GEOTECHNICAL INVESTIGATION

PORTAGE AVENUE AT TRURO CREEK REHABILITATION

Prepared for

CITY OF WINNIPEG

PUBLIC WORKS DEPARTMENT

ENGINEERING DIVISION

August 2011 **Project No. 113321**

1.0 INTRODUCTION

Dyregrov Robinson Inc. were retained by the City of Winnipeg, Public Works Department to undertake a geotechnical investigation for the proposed "Portage Avenue at Truro Creek Rehabilitation Project". Authorization to proceed with the investigation was received from the City of Winnipeg, Public Works Department, by Purchase Order 00251286 dated April 4, 2011.

2.0 SITE CONDITIONS

Truro Creek crosses Portage Avenue between Albany and Sackville Streets and continues south through Bruce Park and discharges into the Assiniboine River. Its headwaters are in the northwest area of the City and carries through the James Armstrong Richardson International Airport and the Truro Park near Ness Avenue. The Portage Avenue crossing is illustrated on Figure 1. There are six lanes of traffic on Portage Avenue, a median and sidewalks and boulevards on the north and south sides. The flow of the Creek is carried under Portage Avenue in a 2740 mm diameter culvert which was recently repaired with the installation of a 2133 mm diameter culvert liner. The upstream and downstream inverts are 228.328 and 228.00 metres, respectively. There are concrete headwalls at the inlet and outlet of the culvert which retain fill between the headwall and an upper grassed slope to the sidewalks. The low flow channel of the Truro Creek is narrow at both the entrance and the exit of the culvert.

The side slopes of the Creek channel are relatively flat on the east side of the entrance channel and the west side of the discharge channel. This contrasts with steeper slopes on the west side of the entrance channel and the east side of the discharge channel.

3.0 PROPOSED DEVELOPMENT

The City of Winnipeg proposes to install a 1200 mm diameter precast concrete culvert adjacent to the east side of the existing 2740 mm culvert crossing of Portage Avenue at Truro Creek. It is understood that the inlet and outlet invert elevations will be about 300 mm lower than the existing culvert. The culvert installation is proposed to be undertaken by tunneling/jacking techniques to avoid disruption to traffic on Portage Avenue. In addition to the evaluation of the geotechnical conditions relative to the culvert installation are the impacts of the inlet and outlet works on the slope stability of the Creek banks in the northeast and southeast quadrants of the site.

4.0 DESCRIPTION OF FIELDWORK

The field investigation included the drilling and sampling of 13 test holes on May 5 and 6, 2011 using a track-mounted Mobile S-61 drill which was operated by Paddock Drilling Ltd. of Brandon, Manitoba. The test holes were drilled with 125 mm diameter solid stem augers. General site supervision was performed by Dyregrov Robinson Inc.

Test Holes 1 to 4 and 7 to 12 were drilled to evaluate the subsurface conditions for the installation of the proposed culvert. Test Holes 5 and 6 were drilled on the northeast Creek bank and Test Hole 13 on the southeast bank. Representative disturbed off auger samples were obtained at frequent depth intervals in all of the test holes and undisturbed Shelby tube samples were recovered in Test Holes 5, 11, 12 and 13. Standpipe piezometers were installed in Test Holes 5 and 13. The test holes were backfilled with auger cuttings. Where the test holes were drilled in the east curb lane, the pavement surface was patched by placing the concrete cores into the backfilled test hole and adding a layer of cold mix asphalt to the surface. The locations of the test holes are illustrated on Figure 1.

The recovered soil samples were returned to our soil testing laboratory for testing including visual classification, determination of soil moisture contents for all recovered samples, measurement of undrained shear strengths and unit weights on the undisturbed samples. Plasticity characteristics were determined on four selected samples.

The logs of the test holes are attached on Figures 2 to 14 inclusive. The soil profile is included on each of the logs as are the results of the laboratory testing.

5.0 THE CULVERT ALIGNMENT SOIL PROFILE

It was understood that the proposed alignment of the new culvert should be located close to the east side of the existing culvert and that the backfill of this culvert could influence the location of the proposed new culvert. This was the primary purpose of the groups of test holes on Portage Avenue.

The soil profile identified at the north, median and south test hole locations for the culvert alignment are illustrated on Figure 15. The soil profile includes variable thicknesses of fill, silt and clay.

The fill is a medium plastic clayey silt which contains some sand, some gravel with traces of organics and at some locations cobbles/boulders were also encountered. The fill is generally identified as firm to stiff in consistency and is of intermediate plasticity. It ranges in thickness from 1.3 metres at Test Hole 12 to 5.0 metres at Test Hole 3. It is deepest in the test holes which are closest to the existing culvert. Cobbles/boulders were noted below a depth of 2.1 metres in Test Holes 1 to 4 driven through the median section and below 0.6 metres in Test Holes 7 and 8 in the north section. No cobbles/boulders were noted in the south section, Test Holes 10, 11 and 12. The size of the cobbles/boulders could not be identified due to the small diameter test holes (125 mm) which were drilled.

Beneath the fill is a sandy or clayey silt which is firm to stiff in consistency. It varies from low to intermediate plasticity as indicated by the classification tests on samples from Test Holes 1, 8, 9 and 11. The Liquidity Indices were similar in Test Holes 1 and 8, being 0.82 and 0.95 and in Test Holes 9 and 11, 0.38 and 0.53 range. Beneath the sandy silt was a firm to stiff highly plastic silty clay at elevation 228.00 metres on the north section (Test Holes 8 and 9) and the south section (Test Holes 10, 11 and 12) and at the median section, the silty clay was a metre lower at elevation 227.00 metres (Test Holes 1 and 2).

It should be noted that the 125 mm auger met refusal in Test Hole 4 at a depth of 2.3 metres (elevation 230.1 metres) and in Test Hole 7 at a depth of 3.4 metres (elevation 228.7 metres). In Test Hole 3, some timber was encountered at a depth of 4.8 metres (elevation 227.6 metres). The test hole was advanced past the timber. A Hydro Vac excavation was witnessed on the north section between Test Holes 8 and 9. No cobbles/boulders were encountered down to an elevation of 223.4 metres.

6.0 UPSTREAM AND DOWNSTREAM SOIL PROFILES

Test Holes 5 and 6 were drilled on the northeast Creek bank and Test Hole 13 on the southeast bank of the Creek. The natural soil profile at each of the test holes was similar, namely a clayey silt over a silty clay on a glacial silt till. At Test Hole 6, there is a surface covering of 0.8 metres of a silt fill.

The clayey silt extends to elevations between 227.6 and 228.4 metres. It contains trace amounts of sand and gravel and is firm to stiff in consistency. Moisture contents are in the 20 to 40 percent range.

The silty clay extends down to elevations between 223.0 and 223.5 metres. It contains traces of sand and gravel and is firm to stiff in consistency except that it becomes softer below about elevation 226.0 metres on the north side and 224.6 metres on the south side. This is confirmed by the results of the undrained shear strengths determined on the undisturbed soil samples. Moisture contents are in the 40 to 60 percent range with a trend to increase in depth.

Below the silty clay is a silt till deposit. It is known to contain a heterogeneous mixture of sand, gravel, cobble and boulder-size materials in a silt and clay matrix. The cobble/boulder sized materials were not recovered from the test holes. The till is loose in consistency having moisture contents in excess of 12 percent. It is visually described as loose to wet. Seepage at the surface of the till was noted in Test Hole 6 and "squeezing" of the test hole in Test Hole 5.

Standpipe piezometers installed in Test Holes 5 and 13 had water elevations of 226.9 and 229.2 metres, respectively, 12 and 11 days after installation.

7.0 DISCUSSION AND RECOMMENDATIONS

7.1 General

The proposal is to install a 1200 mm diameter precast concrete culvert adjacent to the existing 2740 mm diameter culvert by tunneling/jacking techniques. The new culvert will have an invert about

300 mm lower than the existing. The installation will require consideration of the inlet and outlet treatment and consideration of the proposed work on the stability of the banks of the Creek during and after construction.

7.2 <u>Culvert Alignment</u>

It is recommended that the new culvert be installed to avoid encountering the backfill of the existing culvert particularly at the locations where cobbles/boulders have been noted. A preliminary assessment suggests that the alignment could be offset about 6 metres from the east side of the existing culvert. The alignment would not necessarily have to be parallel to the alignment of the existing culvert.

The new culvert will be located within the clayey silt deposit but could be partially installed on/in the underlying silty clay. Both of these materials are expected to be suitable for tunneling/jacking techniques.

7.3 <u>Excavation and Shoring</u>

It is expected that the tunneling/jacking will begin on the south side of Portage Avenue. This will require an excavation, probably in excess of 3.0 metres deep, which will have to be shored. The Contractor should provide an engineered excavation and shoring plan designed in accordance with the current Manitoba Government Workplace Safety and Health Regulations. Details on performance monitoring of the excavation and shoring system should also be provided by the Contractor.

The earth pressure distribution shown on Figure 16 can be used for the design of the temporary shoring. It should be appreciated that a certain amount of ground movement is unavoidable and that it can be minimized through good construction practice and workmanship. Good contact between the shoring and retained soil should be maintained throughout the construction process. Free draining sand fill should be used to fill any voids behind the shoring.

The backfilling procedures to be followed, once the shoring is to be removed, should be detailed by the Contractor indicating the type of backfill to be used and compaction requirements to be achieved.

The backfilling must be undertaken to ensure that the long term performance of the existing Creek bank is not negatively impacted.

7.4 Inlet and Outlet

At the inlet, consideration is presently being given to providing minor chanelization a short distance upstream where a precast concrete flared end section will be provided with the intervening connecting piping buried. The location of the inlet has yet to be determined.

Two alternatives are being considered for the outlet. The outlet could be located adjacent to, or close to, the existing outlet headworks or downstream past the large tree where the Creek bank has a relatively flatter slope gradient. The culvert would be extended to this location by open cut and backfill methods. These two locations are illustrated on Figure 17. This figure also illustrates features of both the upstream and downstream areas of the proposed work.

The proposed construction at the inlet and outlet have to consider the stability of the Creek banks during construction and in the long term. In this regard, slope stability analyses have been conducted for the east bank both upstream and downstream of the new culvert crossing. The locations of slope profiles which were used for stability analyses are noted and a "large tree" identified which is referenced in the following discussion. The west banks of the Creek will not be affected by the proposed construction.

An inspection of the east banks of the Creek slopes did not identify any signs of slope instability. This may be in part due to the thick grass cover which was present in some areas. Where the grass has been cut, no indication of instability was noted. At the location of the "large tree", which is at the edge of the Creek bank, its root system is believed to be maintaining the lower bank at its location.

The northeast bank is at a gradient of approximately 5 horizontal to 1 vertical with a sharp drop at the Creek edge (i.e. from the toe of the slope down into the low flow channel). The overall bank height is in the order of 4 metres including the drop into the Creek. Using typical effective stress soil parameters for the soil profile, as shown on Figures 18 and 19, and with assumed groundwater pressures, the global Factor of Safety was determined to be in excess of 1.75. With possible excavation needed for construction near the toe of slope, the calculated global Factor of Safety is 1.49, Figure 20. The Contractor will have to maintain the lower slope stability, which should be detailed in his excavation and shoring plan. These analyses indicate that the proposed work can be safely undertaken with no major impact on the northeast bank of the Creek. Restoration of any excavation will be required.

The geometry of the existing southeast bank varies significantly from near the headwall of the existing culvert to a point about 6 to 7 metres downstream. Some of the difference is related to the large tree which is located about 3 to 4 metres from the headwall on the crest of the bank. The slope of the lower bank is controlled by the root system of the tree. The lower bank is about 1.0 to 1.5 metres high.

The stability analyses were performed on slope profiles between the tree and the headwall at distances of 1.2 metres and 6.6 metres south of the east headwall as indicated on Figure 17. The soil parameters which were used in the analyses were the same as those used for the northeast bank.

At the 1.2 metre section, the slope gradient is in the order of 4 horizontal to 1 vertical with a steep lower slope. The overall bank height is approximately 5.0 metres. Assuming a piezometric surface 2 metres below grade, the global Factor of Safety is 1.5 (Figure 21) and with a piezometric surface 1 metre below grade, the global Factor of Safety is 1.39 (Figure 22). It is expected that the tree root system has a positive impact on the stability of the lower slope area. If the new outlet is to be located adjacent to the existing, it will require permanent excavation at the bottom of the lower slope, such as illustrated on Figure 23. The global Factor of Safety reduces to an unacceptable level of 1.24 and the lower slope stability reduces to 1.03 (Figure 23). Depending on the details of the excavation and shoring, the stability of the lower level could possibly be addressed during construction. The global stability will be low as the excavation which was made will have to be maintained for the operation of the new culvert.

Figure 24 illustrates an assumed location where the excavation required for the tunneling/jacking equipment could be located for installation of the culvert. This is shown as fill for the analyses on Figure 24. The analyses indicate that this excavation and backfill will not impact the global stability at this location, however, it must be understood that the excavation shoring must be well designed, properly installed and the excavation must be backfilled properly with suitable compacted materials on completion. The construction sequencing will also be important.

At the 6.6 metre section, where the new outlet could be located, the overall slope gradient is in the order of 5 horizontal to 1 vertical with a relatively flatter lower slope compared to other sections. The global Factor of Safety of the existing slope with high groundwater conditions is at least 1.47, Figure 25. The site conditions are such that local excavations at the lower slope would be expected to be minimal and would have no consequential impact on the global stability and only minor impact on the lower slope stability during construction.

Additional slope stability analyses were undertaken to assess the impact of a trench excavation to extend the new culvert to the outlet area. Since the trench may cross the slope diagonally, analyses were made with the trench located near the upper, middle and lower slope areas. The analyses indicate that there is no impact on the global stability with the trench at these locations (Figures 27, 28 and 29) and local stability of the backfilled trench is satisfactory.

From a geotechnical perspective, the outfall location in the area of the 6.6 metre section is preferred since there is no consequential impact on the slope stability of the existing Creek banks.

The stability of the trench side walls must be assured by the Contractor during construction and should be backfilled with suitable materials which should be compacted in 300 mm lifts to 90 percent of Standard Proctor Maximum Dry Density. The preferred backfill should be fine grained silty and clayey materials such as will be excavated from the trench. Conventional bedding of the piping would be acceptable. The reason for requiring compaction is to promote runoff rather than infiltration into the trench backfill which could cause soil softening which in turn could impact the long term stability of the Creek bank.

Erosion protection should be provided at both the inlet and outlet of the new culvert. The details of the erosion protection should be developed in the final design.

We recommend that Dyregrov Robinson Inc. undertake a geotechnical review of the final design. Part of this review could be done to be supportive of an Application for a Waterways Permit.

Respectfully submitted,

DYREGROV ROBINSON INC.

