID
0 50 100

Continued Next Page

SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

M. Block & Associates Ltd.
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Winnipeg, Manitoba, R2V 4P6
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Fax: (204)-339-7976

TEST HOLE NO.: 8

Sheet 2 of 2

Client:	The City of Winnipeg	Job No.:	2018-1842	Logged By: J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library			Reviewed By: J. Block, P. Eng.	Time: 12:45 PM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation:	99.19m	Drawing Number: 5883	

Depth, ft	Sample Type	Sample Number	USCS	Graphic Log	MATERIAL DESCRIPTION
27.5			CH		Grey, glaciolacustrine, stiff to firm, moist, silty CLAY with silt inclusions *(continued)*
30.0		83			
			CL		Grey, soft, wet, sandy clayey SILT with potential cobbles and boulders (GLACIAL TILL)
32.5			CL-ML		Grey, stiff, moist, compact, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
35.0		84			
37.5					
			CL-ML		Grey, hard, dry, very dense, gravelly sandy SILT with cobbles and boulders (GLACIAL TILL)
40.0		85			40'6" - Auger refusal on suspected boulder; - No groundwater seepage and/or soil sloughing in test hole
42.5					
45.0					
47.5					
50.0					
52.5					

UNDRAINED SHEAR STRENGTH (psf)
Pocket Pen ☐ Vane Shear ✕
0 1750 3500

PLASTIC M.C. LIQUID
0 50 100

SAMPLE TYPE SYMBOLS

- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig	**WATER LEVELS**
Auger:	5" dia. continuous flight augers	No Ground Water Encountered
Contractor:	Maple Leaf Drilling Ltd.	

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18

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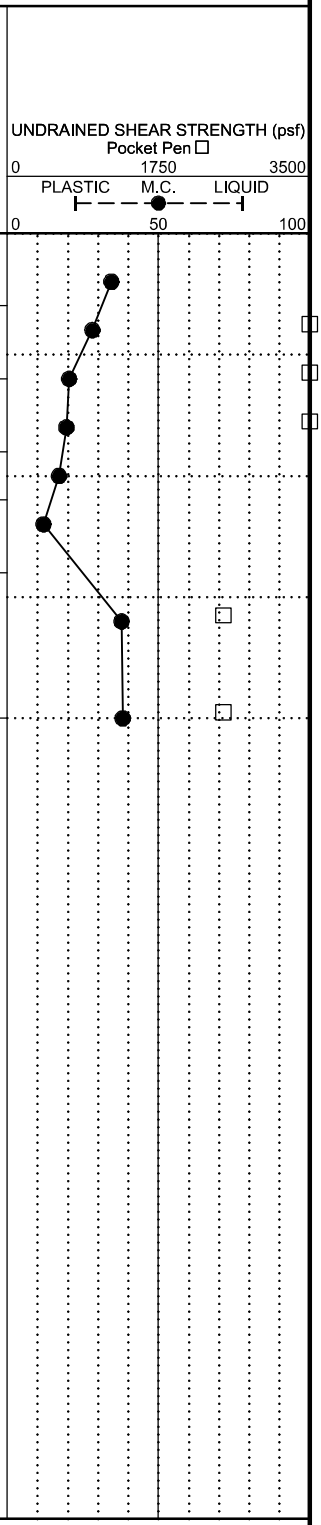
Fax: (204)-339-7976

TEST HOLE NO.: 9

Sheet 1 of 1

Client:	The City of Winnipeg	Job No.: 2018-1842	Logged By:	J. Block, P. Eng.	Date: 30/10/18
Project:	One-storey, steel-frame, 14,000 sq. ft. Norrie Library		Reviewed By:	J. Block, P. Eng.	Time: 2:00 PM
Location:	25 Poseidon Bay, Winnipeg, Manitoba	Elevation: 99.07m	Drawing Number:	5883	

Depth, ft	Sample Type	Sample Number	U S C S	Graphic Log	MATERIAL DESCRIPTION
0.0		86	FILL		Black,grey/brown, very stiff, damp, silty CLAY FILL
		87	CH		Black, alluvially deposited, very stiff, damp, silty CLAY
2.5		88			
		89	CH		Grey, alluvially deposited, very stiff, damp, silty CLAY
5.0		90	CH		Brown, alluvially deposited, very stiff, damp, silty CLAY
		91	ML		Brown, alluvially deposited, powdery dry, SILT
7.5		92	CH		Brown, glaciolacustrine, very stiff, damp, silty CLAY with silt and gypsum inclusions
10.0		93			10' - End of test hole; - No groundwater and/or soil sloughing in test hole
12.5					
15.0					
17.5					
20.0					
22.5					
25.0					



SAMPLE TYPE SYMBOLS

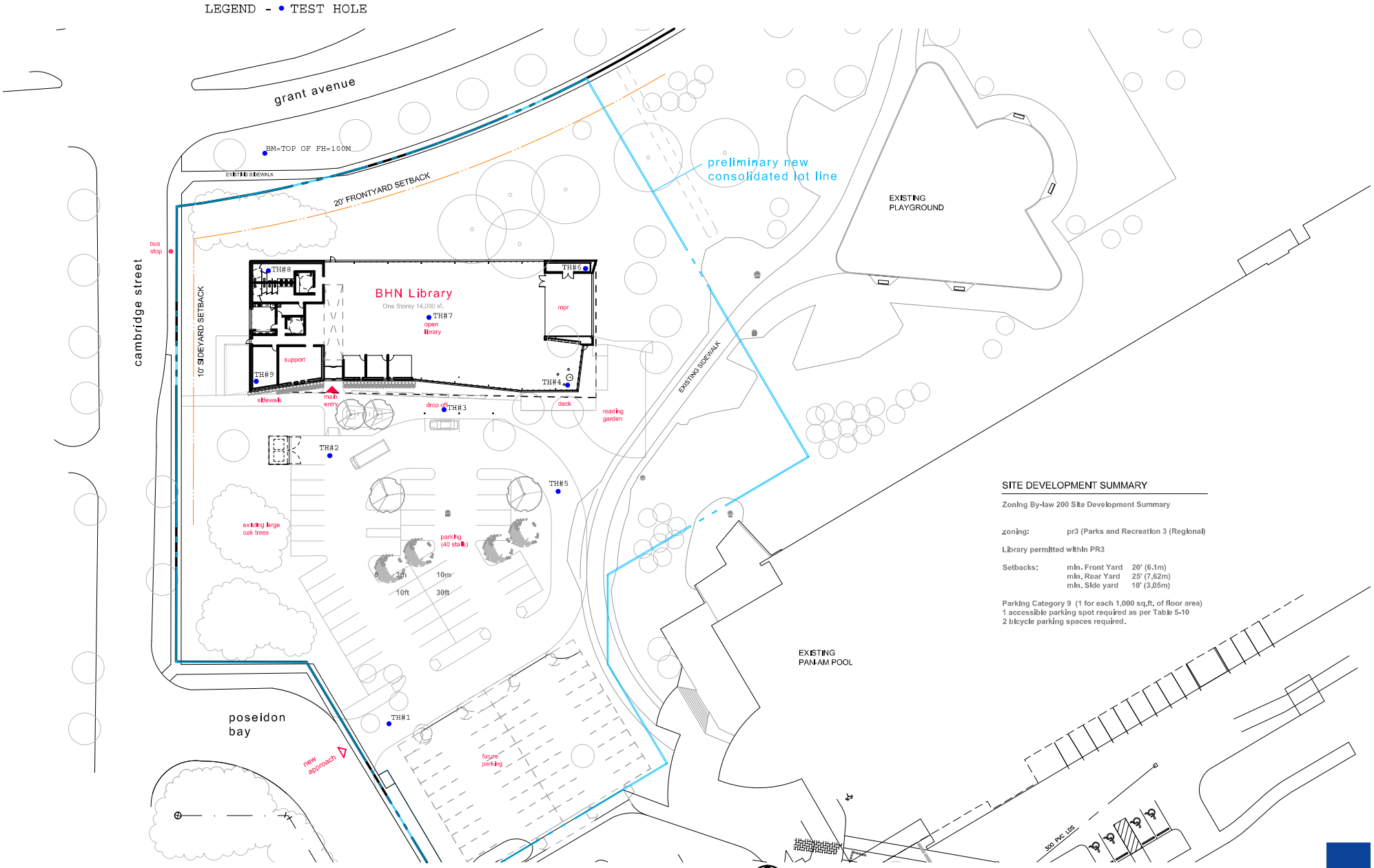
- Split Spoon
- Shelby Tube
- Vane Shear
- Auger Cuttings
- Grab Sample
- Rock Core

Drill Rig:	Track-mounted Acker drill rig
Auger:	5" dia. continuous flight augers
Contractor:	Maple Leaf Drilling Ltd.

