THE NATIONAL TESTING LABORATORIES LIMITED
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# GEOTECHNICAL INVESTIGATION AND FOUNDATION ENGINEERING REPORT FOR TRANSIT BUS PARKING AND SERVICING GARAGE 600 BRANDON AVENUE WINNIPEG, MANITOBA

Prepared for
**CASPIAN PROJECTS INC**
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**April 19, 2013**

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# TABLE OF CONTENTS



**List of Tables**



**List of Appendices**

## 1.0 SUMMARY

The National Testing Laboratories Limited was retained by Caspian Projects to provide geotechnical engineering services for the City of Winnipeg Transit Bus Parking and Servicing Garage at 600 Brandon Avenue. A preliminary geotechnical investigation of the project site was completed by AMEC in September 2011. On August 28, 2012, twelve testholes were drilled within the footprint of the proposed building to evaluate the fill materials on the project site. Recommendations for design of a pile foundation system, and construction of a soil-supported floor slab and exterior pavements are provided in this report.

## 2.0 PROJECT SITE AND PROPOSED CONSTRUCTION

The project site is located on the property commonly known as the Fort Rouge Rail Yards, and is generally bounded to the north by Brandon Avenue, to the east by the Argue Street Bicycle (and lane), to the south by the virtual extension of Arnold Avenue, and to the west by the newly constructed Southwest Rapid Transit Corridor Roadway. The site is typically flat lying with fill materials exposed at the ground surface. It is our understanding that the Transit bus garage will have the capacity to park and service approximately 135 transit buses. A soil-supported floor slab will be utilized for the servicing garage with the exception of the office and administrative areas where structural slabs will be provided.

## 3.0 GEOTECHNICAL INVESTIGATION

### 3.1 Testhole Drilling, Soil Sampling and Compaction Testing

A site investigation to evaluate the soil conditions for the foundation system was not undertaken. Foundation recommendations for the proposed building are based upon the geotechnical report prepared by AMEC. A copy of this geotechnical report is provided in Appendix A.

A site investigation to evaluate the fill materials within the footprint of the proposed building was conducted on August 28, 2012. Drilling services were provided by Kletke Enviro Drilling Ltd under the supervision of our geotechnical field personnel. Twelve testholes were drilled to a depth of approximately 2.5 m at the locations shown on the Testhole Location Plan provided in Appendix B. The depth of fill material at the testhole locations is summarized in the following table.

**Table 1 - Depth of Fill Material**

| Testhole no. | Depth of Fill Material (m) | Testhole no. | Depth of Fill Material (m) | Testhole no. | Depth of Fill Material (m) |
|---|---|---|---|---|---|
| TH1 | 1.4 | TH5 | 1.4 | TH9 | 1.1 |
| TH2 | 1.5 | TH6 | 1.1 | TH10 | 1.5 |
| TH3 | 1.7 | TH7 | 0.9 | TH11 | 1.5 |
| TH4 | 1.5 | TH8 | 1.4 | TH12 | 0.9 |

Soil samples were recovered from the testholes in Shelby tubes. Due to the presence of granular material and construction debris within the fill material, Shelby tubes could not be obtained near the ground surface. All soil samples obtained from the testholes were visually classified in the field and returned to our soils laboratory for additional examination and testing.

On September 14 and 25, field density tests were conducted with a nuclear gauge. A representative sample of the fill material was obtained from the field density test locations and returned to our laboratory for determination of maximum dry (proctor) density. The compaction results ranged from 81% to 113% with an average of 99%. Due to the variability of the fill material, the reported compaction results may not representative of the materials tested on site. The compaction reports are provided in Appendix C.

### 3.2 Laboratory Testing

The composite sample obtained from the project site during field density tests and composite samples prepared from the Shelby tube soil samples were tested in accordance with ASTM D698, Laboratory Compaction Characteristics of Soil Using Standard Effort. The laboratory reports for the proctor tests are provided in Appendix D and are summarized in the following table.

**Table 2 - Standard Proctor Test Data**

| Proctor no. | Sample Description | Maximum Dry Density (kg/m3) | Optimum Moisture Content (%) |
|---|---|---|---|
| 1 | Fill material (Shelby tube samples) | 1734 | 16.5 |
| 2 | Fill material (Shelby tube samples) | 1774 | 16.0 |
| 3 | Fill material (Shelby tube samples) | 1742 | 12.5 |
| 4 | Native clay | 1472 | 24.5 |
| 5 | Fill material (field density tests) | 1837 | 14.5 |

Soil samples extruded from the Shelby tubes were tested in accordance with ASTM D7263, Standard Test Methods for Laboratory Determination of Density (Unit Weight) of Soil Specimens. Compaction of the soil samples recovered in Shelby tubes is based upon the average proctor density for the fill material samples (1750 kg/m3). The soil density and compaction test data is summarized in the following table.

**Table 3 - Compaction Test Data for Shelby Tube Samples**

| Testhole no. | Soil Density (kg/m3) | Compaction (%) |
|---|---|---|
| TH1 | 1510 | 86 |

| Testhole no. | Soil Density (kg/m3) | Compaction (%) |
|---|---|---|
| TH2 | 1540 | 88 |
| TH3 | 1555 | 89 |
| TH4 | 1555 | 90 |
| TH5 | 1570 | 90 |
| TH6 | 1710 | 98 |
| TH7 | 1640 | 94 |
| TH8 | 1610 | 92 |
| TH9 | sample disturbed | |
| TH10 | 1590 | 91 |
| TH11 | 1650 | 94 |
| TH12 | sample disturbed | |
| average | 1593 | 91 |

## 4.0 SUBSURFACE CONDITIONS

### 4.1 Soil Profile

Based upon the testhole logs provided with the AMEC geotechnical report and the findings from our geotechnical investigation, the soil profile on the project site typically consists of fill materials and clay overlying silt till. A silt layer was typically encountered at a depth between 1 and 2 m. The fill material consists of a random mixture of clay, granular material and construction debris. The thickness of the fill material ranges from 0.9 to 1.7 m. It is our understanding that the source of fill material was the rapid transit tunnel located approximately 0.5 km north of the project site. The fill material was placed during the period from the fall of 2010 to the fall of 2011. It was reported that the fill material was generally placed in lifts using dozers and scrapers, and it was spread and compacted from the weight of the equipment only. The thickness of the silt layer encountered beneath the fill material ranged from 0.1 to 0.5 m. The silt was moist to very moist, soft, light brown to tan and of low plasticity. The clay was brown, moist, stiff to very stiff, silty and of high plasticity. Generally, the clay was stiff and became firm and grey with increasing depth. The silt till was moist, soft, grey, of low plasticity and contained traces of sand and gravel.

### 4.2 Groundwater

Minor to heavy groundwater seepage was noted from the shallow silt layer and from the silt till. Sloughing conditions were also noted in the silt layer and silt till. However, it should be noted that only short-term seepage and sloughing conditions were observed in the testholes. Groundwater levels will normally fluctuate during the year and will be dependent on precipitation, surface drainage, and regional groundwater regimes.

## 5.0 GEOTECHNICAL CONSIDERATIONS

Based upon the findings from the geotechnical investigations and our understanding of the proposed construction, the primary geotechnical concerns for the project site are:

- potential for groundwater seepage and soil sloughing during installation of cast-in-place concrete piles,
- potential for movement of soil-supported floor slab due to settlement within the fill material and volume change within the high plasticity clay, and
- frost heave and thaw weakening of frost-susceptible subgrade soil.

These issues will be discussed in the following sections.

## 6.0 DESIGN RECOMMENDATIONS AND COMMENTS

### 6.1 Cast-in-Place Concrete Friction Piles

Based upon discussions with the structural engineer for the project, it is our understanding the preferred foundation for the proposed building is a system of cast-in-place concrete friction piles. Based upon a review of the strength test data provided for the lacustrine clay in the AMEC report, cast-in-place concrete friction piles may be designed based upon an allowable skin friction of 17 kPa.

Due to the presence of clay fill and silt at a shallow depth and the potential for soil drying and shrinkage near the ground surface, the frictional support should be excluded in the calculation of the pile capacity to a depth of 2.5 m measured from existing grade. The allowable skin friction value is applied to the pile circumference within the clay stratum. The contribution from end bearing should be ignored in pile capacity calculations. Minimum pile spacing should be three pile diameters, measured center to center. Piles located in heated and unheated areas should have minimum pile lengths of 6 and 8 m respectively, measured from final grade. To prevent frost jacking due to adfreeze forces, all piles in unheated areas should be provided with steel reinforcement to a minimum depth of 8 m and have sonotube casings installed to a depth of 3 m. The sonotubes should be coated with grease and wrapped in 6 mil poly sheeting.

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

It is recommended that the pile length not exceed 14 m from existing grade to avoid penetration of the silt till and potential groundwater seepage below this depth. A minimum void space of 150 mm should be provided beneath all structural elements to accommodate potential heave of the high plasticity clay and clay fill. Settlement of a cast-in-place concrete pile developing its capacity on the basis of skin friction is estimated to be less than 10 mm.

## 6.2 Soil-Supported Floor Slab

For a soil-supported floor slab constructed at or near existing ground level, fill material is anticipated to be encountered at the slab subgrade level. Uncontrolled fills have the potential to settle significant amounts beneath their own weight, with settlement continuing for long periods after placement. Total and differential settlement of uncontrolled fills is increased when new loads are added. Factors affecting the magnitude and duration of total and differential settlements include placement procedures, material composition, depth of fill, age of fill, groundwater levels, rate of surface water infiltration and loading conditions. Some of these factors are more difficult to quantify than others. Overall, estimating uncontrolled fill settlement is very imprecise. However, empirical correlations indicate that uncontrolled fill placed at approximately 90% compaction could settle between 3 and 5 percent of its thickness under its own weight for a period of 20 to 30 years after placement. At the project site, that could translate into total long-term settlements of up to 100 mm. A portion of the expected total settlement (approximately 50%) will occur during placement and in the two to three years immediately following placement, with the remaining portion of the settlement occurring over several years following completion of construction. Based upon the compaction test data and placement history for the fill material, it is estimated that an additional 15 to 50 mm of settlement will occur after construction of the soil-supported floor slab. It is our understanding that the proposed construction for the soil-supported floor slab will include excavation of the existing fill material to a depth of 450 mm prior to placement of 300 mm of crushed limestone base course. Based upon the proposed construction, maximum settlement of the floor slab is estimated to be in the range of 30 to 40 mm. The modulus of subgrade reaction at the underside of the soil-supported floor slab is estimated to be in the range of 30 to 40 MPa/m.

Due to the presence of high plasticity clay on the project site, the potential exists for heave of a soil-supported slab. Soil moisture contents will typically increase after construction which causes swelling of clay soils. The magnitude of heave for soil-supported floor slabs is typically in the range of 20 to 50 mm but can be as high as 100 mm. Based upon the soil conditions encountered on the project site, the maximum heave of a soil-supported slab is estimated to be in the range of 20 to 40 mm. Heave is generally higher on sites where leaking water supply or sewer lines, removal of vegetation, or poor drainage lead to increased moisture contents in the clay soil after construction. To minimize potential heave of a soil-supported floor slab, measures must be taken to prevent drying of the subgrade soils during construction.

Subgrade preparation for a soil-supported floor slab will require removal of all topsoil, organic material, and loose or soft soil. Proof rolling should be conducted to identify soft areas within the exposed subgrade. All soft or weak subgrade soils identified during proof rolling must be excavated and replaced with crushed limestone subbase. The prepared subgrade surface should not be exposed to excessive moisture or drying during construction and must be protected from freezing during cold weather construction. Inspection of the subgrade by

qualified geotechnical personnel is recommended during subgrade preparation prior to placement of the granular fill materials. All granular fill materials must be placed in lifts not exceeding 200 mm in thickness and compacted to at least 98% of the maximum dry density (Standard Proctor). Sieve analysis and compaction testing of the granular fill materials should be conducted to ensure the materials and compaction comply with the design specifications.