PROVINCE OF MANITOBA
A. O.
DYREGROV
04/08/11
REGISTERED PROFESSIONAL ENGINEER

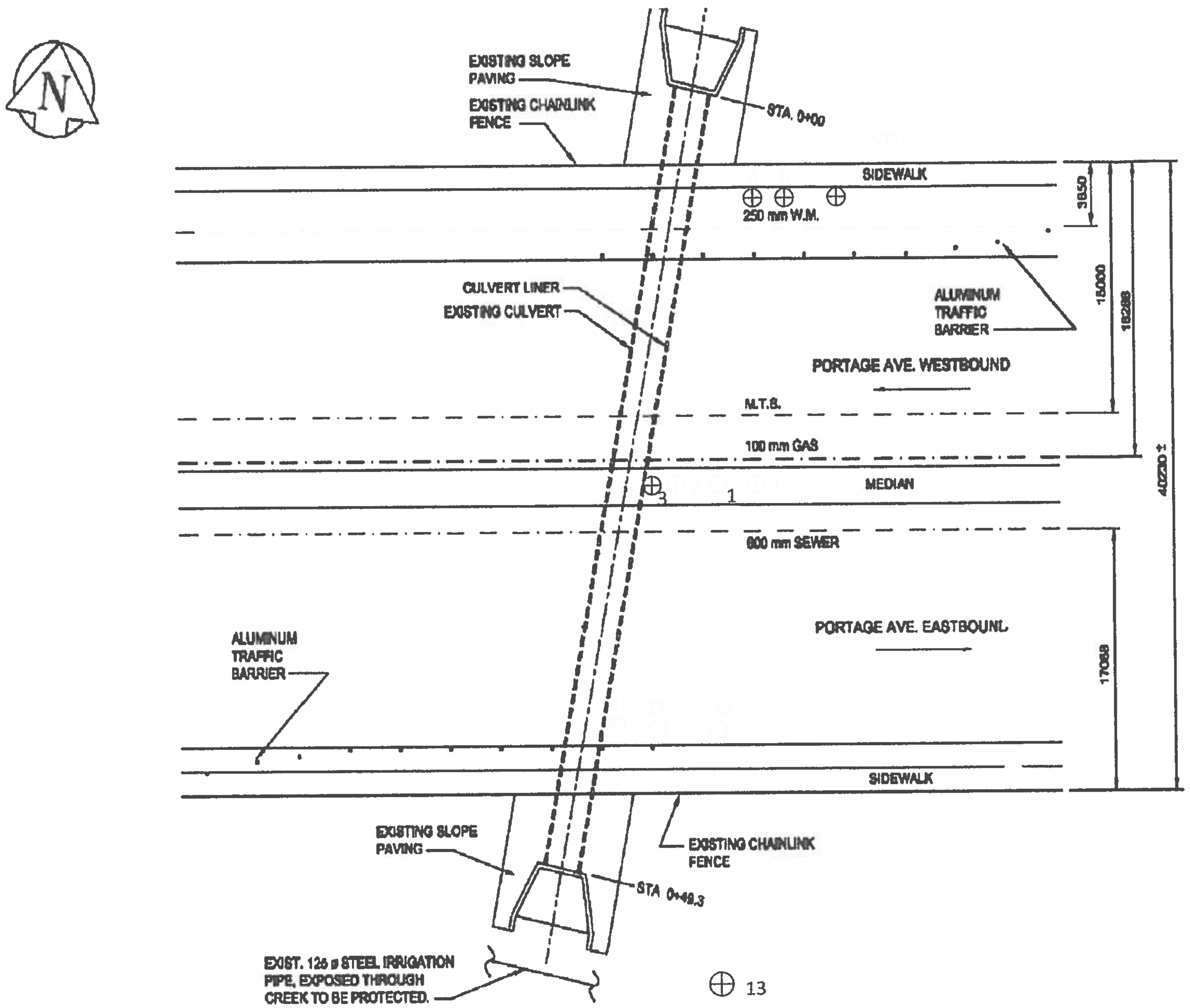
Per: AO Dyregrov

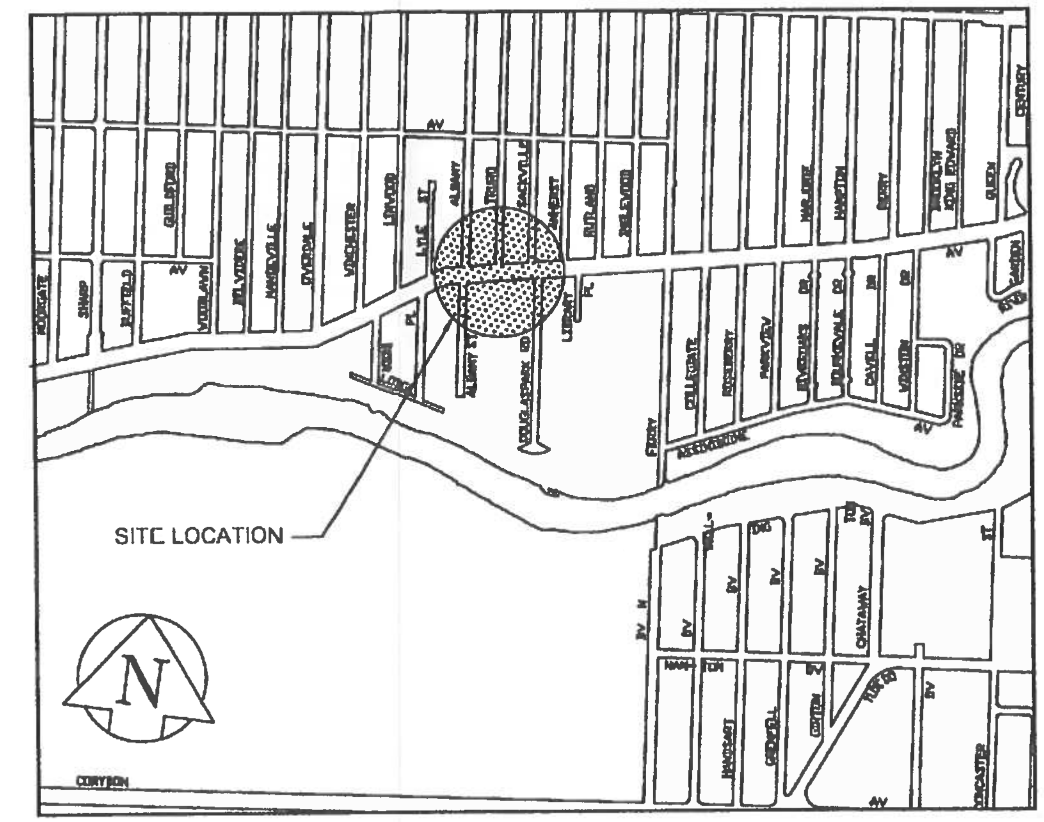
A.O. Dyregrov, P.Eng.

Reviewed by: Gil Robinson

Gil Robinson, M.Sc., P.Eng.

APEGM
Certificate of Authorization
Dyregrov Robinson Inc.
No. 86 Date: 04/08/11





LOCATION PLAN

TEST HOLE LOCATION

IMAGE TAKEN FROM DRAWING PROVIDED BY THE CITY OF WINNIPEG

PORTAGE AVENUE AT TRURO CREEK CULVERT RELINING

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS			**PORTAGE AVENUE AT TRURO CREEK REHABILITATION** **SITE PLAN**		
SCALE: NTS	MADE BY: RB	CHKD BY: AOD	PROJECT NO. 113321	DATE: AUGUST 4, 2011	**FIGURE 1**

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 1

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Median, 3.7 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 5, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	6.1

DEPTH (m)	ELEVATION (m)
0.00	232.40
0.25	232.15
0.50	231.90
0.75	231.65
1.00	231.40
1.25	231.15
1.50	230.90
1.75	230.65
2.00	230.40
2.25	230.15
2.50	229.90
2.75	229.65
3.00	229.40
3.25	229.15
3.50	228.90
3.75	228.65
4.00	228.40
4.25	228.15
4.50	227.90
4.75	227.65
5.00	227.40
5.25	227.15
5.50	226.90
5.75	226.65
6.00	226.40
6.25	226.15
6.50	225.90
6.75	225.65
7.00	225.40
7.25	225.15
7.50	224.90

SOIL SYMBOL	SOIL DESCRIPTION		COMMENTS
	0 - 0.3 m	GRANULAR BASE	
	0.3 - 2.8 m	SILT (Fill) - clayey - some sand, some gravel - trace organics - dark grey to black - firm to stiff, moist, intermediate plasticity - cobbles/boulders below 2.1 m	
	2.8 - 5.0 m	SILT - sandy - dark grey - firm, moist, low plasticity - clayey, intermediate plasticity below 3.8 m	
	5.0 - 6.1 m	CLAY - silty - trace silt inclusions (< 25 mm dia.) - mottled brown and grey - stiff, moist, high plasticity	
	6.1 m	END OF TEST HOLE AT 6.1 m IN CLAY Notes: 1. Squeezing in silt layer. 2. Test hole backfilled with auger cuttings.	

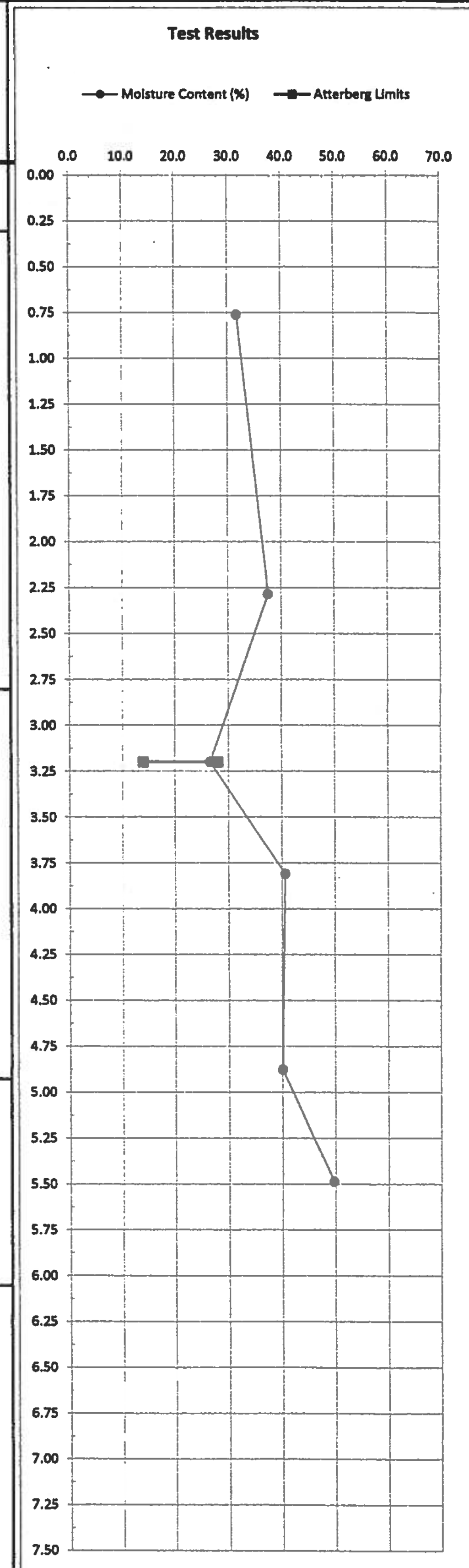


Figure No.: 2

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS	PROJECT # 113321	TEST HOLE NO. 2

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Median, 1.4 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 5, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	6.1

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION		COMMENTS
0.00	232.40		0 - 0.3 m	GRANULAR BASE	
0.25	232.15				
			0.3 - 3.5 m	SILT (Fill) - clayey	
0.50	231.90			- some sand, some gravel	
				- trace organics	
0.75	231.65			- dark grey to black	
				- firm to stiff, moist, intermediate plasticity	
1.00	231.40				
1.25	231.15				
1.50	230.90				
1.75	230.65				
2.00	230.40				
				- cobbles/boulders below 2.1 m	
2.25	230.15				
2.50	229.90				
				- trace peat below 2.6 m	
2.75	229.65				
3.00	229.40				
3.25	229.15				
3.50	228.90		3.5 - 5.0 m	SILT - sandy	
				- dark grey	
3.75	228.65			- firm, moist, low plasticity	
4.00	228.40				
4.25	228.15			- clayey, intermediate plasticity below 4.3 m	
4.50	227.90				
4.75	227.65				
5.00	227.40		5.0 - 6.1 m	CLAY - silty	
				- trace silt inclusions (< 25 mm dia.)	
5.25	227.15			- mottled brown and grey	
				- stiff, moist, high plasticity	
5.50	226.90				
5.75	226.65				
6.00	226.40				
			6.1 m	END OF TEST HOLE AT 6.1 m IN CLAY	
6.25	226.15			Notes:	
				1. Squeezing in silt layer.	
6.50	225.90			2. Test hole backfilled with auger cuttings.	
6.75	225.65				
7.00	225.40				
7.25	225.15				
7.50	224.90				

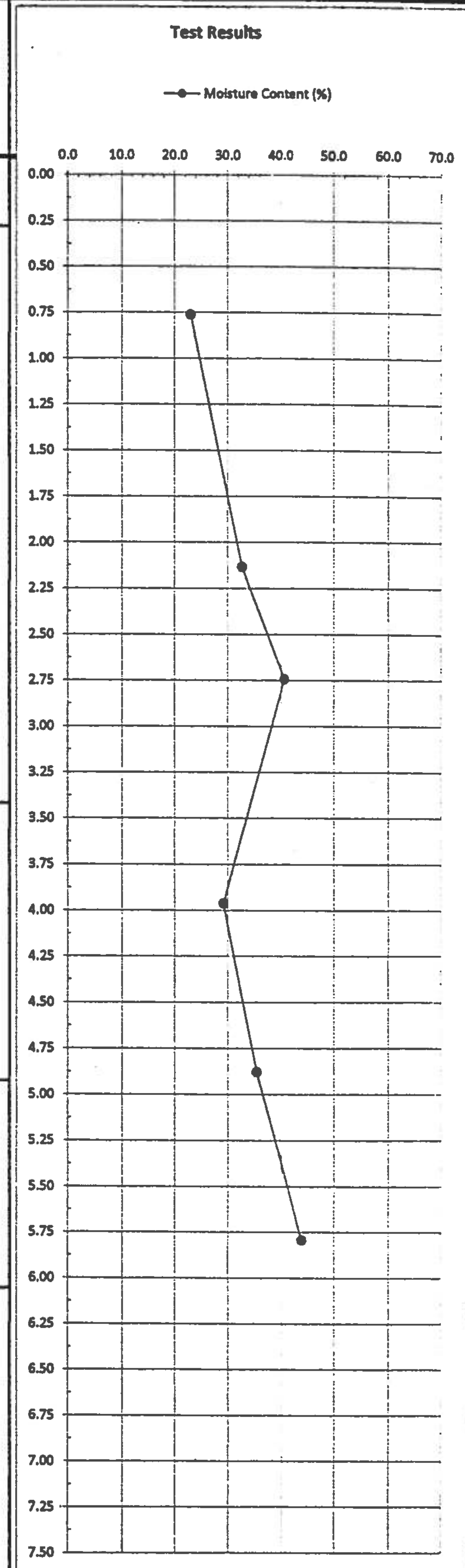


Figure No.: 3

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 3

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Median, 0.6 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 5, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	6.1

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION	COMMENTS
0.00	232.40		0 - 0.3 m GRANULAR BASE	
0.25	232.15			
0.50	231.90		0.3 - 5.0 m SILT (Fill) - clayey - some sand, some gravel - trace organics - dark grey to black - firm to stiff, wet, intermediate plasticity	
0.75	231.65			
1.00	231.40			
1.25	231.15			
1.50	230.90			
1.75	230.65			
2.00	230.40		-cobbles/ boulders below 2.1 m	
2.25	230.15			
2.50	229.90		- trace peat below 2.6 m	
2.75	229.65			
3.00	229.40			
3.25	229.15			
3.50	228.90			
3.75	228.65			
4.00	228.40			
4.25	228.15			
4.50	227.90			
4.75	227.65		- timber below 4.8 m	
5.00	227.40		5.0 - 6.1 m CLAY - silty - trace silt inclusions (< 25 mm dia.) - mottled brown and grey - stiff, moist, high plasticity	
5.25	227.15			
5.50	226.90			
5.75	226.65			
6.00	226.40		6.1 m END OF TEST HOLE AT 6.1 m IN CLAY Notes: 1. Squeezing in silt layer. 2. Test hole backfilled with auger cuttings.	
6.25	226.15			
6.50	225.90			
6.75	225.65			
7.00	225.40			
7.25	225.15			
7.50	224.90			

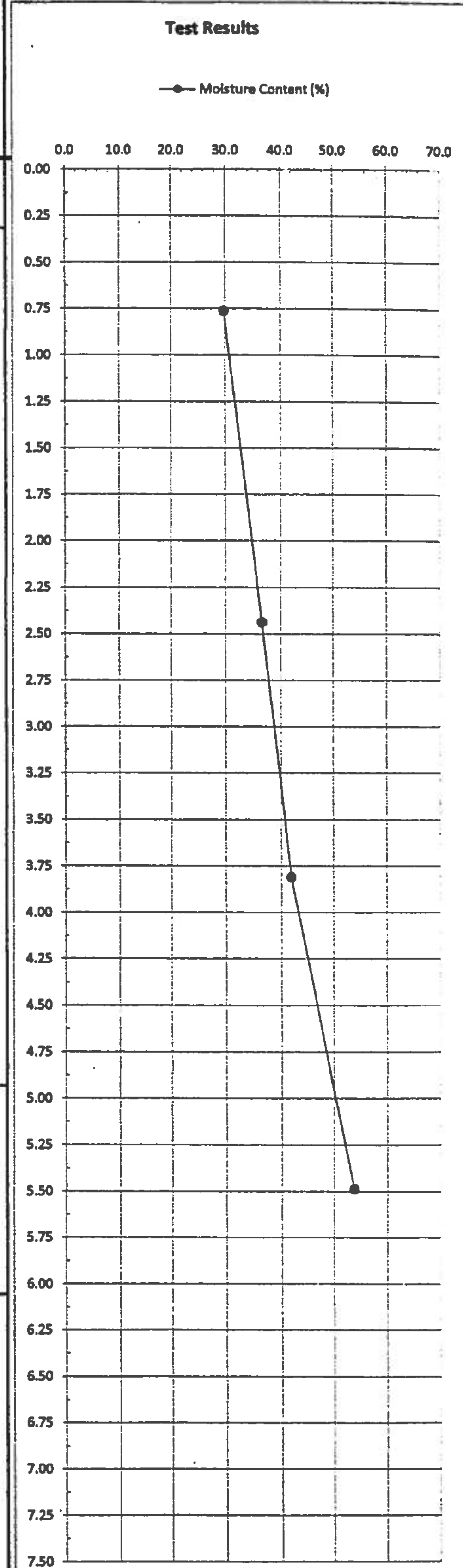


Figure No.: 4

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 4
PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Median, 5.8 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 5, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	2.3