WATER LEVELS

No Ground Water Encountered

TEST HOLE LOG 2018-1842-CITY OF WINNIPEG-NORRIE LIBRARY.GPJ M BLOCK ASSOC.GDT 8/11/18



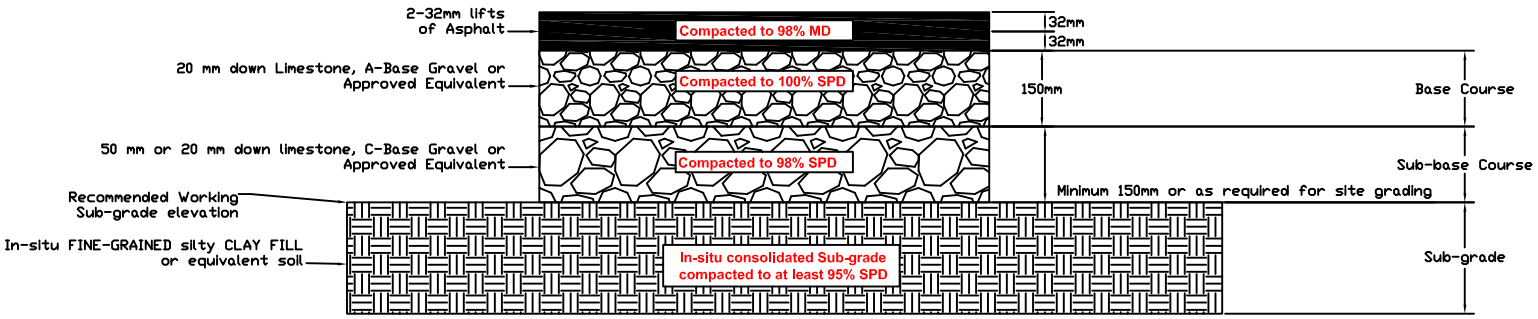
City of Winnipeg - Bill and Helen Norrie Library - Preliminary Building Location Plan

scale 1:600

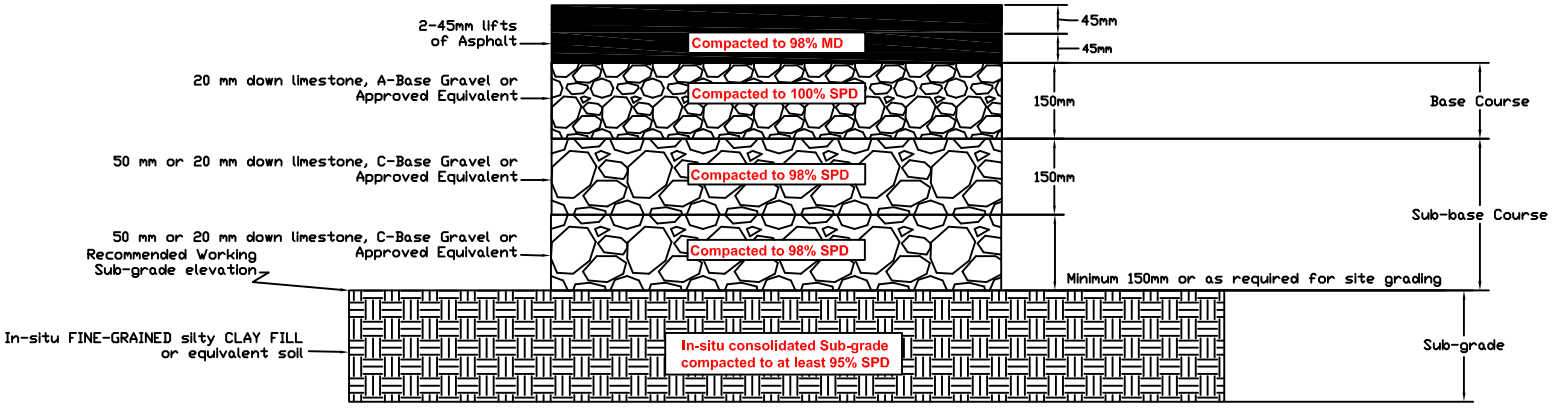
october 17, 2018

PAVEMENT DETAILS

Car Traffic Areas



Truck Traffic Areas



M. Block & Associates Ltd.
2484 Ferrier Street
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R2V 4P6
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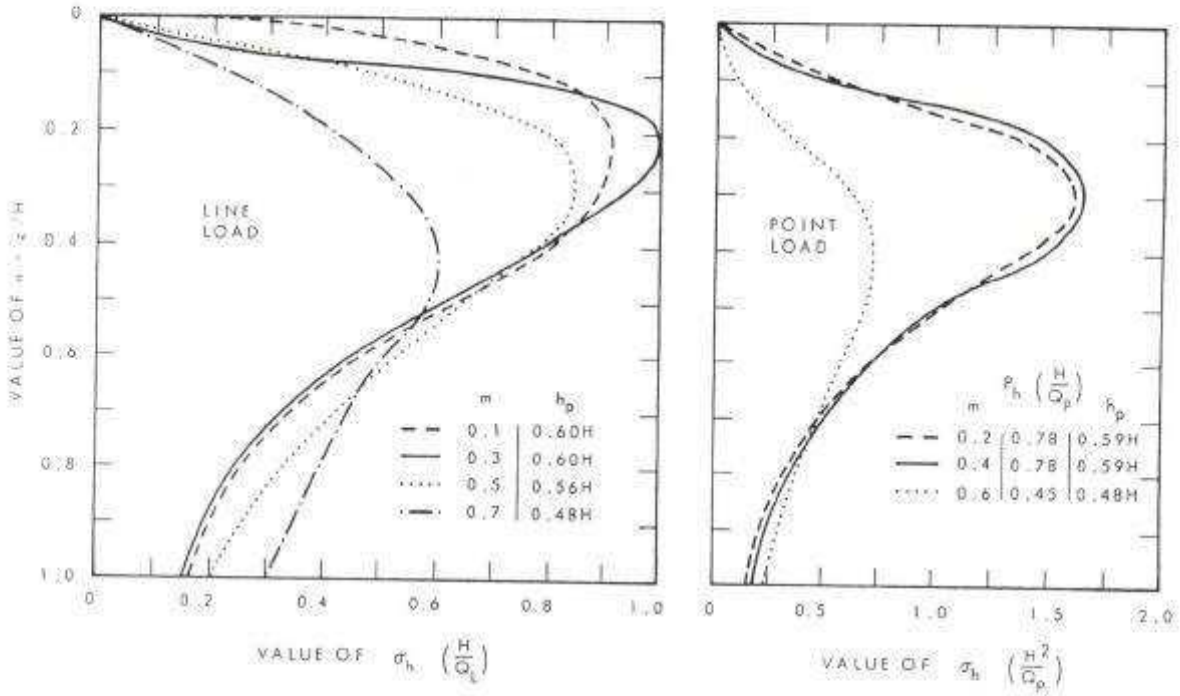
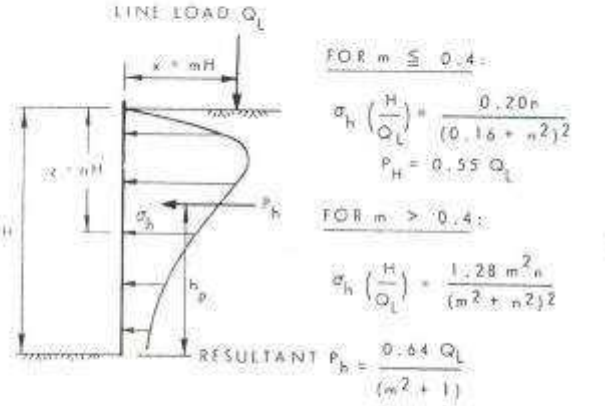
Drawing: PAVEMENTS' STRUCTURES
Drawn By: TG/JB
Reviewed By: J. Block, P. Eng.