### 6.3 Pavement Areas

It is our understanding that asphalt paving and concrete busways will be constructed on the project site. The testholes revealed a soil profile of fill material and silt near the ground surface. The upper limit of the silt was generally encountered between a depth of 1 and 2 m below the ground surface. Silt is a frost-susceptible soil and the potential for frost heave of the pavement surface exists if the silt layer is present within the depth of annual frost penetration. In the Winnipeg area, the depth of frost penetration is approximately 2 m where the ground surface is kept clear of snow during the winter months. Increased maintenance costs for the pavement should be anticipated if the silt is not removed within the depth of annual frost penetration. To minimize pavement distress related to freezing and thawing of the silt, a minimum soil cover of 1 m should be provided above the frost -susceptible silt layer. To avoid the potential requirement for subexcavation and reduce the risk of frost -related distress in the pavement, it is recommended that the final grades for the pavement areas be set as high as possible. If the final grades for the pavement areas are at or above existing grade, it is expected that subexcavation of the silt will not be required.

It is our understanding that Genivar will be providing the pavement designs for the asphalt paving and concrete busways. Based upon the soil profile revealed in the testholes, the modulus of subgrade reaction is estimated to be in the range of 20 to 50 MPa/m. Proof rolling of the subgrade soil must be conducted to identify soft areas at the subgrade level. Low strength subgrade soils identified during proof rolling must be excavated and replaced with crushed limestone sub-base.

Construction of the sub-base and base course for the pavement areas should comply with the City of Winnipeg Standard Construction Specification CW 3110. Construction for the asphaltic concrete pavement should comply with the requirements of the City of Winnipeg Standard Construction Specification CW 3410. Construction of the concrete pavement should comply with the City of Winnipeg Standard Construction Specification CW 3310. Sieve analysis and compaction testing of the base course and sub-base materials should be conducted to ensure that the materials and compaction comply with the design specifications. For the hot mix asphaltic concrete, compaction testing and Marshall analysis of the paving mix during construction should be undertaken. Concrete tests should be conducted to confirm the concrete supplied to the project site complies with the specification requirements.

## 6.4 Foundation Concrete

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

**Table 4 - Mix Requirements for Foundation Concrete**

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

Concrete in contact with the native soils should meet the above requirements.

## 7.0 CLOSURE

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

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

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

APEGM
Certificate of Authorization
The National Testing Laboratories Limited
No. 690 Date: April 19, 2013

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

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

## APPENDIX A

# AMEC GEOTECHNICAL REPORT

23 September 2011
Project No. WX16667

Dillon Consulting Limited
895 Waverley Street, Suite 200
Winnipeg, Manitoba
R3T 5P4

Attention: Mr. David Krahn, P. Eng.

**Re: Geotechnical Investigation**
**Proposed New Transit Garage – Brandon Avenue**
**Winnipeg, Manitoba**

## 1.0 INTRODUCTION

As requested, AMEC Environment & Infrastructure, a Division of AMEC Americas Limited (AMEC), completed a preliminary geotechnical investigation at the above noted site. The investigation included the supervision of test hole drilling and geotechnical lab testing. Geotechnical recommendations were not requested and therefore are not included herein. An environmental investigation program was completed concurrently with the geotechnical investigation and is presented under separate cover.

Based on the information provided by Dillon, it was understood that the proposed transit garage will be constructed using a design-build approach and as such, specific building information such as dimensions, location and foundation loads were not available at the time of drilling.

This report presents a summary of our findings during our field investigation and lab testing program.

## 2.0 SITE CONDITIONS

The site is located at the west end of Brandon Avenue, near Hethrington Avenue, in Winnipeg, Manitoba. The site was undeveloped at the time of the investigation, however construction of a Rapid Transit Corridor is occurring immediately adjacent to the site, and as such debris and construction equipment from the construction site were located on various parts of the site.

The site is bordered to the east by residential dwellings, and to the west by an operating rail yard and the recently constructed Rapid Transit Corridor. North and south of the site are undeveloped areas that will become part of the Rapid Transit Corridor. The site is generally flat lying and is partially covered by short grass.


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## 3.0 GEOTECHNCIAL FIELD INVESTIGATION

A total of twelve test holes were drilled across the site area using a SoilMec SR-30 track-mounted piling rig owned and operated by Subterranean Ltd. of West St. Paul, Manitoba. Four of the test holes were advanced to auger refusal, four test holes were drilled to a depth of 5 m, while the remaining four holes were completed at a depth of 3 m.

It should be noted that during drilling of test hole TH07, an abandoned water line was struck at approximately 0.9 m below existing ground surface. Dillon Consulting was informed. Drilling of the test hole continued until the seepage from the water line caused the test hole to fill with water. Drilling of the hole was subsequently ceased at a depth of 13.7 m. The test hole was moved to avoid the water line and drilling continued as normal. The original test hole was backfilled using 19mm down crushed gravel.

During drilling, soil stratigraphy was classified according to the Modified Unified Soil Classification System (MUSCS) by AMEC's field technician, Mr. Anthony Lospe. Disturbed grab samples were collected from the auger at regular intervals, while relatively undisturbed Shelby Tube samples were collected at select depths. Pocket penetrometers readings were taken to assess the relative consistency of cohesive samples. All samples were sealed in plastic bags to limit moisture loss and transported to AMEC's Winnipeg laboratory.

A laboratory testing program was undertaken and consisted of natural moisture content determination, unconfined compression and laboratory vane testing.

## 4.0 SUBSURFACE CONDITIONS

Based on the twelve test holes drilled on 8 September 2011, the soil stratigraphy at the test hole locations was as follows:

- Fill
- Organic Clay
- Silt
- Clay
- Silt Till

Fill

Clay fill materials were found at the ground surface at all test hole locations, with the exception of test hole TH11 (where no fill was observed) and at test hole TH12 (where it was found beneath a layer of surface granular fill). The clay fill was generally described as silty, low plastic, moist, stiff, brown to dark grey, and contained trace to some sand and gravel. Rubble, bricks and other debris was also found within the clay fill in several test holes. The clay fill extended to depths ranging between 0.6 m and 1.6 m.

Granular fill was found at the surface in test holes TH11 and TH12 and was described as being gravelly, sandy, poorly graded, medium to coarse grained, loose to compact, moist, brown and contained some gravel. The granular fill extended to 1.1 and 0.4 m from grade at the two

locations, respectively. A thin layer of sand fill was also noted beneath the clay fill in test holes TH08 and TH09. The sand fill at these locations was generally described as being poorly graded, medium to coarse grained, loose to compact, moist, brown and ranged between trace silt and silty. The sand extended to depths ranging between 0.9 m and 1.3 m.

Organic Clay

A layer of organic clay was found beneath the fill material in test hole TH01. The organic clay was described as being low to medium plastic, moist, firm, black and contained traces of silt, sand, and rootlets. The organic clay extended to 0.9 m.

Silt

A thin layer of silt was found in the majority of the test holes, either directly beneath the fill materials (TH02 to TH08 and TH12) or within the underlying native clay (test holes TH01, TH03, TH10 and TH11). Silt was not observed in test hole TH09.

Generally the silt was low plastic, moist to very moist, soft and light brown to tan. The silt layer was encountered at depths ranging between 0.9 m and 2.2 m, and extended to depths ranging between 1.4 m and 2.6 m.

Clay

Native clay was observed below the fill, silt and organic layers in all the test holess. The clay was silty, high plastic, moist, stiff to very stiff and brown. Generally, the clay became stiff and then firm and grey with increasing depth in the deep test holes. Sulphate inclusions were found within the clay below depths of approximately 3.1 m or greater. Traces of gravel and silt till inclusions were also noted within the clay below depths of approximately 12.2 m. The clay extended to depths ranging between 14.3 m and 15.4 m (although TH07 was terminated while still in clay at 13.7 m).

Silt Till

Glacial silt till was present below the clay in each of the deep test holes (TH01, TH06, TH07 and TH12) except test hole TH01, where refusal was met prior to reaching the till layer. The silt till was low plastic, moist, soft, grey and contained traces of sand and gravel. With depth, the till becamse damp dense and the till extended to the maximum depths explored in each test hole where it was found (16.0 to 16.5 m).

### 4.1 Sloughing and Seepage Conditions

Each test hole was left open for approximately 10 minutes after completion of drilling in order to measure short term sloughing and seepage conditions. The table below provides a summary of the sloughing and seepage conditions observed at the test holes.

**Table 1: Sloughing and Seepage Conditions**

| Test Hole # | Drilled Depth (m) | Sloughing Below (m) | Test Hole Open To (m) | Seepage Below (m) | Water Level Prior to Backfill (m) |
|---|---|---|---|---|---|
| TH01 | 14.6 | -- | 14.6 | 1.7 (very slight) | -- |
| TH02 | 3.0 | -- | 3.0 | -- | -- |
| TH03 | 3.0 | -- | 3.0 | 1.7 (very slight) | -- |
| TH04 | 5.0 | -- | 4.9 | 1.4 (slight) | 4.7 |
| TH05 | 5.0 | 1.5 (moderate) | 1.7 | 1.5 (moderate) | 1.5 |
| TH06 | 16.5 | -- | 16.5 | 0.9 (very slight) | -- |
| TH07 | 13.7 | -- | 13.7 | 0.9 (significant; from water line) | 3.7 |
| TH07-A | 16.3 | 15.2 (slight) | 16.2 | 15.2 (slight) | 15.2 |
| TH08 | 5.0 | -- | 5.0 | -- | -- |
| TH09 | 5.0 | -- | 5.0 | 3.1 (heavy) | 3.1 |
| TH10 | 3.0 | -- | 3.0 | -- | -- |
| TH11 | 3.0 | -- | 3.0 | -- | -- |
| TH12 | 16.0 | -- | 15.8 | 15.3 (slight) 15.8 (moderate to heavy) | 13.7 |

"--" indicates not encountered

## 5.0 LABORATORY TESTING

A laboratory testing program was conducted on selected samples and consisted of natural moisture content determination, unconfined compression and laboratory vane testing. Results of all laboratory testing can be found on the test hole logs, however a summary of the unconfined compression and laboratory vane testing is presented below.

**Table 2: Laboratory Testing Results**

| Test Hole and Sample Number | Sample Depth (m) | Unconfined Compressive Strength (kPa) | Laboratory Vane Shear Strength (kPa) | Bulk Unit Weight ($kg/m^3$) | Moisture Content (%) |
|---|---|---|---|---|---|
| TH06 Sample 6 | 3.1 – 3.7 | 19.9* | 77.4 | 1701 | 55.0 |
| TH06 Sample 9 | 6.1 – 6.7 | 116.2 | 74.0 | 1708 | 51.9 |
| TH06 Sample 12 | 9.1 – 9.7 | 103.5 | 59.0 | 1772 | 47.9 |
| TH07 Sample 7 | 4.6 – 5.2 | 80.1 | 82.9 | 1706 | 57.1 |
| TH07 Sample 10 | 7.6 – 8.2 | 124.4 | 62.8 | 1734 | 45.0 |
| TH07-A Sample 2 | 13.7 – 14.3 | 76.6 | 53.2 | 1770 | 46.6 |

*Low unconfined compressive strength confirmed due to presence of slickenside in sample

## 6.0 CLOSURE

Soil conditions, by their nature, can be highly variable across a construction site. The placement of fill during and prior to construction activities on a site can contribute to variable soil conditions. A contingency amount should be included in the construction budget to allow for the possibility of unexpected variations in soil conditions, which may result in modification of the design, and/or changes in construction procedures.