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION		COMMENTS
0.00	232.40		0 - 0.3 m	GRANULAR BASE	
0.25	232.15				
			0.3 - 2.3 m	CLAY (Fill) - silty	
0.50	231.90			- some sand, some gravel	
				- trace organics	
0.75	231.65			- dark grey to black	
				- firm to stiff, moist, intermediate plasticity	
1.00	231.40				
1.25	231.15				
1.50	230.90				
1.75	230.65				
2.00	230.40				
				- cobbles/boulders below 2.1 m	
2.25	230.15				
			2.3 m	END OF TEST HOLE AT REFUSAL AT 2.3 m IN CLAY FILL	
2.50	229.90			Notes:	
2.75	229.65			1. Test hole backfilled with auger cuttings.	
3.00	229.40				
3.25	229.15				
3.50	228.90				
3.75	228.65				
4.00	228.40				
4.25	228.15				
4.50	227.90				
4.75	227.65				
5.00	227.40				
5.25	227.15				
5.50	226.90				
5.75	226.65				
6.00	226.40				
6.25	226.15				
6.50	225.90				
6.75	225.65				
7.00	225.40				
7.25	225.15				
7.50	224.90				

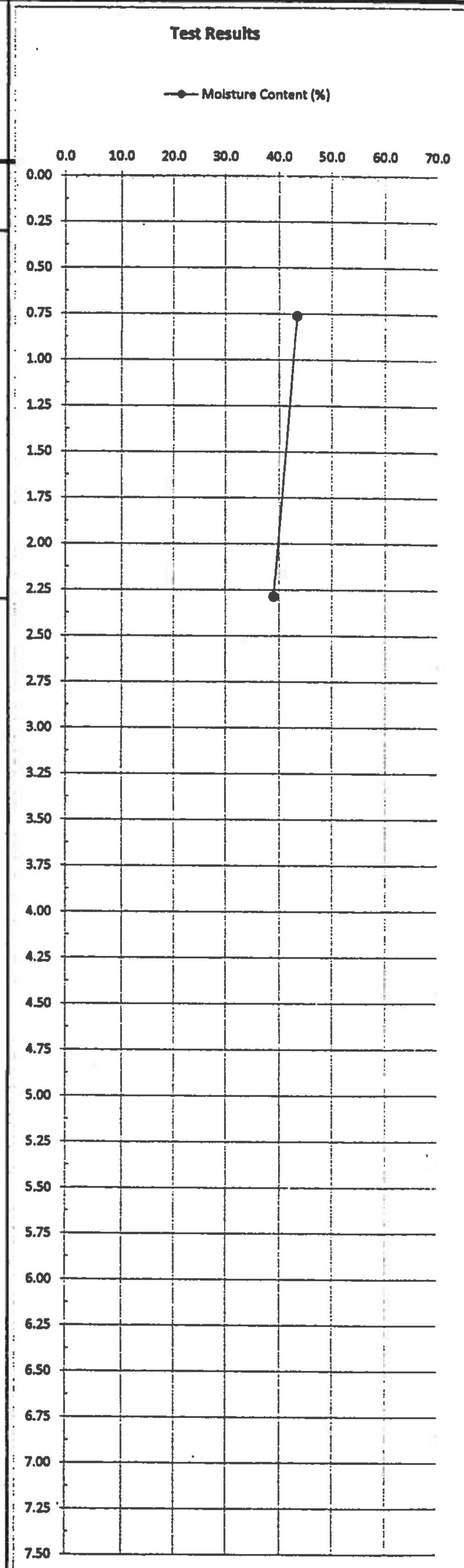


Figure No.: 5

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 5
PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Inlet, Toe of Creek Bank, 8.5 m North and 7.3 m East of East Wing Wall Edge	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 5, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	9.1

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	COMMENTS
0.00	230.40	0 - 0.15 m TOPSOIL	
		0.15 - 2.4 m SILT - clayey	
0.50	229.90	- trace sand, trace gravel - grey	
1.00	229.40	- firm, moist, intermediate plasticity	
1.50	228.90	- some organics, organic odor below 1.5 m	
2.00	228.40		
		2.4 - 7.0 m CLAY - silty	
2.50	227.90	- trace sand, trace silt inclusions (< 10 mm dia.) - trace gravel	
3.00	227.40	- mottled brown and grey - firm, moist, high plascitiy	Qu = 26.9 kPa TV = 41.7 kPa
3.50	226.90		PP = 43.5 kPa γbulk = 16.9 kN/m³
4.00	226.40		
4.50	225.90	- grey, soft below 4.6 m	
5.00	225.40		
5.50	224.90		
6.00	224.40		Qu = 15.9 kPa TV = 34.3 kPa
6.50	223.90		PP = 32.7 kPa γbulk = 16.3 kN/m³
7.00	223.40	7.0 - 9.1 m SILT (Till) - trace clay, some sand, some gravel - light grey	
7.50	222.90	- loose, wet, low plasticity	
8.00	222.40		
8.50	221.90		
9.00	221.40		
		9.1 m END OF TEST HOLE AT 9.1 m IN SILT TILL Notes:	
9.50	220.90	1. Seepage below 7.0 m in silt till layer.	
10.00	220.40	2. Squeezing below 7.0 m in silt till layer. 3. Standpipe piezometer, with Casagrande tip,	
10.50	219.90	installed to 8.8 m in silt till layer. 4. Test hole backfilled with bentonite chips from	
11.00	219.40	6.0 to 7.0 m and auger cuttings to ground surface. 5. Water level in piezometer at elevation 226.9 m	
11.50	218.90	on May 17, 2011.	
12.00	218.40		
12.50	217.90		
13.00	217.40		
13.50	216.90		
14.00	216.40		
14.50	215.90		
15.00	215.40		

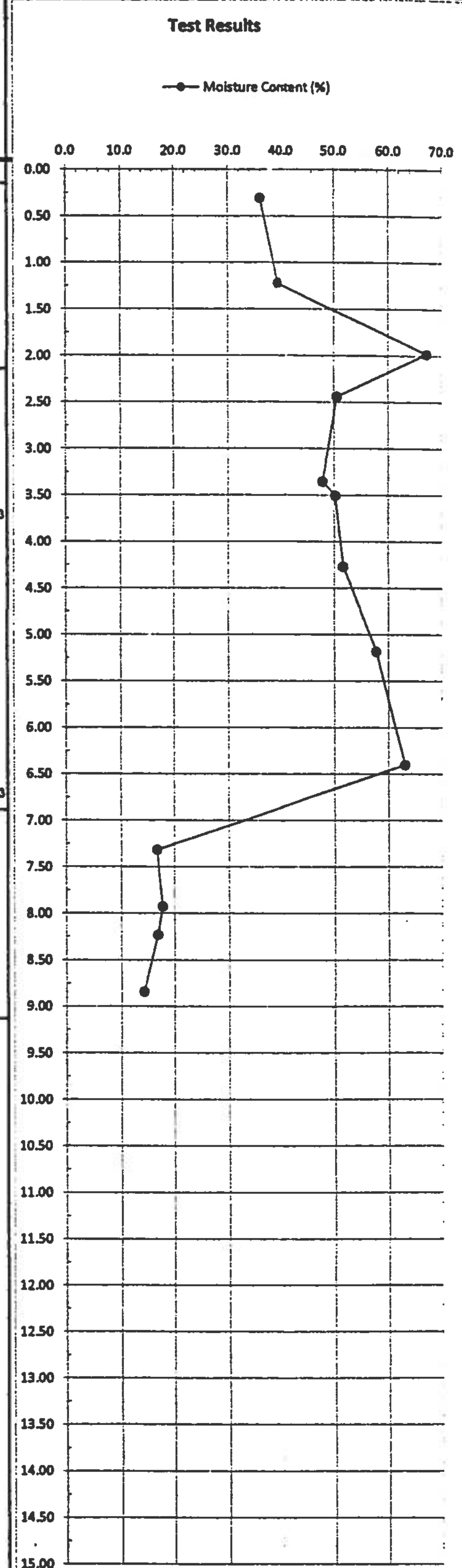


Figure No.: 6

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 6

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Inlet, Crest of Creek Bank, 1.5 m North and 8.0 m East of Fence	VIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 5, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	10.7

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION		COMMENTS
0.00	231.80		0 - 0.15 m	TOPSOIL	
			0.15 - 0.8 m	SILT (Fill) - clayey	
0.50	231.30			- trace sand, trace gravel, trace organics	
				- Dark brown and black	
1.00	230.80			- stiff, moist, intermediate plasticity	
			0.8 - 3.4 m	SILT - clayey	
1.50	230.30			- trace sand, trace gravel	
				- grey	
2.00	229.80			- firm to stiff, moist, intermediate plasticity	
				- sand seam at 2.0 m (< 3 mm thick)	
2.50	229.30			- firm below 2.5 m	
3.00	228.80				
			3.4 - 8.5 m	CLAY - silty	
3.50	228.30			- mottled brown and grey	
				- firm to stiff, moist, high plasticity	
4.00	227.80				
4.50	227.30				
				- trace gravel, trace silt inclusions (< 3 mm dia.),	
5.00	226.80				
5.50	226.30			- grey, soft below 5.5 m	
6.00	225.80				
					Qu = 22.5 kPa
6.50	225.30				TV = 38.0 kPa
					PP = 24.5 kPa
7.00	224.80				γbulk = 16.6 kN/m³
7.50	224.30				
8.00	223.80				
8.50	223.30		8.5 - 10.7 m	SILT (Till) - trace clay, some sand, some gravel	
				- light grey	
9.00	222.80			- loose, wet, low plasticity	
9.50	222.30				
10.00	221.80				
10.50	221.30				
			10.7 m	END OF TEST HOLE AT 10.7 m IN SILT TILL	
11.00	220.80			Notes:	
				1. Seepage below 8.5 m in silt till layer.	
11.50	220.30			2. Squeezing below 8.5 m in silt till layer.	
				3. Test hole backfilled with auger cuttings.	
12.00	219.80				
12.50	219.30				
13.00	218.80				
13.50	218.30				
14.00	217.80				
14.50	217.30				
15.00	216.80				

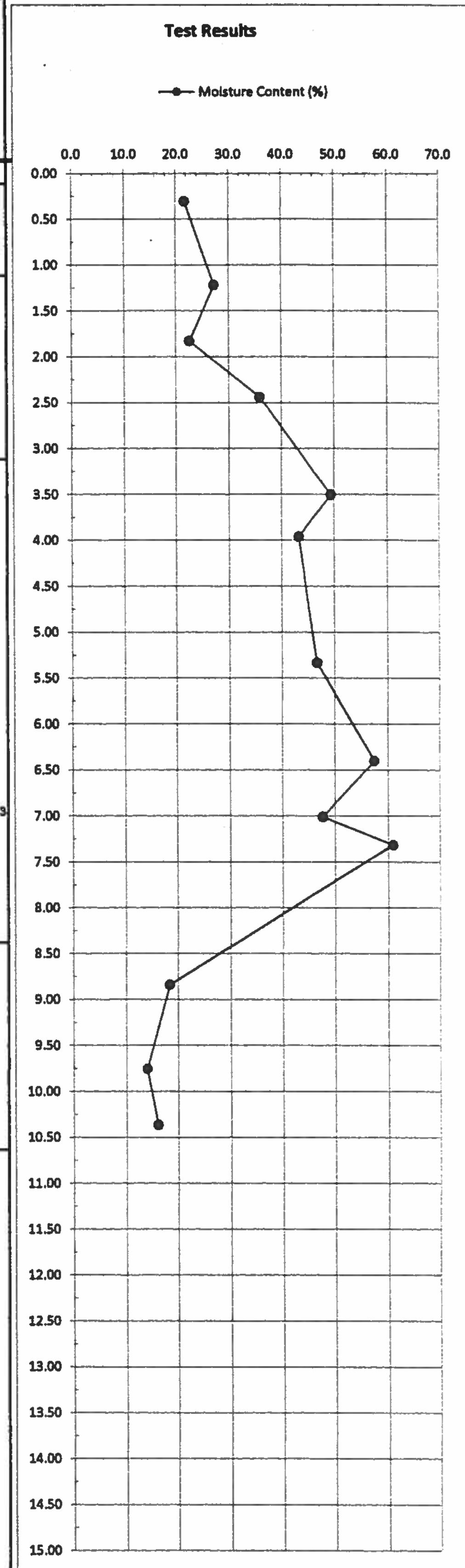


Figure No.: 7

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 7

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Westbound Portage Ave. Boulevard, 3.4 m north of curb, 3.5 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 5, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	3.4

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION		COMMENTS
0.00	232.10		0 - 3.4 m	SILT (Fill) - sandy, some gravel - trace organics - dark brown to black - stiff, moist, low Plasticity	
0.25	231.85				
0.50	231.60			- cobbles/boulders below 0.6 m	
0.75	231.35				
1.00	231.10				
1.25	230.85				
1.50	230.60				
1.75	230.35			- clayey, intermediate plasticity below 1.8 m	
2.00	230.10				
2.25	229.85				
2.50	229.60				
2.75	229.35				
3.00	229.10				
3.25	228.85		3.4 m	END OF TEST HOLE AT REFUSAL at 3.4 m IN SILT FILL Notes: 1. Test hole backfilled with auger cuttings.	
3.50	228.60				
3.75	228.35				
4.00	228.10				
4.25	227.85				
4.50	227.60				
4.75	227.35				
5.00	227.10				
5.25	226.85				
5.50	226.60				
5.75	226.35				
6.00	226.10				
6.25	225.85				
6.50	225.60				
6.75	225.35				
7.00	225.10				
7.25	224.85				
7.50	224.60				

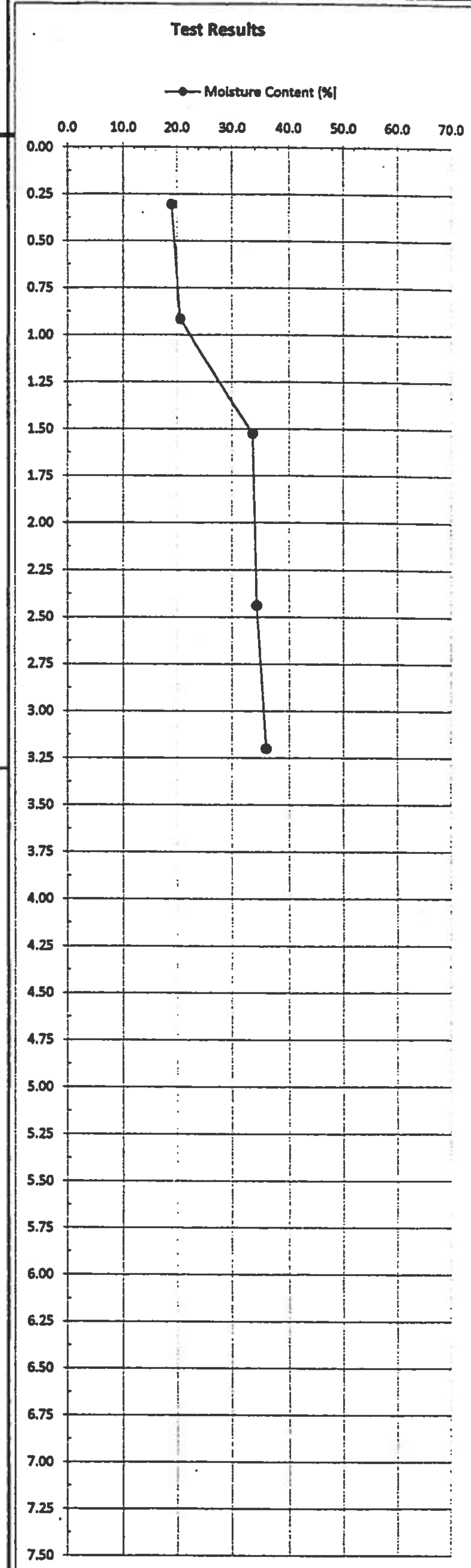


Figure No.: 8

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 8

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Westbound Portage Ave. Boulevard, 3.4 m north of curb, 5.8 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 5, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	6.1

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION		COMMENTS
0.00	232.10		0 - 2.1 m	SILT (Fill) - sandy, some gravel - trace organics - dark brown to black - stiff, moist, low Plasticity - cobbles/boulders below 0.6 m	
0.25	231.85				
0.50	231.60				
0.75	231.35				
1.00	231.10				
1.25	230.85				
1.50	230.60				
1.75	230.35				
2.00	230.10		2.1 - 4.0 m	SILT - clayey - trace sand, trace gravel - grey - firm, moist, intermediate plasticity	
2.25	229.85				
2.50	229.60				
2.75	229.35				
3.00	229.10				
3.25	228.85				
3.50	228.60				
3.75	228.35				
4.00	228.10		4.0 - 6.1 m	CLAY - silty - trace silt inclusions (< 15 mm dia.) - grey, mottled brown and grey below 4.7 m - firm to stiff, moist, high plasticity	
4.25	227.85				
4.50	227.60				
4.75	227.35				
5.00	227.10				
5.25	226.85				
5.50	226.60				
5.75	226.35				
6.00	226.10				
6.25	225.85		6.1 m	END OF TEST HOLE AT 6.1 m IN CLAY Notes: 1. Squeezing in silt layer. 2. Test hole backfilled with auger cuttings.	
6.50	225.60				
6.75	225.35				
7.00	225.10				
7.25	224.85				
7.50	224.60				

