GEOTECHNICAL INVESTIGATION
EAST DISTRICT POLICE STATION
ST. BONIFACE INDUSTRIAL PARK
WINNIPEG, MANITOBA

Submitted to:

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30 June 2006

AMEC File no. WX15309

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1.0 INTRODUCTION

AMEC Earth and Environmental, a division of AMEC Americas Limited (AMEC), was retained by Number Ten Architectural Group to conduct a geotechnical investigation for the proposed East District Police Station to be located in the St. Boniface Industrial Park in Winnipeg, Manitoba. The Terms of Reference were presented in AMEC's proposal WPG2006.129, dated 1 May 2006. The purpose of the geotechnical investigation was to determine the local subsurface soil and groundwater conditions and, on this basis, to provide geotechnical recommendations for the design and construction of foundations and floor slabs for the proposed building and asphalt pavement for the proposed parking lot.

2.0 PROPOSED FACILITIES

Based on the information and drawings provided by Number Ten Architectural Group, it was understood that the proposed police station will be two storeys in height and will cover an area of approximately 2,230 m^2 (24,000 ft^2) and will be located within a grass covered open field. A crawlspace is expected to underlie most of the main floor and no basement is anticipated. The building construction is expected to consist of open-web steel roof joists supporting a steel deck, and open-web steel floor joists supporting steel deck and concrete topping. The exterior walls will be a combination of concrete block and steel stud, both with brick veneers. The interior partitions will also be a combination of concrete block and steel stud/gypsum board assemblies. The garage floor may be structural concrete although a slab on grade is also possible.

There is a possibility of future development of a Canine Training Facility at the south end of the property. This would be a single storey structure; likely slab-on-grade floor with concrete block interior and exterior walls.

A total of 139 asphalt paved parking spaces will be required for employees, cruisers and visitors with traffic areas connecting. Concrete sidewalks will also be provided around the building. The balance of the site will be landscaped. The layout of the proposed development is shown on Figure 1.

3.0 SITE CONDITIONS

The site is situated on the northeast side of the intersection of Durand Road and directly south of Dugald Road in the St. Boniface Industrial Park. The site is currently vacant and consists of a grass covered field that has been built up with clay fill. The site is enclosed by Dugald Road to the north, an undeveloped property to the east and commercial buildings to the west and south. The site is relatively flat lying.

4.0 FIELD INVESTIGATION

On 5 June 2006 and 14 June 2006, a total of eleven (11) test holes (TH1 through TH11) were drilled at the proposed oolice station, canine training unit and parking lot locations utilizing a CME75 truck mounted drill rig equipped with 150 mm diameter solid stem, continuous flight augers, and operated by Subterranean Limited of Winnipeg, Manitoba. Test hole logging and site supervision was provided by Mr. Jason Plohman of AMEC on a full-time basis. Test holes TH1 to TH3 were drilled within the proposed building footprint and were advanced to auger refusal for the purpose of assessing deep piled foundation options. Test holes TH4 to TH10 were drilled within the proposed parking lot and driveway areas, to depths ranging from 2.3 to 3.0 m for assessment of possible fill materials and to provide information relating to asphalt pavement design. Test Hole TH11 was also drilled to auger refusal, within the proposed future development area at the south of end of the site. The approximate test hole locations, as specified by Number Ten Architectural Group, are shown on the Test Hole Location Plan (Figure 1). The details of the test holes depths and locations are summarized in Table I.

Table I: Summary of Test Hole Depths and Locations

Location	Test Hole Number	Test Hole Depth (m) Below Grade
Proposed Building Footprint	TH1*	19.5
	TH2*	16.5
	TH3*	17.1
Proposed Parking Lot and Driveway	TH4	2.4
	TH5	2.4
	TH6	2.4
	TH7	2.4
	TH8	2.4
	TH9	3.0
	TH10	3.0
Future Development	TH11*	18.0

Notes: * test hole drilled to auger refusal

All soils observed during test hole drilling were visually classified on site according to the Modified Unified Soil Classification System. Groundwater and drilling conditions, as well as any pertinent subsurface observations, were also recorded at the time of the investigation. Disturbed soil samples were taken at regular intervals from the auger cuttings and relatively undisturbed Shelby tube samples were obtained at select depths in test hole TH2. Pocket Penetrometer tests were performed on auger cuttings and on the ends of the Shelby tube samples during drilling to estimate the undrained shear strength of the clay soils.

Each test hole was backfilled with auger cuttings at the completion of drilling, after verification of short-term sloughing and seepage conditions. Excess cuttings were left adjacent to the test hole locations.

The test hole logs are presented in Appendix A and show the soil profile, results of the field and laboratory testing, and comments relative to groundwater and sloughing conditions encountered.

5.0 LABORATORY TESTING

All soil samples obtained during the field investigation were labelled, sealed in plastic bags to limit moisture loss and transported to AMEC's Soils Laboratory in Winnipeg for further examination and testing. Select samples were visually classified and tested to determine their natural moisture contents and unconfined compressive strengths. The laboratory results are shown on the individual test holes logs in Appendix A.

6.0 SUBSURFACE CONDITIONS

6.1 SOIL PROFILE

The general soil stratigraphy at the site, as noted in descending order from the ground surface at the test holes locations, was as follows:

- Fills (Topsoil and Clay)
- High Plastic Clay with interbedded Silt
- Silt Till

Fills

A 50 to 250 mm thick grass covered organic layer (i.e. topsoil) was encountered at the surface of all of the test holes.

Clay fill was encountered underlying the topsoil at all of the test holes and extended to depths ranging from 0.5 to 1.2 m below existing ground surface. The clay fill was typically high plastic, moist, stiff, brown to dark brown and contained trace amounts of sand, numerous silt pockets and organics inclusions.

High Plastic Clay

Native high plastic clay was encountered below the clay fill in all of the test holes and extended to depths ranging from approximately 14.0 to 15.8 m below existing ground surface in the deep test holes (TH1 to TH3 and TH11) and to the depths explored in test holes TH4 to TH10. The high plastic clay was moist, stiff, grey to dark grey with some silt and trace amounts of fine sand and organics present between about 1.2 to 1.8 m below grade. Below this depth the clay became mottled grey and brown with oxidation and trace amounts of silt and sulphate inclusions, further becoming soft to firm, very moist and grey in colour with increasing depth.

Based on laboratory testing conducted, the moisture content of the high plastic clay ranged from about 32% to 56%.