This memorandum has been prepared for the exclusive use of Dillon Consulting Limited and the City of Winnipeg for inclusion in the Rapid Transit Garage Design Build request for proposals. The information contained herein should be used for informational purposes only and should be verified by the successful design build team. Any use that a third party makes of this memo, or any reliance or decisions based on this memo are the sole responsibility of those parties. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty is made, either expressed or implied.

AMEC trusts the above information satisfies your requirements at this time. We would be pleased to provide any further information that may be needed during design. If you require additional information, please do not hesitate to contact one of the undersigned.

Sincerely,
**AMEC EARTH & ENVIRONMENTAL**

PROVINCE OF MANITOBA
T.R.
GLUCK
Member
22305
SEPT 23/11
REGISTERED PROFESSIONAL ENGINEER

Jorden Wiwcharyk, EIT
Geotechnical Engineer-In-Training

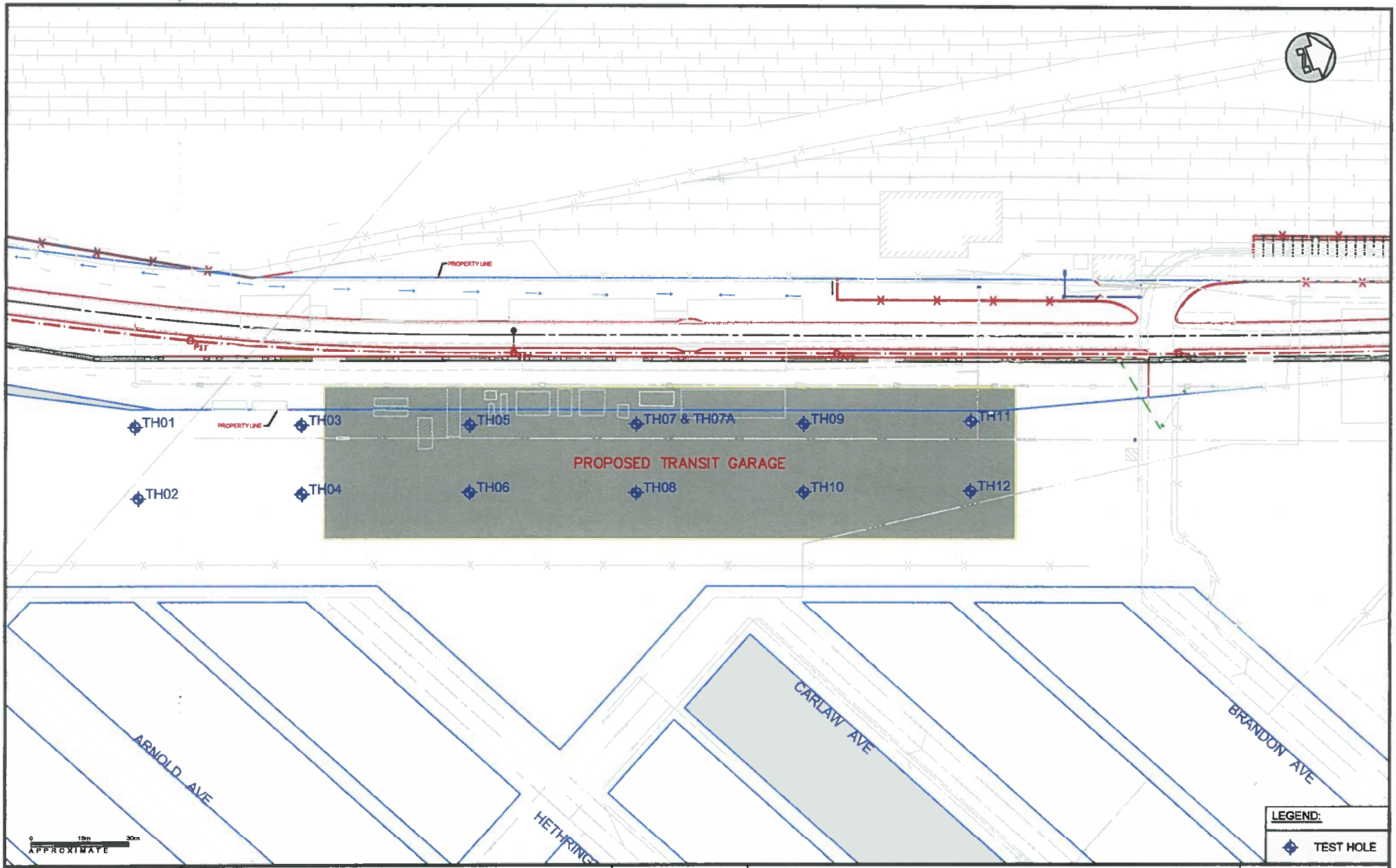
Trevor Gluck, P. Eng
Senior Geotechnical Engineer

Reviewed By:

Harley Pankratz, P. Eng.
Vice President: Eastern Prairies/Northern Alberta

Certificate of Authorization
AMEC Environment & Infrastructure, a Division of AMEC Americas Limited
No. 555 Date: Sept 23/11

Attachments: Figure 1: Test Hole Location Plan
Figure 2-14: Test Hole Logs



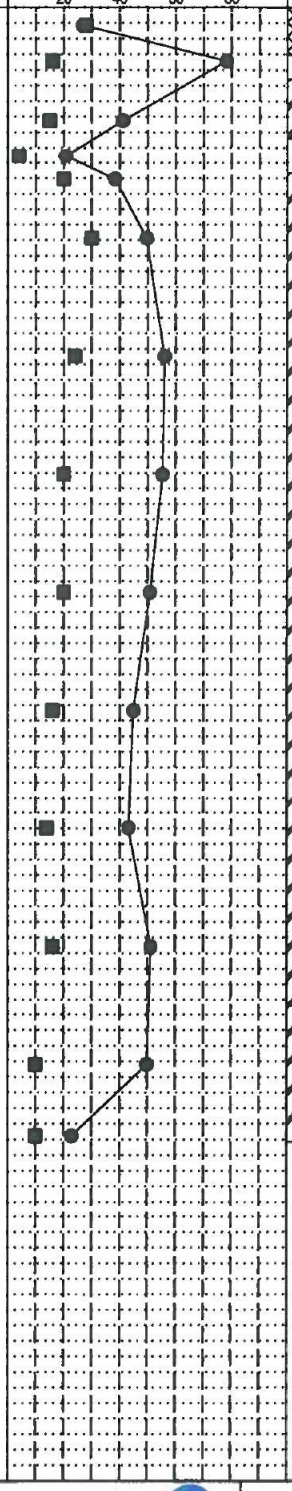

P:\Jobs\16600's\16660's\16667 - Dillon Rapid Transit Garage\Drawings

| | | | | |
|---|---|---|---|---|
| CLIENT LOGO | CLIENT: DILLON CONSULTING LIMITED | DWN BY: MD<br>CHK'D BY: TG | PROJECT: GEOTECHNICAL INVESTIGATION<br>TRANSIT GARAGE - BRANDON AVENUE<br>WINNIPEG, MANITOBA | REV. NO.: A<br>DATE: SEPTEMBER 2011 |
| AMEC Earth & Environmental<br>440 DOVERCOURT DRIVE<br>WINNIPEG, MANITOBA | amec | DATUM: NAD99<br>PROJECTION: UTM Zone 0<br>SCALE: AS SHOWN | TITLE: TEST HOLE LOCATION PLAN | PROJECT NO: WX16667<br>FIGURE No. FIGURE 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: TH01 |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.57 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand




| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CL | CLAY FILL - silty, some sand, trace gravel, low plastic, moist, stiff, brown to dark grey, occasional oxidation inclusions | | 1 | | | 232 |
| 1 | | OL | ORGANIC CLAY - trace silt and sand, low to medium plastic, moist, firm, black, trace organics and rootlets | | 2 | | | 231 |
| 2 | | CH | CLAY - silty, trace sand, high plastic, moist, firm, dark grey | | 3 | | | 230 |
| 3 | | ML | SILT - low plastic, very moist to wet, soft, tan | | 4 | | | 229 |
| 4 | | | CLAY - silty, high plastic, moist, stiff, brown | | 5 | | | 228 |
| 5 | | | | | 6 | | | 227 |
| 6 | | | - occasional sulphate inclusions below 6.1m | | 7 | | | 226 |
| 7 | | | - brownish grey below 6.7m | | 8 | | | 225 |
| 8 | | CH | | | 9 | | | 224 |
| 9 | | | - firm, grey below 9.1m | | 10 | | | 223 |
| 10 | | | | | 11 | | | 222 |
| 11 | | | | | 12 | | | 221 |
| 12 | | | | | 13 | | | 220 |
| 13 | | | - trace silt till inclusions below 13.7m | | 14 | | | 219 |
| 14 | | | - trace sand below 14.5m | | | | | 218 |
| 15 | | | AUGER REFUSAL AT 14.6m BELOW EXISTING GROUND SURFACE ON SUSPECTED BOULDERS OR BEDROCK. | | | | | 217 |
| 16 | | | NOTES: No sloughing was observed during drilling. Very slight seepage was observed below 1.7m. Test hole remained open to 14.6m with no water accumulation upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 216 |
| 17 | | | | | | | | 215 |
| 18 | | | | | | | | 214 |
| 19 | | | | | | | | |



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|---|---|
| LOGGED BY: AL | COMPLETION DEPTH: 14.6 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 2 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: TH02 |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.21 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

■ POCKET PENETROMETER (kPa) ■ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CL | CLAY FILL - silty, trace sand and gravel, low plastic, moist, black, crumbly | | 1 | | | 232 |
| 1 | | | - trace rubble, bricks and wood pieces below 0.8m | | 2 | | | 231 |
| | | ML | SILT - trace clay, low plastic, moist to very moist, soft, tan | | 3 | | | |
| 2 | | CH | CLAY - silty, high plastic, moist, stiff, brown | | 4 | | | 230 |
| 3 | | | - firm to stiff below 2.3m | | 5 | | | 229 |
| 4 | | | TEST HOLE TERMINATED AT 3.0m BELOW EXISTING GROUND SURFACE. | | | | | 228 |
| 5 | | | NOTES: No sloughing or seepage was observed below ground surface. Test hole remained open to 3.0m and was dry upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 227 |
| 6 | | | | | | | | 226 |
| 7 | | | | | | | | 225 |
| 8 | | | | | | | | 224 |
| 9 | | | | | | | | 223 |
| 10 | | | | | | | | 222 |
| 11 | | | | | | | | 221 |
| 12 | | | | | | | | 220 |
| 13 | | | | | | | | 219 |
| 14 | | | | | | | | 218 |
| 15 | | | | | | | | 217 |
| 16 | | | | | | | | 216 |
| 17 | | | | | | | | 215 |
| 18 | | | | | | | | 214 |
| 19 | | | | | | | | |

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| LOGGED BY: AL | COMPLETION DEPTH: 3 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 3 | Page 1 of 1 |

16667 - DILLON NEW TRANSIT BUS GARAGE.GPJ 11/09/23 03:30 PM (GEOTECHNICAL REVISED)

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: TH03 |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.8 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

■ POCKET PENETROMETER (kPa) ■ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CL | CLAY FILL - some sand, trace gravel, low plastic, moist, black, crumbly | | 1 | | | 232 |
| 1 | | | - trace brick and rootlets below 0.8m | | 2 | | | |
| | | CH | CLAY - silty, high plastic, moist, firm to stiff, greyish brown | | 3 | | | 231 |
| 2 | | ML | SILT - trace clay, low plastic, moist to very moist, soft, tan | | 4 | | | |
| 3 | | CH | CLAY - silty, high plastic, moist, stiff, brown | | 5 | | | 230 |
| 4 | | | TEST HOLE TERMINATED AT 3.0m BELOW EXISTING GROUND SURFACE. | | | | | 229 |
| 5 | | | NOTES: No sloughing was observed below ground surface. Very slight seepage was observed below 1.7m from ground surface. Test hole remained open to 3.0m with no water accumulation upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 228 |
| 6 | | | | | | | | 227 |
| 7 | | | | | | | | 226 |
| 8 | | | | | | | | 225 |
| 9 | | | | | | | | 224 |
| 10 | | | | | | | | 223 |
| 11 | | | | | | | | 222 |
| 12 | | | | | | | | 221 |
| 13 | | | | | | | | 220 |
| 14 | | | | | | | | 219 |
| 15 | | | | | | | | 218 |
| 16 | | | | | | | | 217 |
| 17 | | | | | | | | 216 |
| 18 | | | | | | | | 215 |
| 19 | | | | | | | | 214 |