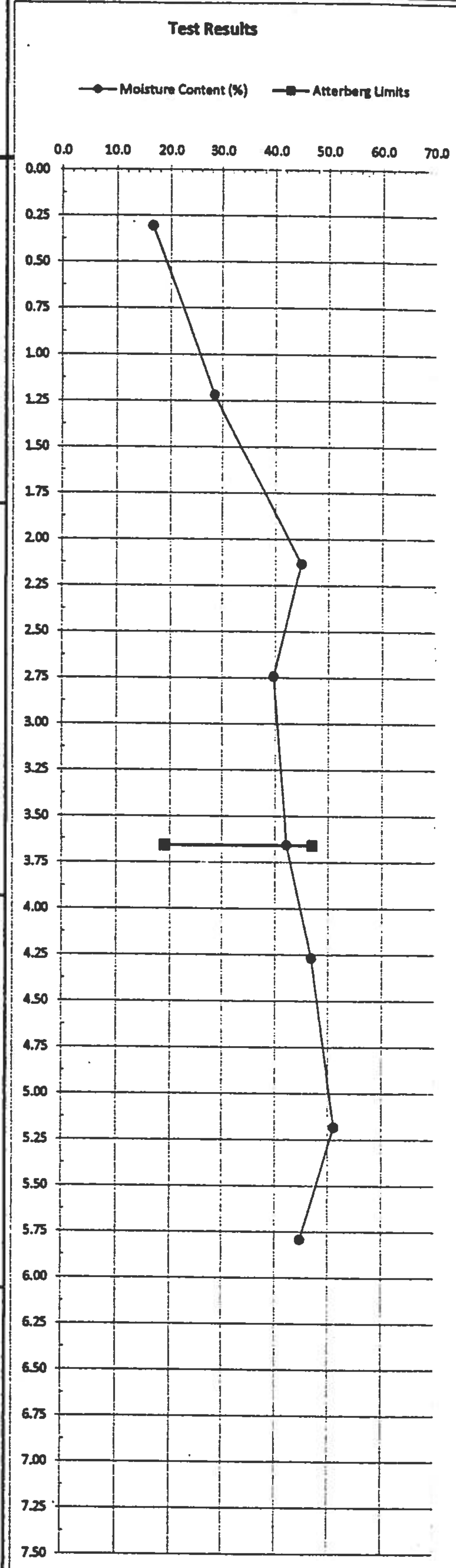


Figure No.: 9

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 9

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Westbound Portage Ave. Boulevard, 3.4 m north of curb, 8.8 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 5, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	6.1

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION	COMMENTS
0.00	232.10		0 - 2.1 m SILT (Fill) - sandy, some gravel - trace organics - dark brown to black - stiff, moist, low Plasticity	
0.25	231.85			
0.50	231.60			
0.75	231.35			
1.00	231.10			
1.25	230.85			
1.50	230.60			
1.75	230.35			
2.00	230.10		2.1 - 4.2 m SILT - clayey - trace sand, trace gravel - grey - firm, moist, intermediate plasticity	
2.25	229.85			
2.50	229.60			
2.75	229.35			
3.00	229.10			
3.25	228.85			
3.50	228.60			
3.75	228.35			
4.00	228.10			
4.25	227.85		4.2 - 6.1 m CLAY - silty - trace silt inclusions (< 15 mm dia.), trace sand - grey, mottled brown and grey below 4.3 m - firm to stiff, moist, high plasticity	
4.50	227.60			
4.75	227.35			
5.00	227.10			
5.25	226.85			
5.50	226.60			
5.75	226.35			
6.00	226.10			
6.25	225.85		6.1 m END OF TEST HOLE AT 6.1 m IN CLAY Notes: 1. Squeezing in silt layer. 2. Test hole backfilled with auger cuttings.	
6.50	225.60			
6.75	225.35			
7.00	225.10			
7.25	224.85			
7.50	224.60			

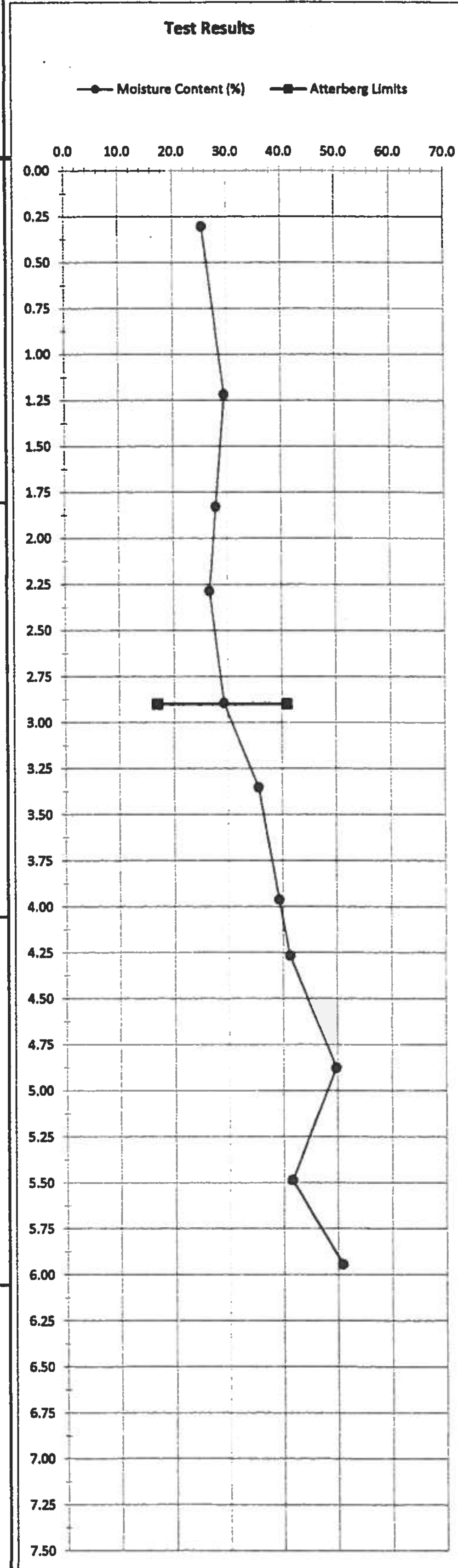


Figure No.: 10

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 10

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Eastbound Portage Ave. Curb Lane, 1.1 m north of curb, 0.6 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 6, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	6.1

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION	COMMENTS
0.00	232.00		0 - 0.09 m ASPHALT (90 mm)	
			0.09 - 0.39 m CONCRETE (300 mm)	
0.25	231.75			
			0.39 - 0.70 m GRANULAR BASE (310 mm)	
0.50	231.50			
			0.70 - 3.0 m SILT (Fill) - clayey, some sand, some gravel - trace organics - dark brown to black - firm, moist, intermediate plasticity - woody fragments	
0.75	231.25			
1.00	231.00			
1.25	230.75			
1.50	230.50		- black, stiff below 1.5 m	
1.75	230.25			
2.00	230.00			
2.25	229.75			
2.50	229.50			
2.75	229.25			
3.00	229.00		3.0 - 4.8 m SILT - clayey - trace sand, trace gravel - grey - firm, moist, intermediate plasticity	
3.25	228.75			
3.50	228.50			
3.75	228.25			
4.00	228.00			
4.25	227.75			
4.50	227.50			
4.75	227.25			
			4.8 - 6.1 m CLAY - silty - trace sand, trace gravel - trace silt inclusions (< 15 mm dia.) - mottled brown and grey - firm to stiff, moist, high plasticity	
5.00	227.00			
5.25	226.75			
5.50	226.50			
5.75	226.25			
6.00	226.00			
			6.1 m END OF TEST HOLE AT 6.1 m IN CLAY Notes: 1. Squeezing in silt layer. 2. Test hole backfilled with auger cuttings, concrete core and cold patch asphalt.	
6.25	225.75			
6.50	225.50			
6.75	225.25			
7.00	225.00			
7.25	224.75			
7.50	224.50			

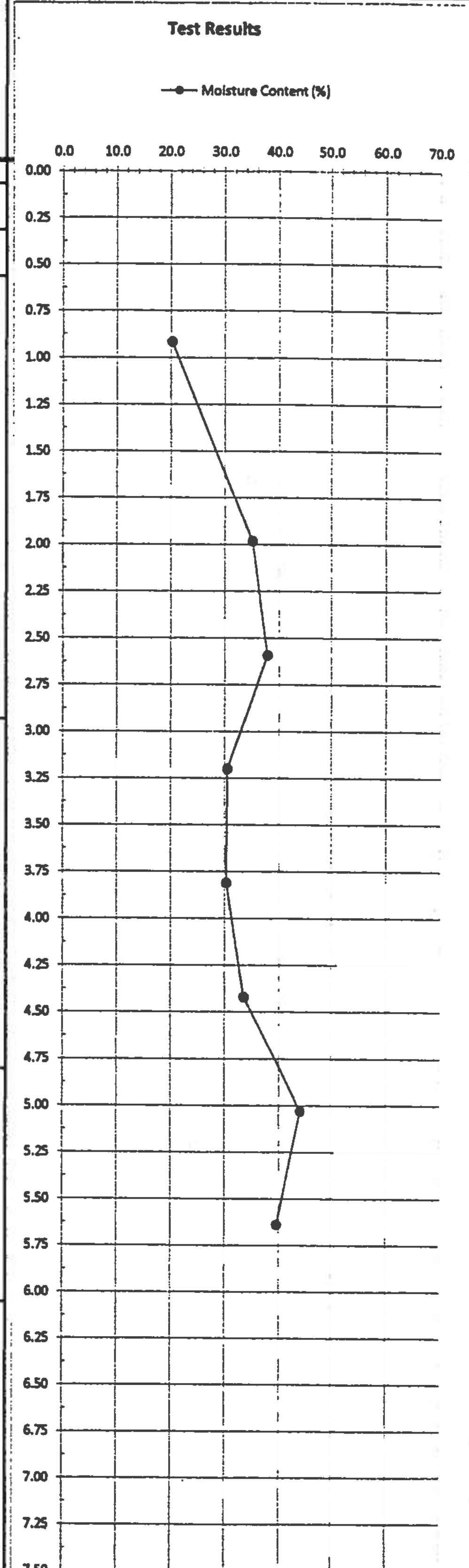


Figure No.: 11

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 11

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Eastbound Portage Ave. Curb Lane, 0.6 m north of curb, 3.8 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 6, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	6.1

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION		COMMENTS
0.00	232.00		0 - 0.09 m	ASPHALT (90 mm)	
0.25	231.75		0.09 - 0.39 m	CONCRETE (300 mm)	
0.50	231.50		0.39 - 0.70 m	GRANULAR BASE (310 mm)	
0.75	231.25		0.70 - 2.3 m	SILT (Fill) - clayey, some sand, some gravel - trace organics - dark brown to black - firm, moist, intermediate plasticity	
1.00	231.00				
1.25	230.75				
1.50	230.50				
1.75	230.25				
2.00	230.00				
2.25	229.75				
2.50	229.50		2.3 - 4.8 m	SILT - clayey - trace sand, trace gravel - grey - firm, moist, intermediate plasticity	
2.75	229.25				
3.00	229.00				
3.25	228.75				
3.50	228.50				
3.75	228.25				
4.00	228.00				
4.25	227.75				
4.50	227.50				
4.75	227.25				
5.00	227.00		4.8 - 6.1 m	CLAY - silty - trace sand, trace gravel - trace silt inclusions (< 15 mm dia.) - mottled brown and grey - firm to stiff, moist, high plasticity	Qu = 40.9 kPa TV = 84.2 kPa PP = 78.5 kPa γbulk = 17.5 kN/m^3
5.25	226.75				
5.50	226.50				
5.75	226.25				
6.00	226.00				
6.25	225.75		6.1 m	END OF TEST HOLE AT 6.1 m IN CLAY Notes: 1. Squeezing in silt layer. 2. Test hole backfilled with auger cuttings, concrete core and cold patch asphalt.	
6.50	225.50				
6.75	225.25				
7.00	225.00				
7.25	224.75				
7.50	224.50				

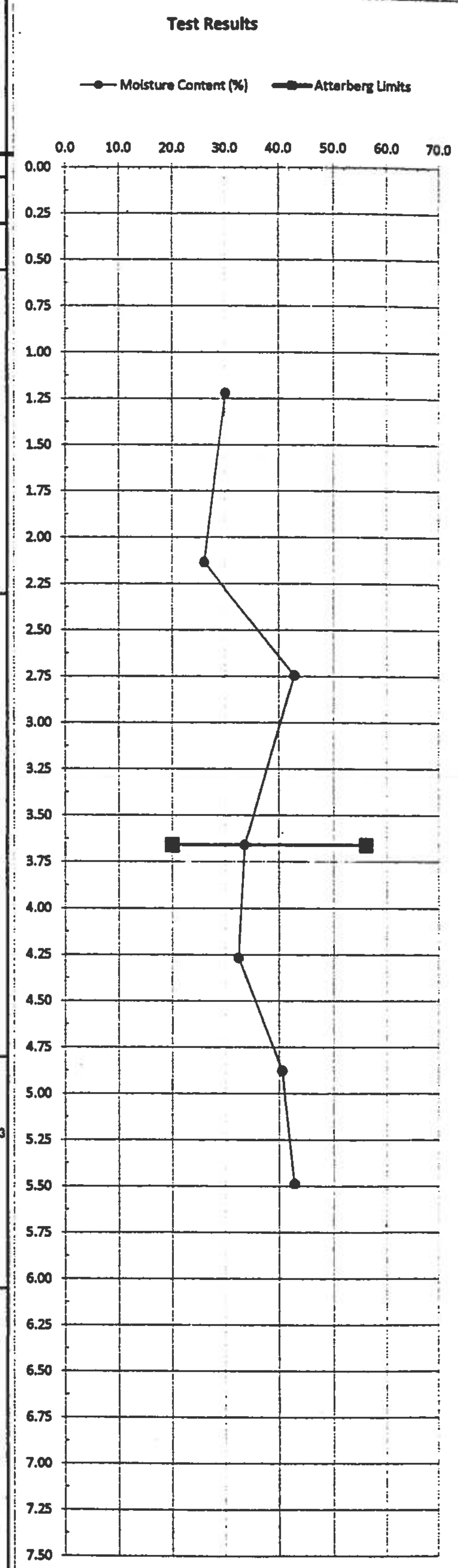


Figure No.: 12

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 12

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Eastbound Portage Ave. Curb Lane, 0.8 m north of curb, 6.9 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 6, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	6.1

DEPTH (m)	ELEVATION (m)	SOIL SYMBOL	SOIL DESCRIPTION		COMMENTS
0.00	232.00		0 - 0.09 m	ASPHALT (90 mm)	
			0.09 - 0.39 m	CONCRETE (300 mm)	
0.25	231.75				
			0.39 - 0.70 m	GRANULAR BASE (310 mm)	
0.50	231.50				
			0.70 - 1.3 m	SILT (Fill) - clayey, some sand, some gravel - trace organics - dark brown to black - firm, moist, intermediate plasticity	
0.75	231.25				
1.00	231.00				
1.25	230.75				
			1.3 - 4.8 m	SILT - clayey - trace sand, trace gravel - grey - firm, moist, intermediate plasticity	
1.50	230.50				
1.75	230.25				
2.00	230.00				
2.25	229.75				
2.50	229.50				
2.75	229.25				
3.00	229.00				
3.25	228.75				
3.50	228.50				
3.75	228.25				
4.00	228.00				
4.25	227.75				
4.50	227.50				
4.75	227.25				
			4.8 - 6.1 m	CLAY - silty - trace silt inclusions (< 25 mm dia.) - grey, mottled brown and grey below 4.0 m - firm to stiff, moist, high plasticity	Qu = 42.5 kPa TV = 69.9 kPa PP = 60.5 kPa γbulk = 17.5 kN/m^3
5.00	227.00				
5.25	226.75				
5.50	226.50				
5.75	226.25				
6.00	226.00				
			6.1 m	END OF TEST HOLE AT 6.1 m IN CLAY Notes: 1. Squeezing in silt layer. 2. Test hole backfilled with auger cuttings, concrete core and cold patch asphalt.	
6.25	225.75				
6.50	225.50				
6.75	225.25				
7.00	225.00				
7.25	224.75				
7.50	224.50				