Project: Bill & Helen Norrie Library in Winnipeg
Project Number: 2018-1842
Drawing Number: 5883





FOR $m \leq 0.4$:

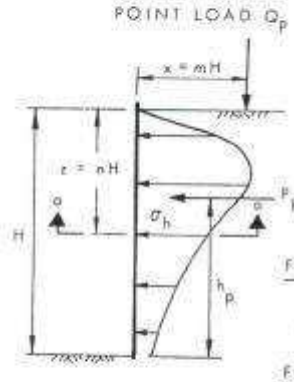
$$\sigma_h\left(\frac{H}{Q_L}\right) = \frac{0.20n}{(0.16+n^2)^2}$$

$$P_H = 0.55\,Q_L$$

FOR $m > 0.4$:

$$\sigma_h\left(\frac{H}{Q_L}\right) = \frac{1.28\,m^2 n}{(m^2+n^2)^2}$$

PRESSURES FROM LINE LOAD Q_L
(BOUSSINESQ EQUATION MODIFIED BY EXPERIMENT)



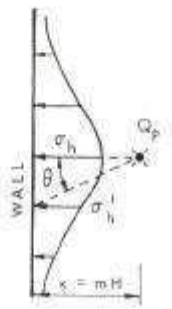
FOR $m \leq 0.4$:

$$\sigma_h\left(\frac{H^2}{Q_p}\right) = \frac{0.28n^2}{(0.16+n^2)^3}$$

FOR $m > 0.4$:

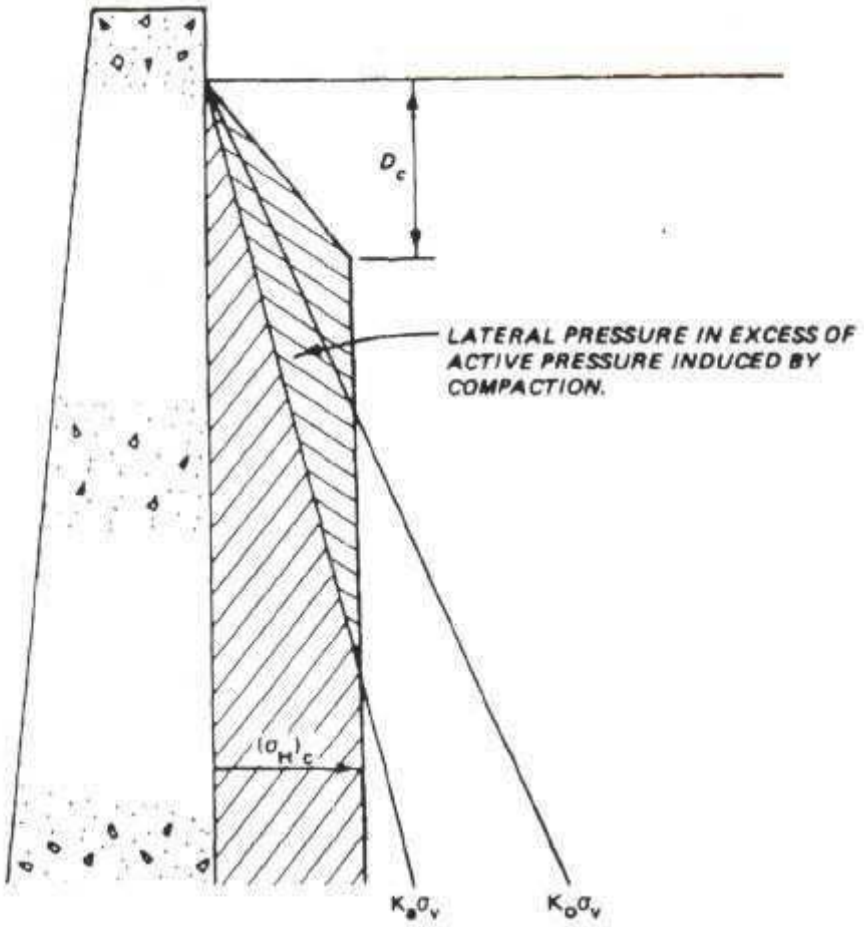
$$\sigma_h\left(\frac{H^2}{Q_p}\right) = \frac{1.77\,m^2 n^2}{(m^2+n^2)^3}$$

$$\sigma_h' = \sigma_h \cos^2(1.1\,\theta)$$



SECTION a - a
PRESSURES FROM POINT LOAD Q_p
(BOUSSINESQ EQUATION MODIFIED BY EXPERIMENT)

Figure 25.5: Horizontal pressures on a wall due to point and line load surcharges.



COMPACTION EQUIPMENT	CRITICAL DEPTH, D_c, ft	$(\sigma_H)_c$ psf
10-TON SMOOTH WHEEL ROLLER	1.9	420
3.2-TON VIBRATORY ROLLER	1.7	400
1.4-TON VIBRATORY ROLLER	1.2	260
400-KG VIBRATORY PLATE	1.5	340
120-KG VIBRATORY PLATE	1.0	240

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
1	1.0							28.0			
1	2.0							26.4			
1	3.0							23.5			
1	4.0							23.7			
1	5.0							23.6			
1	6.0							31.7			
1	8.0							42.0			
1	10.0							45.7			
2	1.0							28.9			
2	2.0							21.2			
2	3.0							20.5			
2	4.0							23.4			
2	5.0							26.4			
2	6.0							31.3			
2	8.0							40.8			
2	10.0							47.4			
3	1.0							27.8			
3	2.0							22.4			
3	3.0							20.1			
3	4.0							22.4			
3	5.0							24.5			
3	6.0							30.2			
3	8.0							44.9			
3	10.0							51.4			
4	1.0							16.2			
4	2.0							21.7			
4	3.0							26.1			
4	4.0							27.4			
4	5.0							29.8			
4	6.0							37.3			
4	8.0							48.2			
4	10.0							54.1			
4	15.0							44.9			
4	20.0							46.9			
4	25.0							50.4			
4	30.0							55.0			
4	35.0							17.6			
4	40.0							11.1			
4	45.0							16.4			
4	51.5							15.0			
5	1.0							22.8			
5	2.0							18.1			
5	3.0							27.1			

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Fax: (204)-339-7976

Summary of Laboratory Results

Client: The City of Winnipeg
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library
Location: 25 Poseidon Bay, Winnipeg, Manitoba
Number: 2018-1842

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
5	4.0							28.3			
5	5.0							27.6			
5	6.0							33.1			
5	8.0							49.0			
5	10.0							50.9			
6	1.0							23.0			
6	2.0							28.1			
6	3.0							20.7			
6	4.0							21.1			
6	5.0							24.8			
6	6.0							33.0			
6	8.0							38.9			
6	10.0							44.8			
7	1.0							14.9			
7	2.0							19.7			
7	3.0							21.2			
7	4.0							22.0			
7	5.0							24.8			
7	6.0							34.0			
7	8.0							40.9			
7	10.0							47.8			
7	15.0							52.5			
7	20.0							53.9			
7	25.0							50.0			
7	30.0							42.7			
7	35.0							11.4			
7	40.0							13.0			
7	45.0							8.1			
8	1.0							29.6			
8	2.0							20.3			
8	3.0							18.2			
8	4.0							21.8			
8	5.0							19.6			
8	6.0							43.6			
8	8.0							19.9			
8	10.0							53.5			
8	15.0							48.5			
8	20.0							52.0			
8	25.0							52.1			
8	30.0							59.1			
8	35.0							9.9			
8	40.5							9.5			
9	1.0							34.4			

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Summary of Laboratory Results

Client: The City of Winnipeg
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library
Location: 25 Poseidon Bay, Winnipeg, Manitoba
Number: 2018-1842

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
9	2.0							28.1			
9	3.0							20.4			
9	4.0							19.5			
9	5.0							17.1			
9	6.0							12.0			
9	8.0							37.8			
9	10.0							38.2			

M. Block & Associates Ltd.
2484 Ferrier Street
Winnipeg, Manitoba, R2V 4P6
Telephone: (204)-334-5356
Fax: (204)-339-7976

Summary of Laboratory Results

Client: The City of Winnipeg
Project: One-storey, steel-frame, 14,000 sq. ft. Norrie Library
Location: 25 Poseidon Bay, Winnipeg, Manitoba
Number: 2018-1842

APPENDIX B

Observation Report by Tower Engineering, dated May 31, 2023.