16667 - DILLON NEW TRANSIT BUS GARAGE.GPJ 11/09/23 03:30 PM (GEOTECHNICAL REVISED)

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| LOGGED BY: AL | COMPLETION DEPTH: 3 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 4 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH04** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.21 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

■ POCKET PENETROMETER (kPa) ■ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CL | CLAY FILL - silty, some to trace sand and gravel, low plastic, moist, crumbly, black | | 1 | | | 232 |
| 1 | | | - trace wood chips, stiff, dark grey below 0.8m | | 2 | | | 231 |
| 2 | | ML | SILT - trace clay, low plastic, moist to very moist, soft, tan | | 3 | | | 230 |
| 3 | | CH | CLAY - silty, high plastic, moist, stiff, brown | | 4 | | | 229 |
| 4 | | | | | 5 | | | 228 |
| 5 | | | - grey, occasional sulphate inclusions below 4.6m | | 6 | | | 227 |
| | | | | | 7 | | | |
| 6 | | | TEST HOLE TERMINATED AT 5.0m BELOW EXISTING GROUND SURFACE. | | | | | 226 |
| 7 | | | NOTES: No sloughing was observed below ground surface. Slight seepage was observed below 1.4m from ground surface. Test hole remained open to 4.9m and water level was measured at 4.7m upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 225 |
| 8 | | | | | | | | 224 |
| 9 | | | | | | | | 223 |
| 10 | | | | | | | | 222 |
| 11 | | | | | | | | 221 |
| 12 | | | | | | | | 220 |
| 13 | | | | | | | | 219 |
| 14 | | | | | | | | 218 |
| 15 | | | | | | | | 217 |
| 16 | | | | | | | | 216 |
| 17 | | | | | | | | 215 |
| 18 | | | | | | | | 214 |
| 19 | | | | | | | | |



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| LOGGED BY: AL | COMPLETION DEPTH: 5 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 5 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH05** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.75 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

■ POCKET PENETROMETER (kPa) ■ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | CLAY FILL - trace silt, sand and gravel, low plastic, moist, crumbly, black, trace rootlets | | 1 | | | 232 |
| 1 | | CL | - trace organics below 0.8m | | 2 | | | |
| 2 | | | - gravelly, trace bricks, wet below 1.5m | | 3 | | | 231 |
| | | ML | SILT - trace clay and sand, low plastic, very moist, soft, tan | | 4 | | | |
| 3 | | | CLAY - silty, high plastic, moist, stiff, greyish brown | | 5 | | | 230 |
| 4 | | CH | | | | | | 229 |
| 5 | | | | | 6 | | | 228 |
| | | | | | 7 | | | |
| 6 | | | TEST HOLE TERMINATED AT 5.0m BELOW EXISTING GROUND SURFACE. | | | | | 227 |
| 7 | | | NOTES: Moderate sloughing and seepage was observed below 1.5m from ground surface. Test hole remained open to 1.7m and water level was measured at 1.5m upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 226 |
| 8 | | | | | | | | 225 |
| 9 | | | | | | | | 224 |
| 10 | | | | | | | | 223 |
| 11 | | | | | | | | 222 |
| 12 | | | | | | | | 221 |
| 13 | | | | | | | | 220 |
| 14 | | | | | | | | 219 |
| 15 | | | | | | | | 218 |
| 16 | | | | | | | | 217 |
| 17 | | | | | | | | 216 |
| 18 | | | | | | | | 215 |
| 19 | | | | | | | | 214 |

16667 - DILLON NEW TRANSIT BUS GARAGE.GPJ 11/09/23 03:30 PM (GEOTECHNICAL REVISED)

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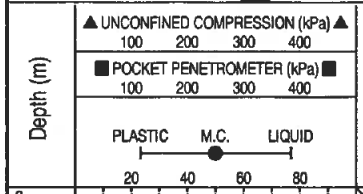
| LOGGED BY: AL | COMPLETION DEPTH: 5 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 6 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH06** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.24 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand




| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CL | CLAY FILL - sandy, some gravel, low plastic, moist, black | | 1 | | | 232 |
| | | | | | 2 | | | |
| 1 | | ML | SILT - trace clay, low plastic, moist to very moist, soft, tan | | | | | 231 |
| | | | | | 3 | | | |
| 2 | | | CLAY - silty, high plastic, moist, very stiff, brown | | | | | |
| | | | | | 4 | | | 230 |
| 3 | | | - stiff below 3.1m | | 5 | | | |
| | | | | | 6 | | | 229 |
| 4 | | | - firm below 3.7m | | | | | |
| | | | | | 7 | | | 228 |
| 5 | | | - occasional sulphate inclusions below 4.6m | | | | | |
| | | | | | | | | 227 |
| 6 | | | | | 8 | | | |
| | | | | | 9 | | | 226 |
| 7 | | | | | | | | |
| | | | | | | | | 225 |
| | | | | | 10 | | | |
| 8 | | CH | | | | | | 224 |
| 9 | | | | | 11 | | | |
| | | | - firm, grey below 9.1m | | 12 | | | 223 |
| 10 | | | | | | | | |
| | | | | | | | | 222 |
| | | | | | 13 | | | |
| 11 | | | - trace till inclusions below 10.7m | | | | | 221 |
| 12 | | | | | 14 | | | |
| | | | - soft below 12.2m | | | | | 220 |
| 13 | | | | | | | | |
| | | | | | | | | 219 |
| 14 | | | | | 15 | | | |
| | | | | | | | | 218 |
| 15 | | | SILT TILL - trace sand and gravel, low plastic, moist, soft, grey, trace rounded gravel | | 16 | | | 217 |
| | | ML | | | | | | |
| 16 | | | - damp below 15.9m | | | | | 216 |
| | | | | | 17 | | | |
| 17 | | | AUGER REFUSAL AT 16.5m BELOW EXISTING GROUND SURFACE ON SUSPECTED BOULDERS OR BEDROCK. | | | | | 215 |
| | | | NOTES: | | | | | |
| 18 | | | No sloughing was observed below ground surface. Very slight seepage was observed below 0.9m from ground surface. Test hole remained open to 16.5m and wth no water accumulation upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 214 |
| 19 | | | | | | | | |



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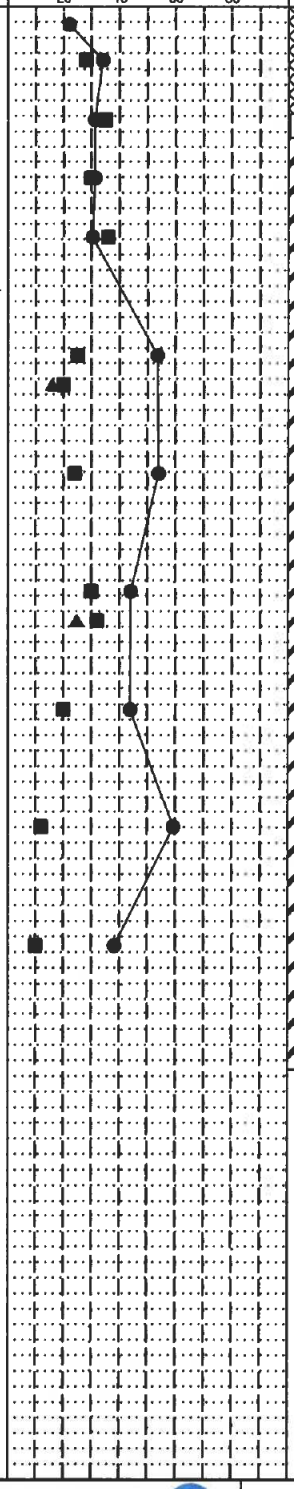
| LOGGED BY: AL | COMPLETION DEPTH: 16.5 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 7 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH07** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.7 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand




| SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|
| | CL | CLAY FILL - silty, trace sand, organics and rootlets, low plastic, moist, crumbly, black | | 1 | | | 232 |
| | | - trace gravel, stiff, occasional grey silt pockets below 0.8m | | 2 | | | |
| | ML-MI | SILT - clayey, low to medium plastic, moist, stiff, grey | | 3 | | | 231 |
| | | CLAY - silty, high plastic, damp to moist, stiff, brown | | 4 | | | 230 |
| | | | | 5 | | | 229 |
| | | - moist below 4.6m | | 6 | | | 228 |
| | | | | 7 | | | |
| | | | | 8 | | | 227 |
| | CH | - occasional sulphate inclusions below 7.6m | | 9 | | | 226 |
| | | - greyish brown below 8.2m | | 10 | | | 225 |
| | | - firm to stiff below 9.1m | | 11 | | | 224 |
| | | - trace silt till pockets, firm below 10.7m | | 12 | | | 223 |
| | | - trace gravel below 12.2m | | 13 | | | 222 |
| | | | | | | | 221 |
| | | | | | | | 220 |
| | | | | | | | 219 |
| | | | | | | | 218 |
| | | | | | | | 217 |
| | | | | | | | 216 |
| | | | | | | | 215 |
| | | | | | | | 214 |

TEST HOLE TERMINATED AT 13.7m BELOW EXISTING GROUND SURFACE DUE TO EXCESSIVE SEEPAGE.

NOTES:

No sloughing was observed during drilling. Significant seepage was observed at 0.9m below ground surface due to contact with an abandonded water line. Test hole remained open to 13.7m with water level at 3.7m upon completion of drilling. Test hole backfilled with 19mm down crushed gravel. Test hole was moved to avoid water line and re-drilled (see TH07-A).