Layers of silt were encountered within the native high plastic clay layer in each of the test holes with the exception of test holes TH's 4, 6 to 8 and 11. The silt layers were encountered at depths ranging from 2 to 3 m below existing ground surface and were generally about 200 to 400 mm thick. The silt was clayey, non to medium plastic, moist, soft to firm and light brown with oxidation.

Silt Till

Silt till was encountered underlying the high plastic clay at the deep test hole locations (i.e. TH1 to TH3 and TH11) and extended to the depths explored. The silt till was low plastic, wet and loose, becoming damp and dense with depth. The till was generally light brown or light grey and contained some sand and gravel.

6.2 POWER AUGER REFUSAL

Practical auger refusal was achieved in test holes TH1 to TH3 and TH11 at depths ranging approximately 16.5 to 19.5 m below the existing ground surface. Based on auger resistance at this refusal depth, it is inferred that cobbles, boulders or very dense silt till prevented further advancement of the auger at these locations.

6.3 GROUNDWATER CONDITIONS

The test holes were left open for approximately five to ten minutes after completion of drilling to observe short-term groundwater seepage and sloughing conditions. Minor groundwater seepage and soil sloughing were encountered from the silt till layers in the deep test holes (i.e. TH1 to TH3 and TH11). Neither significant sloughing nor seepage conditions were observed in the shallow test holes (TH4 to TH10). Water levels recorded immediately prior to backfilling the deep test holes were from 14 to 16.5 m below grade.

It should be noted that only short-term seepage and sloughing conditions were observed and that groundwater levels can fluctuate annually, seasonally or as a result of construction activity.

7.0 DISCUSSION AND RECOMMENDATIONS

7.1 FOUNDATIONS

Based on the subsurface conditions observed at the test holes locations, deep piled foundation systems consisting of either cast-in-place concrete friction piles or driven pre-cast concrete end bearing piles are considered to be suitable alternatives for the proposed structure. Cast-in-place concrete friction piles are typically well suited for the support of relatively light loads (i.e. up to about 265 kN), while pre-cast concrete end bearing piles are better suited for more highly loaded conditions (i.e. up to 800 kN). Given that the foundation loads are expected to be relatively light, cast-in-place concrete friction piles are likely the preferred foundation alternative for the proposed building. Where higher loads are present, AMEC can provide recommendations for the design and construction of driven pre-cast concrete piles.

Shallow foundations such as spread or strip footings are not recommended since they would potentially be subject to considerable vertical movements due to consolidation and / or swelling and shrinkage of the high plastic clay under loading.

7.1.1 Cast-in-Place Concrete Friction Piles

Cast-in-place concrete friction piles are commonly used to support relatively light loads, with pile groups used to support heavier loads. Cast-in-place piles may be designed on the basis of the allowable skin friction values provided in Table II, applied to the pile circumference within the high plastic clay.

Table II: Allowable Skin Friction Values

Depth Interval From Grade	Allowable Skin Friction
	Compressive Loading
0 – X m	0 kPa
X m – 11.0 m	17 kPa
11.0 m – 13.0 m	12 kPa

where X = depth of fill; or,
= 1.5 m for interior heated piles; or
= 2.4 m for exterior or unheated piles; whichever is deeper

Groups of two piles can be effectively utilized without a group reduction factor, whereas the total load carrying capacity of groups of three or more piles may be somewhat less than the sum of the individual pile capacities. Where groups of three or more piles are planned, this office should be contacted to review the proposed pile layout such that a suitable group reduction factor may be provided, if required, based on pile layout and spacing.

Further design and construction recommendations for concrete friction pile design are summarized below:

1. The contribution from end bearing should be ignored.
2. The piles should be spaced a minimum of three pile diameters, measured centre to centre.

3. Piles located in unheated areas should have a minimum length of 8 m, while piles located in heated areas should have a minimum length of 6 m, as measured from the final grade.
4. All piles should be provided with adequate steel reinforcement designed by a structural engineer. Notwithstanding the structural design requirements for steel reinforcement, all piles should be provided with steel reinforcement to the minimum pile depths as noted in bullet number 3 above.
5. If the piles are subject to freezing at any time during construction or prior to completion of the heated structure, then the piles should be designed as if for an unheated structure.
6. The weight of the embedded portion of the pile may be neglected in the design.
7. Concrete should be placed as soon as practical following the drilling of each pile.
8. Seepage and sloughing may occur in pile holes where silt lenses are present. As such, steel sleeves should be available on site and utilized as required during construction to control ground water seepage and sloughing in the pile holes and to maintain pile holes in a clean, dry condition.
9. A void space (minimum of 150 mm thick) should be constructed, using a compressible and biodegradable cardboard material, below all piles caps and grade beams to accommodate the expansive nature of the underlying soil.
10. Piles should not extend past 14 m from the existing grade, so as to avoid penetration of the silt till layer and the corresponding potential for seepage.

7.2 CONCRETE FLOOR SLABS

It was reported that the proposed building will be built with a crawl space underlying a structurally supported floor slab with the future development likely being supported by a grade-supported floor slab. The recommendations contained in this section provide a discussion of risk associated with the performance of grade supported concrete floors and provide design considerations for alternate floor options. Options considered for concrete floor slabs include:

- Grade supported floor slab
- Structurally supported floor slab

Grade supported floor slabs constructed over swelling clays in the Winnipeg area are generally subject to long-term movements which are typically in the order of 25 to 50 mm but may be as high as 150 mm or more under extreme circumstances. These movements are associated with the relatively thick deposit of high plastic clay which underlies the Winnipeg region. The high plastic clay can undergo volumetric changes as a result of moisture content variations. That is, when the moisture content increases, the soil swells and when it decreases the soil shrinks. Construction of buildings and pavements tends to change natural evaporation routes, generally leading to long-term increases in soil moisture content and therefore, swelling.

At this site, the high plastic clay fill and native high plastic clay is considered to be susceptible to long-term volumetric changes. Moisture contents within the clay materials range from 32% to 42% to a depth of 3 m. Given the existing moisture data, the presence of non swelling silt layers within the clay and considerable previous experience with similar conditions in Winnipeg, the overall swelling potential of the soil at the site is about average for the Winnipeg area. As such, long-term swelling movements, potentially in the order of 25 and up to 50 mm, should be accounted for in the design.