OBSERVATION REPORT

Project Number: 181335
Doc No. *181335-S BAR*

To:	City of Winnipeg
Attention:	Tracy Stople
From:	Lisa Thomson
Project: Name:	Bill and Helen Norrie Library – Winnipeg, MB
Project Number:	181335
Issued Date:	May 31, 2023
Observation Date:	May 10, 2023
Discipline	Structural
Re:	Assessment – Exterior Deck

Introduction:

At the request of the City of Winnipeg, related to Warranty Work Order No. 035, Tower Engineering was to provide an assessment of the exterior deck at the above noted location. Lisa Thomson of Tower Engineering, along with Corey Greenham of LM Architectural Group with Gateway Construction present performed a site review of the exterior of the building on May 18, 2023.

The purpose of this review and report is to provide a general assessment of the conditions that may be causing the lifting/heaving of the at grade deck. Some decking boards were removed prior to the site to allow for review of the sub structure.

Limitations:

The review and assessment were based on visual examination of the area which could be examined. No performance testing, functional testing or operational checks were carried out. The complete framing was not visible, therefore, we cannot speak to any condition that may exist in areas that were covered or concealed.

History:

During construction (February 12, 2020) it was noted by the contractor the piling locations as shown on HTFC's drawings did not match the piling locations shown on the Structural drawings and RFI 012 was issued. Formal response to the RFI was provided on March 3, 2020. The number of piles was reduced from what was shown on the structural drawings and the deck framing was revised by HTFC in PCN 10 R1 which was issued June 23, 2020, and the Change Order (CWO No.14) was issued September 10, 2020. Deck framing shop drawings were provided September 4, 2020 and reviewed and returned by HTFC on September 8th, 2020 as reviewed. The shop drawing framing did not follow the framing shown in PCN 10 R1 specifically on the east end where the joists are running in the improper direction. The spacing of the joists is also noted as further spacing than what was shown in the PCN. It does not appear revised deck framing shop drawings were provided to match CWO No.14.

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P 204-925-1150

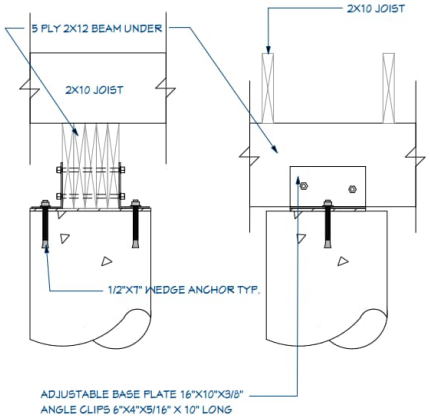
towereng.ca

Calgary Office
100-2139 4th Avenue NW, Calgary, AB T2N 0N6
P 403-235-2655

Site Observations:

It was noted that the deck had heaved significantly on the east end of deck. From what could be seen on site it appears that the construction of the deck follows what is shown on the original shop drawings (and not CWO No.14) in general with some noted discrepancies;

- It was noted that the connection between the piles and built-up beams does not match what was shown on the shop drawings. The beam is to be sitting directly on the piles with 2 angles framing on either side of the beam connected to the pile. On site it was noted one of the angles is turned to be under the beam so the beam does not have full bearing as it is sitting on top of the bolt or shimmed. In one location it appeared the beam was not bearing on anything as a large space was noted under the beam.



- Per the shop drawings the connection between the beam and pile was to have one anchor bolt on each side to connect the angle and pile. It was noted that only one angle was connected to the pile, and the other angle was not connected at all. This allows for the beam to rotate and lift if uplift soil pressure is applied. Also, there were gaps noted between the pile and the underside of the angle as well as the angle and beam. It also appeared that a square pile cap was poured on top of the pile which did not allow the beam to pile connection as per the shop drawings.

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The subgrade below the deck did not appear to have a slope as noted on the HTFC drawings and the beam was sitting directly on the subgrade in some locations. There should be minimum 6" space between the structure and the subgrade to avoid the soil from heaving against the beams and joists.

Compacted subgrade from below the patio stone area was noted to have settled below the plywood protection board and get under the deck.

It appeared that temporary framing of the deck was left in place.

Recommendations:

A 6" void should be maintained between the structure and the subgrade to prevent pressure from soil swelling during the freeze thaw cycle. The deck should be framed as per PCN 10R1 (CWO No. 14), the connections between the piles the beams should be done so that there is anchor connections on both sides on the beam and full bearing of the beam. All temporary framing should be removed, and the plywood protection board should be deep enough to prevent soil from settling from the patio area to under the deck.

A full engineering review of the site conditions should be completed once deck framing is removed, prior to reframing of the deck, including survey of top of pile/top of pilecap to ensure all site conditions are accounted for as previously designed connections may not work due to pile caps and other conditions that may vary from the drawings, as were noted during the visit.

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Prepared by:
Lisa Thomson, P.Eng.
Tower Engineering
2023-05-31

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APPENDIX C

KGS Group 2024 Test Hole Logs

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH24-01

CLIENT	**CITY OF WINNIPEG**	**PROJECT NO.**	24-0107-011
PROJECT	**Bill and Helen Norrie Library - Geotechnical Assessment**	**SURFACE ELEV.**	233.25 m
LOCATION	15 Poseidon Bay, Winnipeg, Manitoba	**START DATE**	11-15-2024
DESCRIPTION	South Side of Library Adjacent to Wood Decking Area	**UTM (m)**	N 5,524,175
DRILL RIG / HAMMER	Acker MP8 with Auto-Hammer		E 631,215 Zone 14
METHOD(S)	0.0 m to 15.2 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
233	0.0	0		**TOPSOIL FILL** - 305 mm, Black, damp, roots/wood fibres.	232.9						
				CLAY FILL - 204 mm, Greyish brown, damp, stiff, intermediate to high plasticity, trace sand, trace silt.	232.7			S1			
	1.0			**FAT CLAY (CH)** - Grey, moist, stiff, high plasticity, trace silt nodules. - LL=81, PL=37, PI=44 at 0.9 m. - PSA: 0% gravel, 1% sand, 9% silt, 90% clay at 0.9 m.				S2	54		
232		5			231.7						
				SILT (ML) - Light brown, moist, firm, low plasticity, some clay.	231.5			S3			
	2.0			**FAT CLAY (CH)** - Greyish brown, moist, stiff, high plasticity, trace silt nodules.				S4			
231								S5			
	3.0	10		- Firm from 3.2 m to 3.5 m. - Trace gypsum nodules below 3.4 m.							
230								S6			
	4.0			- ~25mm diameter gypsum pocket at 3.9 m. - ~25mm diameter gypsum pocket at 4.2 m.							
229		15									
	5.0							S7			
228				- Firm below 5.5 m.							
	6.0	20						S8			
227				- No gypsum below 6.1 m.							
	7.0										
226		25						S9			
	8.0										
225				- Trace fine gravel below 8.5 m.		▼					
	9.0	30						S10			
224				- Some silt till, light grey from 9.4 m to 9.8 m.				S11			
				CLAY TILL - Grey, moist, soft, intermediate to high plasticity, some medium to coarse sand, trace fine gravel.	223.5						
	10.0										
223								S12			

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS
▽ **During Drilling/Digging** 13.30 m
▼ **Upon Completion** 8.84 m

CONTRACTOR
Paddock Drilling

INSPECTOR
C. FRIESEN

APPROVED
T. ERNST

DATE
2-14-2025

KGS_LOG_U:\FMS\24-0107-011\15 POSEIDON BAY.GPJ

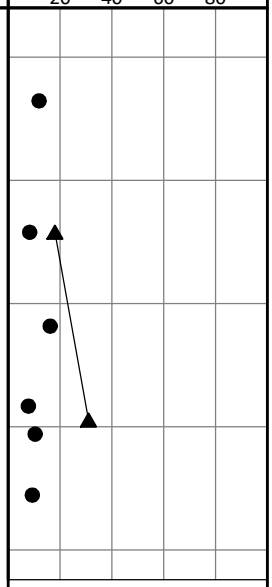
KGS GROUP

TEST HOLE LOG

HOLE NO.
TH24-01

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
222	11.0	35		**SILT TILL** - Light grey, moist, loose, some sand, some fine gravel, some clay.	222.6						
								S13			
221	12.0	40		- Compact below 12.2 m.				S14	78	5 7 11	18
220	13.0					▽		S15			
		45		- ~50mm thick sand and gravel layer, wet around 13.3 m. - Harder drilling, dense below 13.4 m. - Water encountered after drilling to 13.7 m. - ~230 mm thick poorly graded sand layer with gravel, wet, compact at 13.7 m. - Brown, damp to moist, dense, some sand, some gravel, some clay below 13.9 m.				S16a S16b	67	18 17 14	31
219	14.0										
								S17			
218	15.0	50			218.0						
217	16.0			Notes: 1. End of test hole at 15.2 m. 2. Test hole caved to 13.0 m upon completion of drilling/digging. 3. Test hole backfilled with auger cuttings and bentonite chips. An approximate 0.8 m of bentonite seal at surface.							
		55									
216	17.0										
215	18.0	60									
214	19.0										
		65									
213	20.0										
212	21.0	70									
211	22.0										
	23.0	75									