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| LOGGED BY: AL | COMPLETION DEPTH: 13.7 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 8 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH07-A** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.7 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

■ POCKET PENETROMETER (kPa) ■ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | | TEST HOLE NOT LOGGED. SEE TH07 FOR STRATIGRAPHY DESCRIPTION | | | | | 232 |
| 1 | | | | | | | | |
| 2 | | | CLAY - silty, trace silt till inclusions, high plastic, moist, firm, grey | | | | | 231 |
| 3 | | | | | | | | 230 |
| 4 | | | | | | | | 229 |
| 5 | | | | | | | | 228 |
| 6 | | | | | | | | 227 |
| 7 | | | | | | | | 226 |
| 8 | | CH | | | | | | 225 |
| 9 | | | | | | | | 224 |
| 10 | | | | | | | | 223 |
| 11 | | | | | | | | 222 |
| 12 | | | | | | | | 221 |
| 13 | | | | | | | | 220 |
| 14 | | | | | 1 2 | | | 219 |
| 15 | | | | | 3 | | | 218 |
| 16 | | ML | SILT TILL - some clay, trace sand and gravel, low plastic, moist to very moist, grey to tan | | 4 | | | 217 |
| 17 | | | - moist, tan below 16.2m | | | | | 216 |
| 18 | | | AUGER REFUSAL AT 16.3m BELOW EXISTING GROUND SURFACE ON SUSPECTED BOULDERS OR BEDROCK. NOTES: Slight sloughing and seepage was observed below 15.2m below existin ground surface. Test hole remained open to 16.2m and water level was measured at 15.2m below grade upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 215 |
| 19 | | | | | | | | 214 |

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| LOGGED BY: AL | COMPLETION DEPTH: 16.3 m |
| REVIEWED BY: TG | COMPLETION DATE: September 9, 2011 |
| Figure No. 9 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH08** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.23 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

■ POCKET PENETROMETER (kPa) ■ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CI | CLAY FILL - some sand, trace gravel, medium plastic, moist, black, trace wood pieces | | 1 | | | 232 |
| 0.5 | | SM | SAND (FILL) - trace silt and gravel, poorly graded, fine grained, loose to compact (inferred), moist, dark brown | | 2 | | | |
| 1 | | ML | SILT - trace clay, low plastic, moist to very moist, soft, tan | | 3 | | | 231 |
| 1.5 | | | CLAY - silty, high plastic, moist, stiff, brown | | | | | |
| 2 | | | | | 4 | | | 230 |
| 3 | | CH | - occasional sulphate inclusions below 3.1m | | 5 | | | 229 |
| 4 | | | | | | | | 228 |
| 4.5 | | | | | 6 | | | |
| 5 | | | | | 7 | | | 227 |
| | | | TEST HOLE TERMINATED AT 5.0m BELOW EXISTING GROUND SURFACE. NOTES: No sloughing or seepage was observed below ground surface. Test hole remained open to 5.0m and was dry upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 226 |
| 6 | | | | | | | | 225 |
| 7 | | | | | | | | 224 |
| 8 | | | | | | | | 223 |
| 9 | | | | | | | | 222 |
| 10 | | | | | | | | 221 |
| 11 | | | | | | | | 220 |
| 12 | | | | | | | | 219 |
| 13 | | | | | | | | 218 |
| 14 | | | | | | | | 217 |
| 15 | | | | | | | | 216 |
| 16 | | | | | | | | 215 |
| 17 | | | | | | | | 214 |
| 18 | | | | | | | | |
| 19 | | | | | | | | |

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| LOGGED BY: AL | COMPLETION DEPTH: 5 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 10 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH09** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.34 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

■ POCKET PENETROMETER (kPa) ■ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CI | CLAY FILL - some sand, trace gravel, low plastic, moist, black | | 1 | | | 232 |
| 1 | | SM | SAND (FILL) - silty, poorly graded, medium to coarse grained, loose to compact (inferred), moist, tan to brown | | 2 | | | 231 |
| 2 | | | CLAY - silty, trace sand, medium to high plastic, moist, stiff, dark grey | | 3 | | | 230 |
| 3 ▼ | | CH | - high plastic, very stiff, brown below 2.3m | | 4 | | | 229 |
| 4 | | | | | 5 | | | 228 |
| 5 | | | TEST HOLE TERMINATED AT 5.0m BELOW EXISTING GROUND SURFACE. | | 6 | | | 227 |
| 6 | | | NOTES: No sloughing or seepage was observed below ground surface. Test hole remained open to 5.0m and was dry upon completion of drilling. Test hole backfilled with auger cuttings. | | 7 | | | 226 |
| 7 | | | | | | | | 225 |
| 8 | | | | | | | | 224 |
| 9 | | | | | | | | 223 |
| 10 | | | | | | | | 222 |
| 11 | | | | | | | | 221 |
| 12 | | | | | | | | 220 |
| 13 | | | | | | | | 219 |
| 14 | | | | | | | | 218 |
| 15 | | | | | | | | 217 |
| 16 | | | | | | | | 216 |
| 17 | | | | | | | | 215 |
| 18 | | | | | | | | 214 |
| 19 | | | | | | | | |

16667 - DILLON NEW TRANSIT BUS GARAGE.GPJ 11/09/23 03:30 PM (GEOTECHNICAL REVISED)

amec

**AMEC Environment & Infrastructure**
**Winnipeg, Manitoba**

| | |
|---|---|
| LOGGED BY: AL | COMPLETION DEPTH: 5 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 11 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH10** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.11 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

■ POCKET PENETROMETER (kPa) ■ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

| Depth (m) | SOIL SYMBOL | USCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | CI | CLAY (FILL) - sandy, some gravel, trace silt, medium plastic, moist, dark brown to black, trace wood pieces | | 1 | | | 232 |
| 1 | | CI | CLAY - silty, trace sand, medium plastic, moist, stiff, dark grey | | 2 | | | 231 |
| 2 | | CH | CLAY - silty, trace sand, high plastic, moist, stiff, brown | | 3 | | | 230 |
| | | ML | SILT - trace clay, low plastic, very moist to wet, soft, light brown | | 4 | | | |
| 3 | | CH | CLAY - silty, high plastic, moist, stiff, brown | | 5 | | | 229 |
| | | | TEST HOLE TERMINATED AT 3.0m BELOW EXISTING GROUND SURFACE. | | 6 | | | |
| 4 | | | NOTES: No sloughing or seepage was observed below ground surface. Test hole remained open to 3.0m and was dry upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 228 |
| 5 | | | | | | | | 227 |
| 6 | | | | | | | | 226 |
| 7 | | | | | | | | 225 |
| 8 | | | | | | | | 224 |
| 9 | | | | | | | | 223 |
| 10 | | | | | | | | 222 |
| 11 | | | | | | | | 221 |
| 12 | | | | | | | | 220 |
| 13 | | | | | | | | 219 |
| 14 | | | | | | | | 218 |
| 15 | | | | | | | | 217 |
| 16 | | | | | | | | 216 |
| 17 | | | | | | | | 215 |
| 18 | | | | | | | | 214 |
| 19 | | | | | | | | |

16667 - DILLON NEW TRANSIT BUS GARAGE.GPJ 11/09/23 03:30 PM (GEOTECHNICAL REVISED)

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**Winnipeg, Manitoba**

| | |
|---|---|
| LOGGED BY: AL | COMPLETION DEPTH: 3 m |
| REVIEWED BY: TG | COMPLETION DATE: September 8, 2011 |
| Figure No. 12 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH11** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.43 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand

▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400

■ POCKET PENETROMETER (kPa) ■ 100 200 300 400

PLASTIC M.C. LIQUID 20 40 60 80

| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | GP | GRANULAR FILL - sandy, gravelly, trace silt, poorly graded, medium to coarse grained, damp to moist, loose to compact (inferrred), light brown | | 1 | | | 232 |
| 1 | | | | | 2 | | | |
| | | CH | CLAY - silty, trace, sand, high plastic, moist, stiff, greyish brown | | 3 | | | 231 |
| | | ML | SILT - trace sand and clay, low plastic, moist, soft, light brown | | 4 | | | |
| 2 | | CH | CLAY - silty, high plastic, moist, very stiff, brown | | 5 | | | 230 |
| 3 | | | TEST HOLE TERMINATED AT 3.0m BELOW EXISTING GROUND SURFACE. | | 6 | | | 229 |
| 4 | | | NOTES: No sloughing or seepage was observed below ground surface. Test hole remained open to 3.0m and was dry upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 228 |
| 5 | | | | | | | | 227 |
| 6 | | | | | | | | 226 |
| 7 | | | | | | | | 225 |
| 8 | | | | | | | | 224 |
| 9 | | | | | | | | 223 |
| 10 | | | | | | | | 222 |
| 11 | | | | | | | | 221 |
| 12 | | | | | | | | 220 |
| 13 | | | | | | | | 219 |
| 14 | | | | | | | | 218 |
| 15 | | | | | | | | 217 |
| 16 | | | | | | | | 216 |
| 17 | | | | | | | | 215 |
| 18 | | | | | | | | 214 |
| 19 | | | | | | | | |

16667 - DILLON NEW TRANSIT BUS GARAGE.GPJ 11/09/23 03:30 PM (GEOTECHNICAL REVISED)

amec

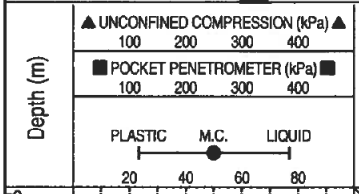
**AMEC Environment & Infrastructure**
**Winnipeg, Manitoba**

| | |
|---|---|
| LOGGED BY: AL | COMPLETION DEPTH: 3 m |
| REVIEWED BY: TG | COMPLETION DATE: September 9, 2011 |
| Figure No. 13 | Page 1 of 1 |

| | | |
|---|---|---|
| PROJECT: New Transit Bus Garage | DRILLED BY: Subterranean Ltd. | BORE HOLE NO: **TH12** |
| CLIENT: Dillon Consulting Limited | DRILL TYPE: Soil Mec SR-30 | PROJECT NO: WX16667 |
| LOCATION: West End of Brandon Avenue, Winnipeg, MB | DRILL METHOD: 508mm Solid Stem Auger | ELEVATION: 232.2 m |

SAMPLE TYPE: Shelby Tube; No Recovery; SPT (N); Grab Sample; Split-Pen; Core

BACKFILL TYPE: Bentonite; Pea Gravel; Drill Cuttings; Grout; Slough; Sand




| Depth (m) | SOIL SYMBOL | MUSCS | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | SPT (N) | COMMENTS | ELEVATION (m) |
|---|---|---|---|---|---|---|---|---|
| 0 | | GP | GRANULAR FILL - sandy, some gravel, poorly graded, medium to coarse grained, loose to compact (inferred), moist, brown | | 1 | | | 232 |
| 1 | | CI | CLAY (FILL) - sandy, silty, low plastic, moist, black | | 2 | | | 231 |
| 2 | | ML | SILT - trace clay and sand, low plastic, moist to very moist, soft, light grey to brown | | 3 | | | 230 |
| | | | CLAY - silty, trace sand, high plastic, moist, very stiff, brown | | 4 | | | |
| 3 | | | - stiff below 3.1m | | 5 | | | 229 |
| 4 | | | | | 6 | | | 228 |
| 5 | | | | | | | | 227 |
| 6 | | | - greyish brown, occasional sulphate inclusions below 6.1m | | 7 | | | 226 |
| 7 | | | | | | | | 225 |
| 8 | | | | | 8 | | | 224 |
| 9 | | CH | | | 9 | | | 223 |
| 10 | | | | | | | | 222 |
| 11 | | | - grey, firm to stiff below 10.7m | | 10 | | | 221 |
| 12 | | | - trace gravel and silt till inclusions below 12.2m | | 11 | | | 220 |
| 13 | | | | | 12 | | | 219 |
| 14 | | | | | | | | 218 |
| 15 | | | | | 13 | | | 217 |
| 16 | | ML | SILT (TILL) - sandy, some gravel, trace clay, low plastic, very moist to wet, compact (inferred), grey | | 14 | | | 216 |
| 17 | | | - gravelly, wet below 15.8m | | | | | |
| 18 | | | AUGER REFUSAL AT 16.0m BELOW EXISTING GROUND SURFACE ON SUSPECTED BOULDERS OR BEDROCK. | | | | | 215 |
| 19 | | | NOTES: Slight seepage observed below 15.3m, with moderate to heavy seepage observed below 15.8m. Test hole remained open to 15.8m and with water level at 13.7m upon completion of drilling. Test hole backfilled with auger cuttings. | | | | | 214 |