During the geotechnical investigation up to about 1.2 m of clay fill was encountered within the proposed footprint of the police station to be located at the north end of the property, while only about 0.6 m of fill was present in the general vicinity of the future canine training centre. The fill generally appeared to be stiff and relatively clean, although some of the fill in the proposed pavement areas was less uniform. Depending on the placement history of the fill, some movements associated with settlement of the fill should be anticipated and these could range from about 1 to 5% of the fill thickness. Where all fill is removed and replaced with well compacted engineered fill the potential for fill settlement can essentially be eliminated. This, however, may become costly. Alternatively, the risk of fill settlement can be reduced considerably by removing the upper 0.6 m of the fill, recompacting the exposed subgrade surface and replacing with well compacted, engineered fill.

In summary, grade-supported slabs are considered to be a suitable option for the future development, where the existing topsoil and a minimum of 0.6 m of the existing fill materials are removed, and assuming that some long-term slab movements can be tolerated. Alternatively, a structurally supported floor slab should be considered (as is proposed for the police station building).

7.2.1 Grade Supported Floor Slab

If the above noted potential for movements is considered to be acceptable to the owner, recommendations for slab-on-grade construction are as follows:

1. Excavate to the design subgrade elevation while further ensuring that all surficial vegetation, organic soils and underlying fill materials within the slab area are removed to a minimum depth of 0.6 m below the existing grade. The exposed subgrade at this depth is anticipated to consist of stiff high plastic clay fill or native high plastic clay.
2. The subgrade should be protected from frost, desiccation and inundation prior to, during and after construction.
3. Once design subgrade elevation has been achieved, the subgrade should be evaluated by competent and knowledgeable geotechnical personnel to identify any soft or weak zones. The subgrade should be proof rolled with heavy non-vibratory equipment such as a fully loaded tandem truck or a sheepsfoot compactor.
4. Any soft or weak areas identified should be replaced, repaired or bridged prior to the placement of any fill materials. Where conditions allow, the subgrade surface should be

compacted with a heavy sheepsfoot (pad foot) roller to a minimum of 95% of standard Proctor maximum dry density (SPMDD).

5. Below slab granular fill should consist of a minimum of 200 mm of granular sub-base topped by 150 mm of granular base course uniformly compacted to a minimum of 98% and 100% of SPMDD, respectively.
6. Additional fill materials, if required between the subgrade elevation and the underside of the granular section described above, may consist of the existing clay fill (free from any deleterious material such as organic or silt pocket) approved for reuse or granular sub-base. The clay or granular fill material should be placed in 150 and 200 mm thick lifts, respectively, and uniformly compacted to 98% of SPMDD. It is extremely important that any clay fill used be placed and compacted with a moisture content on the wet side of (i.e. greater than) the optimum moisture content, otherwise the potential for swell could be aggravated. In addition, clay fill should not be placed over either granular fill or bridging materials.
7. A polyethylene vapour barrier may be utilized below the floor slab to limit moisture migration through the slab. It should be noted that curing problems and curling of the slab at the edges might be encountered where the concrete slab is cast directly on the poly. To limit the potential for slab curling, that slab may be cast over 100 mm of clean sand placed over the vapour barrier. Where the concrete will not require a finished floor covering, a vapour barrier is not necessarily required.

To limit the effects of slab movements on the building structure, the following provisions are recommended:

I. Design equipment and partition walls bearing on the slab with a void space to minimize the potential for structural damage if the slab heaves.
II. Provide control joints at regular intervals in the slab to reduce random cracking.
III. Construct the floor independent of structural elements by the use of isolation joints.

7.2.2 Structurally Supported Floor Slab & Crawl Space

It was reported that the proposed east district police station will likely be designed with a structurally supported floor slab with a crawl space. The crawl space should be provided under the floor slab to separate the soil from the floor, or alternatively the floor can be constructed over a compressible and biodegradable void form at least 150 mm thick. If a crawl space is utilized, the base of the crawl space should be covered with a vapour barrier and a 100 mm thick protective cover of sand. The crawl space should also be heated, ventilated and well drained using a sub-drainage system as described in Section 7.4. Preparation of the subgrade for a structurally supported slab should include the removal of all organic soils to reduce the potential of producing methane gas below the slab.

7.3 FOUNDATION CONCRETE

The degree of exposure of concrete in contact with soil to sulphate attack is classified in CSA-A23.1-04 (Concrete Materials and Methods of Concrete Construction) as moderate, severe or very severe. Based on significant data gathered through previous work in the Winnipeg area and in accordance with the Manitoba Building Code, the degree of exposure for soil in Winnipeg is commonly classified as severe. Therefore, all the concrete in contact with the native soils should be made with sulphate resistant cement (CSA Type 50). Furthermore, the concrete should have a minimum specified 28-day compressive strength of 32 MPa and have a maximum water to cement ratio of 0.45 in accordance with Tables 2 and 3, CSA-A23.1-04. Concrete exposed to freeze-thaw cycles should be adequately air entrained to improve freeze-thaw durability in accordance with Table 4, CSA-A23.1-04

7.4 DRAINAGE AND SUB-DRAINAGE

Drainage adjacent to the building should promote runoff away from the structure. A minimum gradient of about 2% should be used for both landscaped and paved areas immediately around the buildings. All paved areas should be provided with minimum slopes of 2% to improve long-term drainage. Excavations at the perimeter of the building (grade beams, etc.) should be backfilled with well-compacted fill, topped with a medium to high plastic clay cap a minimum of 0.6 m thick to reduce the amount of surface water infiltration into the granular layer below the floor slab.

A suitable subdrainage system consisting of perimeter and interior perforated drain tile wrapped in geotextile and spaced equally across the floor slab at 7 to 10 m spacings is recommended to be used where a structural floor slab is constructed over a crawlspace. All perforated drain tile should be laid in trenches founded at a minimum depth of 300 mm below the underside of the crawlspace floor and backfill with free draining stone. Perimeter drain tile should be connected to solid leaders before crossing beneath the perimeter grade beams and entering the crawlspace area. All trenches for solid and perforated drain tile should be graded to a sump at a minimum gradient of 2%.