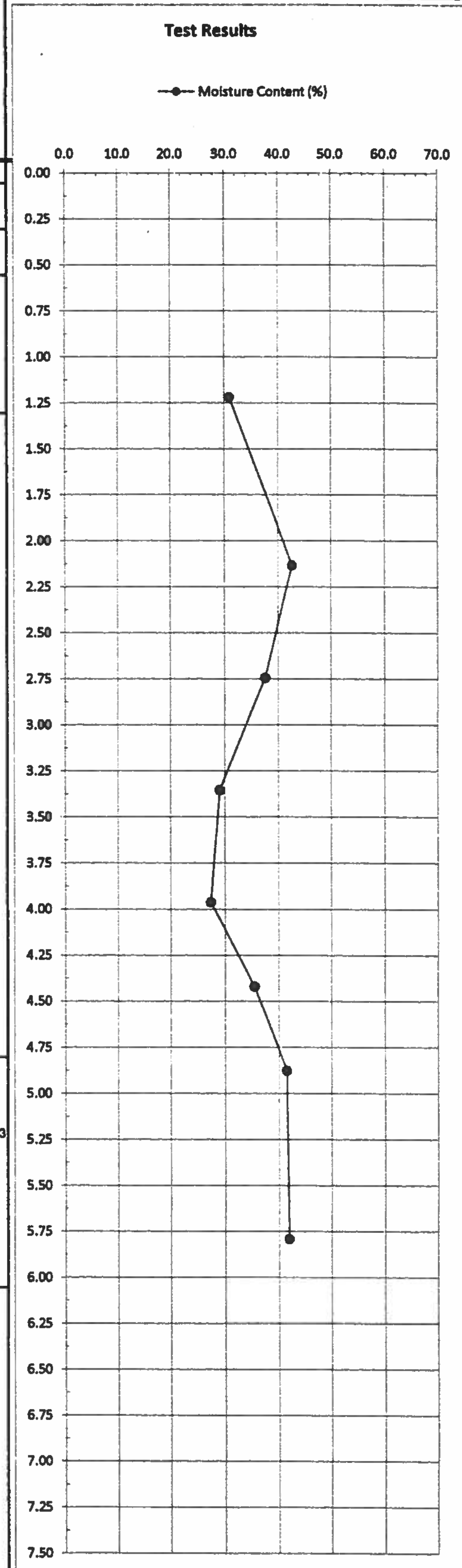


Figure No.: 13

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS		PROJECT # 113321	TEST HOLE NO. 13

PROJECT:	City of Winnipeg	LOGGED BY:	RB
LOCATION:	Outlet, Toe of Creek Bank, 13.5 m South of curb, 7.9 m East of Culvert	REVIEWED BY:	AOD
CONTRACTOR:	Paddock Drilling Ltd.	DRILL DATE:	May 6, 2011
METHOD:	Mobile S-61, 125 mm Solid Stem Auger	DRILL DEPTH (m):	9.1

DEPTH (m)	ELEVATION (m)
0.00	230.60
0.50	230.10
1.00	229.60
1.50	229.10
2.00	228.60
2.50	228.10
3.00	227.60
3.50	227.10
4.00	226.60
4.50	226.10
5.00	225.60
5.50	225.10
6.00	224.60
6.50	224.10
7.00	223.60
7.50	223.10
8.00	222.60
8.50	222.10
9.00	221.60
9.50	221.10
10.00	220.60
10.50	220.10
11.00	219.60
11.50	219.10
12.00	218.60
12.50	218.10
13.00	217.60
13.50	217.10
14.00	216.60
14.50	216.10
15.00	215.60

SOIL DESCRIPTION		COMMENTS
0 - 1.1 m	TOPSOIL - clayey - silty	
1.1 - 2.3 m	SILT - clayey - trace sand - brown - soft to firm, moist, low plasticity	
2.3 - 7.6 m	CLAY - silty - trace sand, trace gravel - trace silt inclusions (< 3 mm dia.) - mottled brown and grey - firm to stiff, moist, high plasticity	Qu = 32.3 kPa TV = 87.0 kPa PP = 83.4 kPa γbulk = 17.3 kN/m^3
	- silt interlayering, soft below 6.0 m	Qu = 34.2 kPa TV = 46.6 kPa PP = 40.1 kPa γbulk = 16.4 kN/m^3
	- some silt till inclusions (<25 mm dia.) below 7.0 m	
7.6 - 9.1 m	SILT (Till) - trace clay, some sand, some gravel - light grey - loose, wet, low plasticity	
9.1 m	END OF TEST HOLE AT 9.1 m IN SILT TILL Notes: 1. Seepage below 7.6 m in silt till layer. 2. Squeezing below 7.6 m in silt till layer. 3. Standpipe piezometer, with Casagrande tip, installed to 9.1 m in silt till layer. 4. Test hole backfilled with bentonite chips from 6.6 to 7.6 m and auger cuttings to ground surface. 5. Water level in piezometer at elevation 229.2 m on May 17, 2011.	

Test Results

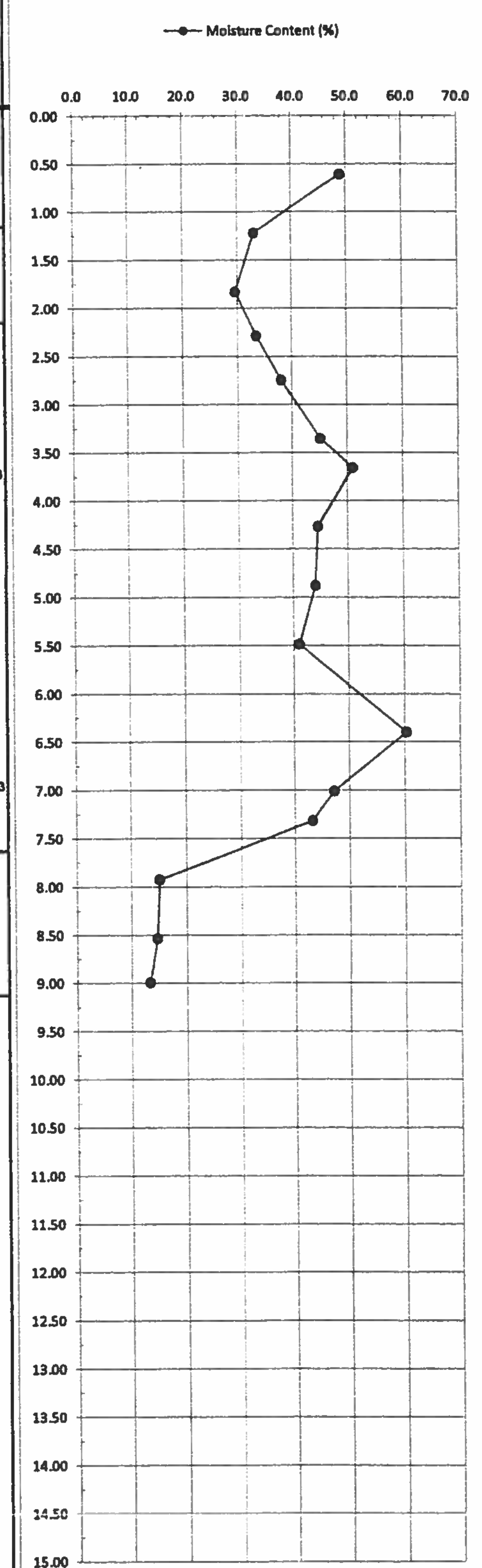
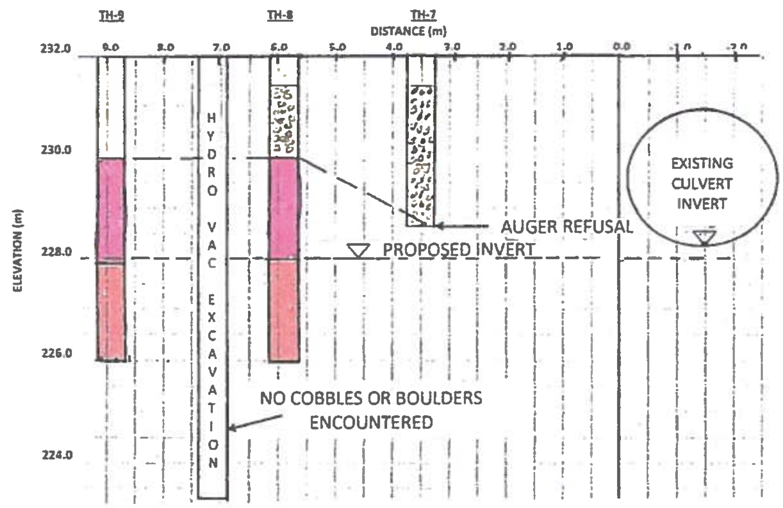
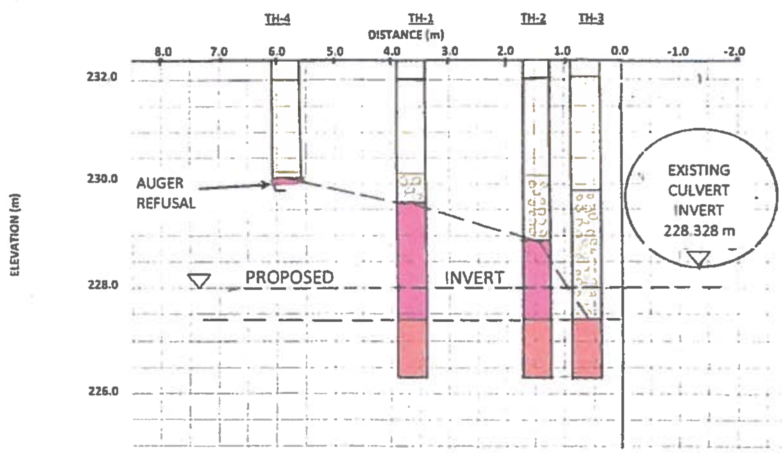


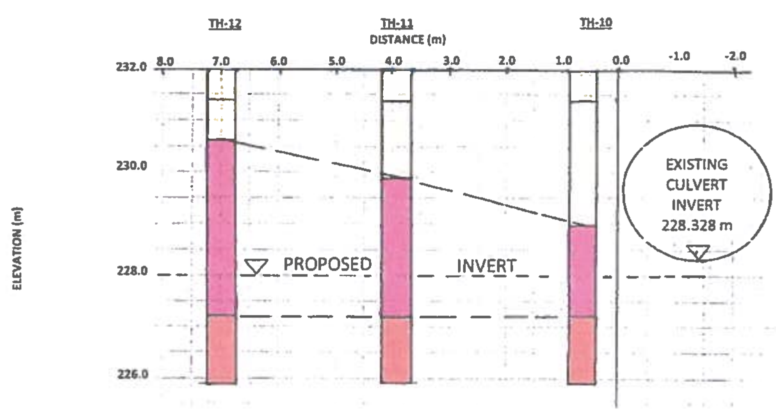
Figure No.: 14



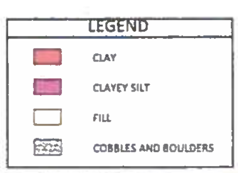
NORTH SOIL PROFILE



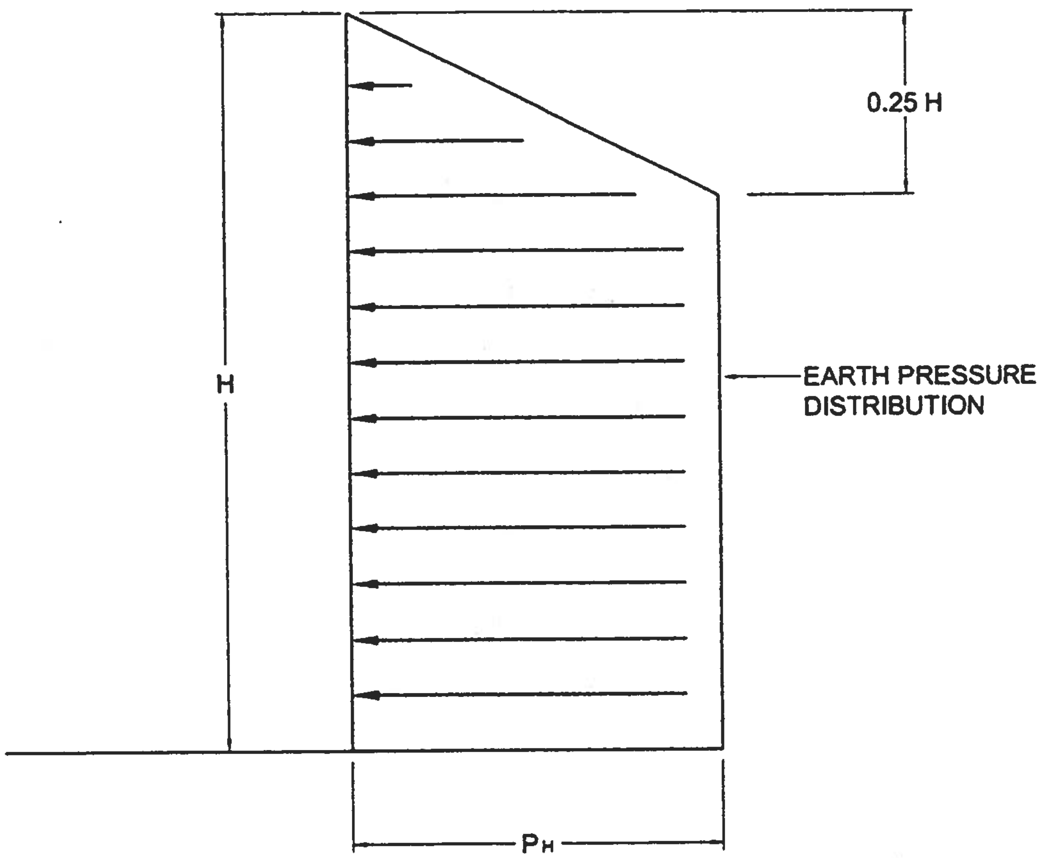
MEDIAN SOIL PROFILE



SOUTH SOIL PROFILE



DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS			**PORTAGE AVENUE AT TRURO CREEK REHABILITATION SOIL PROFILES**		
SCALE: NTS	MADE BY: RB	CHKD BY: AOD	PROJECT NO: 113321	DATE: AUGUST 4, 2011	FIGURE 15



$Ph = 0.4\gamma H$

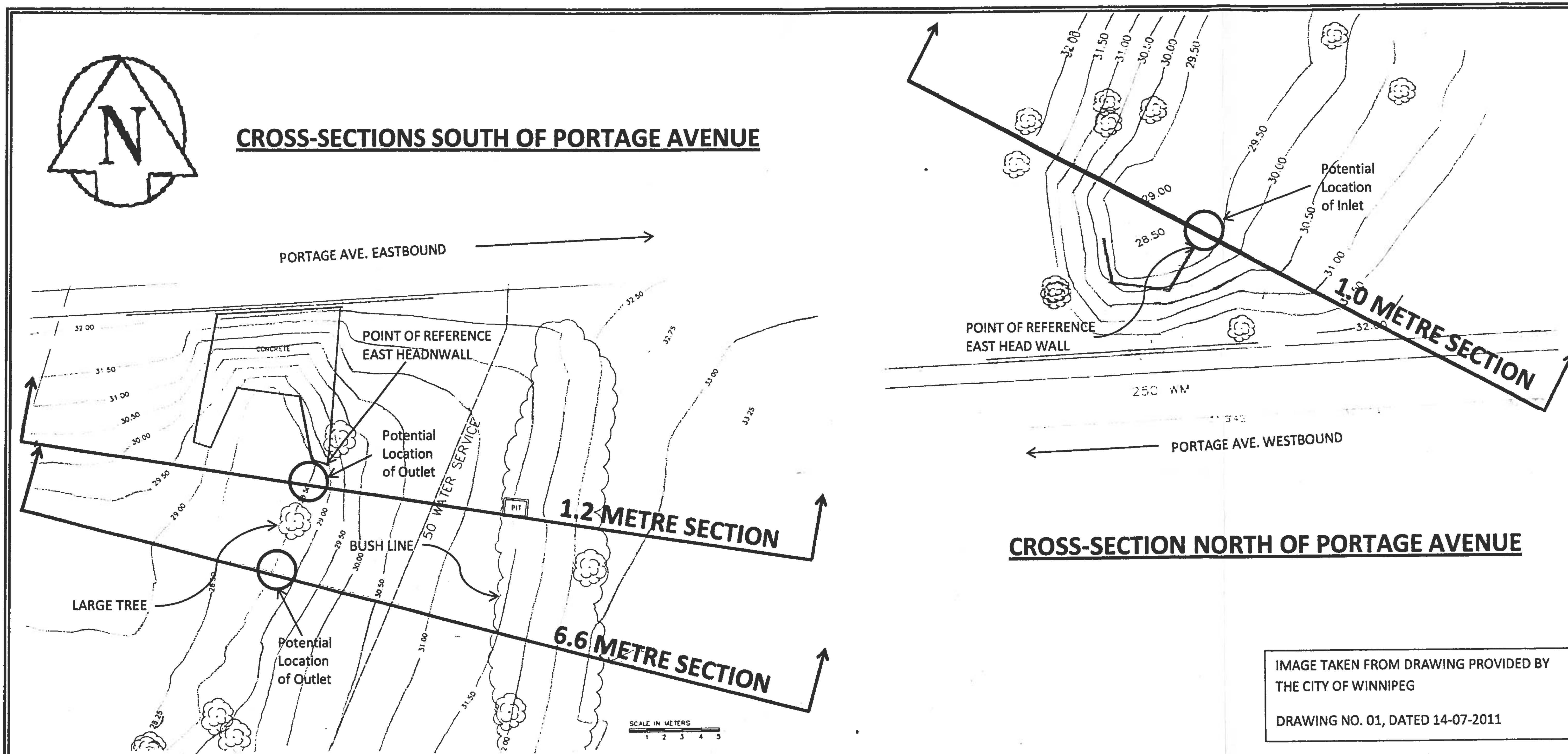
Where:

Ph = Lateral Earth Pressure (kPa)

γ = Soil Unit Weight (17.3 kN/m^3)

H = Depth of Excavation (m)

DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS			EARTH PRESSURE DISTRIBUTION TEMPORARY SHORING		
SCALE: NTS	MADE BY: GR	CHKD BY: AOD	PROJECT NO. 113321	DATE: July 28, 2011	FIGURE 16



DYREGROV ROBINSON INC. CONSULTING GEOTECHNICAL ENGINEERS			PORTAGE AVENUE AT TRURO CREEK REHABILITATION LOCATIONS OF SECTIONS USED FOR STABILITY ANALYSIS		
SCALE: NTS	MADE BY: RB	CHKD BY: AOD	PROJECT NO. 113321	DATE: AUGUST 4, 2011	FIGURE 17

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Inlet - North of Portage Avenue
- 1.0 m North of East Head Wall
Slope Geometry: Existing Geometry
Creek Water Level: 0.5 m
Groundwater Conditions: 1 m below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

Name: SILT FILL
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 15 °

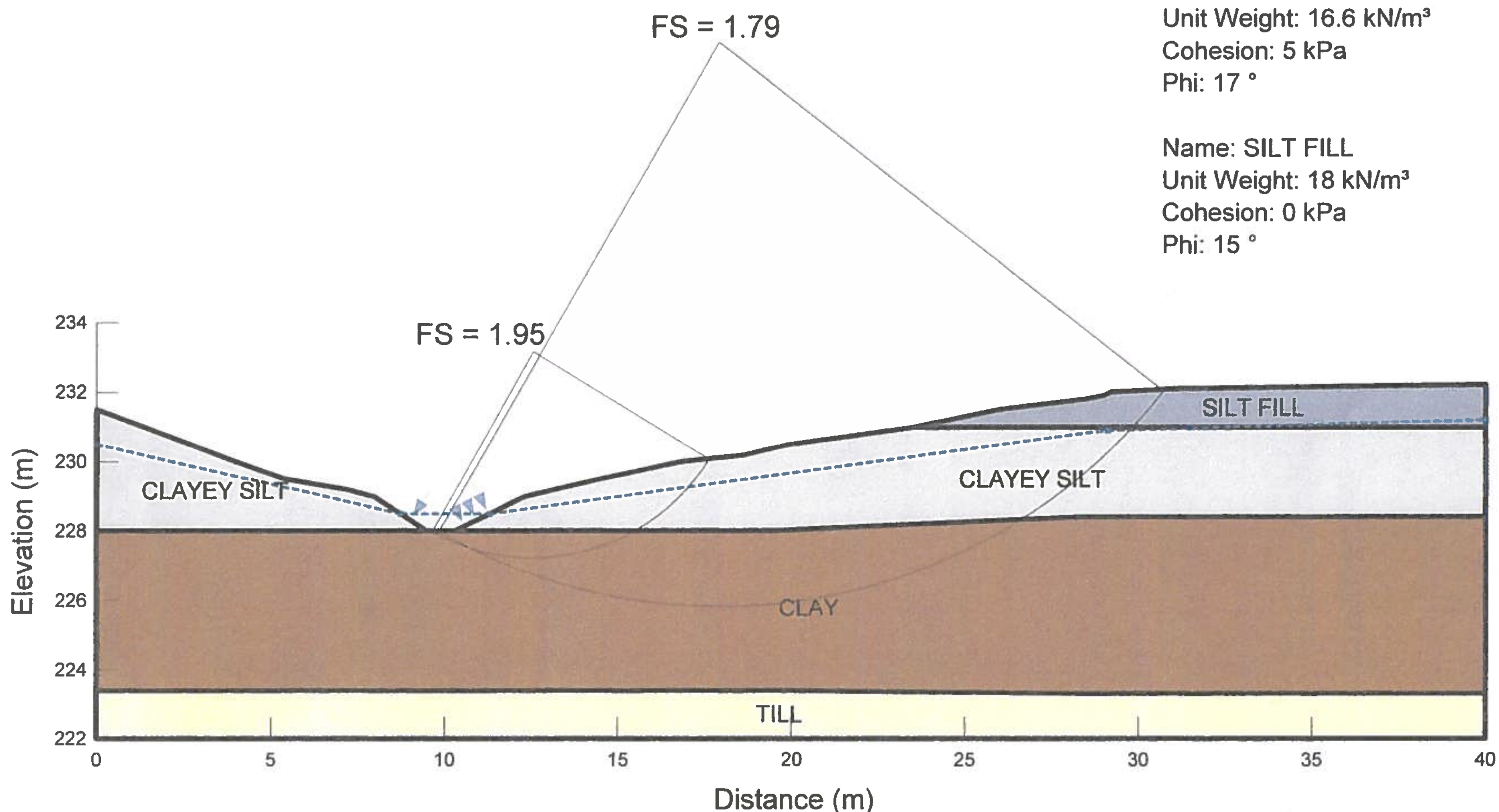


FIGURE 18

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Inlet - North of Portage Avenue
- 1.0 m North of East Head Wall
Slope Geometry: Existing Geometry
Creek Water Level: 0.5 m
Groundwater Conditions: 2 m below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

Name: SILT FILL
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 15 °

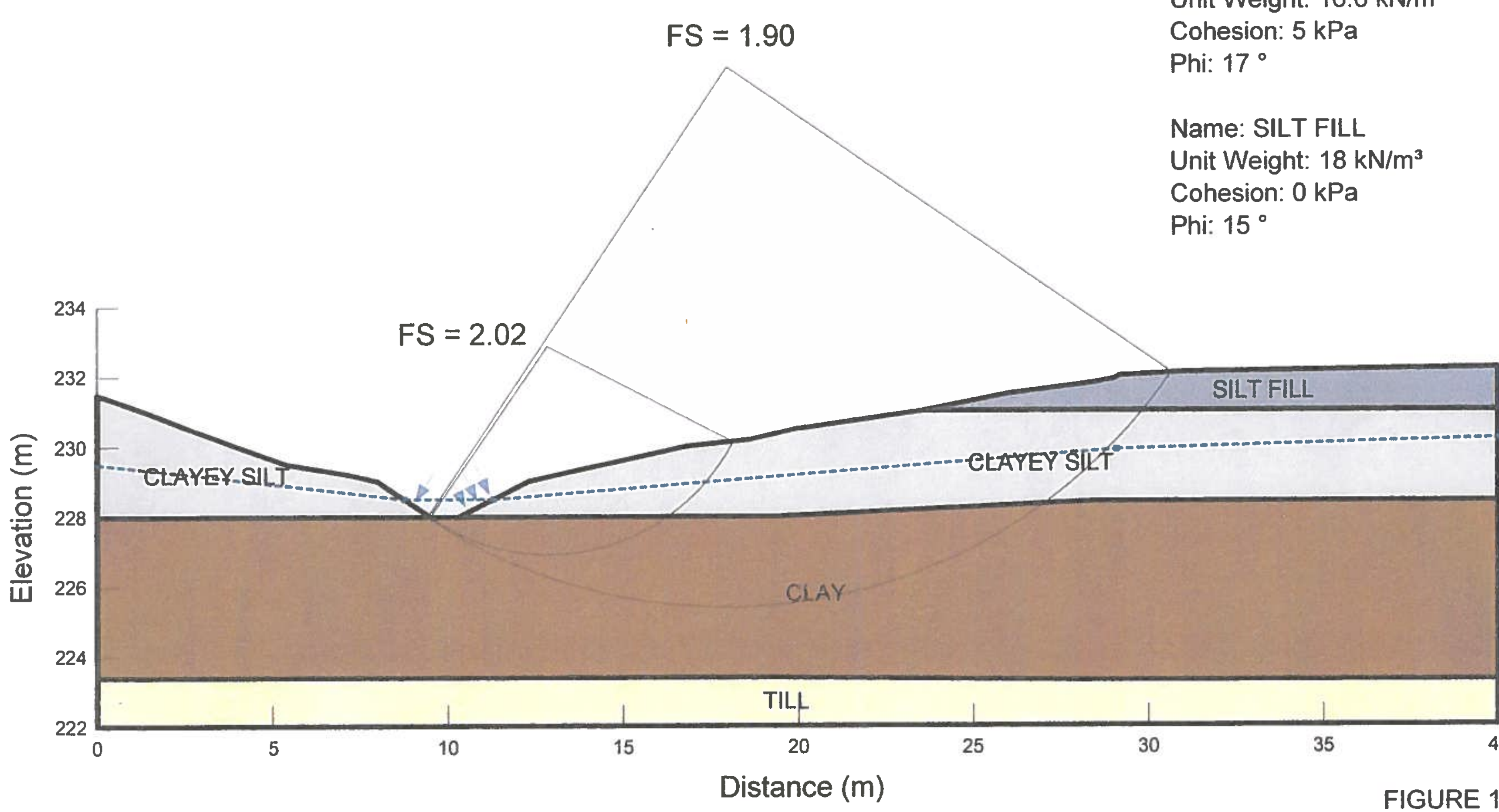


FIGURE 19

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Inlet - North of Portage Avenue
- 1.0 m North of East Head Wall
Slope Geometry: 1.5 m x 3 m Excavation, 1:1 Side Slope
Creek Water Level: 0.5 m
Groundwater Conditions: 1 m below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

Name: SILT FILL
Unit Weight: 18 kN/m³
Cohesion: 0 kPa
Phi: 15 °

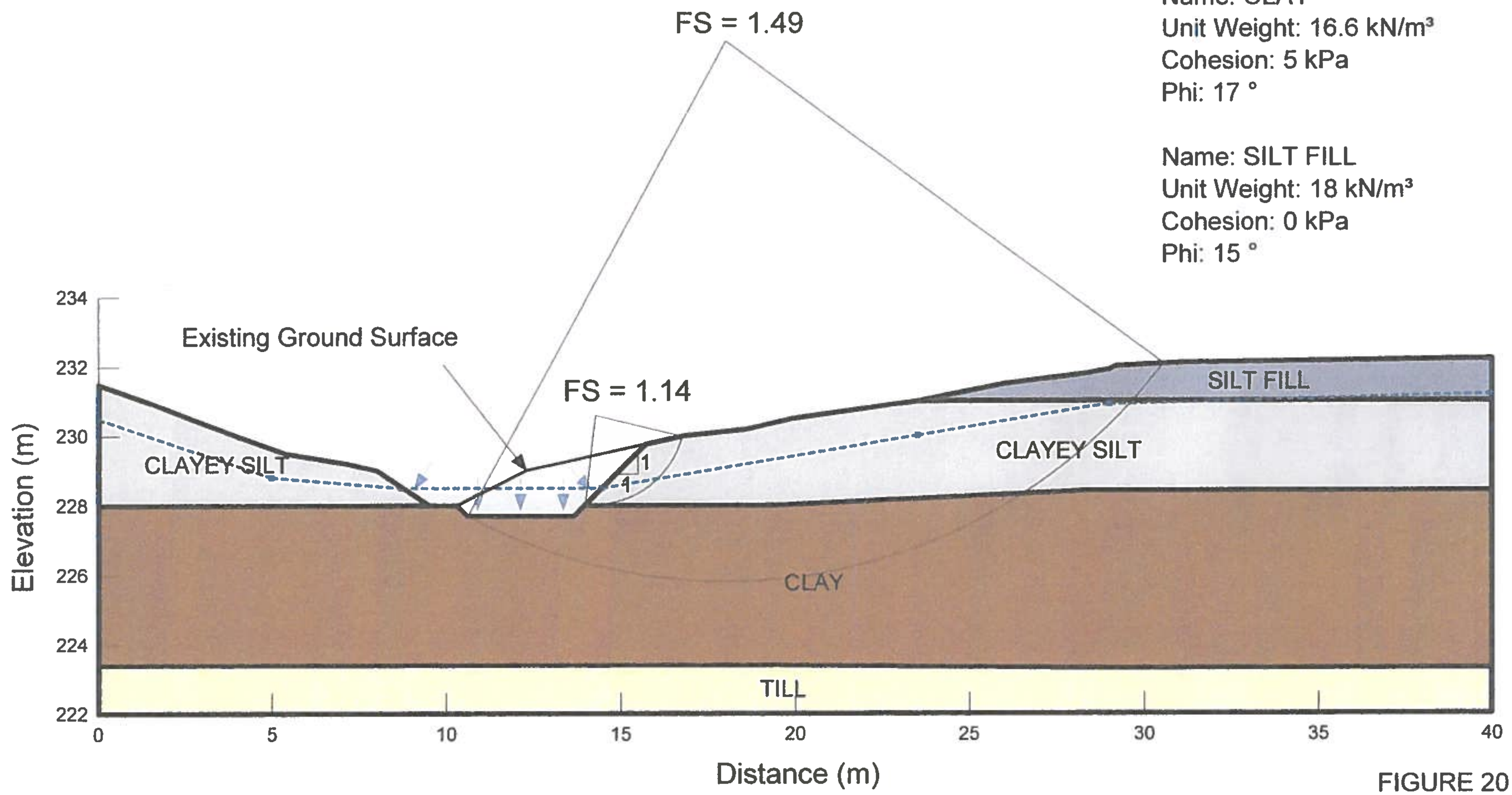


FIGURE 20

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Outlet - South of Portage Avenue
- 1.2 m South of East Head Wall
Slope Geometry: Existing Geometry
Creek Water Level: 0.5 m
Groundwater Conditions: 2 m Below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

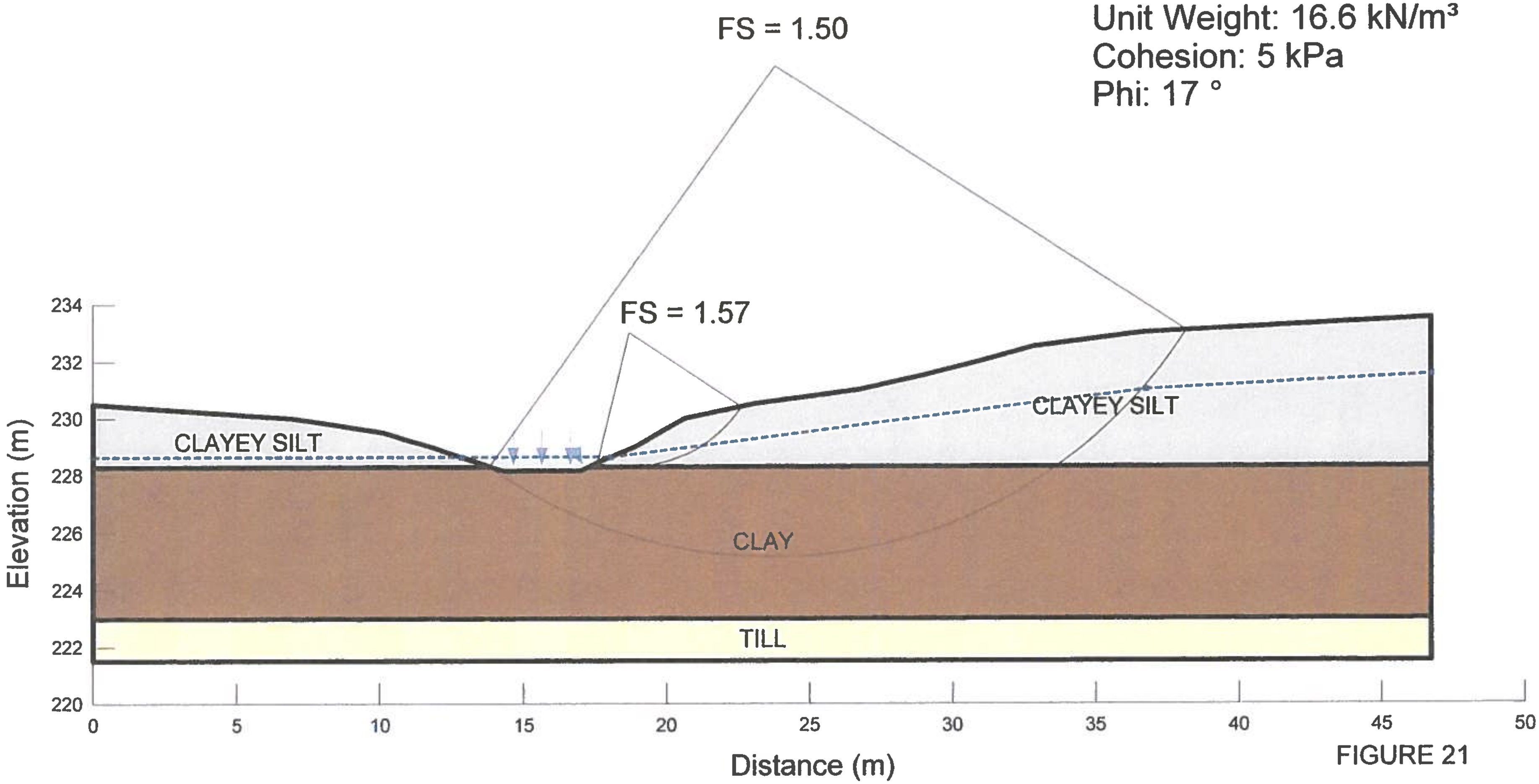


FIGURE 21

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Outlet - South of Portage Avenue
- 1.2 m South of East Head Wall
Slope Geometry: Existing Geometry
Creek Water Level: 0.5 m
Groundwater Conditions: 1 m Below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