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80



WATER LEVELS
▽ **During Drilling/Digging** 13.30 m
▼ **Upon Completion** 8.84 m

CONTRACTOR
Paddock Drilling

INSPECTOR
C. FRIESEN

APPROVED
T. ERNST

DATE
2-14-2025

KGS_LOG_U:\FMS\24-0107-011\15 POSEIDON BAY.GPJ

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH24-02

CLIENT	**CITY OF WINNIPEG**	**PROJECT NO.**	24-0107-011
PROJECT	**Bill and Helen Norrie Library - Geotechnical Assessment**	**SURFACE ELEV.**	233.23 m
LOCATION	15 Poseidon Bay, Winnipeg, Manitoba	**START DATE**	11-15-2024
DESCRIPTION	~3 m East of Southeast Building Corner in Concrete Block Patio	**UTM (m)**	N 5,524,183
DRILL RIG / HAMMER	Acker MP8 with Auto-Hammer		E 631,229 Zone 14
METHOD(S)	0.0 m to 15.2 m: 125 mm ø SSA		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
233				**PATIO PAVER** - 52 mm.	233.2						
				WELL GRADED GRAVEL WITH SAND FILL - 213 mm, Light brown, moist, compact, 20mm crushed limestone, fine gravel, with medium to coarse sand.	233.0			S1			
					232.5			S2			
	1.0			**CLAY FILL** - 445 mm, Grey, moist, stiff, intermediate to high plasticity, some coarse sand, some fine gravel.	232.4						
232		5		**ORGANIC SOIL** - 104 mm, Black, damp, stiff, low plasticity, some clay, trace rootlets.				S3			
	2.0			**FAT CLAY (CH)** - Grey, moist, stiff, high plasticity, trace silt nodules. - Greyish brown below 1.8 m. - LL=91, PL=39, PI=52 at 1.8 m. - PSA: 0% gravel, 2% sand, 13% silt, 85% clay at 1.8 m.				S4	56		
231											
	3.0	10						S5			
230											
	4.0										
229		15						S6			
	5.0			- Firm below 4.6 m. - Trace gypsum nodules from 4.9 m to 5.5 m.							
228											
	6.0	20						S7			
227											
	7.0										
226		25						S8			
	8.0			- Grey below 7.9 m.							
225											
	9.0	30						S9			
224											
	10.0				223.0						
223				**SILT TILL** - Light grey, moist, loose, some fine sand, some clay. - LL=37, PL=14, PI=23 at 10.4 m.				S10			

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS
▽ **During Drilling/Digging** None Encountered
▼ **Upon Completion** Dry

CONTRACTOR **Paddock Drilling**
INSPECTOR **C. FRIESEN**
APPROVED T. ERNST
DATE 2-14-2025

KGS_LOG_U:\FMS\24-0107-011\15 POSEIDON BAY.GPJ

KGS GROUP

TEST HOLE LOG

HOLE NO.
TH24-02

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
222	11.0 (35)		- Some sand, trace to some fine gravel below 11.3 m.							
	12.0 (40)						S11			
221			- Trace gravel below 12.2 m.				S12	78	4 3 5	8
	13.0						S13			
220	(45)									
	14.0		- Thin lens of poorly graded sand with gravel, moist to wet, compact at 13.9 m. - Compact, trace medium to coarse sand, trace fine gravel, trace clay at 14.0 m.				S14	100	5 6 8	14
219			- Damp, dense, some fine gravel, trace coarse gravel below 14.3 m.				S15			
	15.0 (50)			218.0						
218			Notes: 1. End of test hole at 15.2 m. 2. Test hole caved to 8.5 m upon completion of drilling/digging. 3. Test hole backfilled with auger cuttings and bentonite chips. An approximate 1.5 m of bentonite seal at surface.							
	16.0 (55)									
217										
	17.0									
216	(60)									
	18.0									
215										
	19.0 (65)									
214										
	20.0									
213	(70)									
	21.0									
212										
	22.0 (75)									
211										
	23.0									

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80

WATER LEVELS
▽ During Drilling/Digging — None Encountered
▼ Upon Completion — Dry

CONTRACTOR: **Paddock Drilling**
INSPECTOR: **C. FRIESEN**
APPROVED: T. ERNST
DATE: 2-14-2025

KGS_LOG_U:\FMS\24-0107-011\15 POSEIDON BAY.GPJ

KEY TO SYMBOLS

LITHOLOGIC SYMBOLS


Brick or Patio Paver


Clay (CH, high plasticity)


Clay Till


Fill


Silt (ML)


Silt Till


Organic Clay (OL)


Topsoil

SAMPLER SYMBOLS


Auger Grab


Shelby Tube


SPT Split Spoon

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - Liquid Limit
PL - Plastic Limit
PI - Plastic Index
MC - Moisture Content
DD - Dry Density
NP - Non-Plastic
-200 - Percent Passing No. 200 Sieve
TV - Torvane (kPa)
PP - Pocket Penetrometer (kPa)
PSA - Particle Size Analysis
TOC - Top Of Casing

PN - Pneumatic Piezometer
VW - Vibrating Wire Piezometer
PID - Photoionization Detector
ppm - Parts Per Million
▽ Water Level During Drilling
▼ Water Level Upon Completion of Drilling
▼ Water Level Remeasured/Static

KGS GROUP

CLIENT CITY OF WINNIPEG **PROJECT NO.** 24-0107-011
PROJECT NAME Bill and Helen Norrie Library - Geotechnical Assessment **LOCATION** 15 Poseidon Bay, Winnipeg, Manitoba