7.5 FLEXIBLE PAVEMENTS

The construction and performance of the flexible pavements at this site will be influenced by the existing fill to some degree. However, due to the stiffness of the existing clay fill in the parking lot area and the fact that some movements within a paved area are likely tolerable, full depth fill removal is not considered to be necessary. Depending on the final elevation of the paved parking lot, the presence of a highly frost susceptible silt lenses at depths ranging from 2 to 3 m below existing ground level may pose a potential problem associated with the long-term effects of frost action on the finished pavement surface, however, given the depth, these are considered to pose limited risk. Care should be taken to limit disturbance of the silt, if encountered, during construction. The asphalt should be provided with sufficient surface gradient to promote good drainage and a regularly scheduled maintenance program should be initiated following construction to repair any cracks that may develop. On this basis, the procedure for subgrade preparation and fill placement for the parking lot area is described below.

7.5.1 Subgrade Preparation

For flexible pavement construction, subgrade preparation should be as follows, assuming that the finished flexible pavement grade is approximately the same as existing ground surface at the site:

1. Excavate the parking area to the design subgrade elevation, while further ensuring that all surficial vegetation and organic soils are removed to expose the underlying stiff, high plastic clay fill subgrade.
2. The exposed subgrade should be protected from frost, desiccation, inundation and excessive wheel loads at all times.
3. Once excavation has been completed, the exposed subgrade should be evaluated by qualified geotechnical personnel to identify any areas of concern. In order to identify soft, weak or compressible areas, the subgrade should be proof-rolled with suitable heavy non-vibratory equipment such as a fully loaded tandem truck or a sheepsfoot roller once the area has been prepared as noted in item 1.
4. Any areas consisting of poor quality fill or soft, weak or otherwise compressible soils should be replaced, repaired or bridged as directed by the engineer prior to placing any granular fill. The preferred procedure for repairing weak areas should be determined at the time of construction, bearing in mind economics, performance expectations and project schedules.

3. Where proof rolling does not identify the presence of underlying weak zones and stiff medium to high plastic clay or clay fill is present at the subgrade level, the subgrade surface should be uniformly compacted to a minimum of 95% of SPMDD using a heavy sheepsfoot roller.
4. Fill materials required between the subgrade elevation and the underside of the granular section described above should consist of either existing clay fill approved for reuse or additional granular sub-base. The fill material should be placed in 150 mm thick lifts and uniformly compacted to 98% of SPMDD.
5. Below pavement granular fill should consist of the type, thickness and compaction requirements summarized in Table III.

7.5.2 Flexible Pavement Design

Flexible pavement sections constructed on a subgrade prepared as noted in Section 7.5.1, Subgrade Preparation, are summarized in Table III below.

Table III: Asphalt Pavement Design Sections

Material	Standard Duty	Heavy Duty	Compaction Required
Asphalt	65 mm	80 mm	98% of Marshall Density
Base Course	150 mm	150 mm	100% of Standard Proctor
Sub Base	200 mm	300 mm	98% of Standard Proctor
Total Thickness	**415 mm**	**530 mm**	**NA**

All granular materials and asphaltic concrete should meet the City of Winnipeg Construction Specifications. Aggregate gradation and quality requirements for granular base and sub-base are presented in Appendix B.

It is recommended that concrete pads be placed at all locations where heavy static wheel loads may exist, such as at garbage container pickup areas. At these isolated, unheated locations, frost penetration can be significant and can cause seasonal heave and subsidence. To improve performance and minimize maintenance, consideration can be given to localized subsurface drainage, synthetic insulation or provision for greater flexibility to accommodate frost action.

7.6 TESTING AND MONITORING

The engineering design recommendations presented within this report are based on the assumption that an adequate level of testing and monitoring will be provided during construction and that qualified contractors experienced in foundations and earthworks will carry out the construction. An adequate level of testing and monitoring are considered to be full-time monitoring and design review during the installation of piled foundations and regular monitoring and compaction testing for earthworks related to floor-slabs and asphalt areas. AMEC further requests the opportunity to review drawings and specifications related to any foundations, earthworks or other designs based on the recommendations provided in this report to confirm that said recommendations have been correctly interpreted.

8.0 CLOSURE

The findings and recommendations of this report were based on the results of field and laboratory investigations, combined with an interpolation of soil and ground water conditions between test hole locations. If conditions are encountered that appear to be different from those shown by the test holes drilled at this site and described in this report, or if the assumptions stated herein are not in keeping with the design, this office should be notified in order that the recommendations can be reviewed and adjusted, if necessary.

The site investigation was conducted for the sole purpose of identifying geotechnical conditions at the project site. Although no environmental issues were identified during the fieldwork, this does not indicate that no such issues exist. If the owner or other parties have any concern regarding the presence of environmental issues, then an appropriate level environmental assessment should be conducted.

Soil conditions, by their nature, can be highly variable across a site. The placement of fill and prior construction activities on a site can contribute to the variability especially near surface soil conditions. A contingency should always be included in any construction budget to allow for the possibility of variation in soil conditions, which may result in modification of the design and construction procedures.

This report was prepared exclusively for Number Ten Architectural Group and their agents for the proposed development as described in the report. The data and recommendations provided herein should not be used for any other purpose, or by any other parties, without review written authorization of AMEC. The use of this report by third parties is done so at the risk and responsibility of those parties. The findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practice. No other warranty, expressed or implied, is given.

Yours truly,

AMEC Earth & Environmental

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APEGM
Certificate of Authorization
AMEC Earth & Environmental (MB)
No. 555 Expiry: April 30, 2007

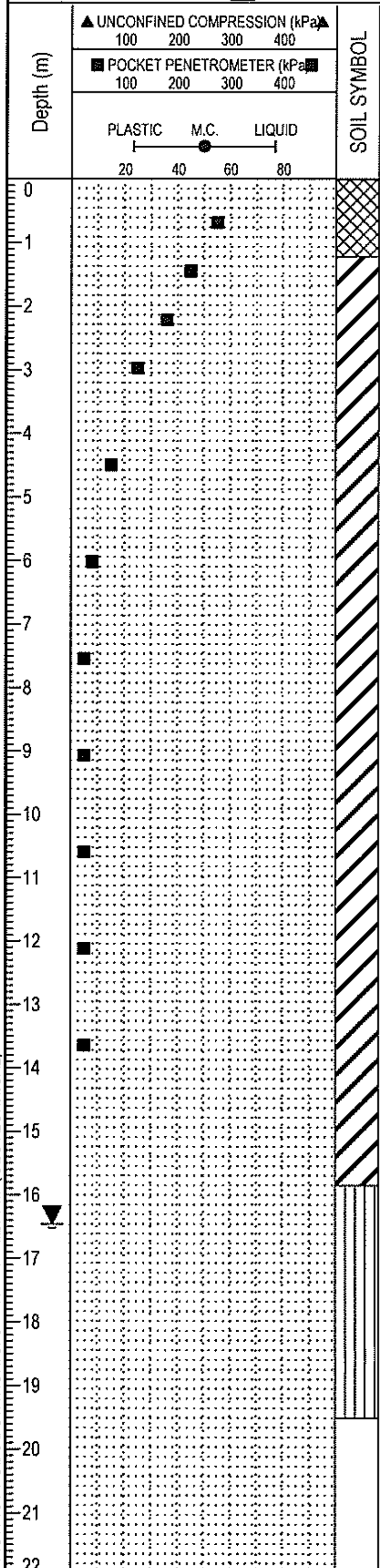
Appendix A

Test Hole Logs

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH1**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