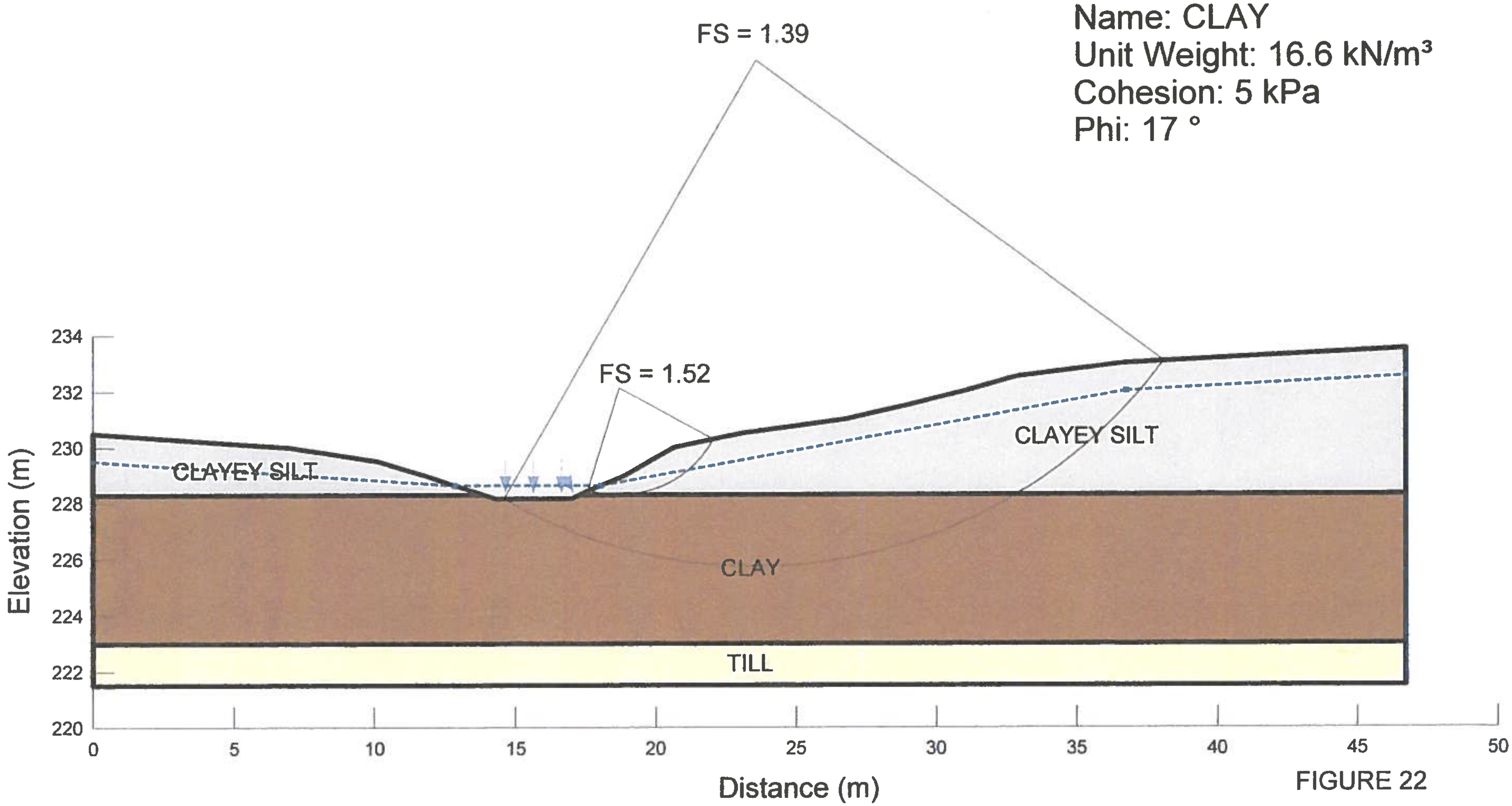


FIGURE 22

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Outlet - South of Portage Avenue
- 1.2 m South of East Head Wall
Slope Geometry: 1.8 m x 3 m Excavation, 1:1 Side Slope
Creek Water Level: 0.5 m
Groundwater Conditions: 1 m Below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

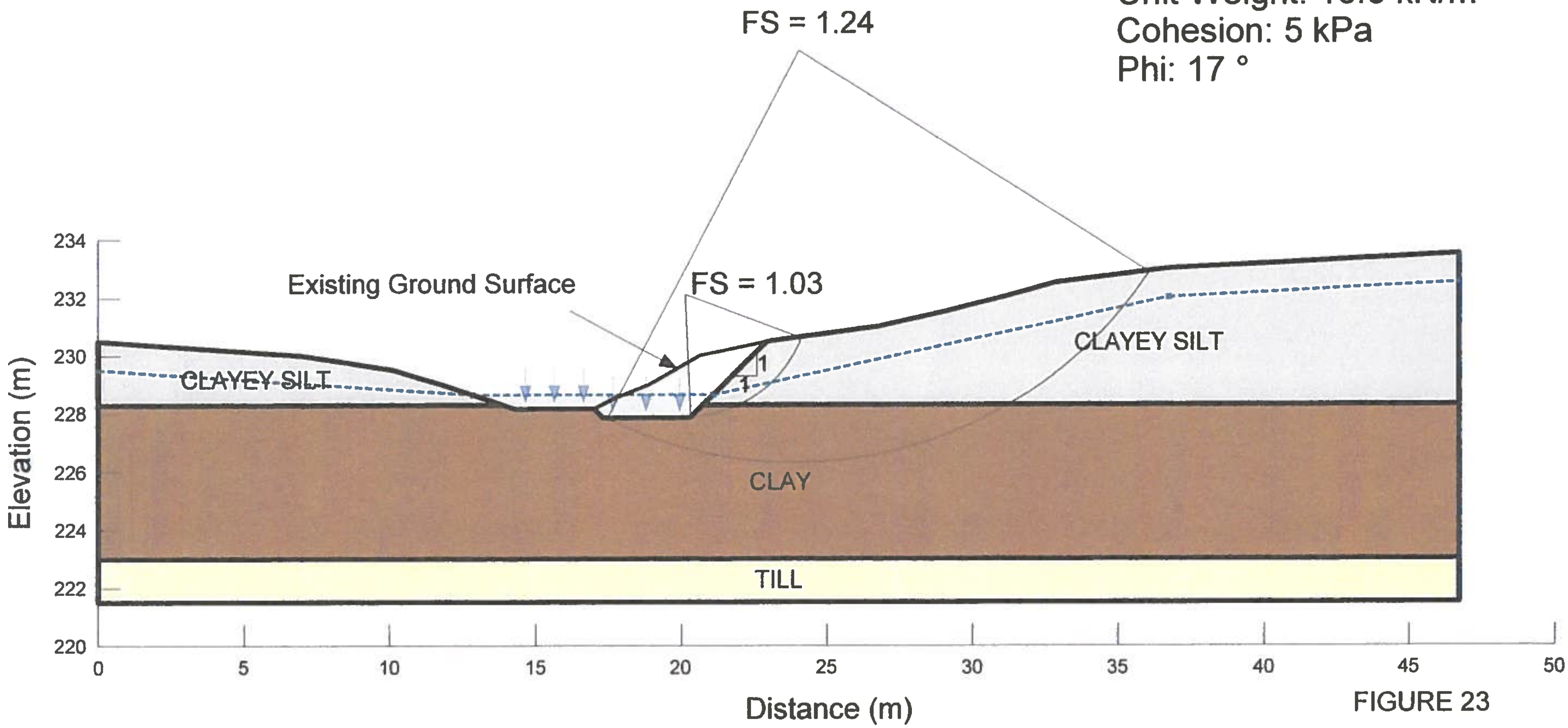


FIGURE 23

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Outlet - South of Portage Avenue
- 1.2 m South of East Head Wall, 1.5 m West of Bush Line
Slope Geometry: 3.2 m x 1.5 m Trench
Creek Water Level: 0.5 m
Groundwater Conditions: 1 m Below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

Name: FILL
Unit Weight: 15 kN/m³
Cohesion: 0 kPa
Phi: 10 °

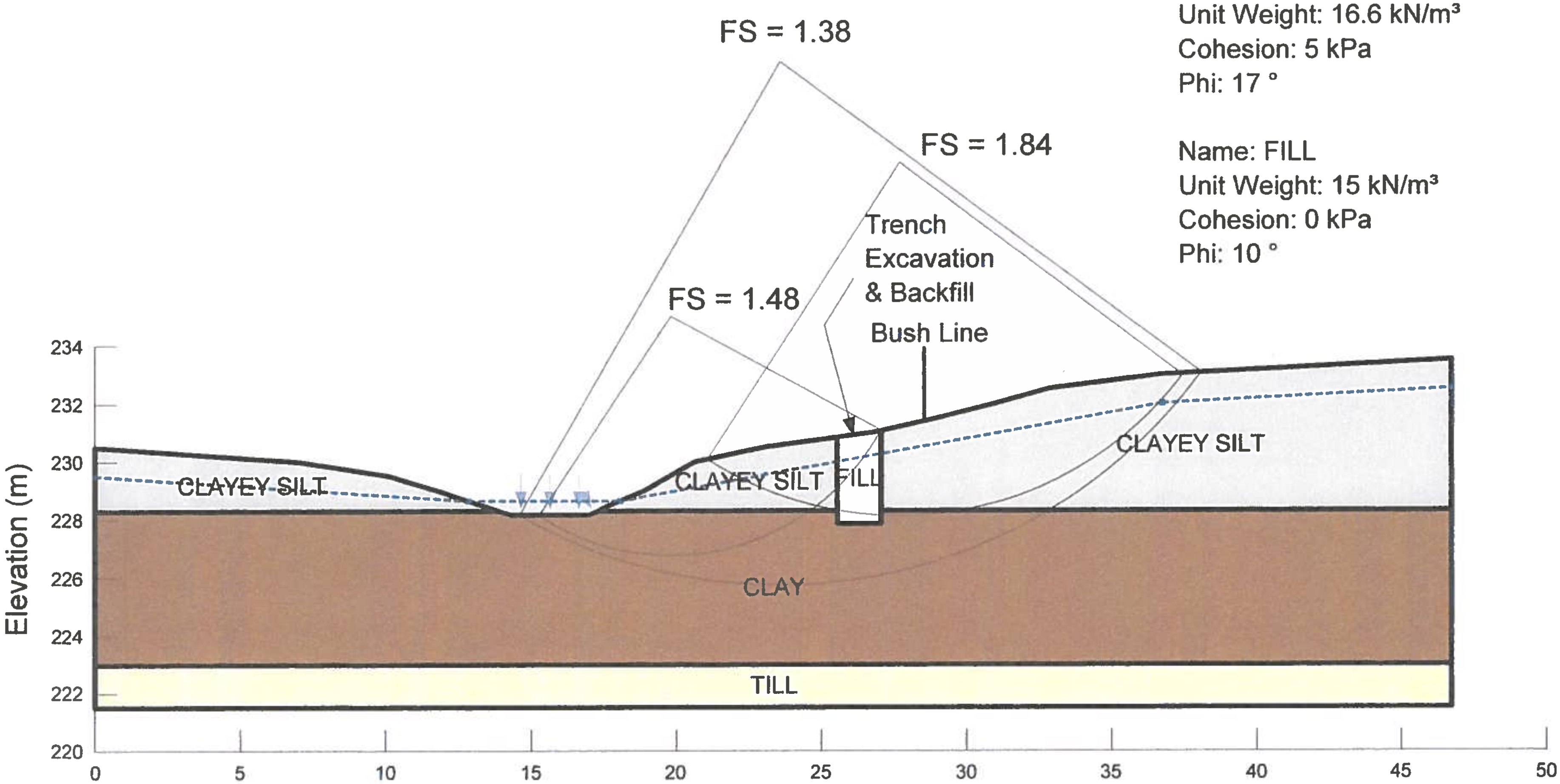


FIGURE 24

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Outlet - South of Portage Avenue
- 6.6 m South of East Head Wall
Slope Geometry: Existing Geometry
Creek Water Level: 0.5 m
Groundwater Conditions: 1 m Below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

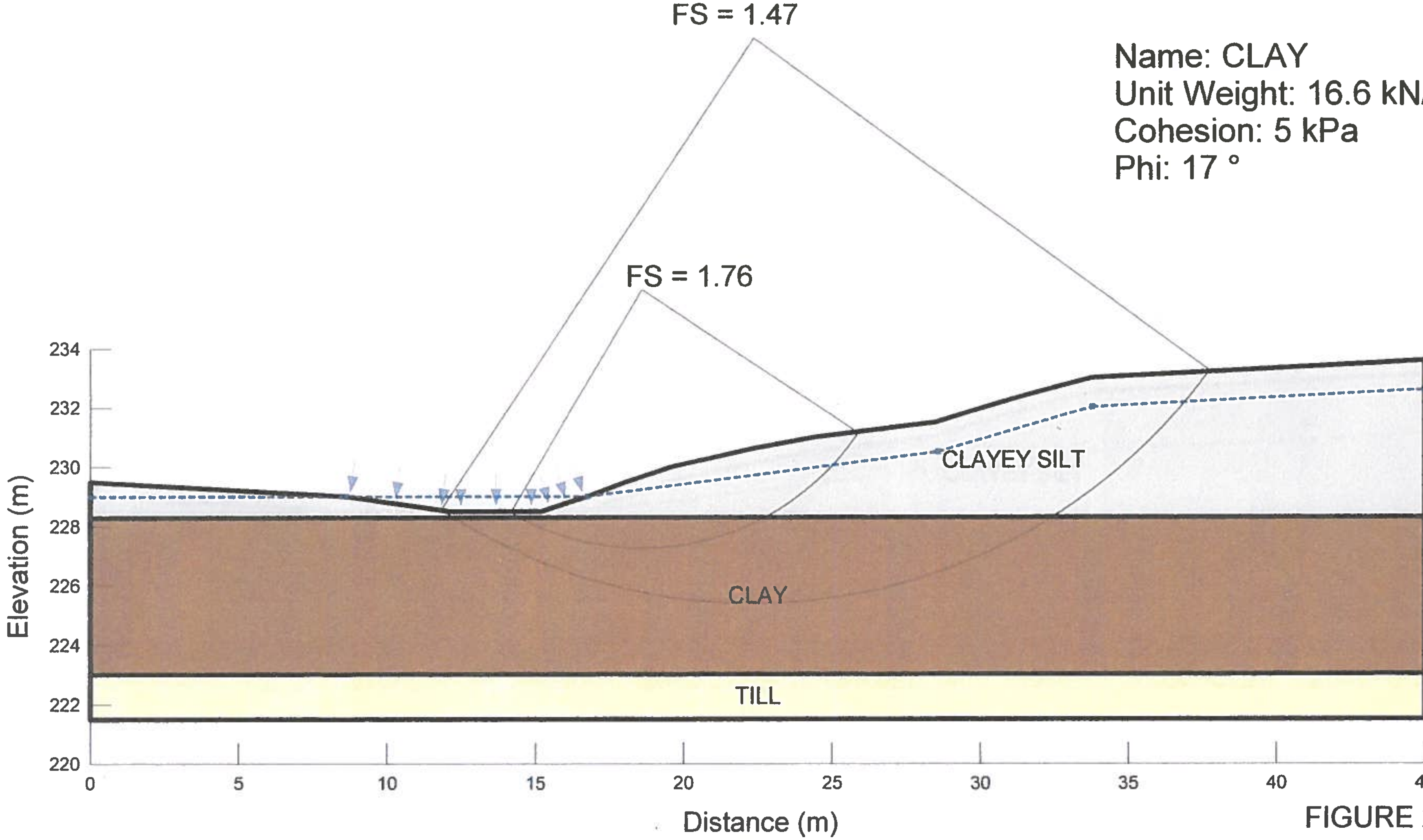


FIGURE 25

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Outlet - South of Portage Avenue
- 6.6 m South of East Head Wall
Slope Geometry: Existing Geometry
Creek Water Level: 0.5 m
Groundwater Conditions: 2 m Below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