APPENDIX D

KGS Group 2024/2025

Laboratory Test Results

SUMMARY OF INDEX TESTS

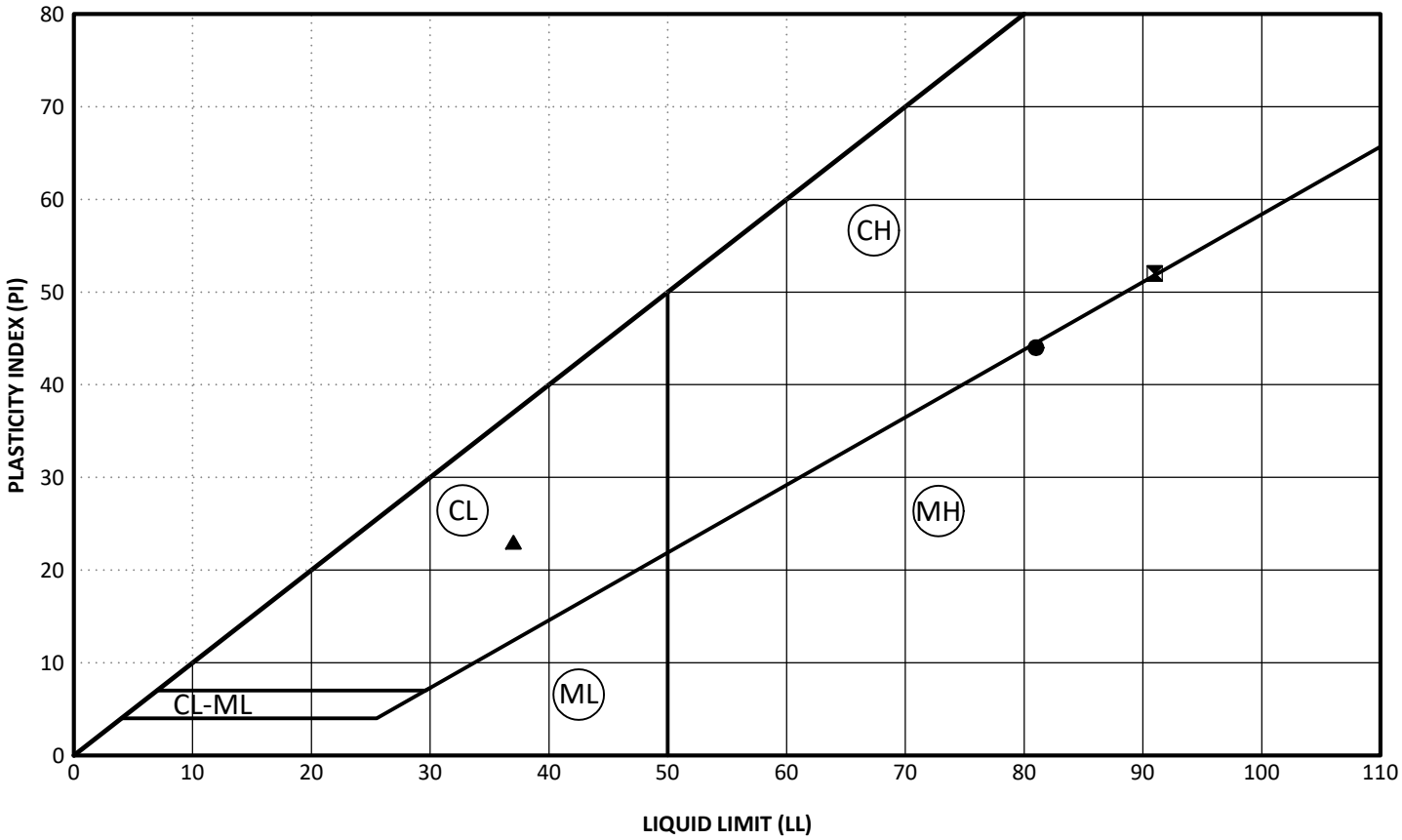
Test Hole ID	Sample No.	Depth (m)	Class-ification	Gravel (%)	Sand (%)	Silt/ Clay (%)	Liquid Limit	Plastic Limit	Plas-ticity Index	Moisture Content (%)	Dry Density (kN/m3)	Specific Gravity	Satur-ation (%)	Void Ratio
TH24-01	S1	0.3	FILL							27				
TH24-01	S2	0.9	CH	0	1	99	81	37	44	31	12.8	2.65**	81	1.024
TH24-01	S3	1.6	ML							34				
TH24-01	S4	1.8	CH							42				
TH24-01	S5	2.7	CH							52				
TH24-01	S6	3.8	CH							51				
TH24-01	S7	4.9	CH							50				
TH24-01	S8	5.8	CH							45				
TH24-01	S9	7.3	CH							49				
TH24-01	S10	8.8	CH							51				
TH24-01	S11	9.4	CH							36				
TH24-01	S12	10.4	CLAY TILL							25				
TH24-01	S13	11.3	SILT TILL							12				
TH24-01	S14	12.2	SILT TILL							8				
TH24-01	S15	13.1	SILT TILL							16				
TH24-01	S16a	13.7	SP							8				
TH24-01	S16b	13.9	SILT TILL							10				
TH24-01	S17	14.5	SILT TILL							9				
TH24-02	S1	0.3	FILL							26				
TH24-02	S2	0.7	FILL							43				
TH24-02	S3	1.2	CH							38				
TH24-02	S4	1.8	CH	0	2	98	91	39	52	40	11.8	2.65**	87	1.209
TH24-02	S5	2.9	CH							47				
TH24-02	S6	4.3	CH							48				
TH24-02	S7	5.8	CH							49				
TH24-02	S8	7.3	CH							48				
TH24-02	S9	8.8	CH							51				
TH24-02	S10	10.4	SILT TILL				37	14	23	25				
TH24-02	S11	11.9	SILT TILL							13				
TH24-02	S12	12.2	SILT TILL							11				
TH24-02	S13	13.1	SILT TILL							20				
TH24-02	S14	13.9	SP							15				
TH24-02	S15	14.6	SILT TILL							7				

* Moisture conditioned and remolded sample.
** Assumed specific gravity.

KGS GROUP

CLIENT	**CITY OF WINNIPEG**	**PROJECT NO.**	24-0107-011
PROJECT NAME	Bill and Helen Norrie Library - Geotechnical Assessment	**LOCATION**	15 Poseidon Bay, Winnipeg, Manitoba
TESTED BY	Stantec	**DATE TESTED**	Nov 2024 - Jan 2025

ATTERBERG LIMITS



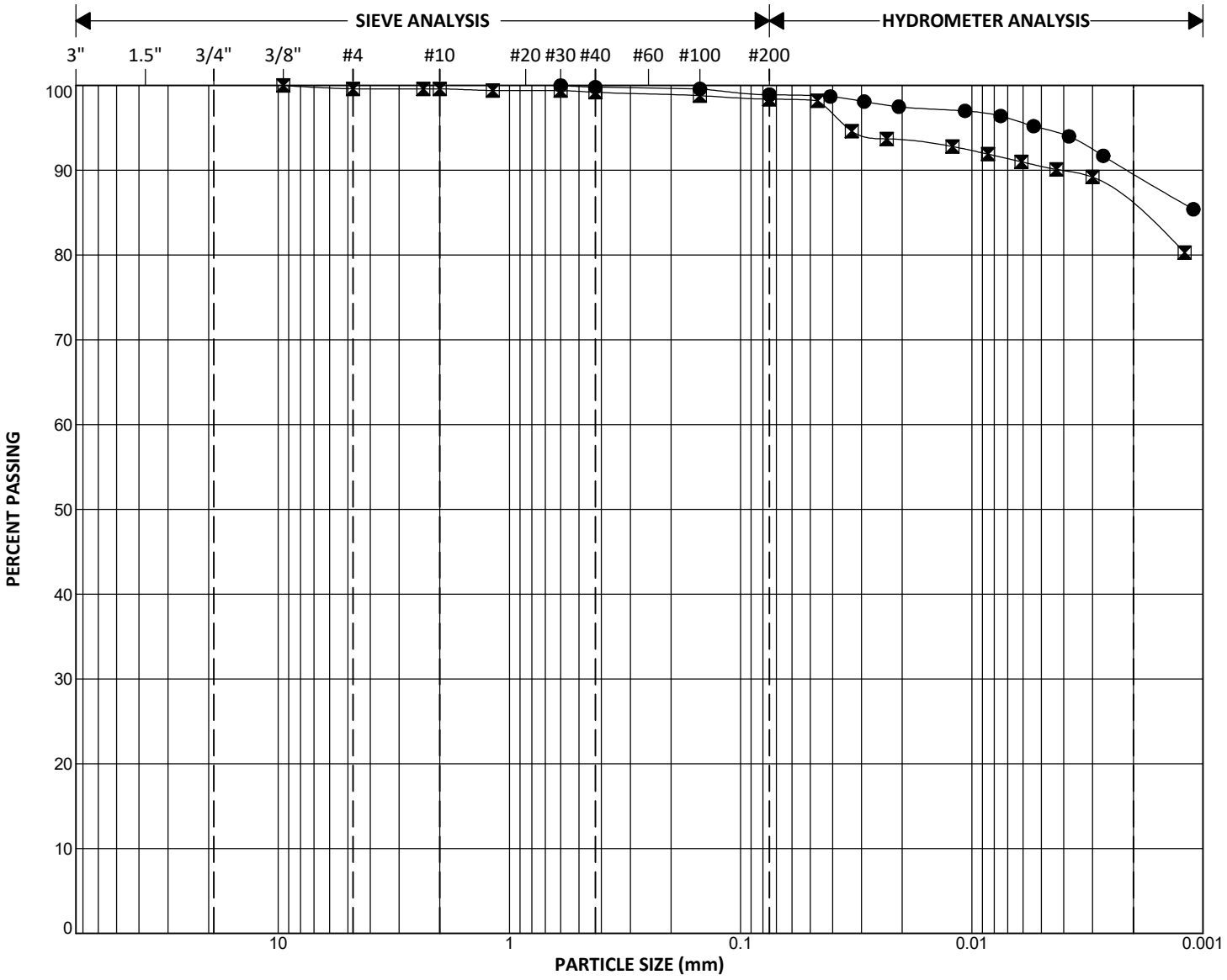
	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	MC (%)	CLASSIFICATION
●	TH24-01	0.9	S2	81	37	44	1	9	90	99	31	CH
⊠	TH24-02	1.8	S4	91	39	52	2	13	85	98	40	CH
▲	TH24-02	10.4	S10	37	14	23					25	SILT TILL

A-LINE PLOT (NO CI) U:\FMS\24-0107-011\15 POSEIDON BAY.GPJ

KGS GROUP

CLIENT	**CITY OF WINNIPEG**	**PROJECT NO.**	24-0107-011
PROJECT NAME	Bill and Helen Norrie Library - Geotechnical Assessment	**LOCATION**	15 Poseidon Bay, Winnipeg, Manitob
TESTED BY	Stantec	**DATE TESTED**	Nov 2024 - Jan 2025