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

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



MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS
OL	TOPSOIL (50mm) - dry, soft, black				
CH	CLAY (Fill) - high plastic, moist, stiff, dark brown, some silt and silt inclusions, trace rootlets, trace organics	Grab	1		
CH	CLAY - high plastic, moist, stiff, dark brown to grey, some silt, trace fine sand and silt inclusions - mottled brown and grey below 2.1 m - clayey silt layer between 2.4 and 2.7m - trace oxidation below 3 m - firm below 3.7m - very moist below 5.2m - occasional silt till inclusions between 7.9 and 8.2m - grey below 8.2m	Grab	2, 3, 4, 5, 6, 7, 8, 9, 10, 11		
ML	SILT (Till) - low plastic, wet, soft, light brown, some sand and gravel - dense below 18.8m	Grab	12		
	AUGER REFUSAL AT 19.5m ON INFERRED BOULDER. NOTES: Test hole was open to 18.3m and water was at 16.5m below existing ground level on completion of drilling. Test hole backfilled with auger cuttings.				

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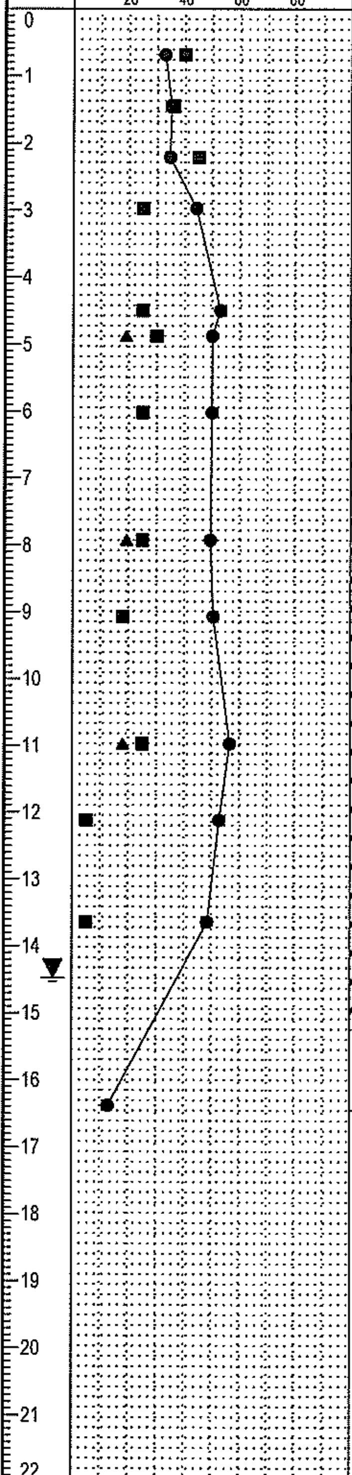
AMEC Earth and Environmental
Winnipeg, Manitoba

LOGGED BY: JP	COMPLETION DEPTH: 19.5 m
REVIEWED BY: HP	COMPLETION DATE: 5 June 2006
Figure No. A1	Page 1 of 1

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH2**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

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)	MUSCS	SOIL DESCRIPTION	SAMPLE NO	SPT (N)	COMMENTS
0	OL	TOPSOIL (50mm) - dry, soft, black			
	CH	CLAY (Fill) - high plastic, moist, stiff, dark brown, some organics, trace sand, silt, rootlets and woodchips	1		
	CH	CLAY - high plastic, moist, stiff, dark brown to dark grey, some silt, trace fine sand and silt inclusions	2		
		- clayey silt layer, low to non-plastic, moist, soft to firm, light brown, oxidized between 2.0 and 2.1m	3		
		- clayey silt layer, low to non-plastic, moist, soft to firm, light brown, oxidized between 2.4 and 2.6m	4		
			5		
			6		
		- grey below 5.8m	7		
			8		
			9		
			10		
		- soft to firm below 11.3m			
			11		
			12		
	ML	SILT (Till) - low plastic, wet, soft, light brown, some sand and gravel	13		

AUGER REFUSAL AT 16.5m ON INFERRED BOULDER.
NOTES:
Test hole was open to 15.5m and water was at 14.5m below existing ground level on completion of drilling. Test hole backfilled with auger cuttings.

amec	AMEC Earth and Environmental Winnipeg, Manitoba	LOGGED BY: JP REVIEWED BY: HP Figure No. A2	COMPLETION DEPTH: 16.5 m COMPLETION DATE: 5 June 2006 Page 1 of 1

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH3**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

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)	MUSCS	SOIL DESCRIPTION	SAMPLE NO	SPT (N)	COMMENTS
0	OL	TOPSOIL (50mm) - black, damp, soft			
	CH	CLAY (Fill) - high plastic, moist, stiff, mottled brown and grey, some silt, trace silt inclusions and rootlets	1		
	CH	CLAY - high plastic, moist, stiff to very stiff, dark grey, some silt, trace fine sand and organics - grey mottled brown, trace silt inclusions below 1.8 m	2, 3		
3	MI	SILT - clayey, medium plastic, moist, soft, light brown, oxidized	4		
	CH	CLAY - high plastic, moist, firm to stiff, mottled grey and brown, some silt, trace silt inclusions - very moist below 4.6 m - grey below 8.2m	5, 6, 7, 8, 9, 10		
	ML	SILT (Till) - low plastic, damp, dense, light brown to light grey, some sand and gravel	11		
17.1		AUGER REFUSAL AT 17.1m ON INFERRED BOULDERS. NOTES: Test hole was open to 16.5m and no water on completion of drilling. Test hole backfilled with auger cuttings.			