16667 - DILLON NEW TRANSIT BUS GARAGE.GPJ 11/09/23 03:30 PM (GEOTECHNICAL REVISED)

amec

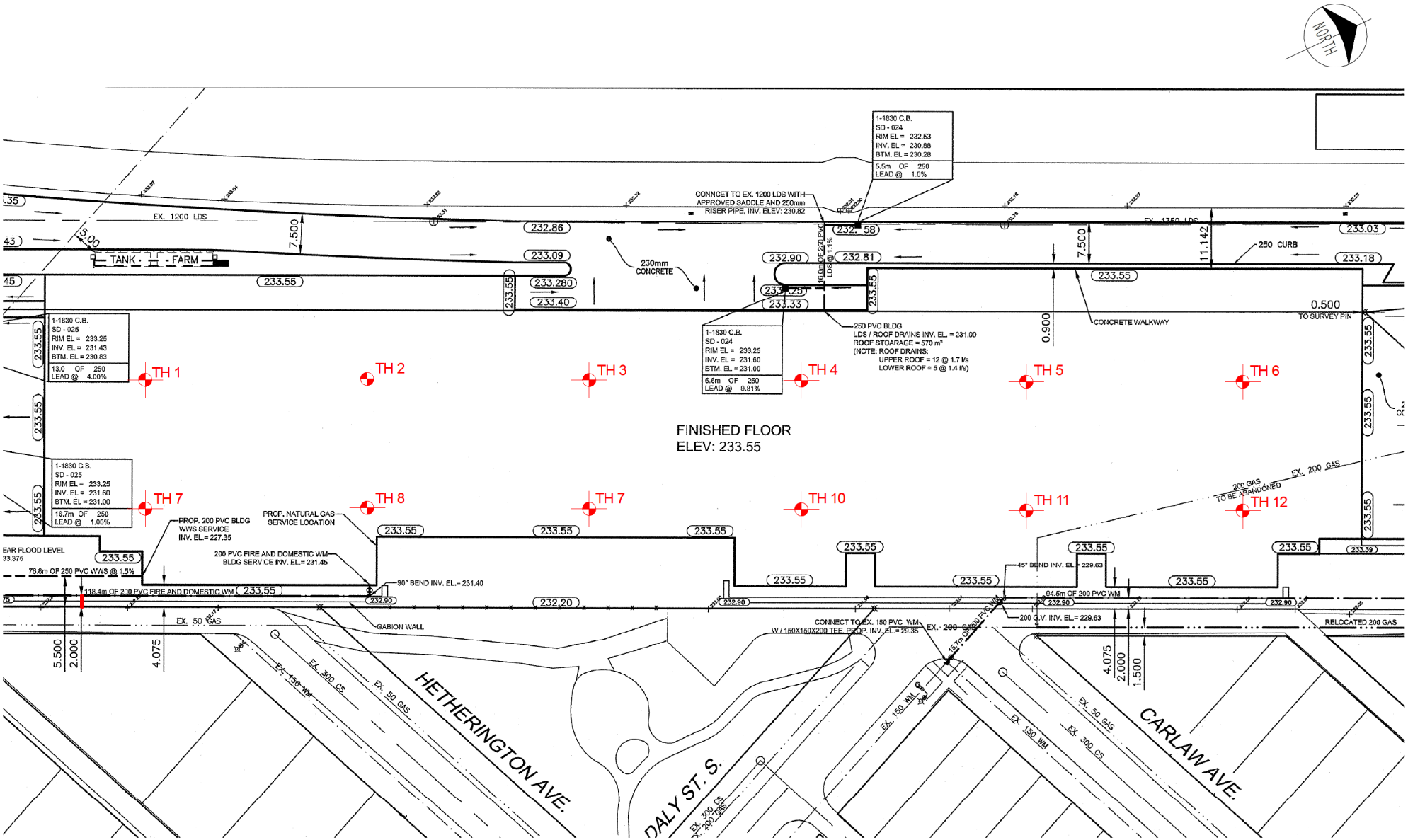
**AMEC Environment & Infrastructure**
**Winnipeg, Manitoba**

| | |
|---|---|
| LOGGED BY: AL | COMPLETION DEPTH: 16 m |
| REVIEWED BY: TG | COMPLETION DATE: September 9, 2011 |
| Figure No. 14 | Page 1 of 1 |

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

## APPENDIX B

# TESTHOLE LOCATION PLAN




| | | | | |
|---|---|---|---|---|
| THE NATIONAL TESTING LABORATORIES LIMITED *Established in 1923* | Project No.CAS-1201 | Drawn by:SB | Figure: 1 | Testhole Location Plan<br>Transit Bus Parking and Service Garage<br>600 Brandon Avenue<br>Winnipeg, Manitoba |
| | Date:October 5, 2012 | Reviewed by: DF | Scale: NTS | |

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

## APPENDIX C

# COMPACTION REPORTS

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

# COMPACTION REPORT

TO Caspian Projects Inc.
2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

CLIENT Caspian Projects Inc.
C.C.

PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

REPORT NO. 1 NO. OF COMPACTION TESTS 13 PROJECT NO. CAS-1201

CONTRACTOR Caspian Projects Inc.
TEST AREA Building Footprint
CONSTRUCTION TYPE Subgrade

DATE TESTED 2012.Sep.14
TIME TESTED 16:00
TESTED BY Kevin Hiraoka

| TEST NO. | TEST LOCATION | TEST DEPTH (mm) | LAB REFERENCE AND MATERIAL TYPE | MOISTURE CONTENT (%) | | DRY DENSITY (kg/m3) | | COMPACTION (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | FIELD | OPTIMUM | FIELD | LAB | |
| 1 | Line 32, 10 m east from line D | 250 | Proctor 5<br>Fill Material | 9.1 | 14.5 | 2066 | 1837 | 113 |
| 2 | Line 32, 10 m west from line D | 200 | Proctor 5<br>Fill Material | 6.0 | 14.5 | 2069 | 1837 | 113 |
| 3 | Line 26, 16 m west from line D | 250 | Proctor 5<br>Fill Material | 8.2 | 14.5 | 2065 | 1837 | 112 |
| 4 | Line 26, 22 m east from line D | 250 | Proctor 5<br>Fill Material | 8.8 | 14.5 | 1923 | 1837 | 105 |
| 5 | 3 m north of line 19, 11 m west from line D | 250 | Proctor 5<br>Fill Material | 9.0 | 14.5 | 1971 | 1837 | 107 |

FIELD METHOD Nuclear ASTM D6938
LABORATORY METHOD Standard Proctor ASTM D698
ROCK CORRECTION METHOD ASTM D4718 Proctor Density Correction
OVERSIZE SCREEN SIZE Passing #4 - 4.75mm

SPECIFIED COMPACTION 95 %

TEST RESULTS BELOW THE SPECIFIED COMPACTION INDICATED WITH AN *

COMMENTS
Material tested consisted of clay fill mixed with wood, metal, sand, gravel, cobbles up to 250 mm, brick & concrete. Materials tested are quite variable and may not be representative of the material tested for Proctor no. 5.



AAR AASHTO R18 ACCREDITED MATERIALS TESTING LABORATORY

REVIEWED BY Jason Thompson, C.E.T.

199 Henlow Bay, Winnipeg, Manitoba R3Y 1G4 Phone (204) 488-6999 Fax (204) 488-6947 Email info@nationaltestlabs.com

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

# COMPACTION REPORT

TO Caspian Projects Inc.
2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

CLIENT Caspian Projects Inc.
C.C.

PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

REPORT NO. 1 NO. OF COMPACTION TESTS 13 PROJECT NO. CAS-1201

CONTRACTOR Caspian Projects Inc.
TEST AREA Building Footprint
CONSTRUCTION TYPE Subgrade

DATE TESTED 2012.Sep.14
TIME TESTED 16:00
TESTED BY Kevin Hiraoka

| TEST NO. | TEST LOCATION | TEST DEPTH (mm) | LAB REFERENCE AND MATERIAL TYPE | MOISTURE CONTENT (%) | | DRY DENSITY (kg/m3) | | COMPACTION (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | FIELD | OPTIMUM | FIELD | LAB | |
| 6 | Line 20, 21 m east from line D | 150 | Proctor 5<br>Fill Material | 10.3 | 14.5 | 1964 | 1837 | 107 |
| 7 | Line 13, 14 m west from line D | 250 | Proctor 5<br>Fill Material | 13.4 | 14.5 | 1761 | 1837 | 96 |
| 8 | Line 13, 21 m east from line D, 0.4 m below grade (in trench near piles) | 250 | Proctor 5<br>Subgrade<br>Clay | 15.5 | 14.3 | 1605 | 1837 | 87 * |
| 9 | Line 7, 10 m west of line D. | 50 | Proctor 5<br>Subgrade<br>Clay | 13.1 | 14.3 | 1749 | 1837 | 95 |
| 10 | Retest of no. 9, alternate probe depth | 250 | Proctor 5<br>Subgrade<br>Clay | 12.9 | 14.3 | 1833 | 1837 | 100 |

FIELD METHOD Nuclear ASTM D6938
LABORATORY METHOD Standard Proctor ASTM D698
ROCK CORRECTION METHOD ASTM D4718 Proctor Density Correction
OVERSIZE SCREEN SIZE Passing #4 - 4.75mm

SPECIFIED COMPACTION 95 %

TEST RESULTS BELOW THE SPECIFIED COMPACTION INDICATED WITH AN *

COMMENTS
Material tested consisted of clay fill mixed with wood, metal, sand, gravel, cobbles up to 250 mm, brick & concrete. Materials tested are quite variable and may not be representative of the material tested for Proctor no. 5.



AAP AASHTO R18 ACCREDITED MATERIALS TESTING LABORATORY

REVIEWED BY Jason Thompson, C.E.T.

199 Henlow Bay, Winnipeg, Manitoba R3Y 1G4 Phone (204) 488-6999 Fax (204) 488-6947 Email info@nationaltestlabs.com

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

# COMPACTION REPORT

TO Caspian Projects Inc.
2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

CLIENT Caspian Projects Inc.
C.C.

PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

REPORT NO. 1 NO. OF COMPACTION TESTS 13 PROJECT NO. CAS-1201

CONTRACTOR Caspian Projects Inc.
TEST AREA Building Footprint
CONSTRUCTION TYPE Subgrade

DATE TESTED 2012.Sep.14
TIME TESTED 16:00
TESTED BY Kevin Hiraoka

| TEST NO. | TEST LOCATION | TEST DEPTH (mm) | LAB REFERENCE AND MATERIAL TYPE | MOISTURE CONTENT (%) | | DRY DENSITY (kg/m3) | | COMPACTION (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | FIELD | OPTIMUM | FIELD | LAB | |
| 11 | Line 7, 23 m east from line D | 250 | Proctor 5 Subgrade Clay | 8.9 | 14.3 | 1910 | 1837 | 104 |
| 12 | 3 m north of line 1, 4 m east from line D | 250 | Proctor 5 Subgrade Clay | 12.4 | 14.3 | 1905 | 1837 | 104 |
| 13 | Line 3, 22 m east from line D | 250 | Proctor 5 Subgrade Clay | 10.3 | 14.3 | 1903 | 1837 | 104 |

FIELD METHOD Nuclear ASTM D6938
LABORATORY METHOD Standard Proctor ASTM D698
ROCK CORRECTION METHOD ASTM D4718 Proctor Density Correction
OVERSIZE SCREEN SIZE Passing #4 - 4.75mm

SPECIFIED COMPACTION 95 %

TEST RESULTS BELOW THE SPECIFIED COMPACTION INDICATED WITH AN *

COMMENTS
Material tested consisted of clay fill mixed with wood, metal, sand, gravel, cobbles up to 250 mm, brick & concrete. Materials tested are quite variable and may not be representative of the material tested for Proctor no. 5.



AAR AASHTO R18 ACCREDITED MATERIALS TESTING LABORATORY

REVIEWED BY Jason Thompson, C.E.T.

199 Henlow Bay, Winnipeg, Manitoba R3Y 1G4 Phone (204) 488-6999 Fax (204) 488-6947 Email info@nationaltestlabs.com

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

# COMPACTION REPORT

TO Caspian Projects Inc.
2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

CLIENT Caspian Projects Inc.
C.C.

PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

REPORT NO. 2 NO. OF COMPACTION TESTS 10 PROJECT NO. CAS-1201

CONTRACTOR Caspian Projects Inc.
TEST AREA Building Footprint
CONSTRUCTION TYPE Subgrade

DATE TESTED 2012.Sep.25
TIME TESTED 13:30
TESTED BY R. Bremner

| TEST NO. | TEST LOCATION | TEST DEPTH (mm) | LAB REFERENCE AND MATERIAL TYPE | MOISTURE CONTENT (%) | | DRY DENSITY (kg/m3) | | COMPACTION (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | FIELD | OPTIMUM | FIELD | LAB | |
| 1 | Line 30, 40 m east of Rapid Transit road | 150 | Proctor 5<br>Fill Material | 16.3 | 14.5 | 1905 | 1837 | 104 |
| 2 | Line 30, 25 m east of Rapid Transit road | 150 | Proctor 5<br>Fill Material | 10.8 | 14.5 | 1837 | 1837 | 100 |
| 3 | Line 28, 40 m east of Rapid Transit road | 150 | Proctor 5<br>Fill Material | 21.0 | 14.5 | 1717 | 1837 | 94 * |
| 4 | Line 28, 28 m east of Rapid Transit road | 150 | Proctor 5<br>Fill Material | 17.0 | 14.5 | 1759 | 1837 | 96 |
| 5 | Line 21, 30 m east of Rapid Transit road | 150 | Proctor 5<br>Subgrade<br>Clay | 22.0 | 14.5 | 1723 | 1837 | 94 * |

FIELD METHOD Nuclear ASTM D6938
LABORATORY METHOD Standard Proctor ASTM D698
ROCK CORRECTION METHOD ASTM D4718 Proctor Density Correction
OVERSIZE SCREEN SIZE Passing #4 - 4.75mm

SPECIFIED COMPACTION 95 %

TEST RESULTS BELOW THE SPECIFIED COMPACTION INDICATED WITH AN *

COMMENTS
Material tested consisted of clay fill mixed with wood, metal, sand, gravel, cobbles up to 250 mm, brick & concrete. Compaction results were corrected based upon the oven-dry moisture content determined in the laboratory. Materials tested are quite variable and may not be representative of the material tested for Proctor no. 5.



AAR AASHTO R18 ACCREDITED MATERIALS TESTING LABORATORY

REVIEWED BY Jason Thompson, C.E.T.

199 Henlow Bay, Winnipeg, Manitoba R3Y 1G4 Phone (204) 488-6999 Fax (204) 488-6947 Email info@nationaltestlabs.com

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

# COMPACTION REPORT

TO Caspian Projects Inc.
2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

CLIENT Caspian Projects Inc.
C.C.

PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

REPORT NO. 2 NO. OF COMPACTION TESTS 10 PROJECT NO. CAS-1201

CONTRACTOR Caspian Projects Inc.
TEST AREA Building Footprint
CONSTRUCTION TYPE Subgrade

DATE TESTED 2012.Sep.25
TIME TESTED 13:30
TESTED BY R. Bremner

| TEST NO. | TEST LOCATION | TEST DEPTH (mm) | LAB REFERENCE AND MATERIAL TYPE | MOISTURE CONTENT (%) | | DRY DENSITY (kg/m3) | | COMPACTION (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | FIELD | OPTIMUM | FIELD | LAB | |
| 6 | Line 21, 40 m east of Rapid Transit road | 150 | Proctor 5 Subgrade Clay | 20.5 | 14.5 | 1632 | 1837 | 89 * |
| 7 | Line 15, 30 m east of Rapid Transit road | 150 | Proctor 5 Subgrade Clay | 27.9 | 14.5 | 1525 | 1837 | 83 * |
| 8 | Line 12, 45 m east of Rapid Transit road | 150 | Proctor 5 Subgrade Clay | 17.2 | 14.5 | 1752 | 1837 | 95 |
| 9 | Line 7, 20 m east of Rapid Transit road | 150 | Proctor 5 Subgrade Clay | 27.3 | 14.5 | 1491 | 1837 | 81 * |
| 10 | Line 5, 20 m east of Rapid Transit road | 150 | Proctor 5 Subgrade Clay | 22.5 | 14.5 | 1649 | 1837 | 90 * |

FIELD METHOD Nuclear ASTM D6938
LABORATORY METHOD Standard Proctor ASTM D698
ROCK CORRECTION METHOD ASTM D4718 Proctor Density Correction
OVERSIZE SCREEN SIZE Passing #4 - 4.75mm

SPECIFIED COMPACTION 95 %

TEST RESULTS BELOW THE SPECIFIED COMPACTION INDICATED WITH AN *

COMMENTS
Material tested consisted of clay fill mixed with wood, metal, sand, gravel, cobbles up to 250 mm, brick & concrete. Compaction results were corrected based upon the oven-dry moisture content determined in the laboratory. Materials tested are quite variable and may not be representative of the material tested for Proctor no. 5.

 2012.Oct.05

AAR ACCREDITED MATERIALS TESTING LABORATORY AASHTO R18

REVIEWED BY Jason Thompson, C.E.T.

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THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

## APPENDIX D

# LABORATORY TEST REPORTS

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

# MOISTURE - DENSITY RELATIONSHIP REPORT

TO
Caspian Projects Inc.
2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

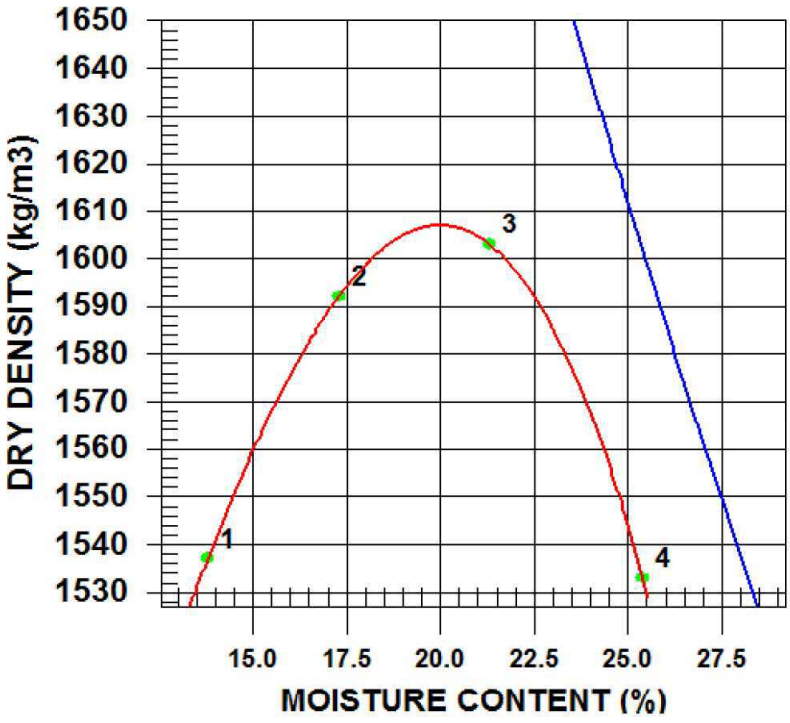
CLIENT Caspian Projects Inc.
C.C.

PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

PROCTOR NO. 1

PROJECT NO. CAS-1201

| | | | |
|---|---|---|---|
| DATE SAMPLED | 2012.Sep.14 | DATE RECEIVED | 2012.Sep.14 |
| SAMPLED BY | Larry Presado | DATE TESTED | 2012.Sep.18 |
| MATERIAL IDENTIFICATION | | COMPACTION STANDARD | Standard Proctor, ASTM D698 |
| MATERIAL USE | | | |
| MAX. NOMINAL SIZE | | COMPACTION PROCEDURE | A: 101.6mm Mold, Passing 4.75mm |
| MATERIAL TYPE | Fill Material | | |
| SUPPLIER | | OVERSIZE CORRECTION METHOD | ASTM 4718 |
| SOURCE | Shelby Tube Samples | RETAINED 4.75mm SCREEN | 18.1 % |




| TRIAL NUMBER | WET DENSITY (kg/m3) | DRY DENSITY (kg/m3) | MOISTURE CONTENT (%) |
|---|---|---|---|
| 1 | 1749 | 1537 | 13.8 |
| 2 | 1868 | 1592 | 17.3 |
| 3 | 1945 | 1603 | 21.3 |
| 4 | 1922 | 1533 | 25.4 |

| | MAXIMUM DRY DENSITY (kg/m3) | OPTIMUM MOISTURE CONTENT (%) |
|---|---|---|
| CALCULATED | 1607 | 20.0 |
| OVERSIZE CORRECTED | 1734 | 16.5 |

COMMENTS
Maximum dry density corrected for oversize materials (ASTM D4718). Material tested is a composite of shelby tube samples.

ACCREDITED MATERIALS TESTING LABORATORY
AASHTO R18

REVIEWED BY Jason Thompson, C.E.T.



199 Henlow Bay, Winnipeg, Manitoba R3Y 1G4 Phone (204) 488-6999 Fax (204) 488-6947 Email info@nationaltestlabs.com

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

# MOISTURE - DENSITY RELATIONSHIP REPORT

TO

Caspian Projects Inc.
2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

CLIENT Caspian Projects Inc.
C.C.

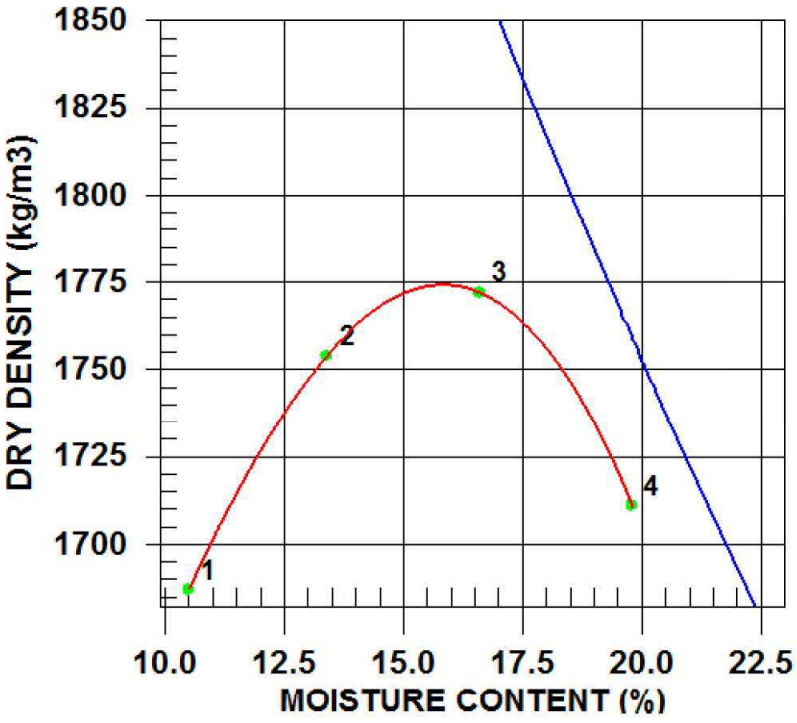
PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

PROCTOR NO. 2

PROJECT NO. CAS-1201

DATE SAMPLED 2012.Sep.14
SAMPLED BY Larry Presado
MATERIAL IDENTIFICATION
MATERIAL USE
MAX. NOMINAL SIZE
MATERIAL TYPE Fill Material
SUPPLIER
SOURCE Shelby Tube Samples

DATE RECEIVED 2012.Sep.14
DATE TESTED 2012.Sep.18
COMPACTION STANDARD Standard Proctor, ASTM D698
COMPACTION PROCEDURE A: 101.6mm Mold, Passing 4.75mm
OVERSIZE CORRECTION METHOD None
RETAINED 4.75mm SCREEN




| TRIAL NUMBER | WET DENSITY (kg/m3) | DRY DENSITY (kg/m3) | MOISTURE CONTENT (%) |
|---|---|---|---|
| 1 | 1864 | 1687 | 10.5 |
| 2 | 1989 | 1754 | 13.4 |
| 3 | 2066 | 1772 | 16.6 |
| 4 | 2050 | 1711 | 19.8 |

| | MAXIMUM DRY DENSITY (kg/m3) | OPTIMUM MOISTURE CONTENT (%) |
|---|---|---|
| CALCULATED OVERSIZE CORRECTED | 1774 | 16.0 |

COMMENTS
Material tested is a composite of shelby tube samples.