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	TH24-01	0.9	S2	0	1	9	90	99			CH
⊠	TH24-02	1.8	S4	0	2	13	85	98			CH

SIEVE ANALYSIS U:\FMS\24-0107-011\15 POSEIDON BAY.GPJ

KGS GROUP

CLIENT	**CITY OF WINNIPEG**	**PROJECT NO.**	24-0107-011
PROJECT NAME	Bill and Helen Norrie Library - Geotechnical Assessment	**LOCATION**	15 Poseidon Bay, Winnipeg, Manitoba
TESTED BY	Stantec	**DATE TESTED**	Nov 2024 - Jan 2025

Stantec

ONE-DIMENSIONAL SWELL OR COLLAPSE OF SOILS
ASTM D4545
METHOD C

Office
200 - 325 25 Street SE
Calgary, Alberta
T2A 7H8
Tel: 403-716-8000

Lab
10830 - 46 Street SE
Calgary, Alberta
T2C 1G4
Tel: 403-716-8000

Project Number:	123317460	**Borehole ID:**	TH24-01
Project Name:	15-Poseidon Bay	**Sample ID:**	S2
Client:	KGS Group Inc.	**Sample Depth (ft):**	3' - 5'
Project Location:	Winnepeg, MB	**Sample Type:**	Shelby Tube

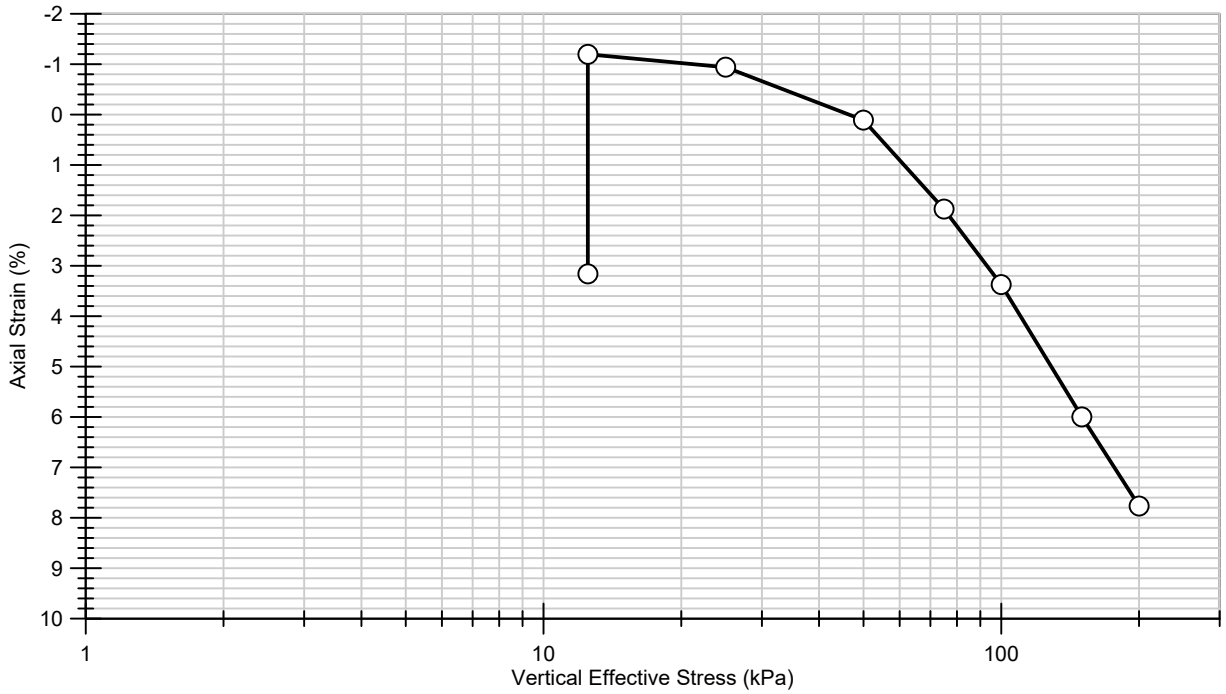
Sample Properties	
Sample Description	Fat Clay (CH)
Sample Preparation Method	Shelby Tube
Liquid Limit	81
Plastic Limit	37

Type of Water to Inundate Specimen	Potable Tap

Parameters	**Initial**	**Final**
Diameter (mm)	50.72	50.72
Height (mm)	21.88	23.77
Water Content (%)	31.4	32.5
Bulk Density (g/cm^3)	1.73	1.60
Dry Density (g/cm^3)	1.31	1.21
Specific Gravity (Assumed)	2.65	2.65
Void Ratio	1.02	1.19
Saturation (%)	82	72

Comments/Remarks

(1) The test procedure was provided by the Engineer who requested the test.
(2) The minimum applicable loading stress was 15 kPa.
(3) Specific Gravity provided by requesting engineer.
(4) Final specimen parameters taken after dismantling.



Tested by: L.Gingco (2025-01-06)
Checked by: M.Shojaedin (2025-01-17)

Stantec

ONE-DIMENSIONAL SWELL OR COLLAPSE OF SOILS
ASTM D4545
METHOD C

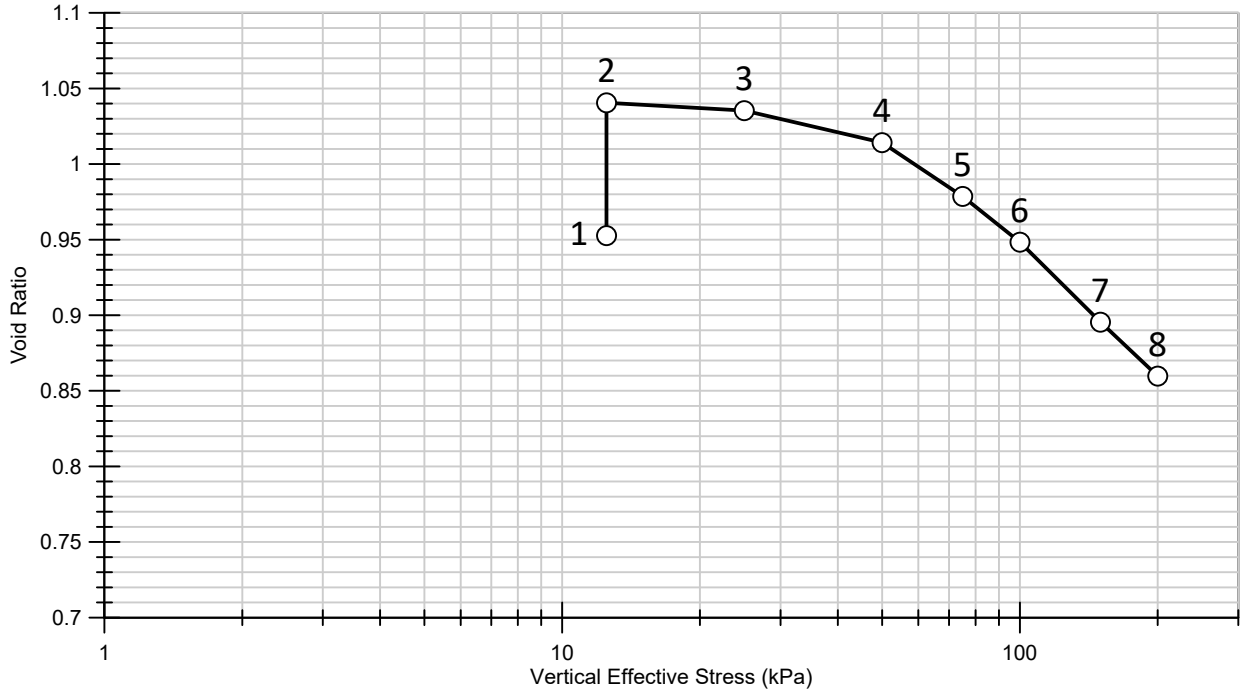
Office
200 - 325 25 Street SE
Calgary, Alberta
T2A 7H8
Tel: 403-716-8000

Lab
10830 - 46 Street SE
Calgary, Alberta
T2C 1G4
Tel: 403-716-8000

Project Number:	123317460	**Borehole ID:**	TH24-01
Project Name:	15-Poseidon Bay	**Sample ID:**	S2
Client:	KGS Group Inc.	**Sample Depth (ft):**	3' - 5'
Project Location:	Winnepeg, MB	**Sample Type:**	Shelby Tube