amec	AMEC Earth and Environmental Winnipeg, Manitoba	LOGGED BY: JP
		REVIEWED BY: HP
		Figure No. A3

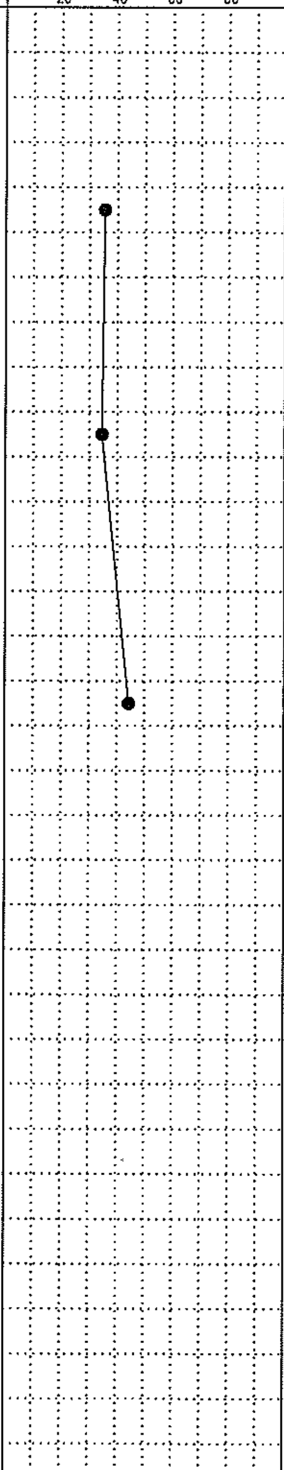
COMPLETION DEPTH: 17.1 m
COMPLETION DATE: 5 June 2006

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH4**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

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)	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS
0	OL	TOPSOIL (50mm) - damp, soft, black				
	CH	CLAY (Fill) - high plastic, moist, stiff, black and brown, some organics				
	CH	CLAY - high plastic, moist, stiff, dark grey, some silt, trace fine sand and organics	Grab Sample	1		
1		- dark brown to grey, trace silt and sulphate inclusions below 1.2 m	Grab Sample	2		
2		- mottled grey and brown, trace oxidation below 2.2 m	Grab Sample	3		
		TEST HOLE TERMINATED AT 2.4 m BELOW GRADE NOTES: Test hole open to 2.4m on completion of drilling. Test hole was backfilled with auger cuttings on completion of drilling.				
3						
4						
5						

AMEC Earth and Environmental Winnipeg, Manitoba	LOGGED BY: JP	COMPLETION DEPTH: 2.4 m
	REVIEWED BY: HP	COMPLETION DATE: 5 June 2006
	Figure No. A4	Page 1 of 1

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH5**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

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

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

Header of plot columns: ▲ 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	Depth (m)
0		OL	TOPSOIL (50mm) - damp, soft, black					
		CH	CLAY (Fill) - high plastic, moist, stiff, brown, trace silt, trace rootlets, trace gravel					
			- mottled grey and brown, trace silt and organic inclusions below 0.6 m	Grab Sample	1			
1								1
		CH	CLAY - high plastic, moist, stiff, grey, trace oxidation, some silt, trace silt lenses and inclusions, trace sulphates	Grab Sample	2			
			- 50 mm thick silt lense at 1.75m					
2								2
			- mottled grey to light grey, trace oxidation below 2.2 m	Grab Sample	3			
			TEST HOLE TERMINATED AT 2.4 m BELOW GRADE NOTES: Test hole open to 2.4m on completion of drilling. Test hole was backfilled with auger cuttings on completion of drilling.					
3								3
4								4
5								

amec	AMEC Earth and Environmental Winnipeg, Manitoba	LOGGED BY: JP	COMPLETION DEPTH: 2.4 m
		REVIEWED BY: HP	COMPLETION DATE: 5 June 2006
		Figure No. A5	Page 1 of 1

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH6**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

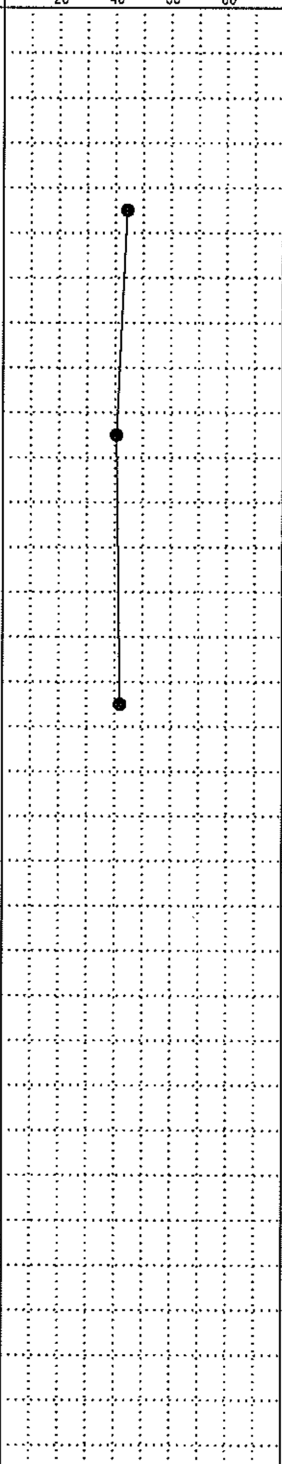
SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

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
0	OL	TOPSOIL (50mm) - damp, soft, black				
	CH	CLAY (Fill) - high plastic, moist, stiff, brown, trace silt and organic inclusions				
	CH	CLAY - high plastic, moist, stiff, some silt, dark grey, trace fine sand, organics and rootlets	Grab Sample	1		
1			Grab Sample	2		
2		- brown to grey, trace oxidation, silt inclusions and sulphates below 1.8 m	Grab Sample	3		
		TEST HOLE TERMINATED AT 2.4 m BELOW GRADE NOTES: Test hole open to 2.4m on completion of drilling. Test hole was backfilled with auger cuttings on completion of drilling.				
3						
4						
5						

amec	AMEC Earth and Environmental Winnipeg, Manitoba	LOGGED BY: JP
		REVIEWED BY: HP
		Figure No. A6
COMPLETION DEPTH: 2.4 m	COMPLETION DATE: 5 June 2006	Page 1 of 1

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH7**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