ACCREDITED MATERIALS TESTING LABORATORY
AASHTO R18

REVIEWED BY Jason Thompson, C.E.T.



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# MOISTURE - DENSITY RELATIONSHIP REPORT

TO
Caspian Projects Inc.
2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

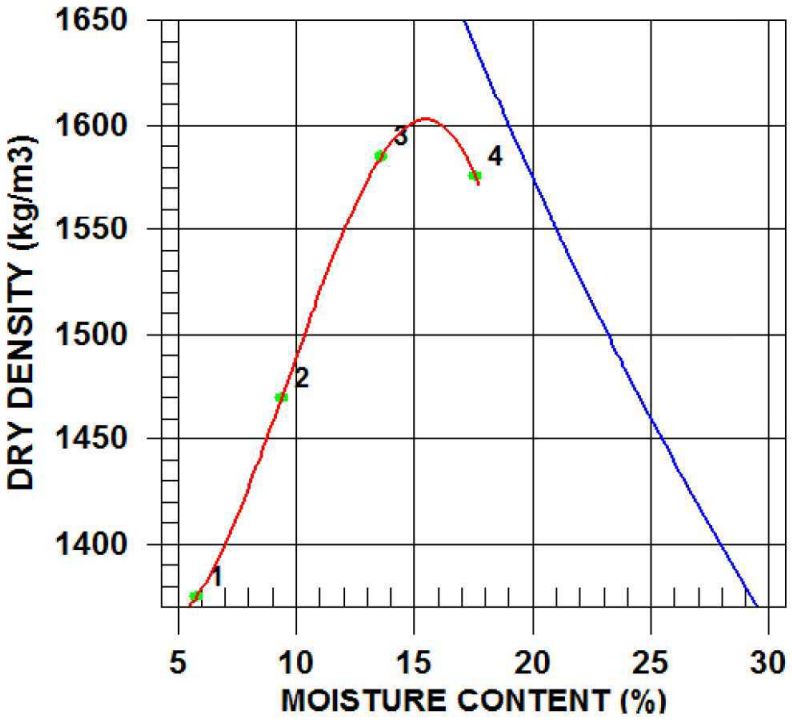
CLIENT Caspian Projects Inc.
C.C.

PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

PROCTOR NO. 3

PROJECT NO. CAS-1201

| | | | |
|---|---|---|---|
| DATE SAMPLED | 2012.Sep.14 | DATE RECEIVED | 2012.Sep.14 |
| SAMPLED BY | Larry Presado | DATE TESTED | 2012.Sep.18 |
| MATERIAL IDENTIFICATION | | COMPACTION STANDARD | Standard Proctor, ASTM D698 |
| MATERIAL USE | | | |
| MAX. NOMINAL SIZE | | COMPACTION PROCEDURE | A: 101.6mm Mold, Passing 4.75mm |
| MATERIAL TYPE | Fill Material | | |
| SUPPLIER | | OVERSIZE CORRECTION METHOD | ASTM 4718 |
| SOURCE | Shelby Tube Samples | RETAINED 4.75mm SCREEN | 19.7 % |




| TRIAL NUMBER | WET DENSITY (kg/m3) | DRY DENSITY (kg/m3) | MOISTURE CONTENT (%) |
|---|---|---|---|
| 1 | 1455 | 1375 | 5.8 |
| 2 | 1608 | 1470 | 9.4 |
| 3 | 1801 | 1585 | 13.6 |
| 4 | 1853 | 1576 | 17.6 |

| | MAXIMUM DRY DENSITY (kg/m3) | OPTIMUM MOISTURE CONTENT (%) |
|---|---|---|
| CALCULATED | 1603 | 15.5 |
| OVERSIZE CORRECTED | 1742 | 12.5 |

COMMENTS
Maximum dry density corrected for oversize materials (ASTM D4718). Material tested is a composite of shelby tube samples.

ACCREDITED MATERIALS TESTING LABORATORY
AASHTO R18

REVIEWED BY Jason Thompson, C.E.T.



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# MOISTURE - DENSITY RELATIONSHIP REPORT

TO
Caspian Projects Inc.
2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

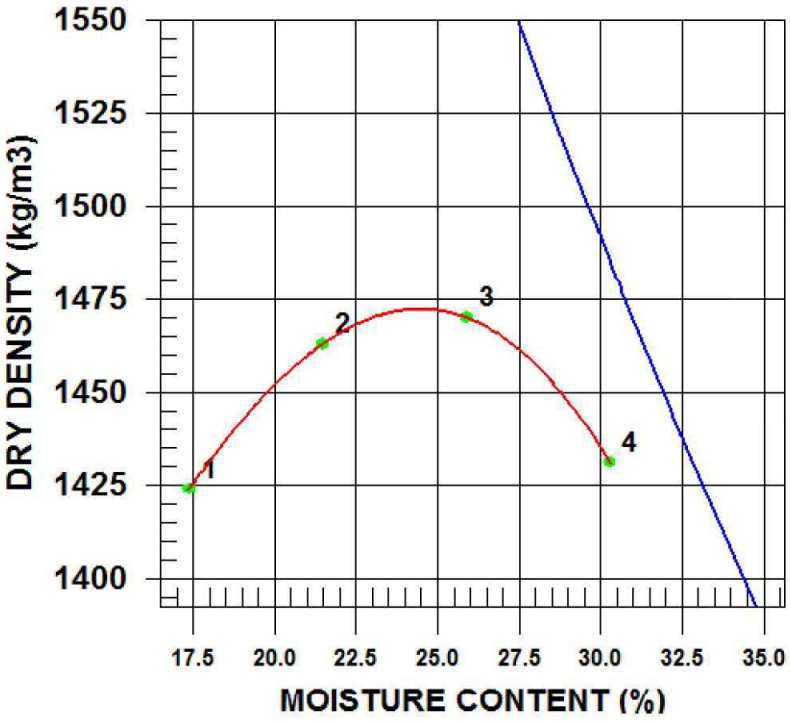
CLIENT Caspian Projects Inc.
C.C.

PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

PROCTOR NO. 4

PROJECT NO. CAS-1201

| | | | |
|---|---|---|---|
| DATE SAMPLED | 2012.Sep.14 | DATE RECEIVED | 2012.Sep.14 |
| SAMPLED BY | Larry Presado | DATE TESTED | 2012.Sep.17 |
| MATERIAL IDENTIFICATION | | COMPACTION STANDARD | Standard Proctor, ASTM D698 |
| MATERIAL USE | | | |
| MAX. NOMINAL SIZE | | COMPACTION PROCEDURE | A: 101.6mm Mold, Passing 4.75mm |
| MATERIAL TYPE | Native Clay | | |
| SUPPLIER | | OVERSIZE CORRECTION METHOD | None |
| SOURCE | Shelby Tube Samples | RETAINED 4.75mm SCREEN | |




| TRIAL NUMBER | WET DENSITY (kg/m3) | DRY DENSITY (kg/m3) | MOISTURE CONTENT (%) |
|---|---|---|---|
| 1 | 1672 | 1424 | 17.4 |
| 2 | 1777 | 1463 | 21.5 |
| 3 | 1851 | 1470 | 25.9 |
| 4 | 1865 | 1431 | 30.3 |

| | MAXIMUM DRY DENSITY (kg/m3) | OPTIMUM MOISTURE CONTENT (%) |
|---|---|---|
| CALCULATED OVERSIZE CORRECTED | 1472 | 24.5 |

COMMENTS
Material tested is a composite of shelby tube samples.

ACCREDITED MATERIALS TESTING LABORATORY
AASHTO R18

REVIEWED BY Jason Thompson, C.E.T.



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# MOISTURE - DENSITY RELATIONSHIP REPORT

TO

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2245 McGillivray Blvd.
Winnipeg, MB
R3Y 1S6

ATTN: Shaun Babakhanians

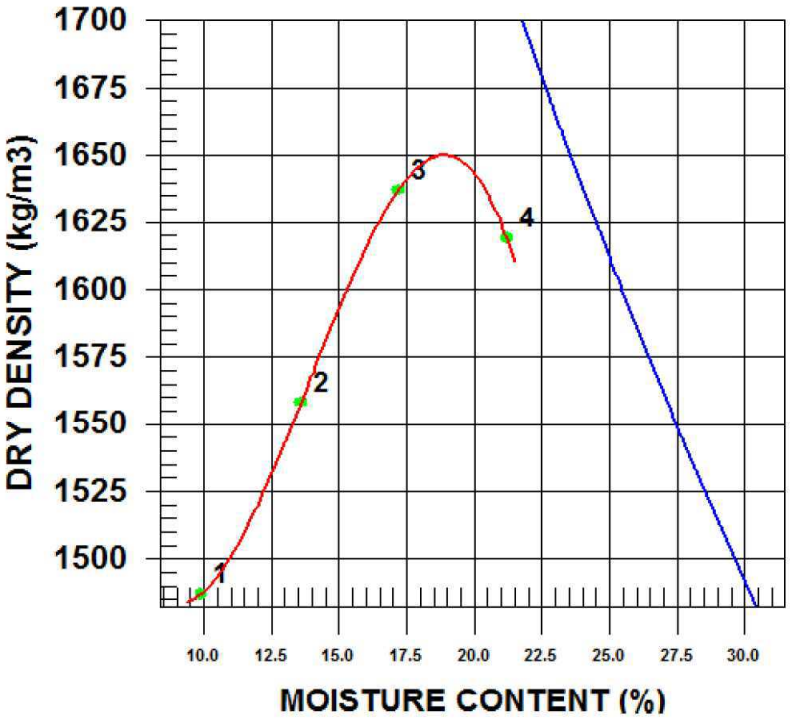
CLIENT Caspian Projects Inc.
C.C.

PROJECT City of Winnipeg RFP No. 901-2011
Transit Bus Parking &
Service Garage

PROCTOR NO. 5

PROJECT NO. CAS-1201

| | | | |
|---|---|---|---|
| DATE SAMPLED | 2012.Sep.14 | DATE RECEIVED | 2012.Sep.14 |
| SAMPLED BY | Kevin Hiraoka | DATE TESTED | 2012.Sep.19 |
| MATERIAL IDENTIFICATION | | COMPACTION STANDARD | Standard Proctor, ASTM D698 |
| MATERIAL USE | | | |
| MAX. NOMINAL SIZE | | COMPACTION PROCEDURE | A: 101.6mm Mold, Passing 4.75mm |
| MATERIAL TYPE | Fill Material | | |
| SUPPLIER | | OVERSIZE CORRECTION METHOD | ASTM 4718 |
| SOURCE | Field Density Locations | RETAINED 4.75mm SCREEN | 26.2 % |




| TRIAL NUMBER | WET DENSITY (kg/m3) | DRY DENSITY (kg/m3) | MOISTURE CONTENT (%) |
|---|---|---|---|
| 1 | 1634 | 1487 | 9.9 |
| 2 | 1770 | 1558 | 13.6 |
| 3 | 1918 | 1637 | 17.2 |
| 4 | 1962 | 1619 | 21.2 |

| | MAXIMUM DRY DENSITY (kg/m3) | OPTIMUM MOISTURE CONTENT (%) |
|---|---|---|
| CALCULATED | 1650 | 19.0 |
| OVERSIZE CORRECTED | 1837 | 14.5 |

COMMENTS
Maximum dry density corrected for oversize materials (ASTM D4718). Material tested is a composite of samples obtained from field density test locations.

ACCREDITED MATERIALS TESTING LABORATORY
AASHTO R18

REVIEWED BY Jason Thompson, C.E.T.



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