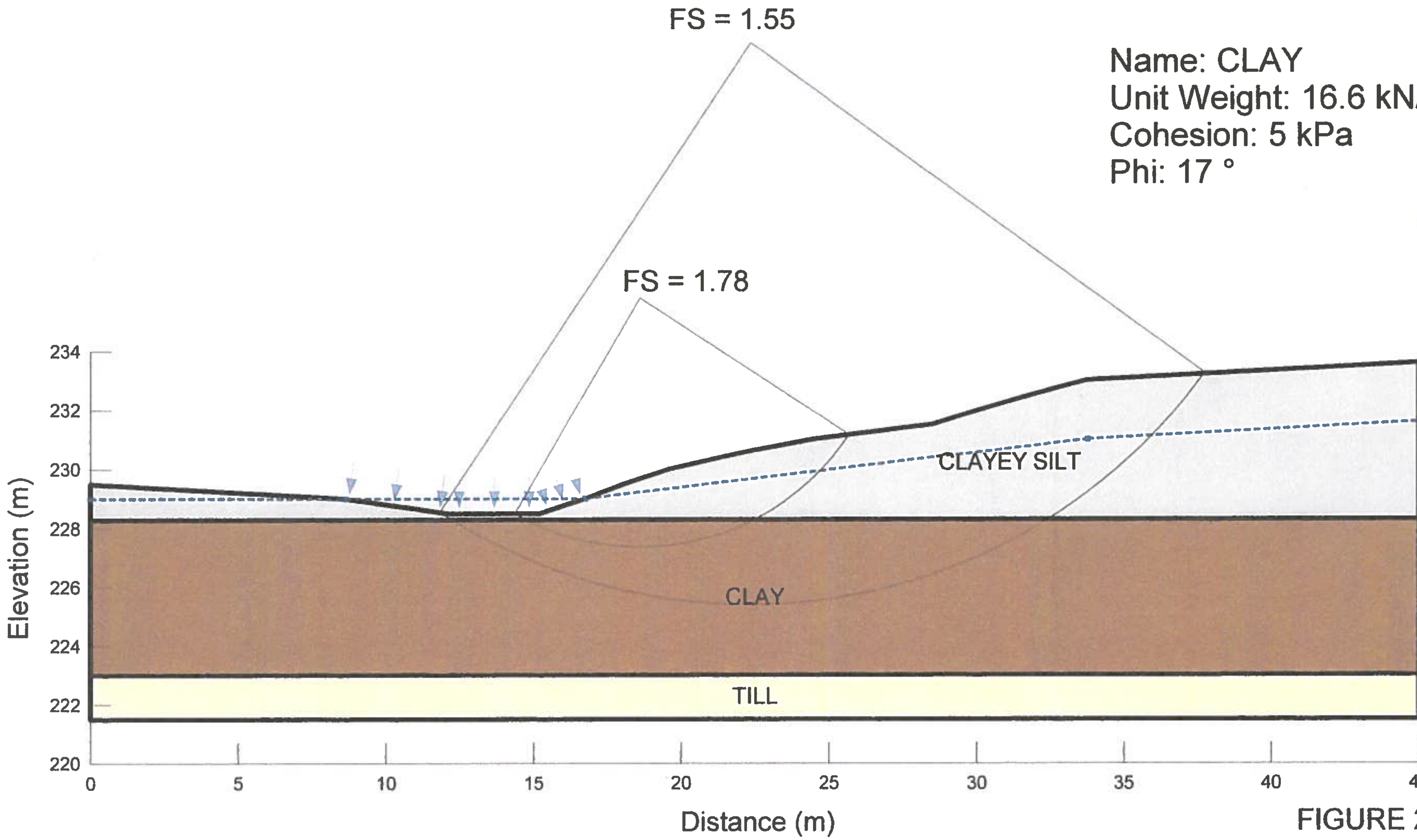


FIGURE 26

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Outlet - South of Portage Avenue
- 6.6 m South of East Head Wall, 1.5 m West of Bush Line
Slope Geometry: 3.4 m x 1.5 m Trench
Creek Water Level: 0.5 m
Groundwater Conditions: 1 m Below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

Name: FILL
Unit Weight: 15 kN/m³
Cohesion: 0 kPa
Phi: 10 °

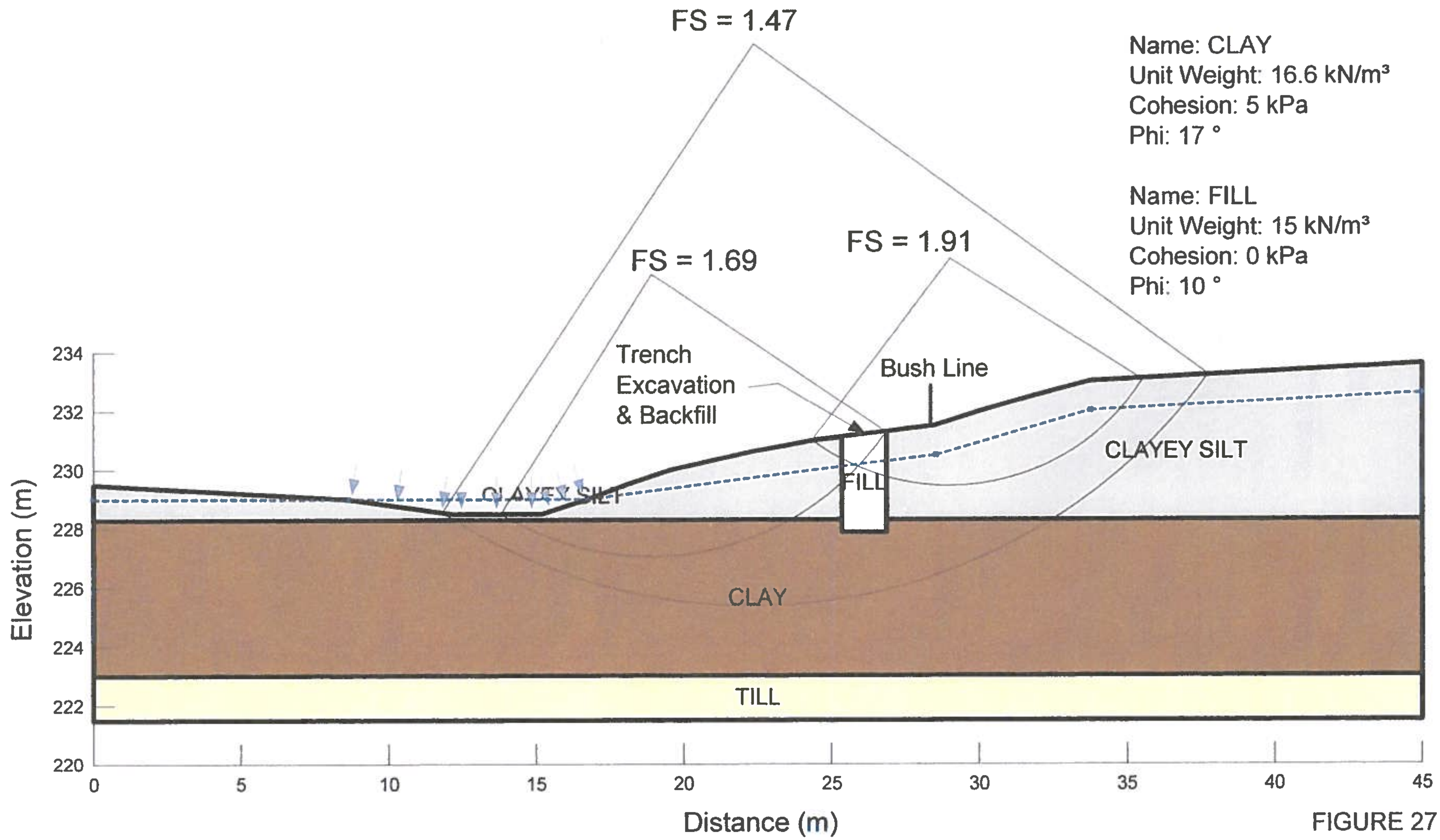


FIGURE 27

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Outlet - South of Portage Avenue
- 6.6 m South of East Head Wall, 6.5 m West of Bush Line
Slope Geometry: 2.6 m x 1.5 m Trench
Creek Water Level: 0.5 m
Groundwater Conditions: 1 m Below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

Name: FILL
Unit Weight: 15 kN/m³
Cohesion: 0 kPa
Phi: 10 °

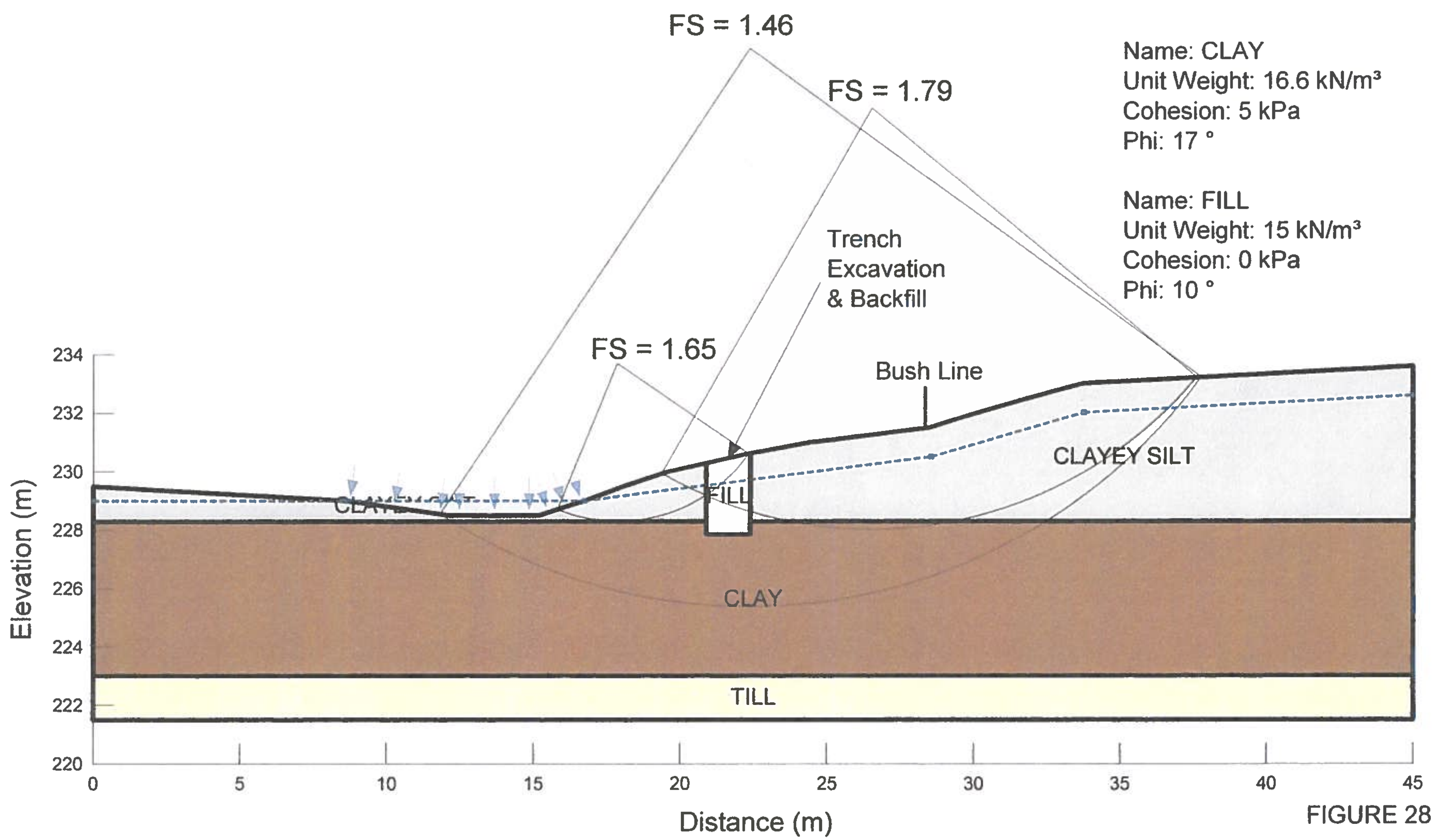


FIGURE 28

Project: Portage Avenue at Truro Creek Rehabilitation
Client: City of Winnipeg
Description: Slope Stability Analysis
Location: Outlet - South of Portage Avenue
- 6.6 m South of East Head Wall, 9.7 m West of Bush Line
Slope Geometry: 1.2 m x 1.5 m Trench
Creek Water Level: 0.5 m
Groundwater Conditions: 1 m Below Ground Surface

Name: TILL
Unit Weight: 22 kN/m³
Cohesion: 0 kPa
Phi: 30 °

Name: CLAYEY SILT
Unit Weight: 18 kN/m³
Cohesion: 3 kPa
Phi: 19 °

Name: CLAY
Unit Weight: 16.6 kN/m³
Cohesion: 5 kPa
Phi: 17 °

Name: FILL
Unit Weight: 15 kN/m³
Cohesion: 0 kPa
Phi: 10 °

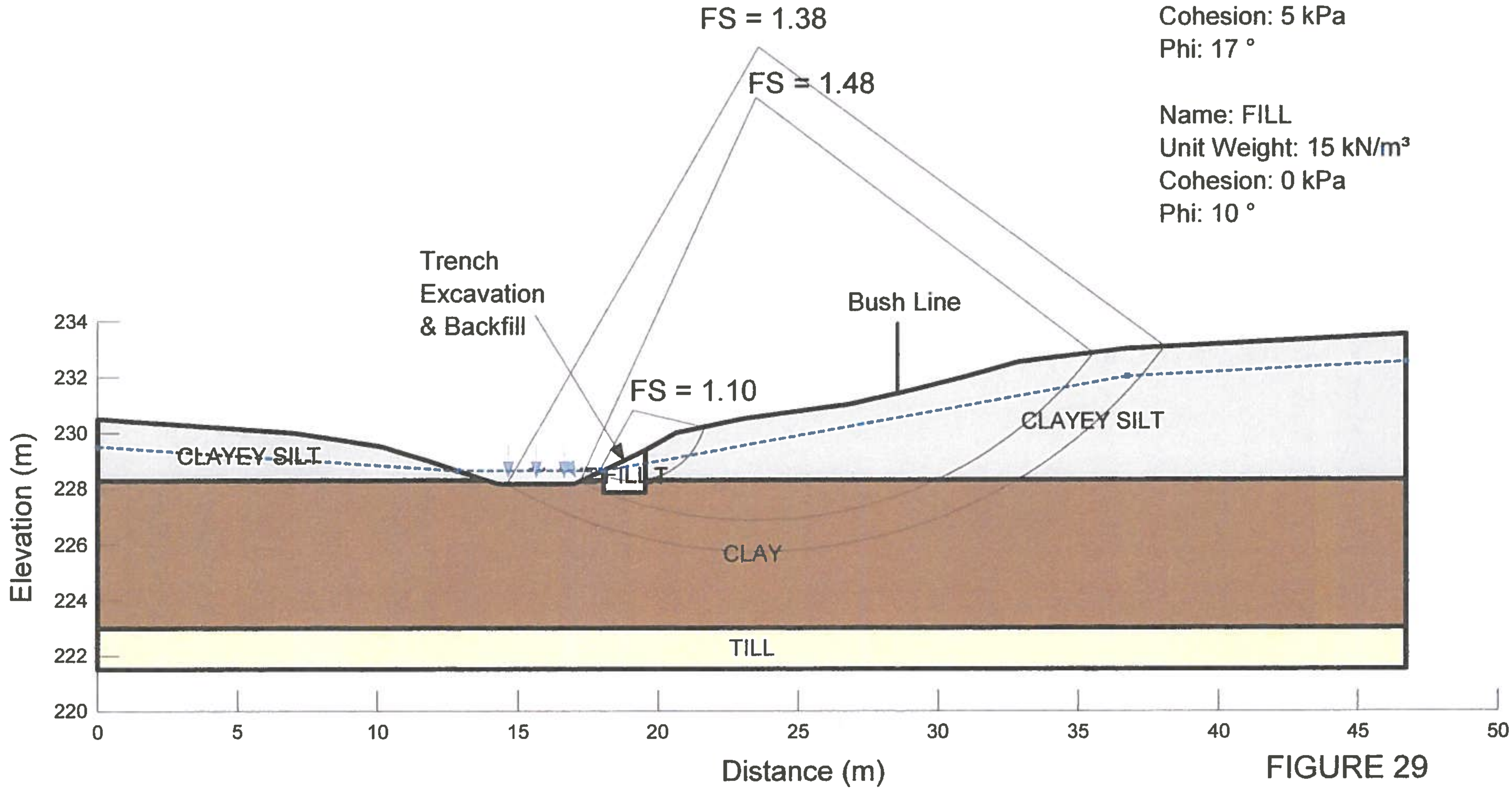


FIGURE 29