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

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

Chart axes: ▲ 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	Depth (m)
0		OL	TOPSOIL (50mm) - damp, soft, black					
		CH	CLAY (Fill) - high plastic, moist, stiff, black and brown, some organics - grey, trace oxidation, some silt inclusions, trace sulphate inclusions below 0.6 m	Grab Sample	1			
1								1
		CH	CLAY - high plastic, moist, stiff, mottled grey to dark grey and brown, some silt, trace fine sand and organics - mottled grey and brown, trace oxidation, silt inclusions and sulphates below 1.8 m	Grab Sample	2			
2				Grab Sample	3			2
			TEST HOLE TERMINATED AT 2.4 m BELOW GRADE NOTES: Test hole open to 2.4m on completion of drilling. Test hole was backfilled with auger cuttings on completion of drilling.					
3								3
4								4
5								

amec	AMEC Earth and Environmental Winnipeg, Manitoba	LOGGED BY: JP	COMPLETION DEPTH: 2.4 m
		REVIEWED BY: HP	COMPLETION DATE: 5 June 2006
		Figure No. A7	Page 1 of 1

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH8**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

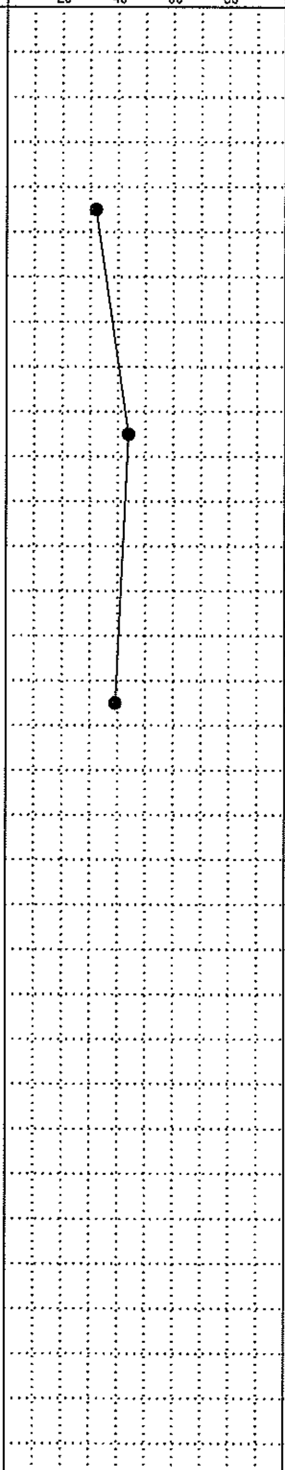
SAMPLE TYPE: Shelby Tube | No Recovery | SPT (N) | Grab Sample | Split-Pen | Core

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)	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS
0	OL	TOPSOIL (50mm) - damp, soft, black				
	CH	CLAY (Fill) - high plastic, moist, stiff, brown and black, some organics, trace silt				
	CH	CLAY - high plastic, moist, stiff, grey to dark grey, trace oxidized inclusions, some silt, trace fine sand	Grab Sample	1		
1		- grey to brown, trace silt inclusions and sulphates below 1.2 m	Grab Sample	2		
2		- mottled grey and brown, trace oxidation below 2.2 m	Grab Sample	3		

TEST HOLE TERMINATED AT 2.4 m BELOW GRADE

NOTES:

Test hole open to 2.4m on completion of drilling. Test hole was backfilled with auger cuttings on completion of drilling.

amec	AMEC Earth and Environmental Winnipeg, Manitoba	LOGGED BY: JP	COMPLETION DEPTH: 2.4 m
		REVIEWED BY: HP	COMPLETION DATE: 5 June 2006
		Figure No. A8	Page 1 of 1

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH9**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

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

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

Graph scales: ▲ 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
0		OL	TOPSOIL (50mm) - damp, black, soft				
		CH	CLAY (Fill) - high plastic, miost, stiff, grey with brown to light brown silty clay pockets, trace oxidation, trace organics and rootlets	Grab Sample	1		
1		CH	CLAY - high plastic, moist, stiff, some silt, grey to dark grey mottled brown, trace fine sand and organics	Grab Sample	2		
2			- mottled grey and brown, trace silt inclusions below 1.8 m	Grab Sample	3		
			- clayey silt, low to non-plastic, moist, soft to firm, light brown, oxidized between 2.4 and 2.6m - very moist, grey with oxidized silt lenses, trace sulphates below 2.6m	Grab Sample	4		
3			TEST HOLE TERMINATED AT3.0 m BELOW GRADE NOTES: Test hole open to 3.0m on completion of drilling. Test hole was backfilled with auger cuttings on completion of drilling.				
4							
5							

amec	AMEC Earth and Environmental Winnipeg, Manitoba	LOGGED BY: JP	COMPLETION DEPTH: 3 m
		REVIEWED BY: HP	COMPLETION DATE: 14 June 2006
		Figure No. A9	Page 1 of 1

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH10**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

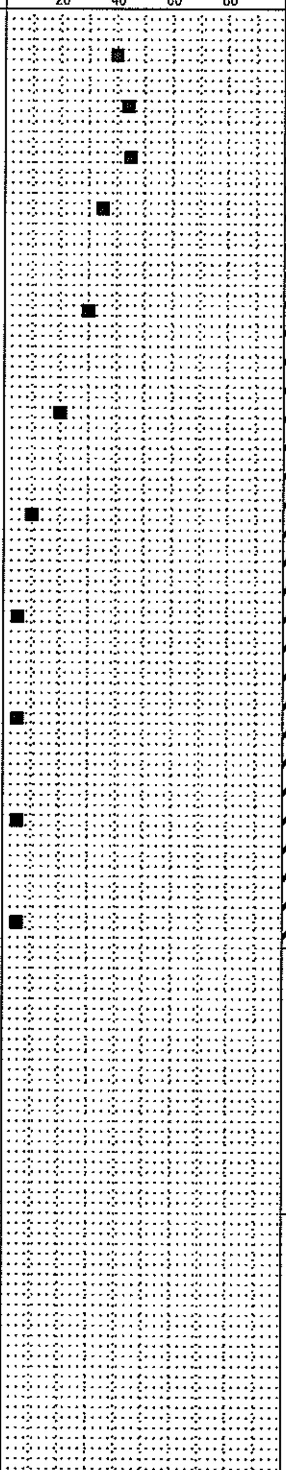
SAMPLE TYPE: Shelby Tube, No Recovery, SPT (N), Grab Sample, Split-Pen, Core