Results

Loading Stage	Stress (kPa)	Specimen Height (mm)	Axial Stain (%)	Void Ratio
1	15.00	21.19	3.16	0.95
2	15.00	22.14	-1.20	1.04
3	25.00	22.09	-0.94	1.04
4	50.00	21.86	0.11	1.01
5	75.00	21.47	1.87	0.98
6	100.00	21.14	3.37	0.95
7	150.00	20.57	6.00	0.90
8	200.00	20.18	7.77	0.86



Tested by: L.Gingco (2025-01-06)
Checked by: M.Shojaedin (2025-01-17)

Stantec

ONE-DIMENSIONAL SWELL OR COLLAPSE OF SOILS
ASTM D4545
METHOD C

Office
200 - 325 25 Street SE
Calgary, Alberta
T2A 7H8
Tel: 403-716-8000

Lab
10830 - 46 Street SE
Calgary, Alberta
T2C 1G4
Tel: 403-716-8000

Project Number:	123317460	**Borehole ID:**	TH24-02
Project Name:	15 Poseidon Bay	**Sample ID:**	S4
Client:	KGS Group Inc.	**Sample Depth (ft):**	6' - 8'
Project Location:	Winnipeg, MB	**Sample Type:**	Shelby Tube

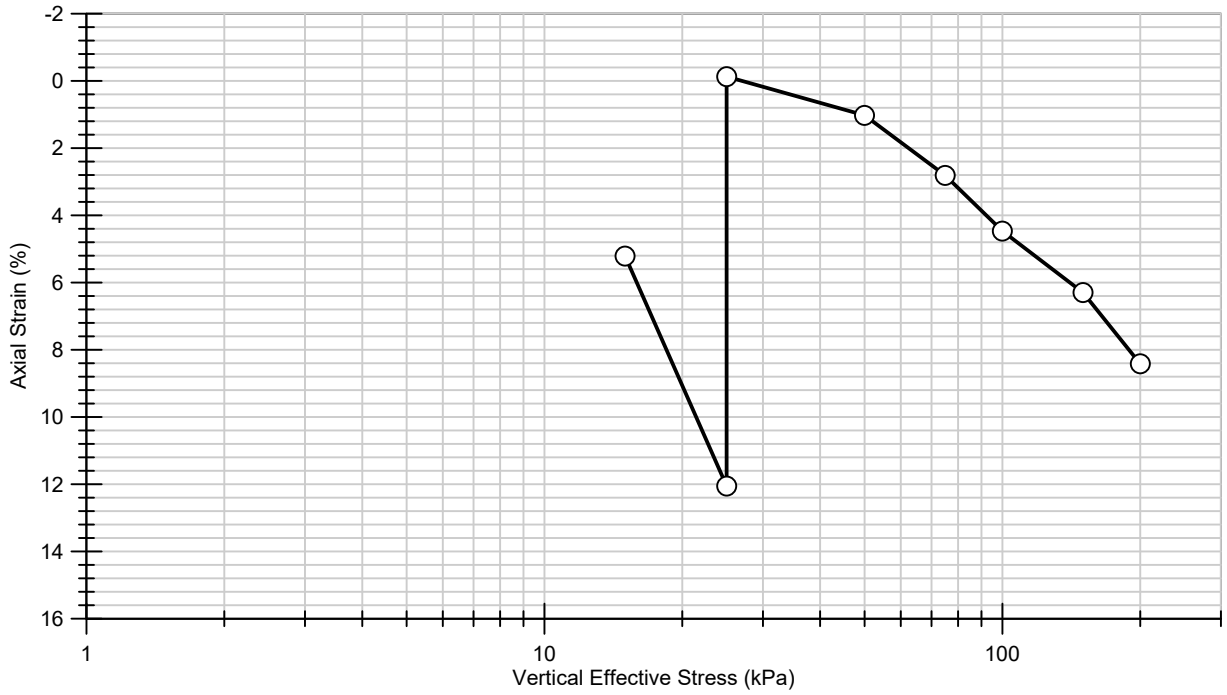
Sample Properties	
Sample Description	Fat Clay (CH)
Sample Preparation Method	Shelby Tube
Liquid Limit	91
Plastic Limit	39

Type of Water to Inundate Specimen	Potable Tap

Parameters	**Initial**	**Final**
Diameter (mm)	50.54	50.54
Height (mm)	21.72	23.99
Water Content (%)	39.9	40.8
Bulk Density (g/cm^3)	1.69	1.54
Dry Density (g/cm^3)	1.20	1.09
Specific Gravity (Assumed)	2.65	2.65
Void Ratio	1.20	1.43
Saturation (%)	88	76

Comments/Remarks

(1) The test procedure was provided by the Engineer who requested the test.
(2) The minimum applicable loading stress was 15 kPa.
(3) Specific Gravity provided by requesting engineer.
(4) Final specimen parameters taken after dismantling.



Tested by: L.Gingco (2025-01-06)
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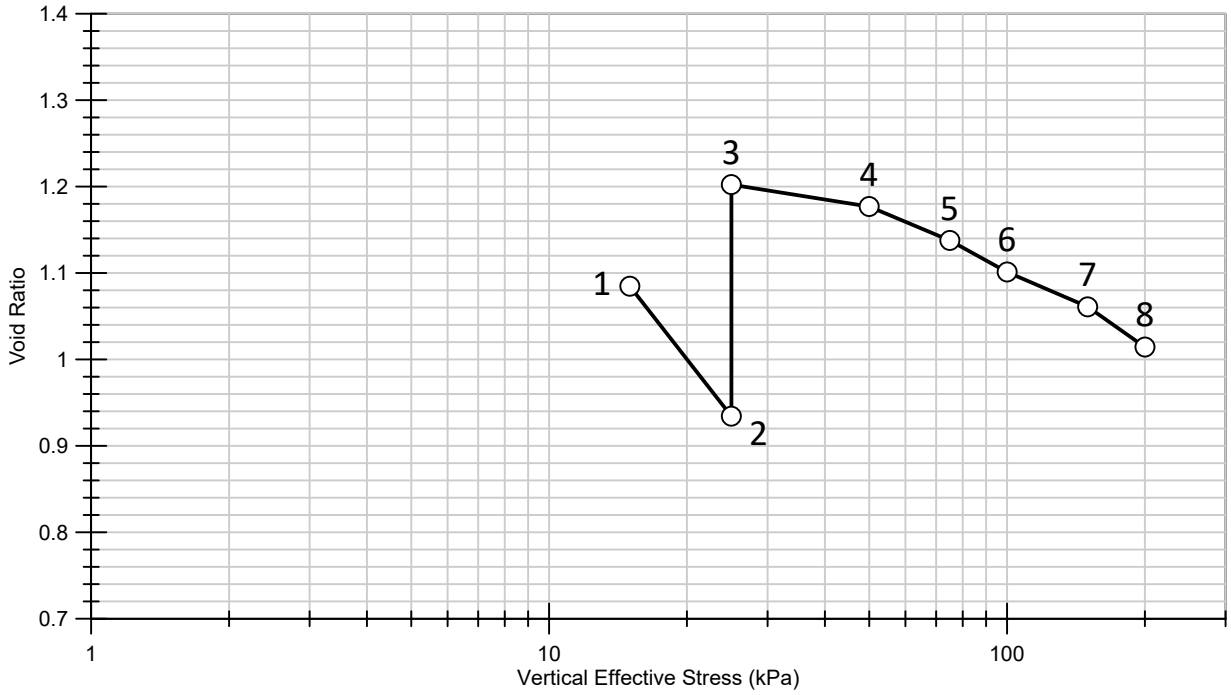
Project Location:	Winnipeg, MB	**Sample Type:**	Shelby Tube

Results

Loading Stage	Stress (kPa)	Specimen Height (mm)	Axial Stain (%)	Void Ratio
1	15.00	20.59	5.21	1.08
2	25.00	19.10	12.05	0.93
3	25.00	21.75	-0.13	1.20
4	50.00	21.50	1.02	1.18
5	75.00	21.11	2.81	1.14
6	100.00	20.75	4.47	1.10
7	150.00	20.35	6.30	1.06
8	200.00	19.89	8.42	1.01



Tested by: L.Gingco (2025-01-06)
Checked by: M.Shojaedin (2025-01-17)

KGS
GROUP

Experience in Action