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

Depth (m)	▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400 / ■ POCKET PENETROMETER (kPa) ■ 100 200 300 400 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	Depth (m)
0			OL	TOPSOIL (250mm) - damp, black, soft					
			CH	CLAY (Fill) - high plastic, miost, stiff, grey with brown to light brown silty clay pockets, trace oxidation, trace organics and rootlets	Grab	1			
1									1
			CH	CLAY - high plastic, moist, stiff, some silt, mottled grey to light grey, trace oxidation, trace fine sand and sulphates	Grab	2			
				- mottled grey and brown, trace silt inclusions below 1.8 m					
2									2
				- clayey silt, low to non-plastic, moist, soft to firm, light brown, oxidized from 2.1 to 2.3 m	Grab	3			
					Grab	4			
				- very moist, mottled grey and brown, with light brown, oxidized , silt lenses below 2.4 m					
				- firm, grey with oxidized lenses and light grey silt inclusions below 2.9 m	Grab	5			
3				TEST HOLE TERMINATED AT3.0 m BELOW GRADE					3
				NOTES: Test hole open to 3.0m on completion of drilling. Test hole was backfilled with auger cuttings on completion of drilling.					
4									4
5									

PROJECT: East District Police Station	DRILLED BY: Subterranean Drilling Ltd.	BORE HOLE NO: **TH11**
CLIENT: Number Ten Architectural Group	DRILL TYPE: CME75	PROJECT NO: WX15309
LOCATION: St. Boniface Industrial Park, Winnipeg	DRILL METHOD: 150mm SSA	ELEVATION:

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)	▲ UNCONFINED COMPRESSION (kPa) ▲ 100 200 300 400 / ■ POCKET PENETROMETER (kPa) ■ 100 200 300 400 / PLASTIC M.C. LIQUID 20 40 60 80	SOIL SYMBOL	MUSCS	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	SPT (N)	COMMENTS	Depth (m)
0			OL	TOPSOIL (200mm) - dry, soft, black					
			CH	CLAY (Fill) - high plastic, moist, stiff, brown to grey with light brown silt pockets, trace sand, organics and rootlets		1			
			CH	CLAY - high plastic, moist, stiff, dark brown to dark grey, some silt, trace fine sand and organics - mottled brown and grey, trace oxidation, silt inclusions and sulphates below 1.8 m - very moist below 3 m - firm to stiff below 5.5m - grey with brown and light grey, oxidized silt lenses belwo 6.1 m - grey soft to firm below 8.5m		2, 3, 4, 5, 6, 7, 8, 9, 10, 11			
14 ▼			ML	SILT (Till) - clayey, low plastic, wet, soft, grey, trace sand and gravel - damp to moist, medium dense to dense, light grey, some sand and gravel, trace clay below 16.8 m - dense below 17.4m		12, 13			14 ▼
18				AUGER REFUSAL AT 18.0m ON INFERRED BOULDER. NOTES: Test hole was open to 15.5m and water was at 14.0m below existing ground level on completion of drilling. Test hole backfilled with auger cuttings.					
22									

amec	AMEC Earth and Environmental Winnipeg, Manitoba	LOGGED BY: JP	COMPLETION DEPTH: 18 m
		REVIEWED BY: HP	COMPLETION DATE: 14 June 2006
		Figure No. A11	Page 1 of 1

Appendix B

Aggregate Gradation and Quality Requirements

Table B1: Requirements for Granular Base Course

Gradation		Aggregate Quality Requirements
Sieve Size	Percent Passing (by dry mass)	The aggregate should have a minimum California Bearing Ratio (CBR) of 60 percent. The material passing the 0.425 mm sieve size should have a liquid limit of less than 25% and a plasticity index less than 6%. The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 35%. The aggregate should consist of sound, durable particles of crushed rock, stone, gravel, sand and fine soil. It should not contain thin elongated particles, sods, topsoil, roots or plants. At least 35% of the material retained on the 4.75 mm sieve should consist of crushed particles, which are not shale or ironstone. A maximum of 12% of the material retained by weight on the 4.75 mm sieve may consist of shale and/or ironstone.
19 mm	100%	
16 mm	80 – 100%	
4.75 mm	40 – 70%	
2 mm	25 – 55%	
0.425 mm	15 – 30%	
0.075 mm	8 – 15%	

Table B2: Requirements for Crushed Stone Base Course

Gradation		Aggregate Quality Requirements
Sieve Size	Percent Passing (by dry mass)	The aggregate should be crushed and have a minimum California Bearing Ratio (CBR) of 60 percent. The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 35%. The aggregate should consist of sound, durable crushed stone. It should not contain thin elongated particles, sods, topsoil, roots or plants. 100% of the material retained on the 4.75 mm sieve should consist of crushed stone.
19 mm	100%	
4.75 mm	35 – 70%	
0.425 mm	15 – 30%	
0.075 mm	6 – 17%	

Table B3: Requirements for Granular Sub-Base

Gradation		Aggregate Quality Requirements
Sieve Size	Percent Passing (by dry mass)	The aggregate should have a minimum California Bearing Ratio (CBR) of 30 percent.
38 mm	100%	The material passing the 0.425 mm sieve size should have a liquid limit of less than 25% and a plasticity index less than 6%.
25 mm	85 – 100%	The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 40%.
4.75 mm	25 – 80%	The aggregate should consist of sound, durable particles of crushed rock, stone, gravel, sand and fine soil. It should not contain thin elongated particles, sods, topsoil, roots or plants.
0.425 mm	15 – 40%	At least 15% of the material retained on the 4.75 mm sieve should consist of crushed particles, which are not shale or ironstone.
0.075 mm	8 – 18%	A maximum of 20% of the material retained by weight on the 4.75 mm sieve may consist of shale and/or ironstone.

Table B4: Requirements for Crushed Stone Sub-Base Course

Gradation		Aggregate Quality Requirements
Sieve Size	Percent Passing (by dry mass)	The aggregate should be crushed and have a minimum California Bearing Ratio (CBR) of 60 percent.
50 mm	100%	The coarse fraction of the aggregate should have a maximum Los Angeles abrasion loss of 40%.
4.75 mm	25 - 80%	The aggregate should consist of sound, durable crushed stone. It should not contain thin elongated particles, sods, topsoil, roots or plants.
0.075 mm	5 - 18%	100% of the material retained on the 4.75 mm sieve should consist of crushed stone.