FOUNDATION INVESTIGATION AND DESIGN REPORT
WATERMAIN CROSSING UNDER HIGHWAY 11
HIGHWAY 11, HIGHWAY 518 WEST to HIGHWAY 520
G.W.P. 480-93-00

Geocres Number: 31E-242

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents a summary of the factual findings obtained from a foundation investigation conducted at the site of a proposed watermain crossing under Highway 11 at the intersection with Highway 520, Burk's Falls, Ontario.

A model of the subsurface conditions was developed from the data presented in a report by DST Consulting Engineers. This model describes the geotechnical conditions along the route of the proposed watermain.

Thurber carried out the investigation as a sub-consultant to Marshall Macklin Monaghan, under the Ministry of Transportation Ontario (MTO) Agreement Number 5005-A-000285.

2 FACTUAL INFORMATION

The factual information used in the preparation of this report is contained in a report prepared in October 2004 by DST Consulting Engineers of Thunder Bay. The entire report, as made available to Thurber, is contained in Appendix A. A summary of the pertinent information is presented in Section 3.

3 SUMMARY OF SUBSURFACE CONDITIONS

3.1 9+835 to 9+900 (BH WM-01 to WM-04)

The soils encountered in this portion of the watermain route consisted of 0.7 to 1.4 m of fill, silt or sand overlying silty clay.

The fill, topsoil and silt are interpreted as being compact and moist to wet. It is anticipated that groundwater is perched on top of the clay and that the near surface soils could be saturated in the spring or after heavy rainfall.

The silty clay has been described by DST as very stiff to hard.

The boreholes were terminated at depths of 3.1 to 3.8 m and were described as "dry on completion". However, as discussed above, perched water should be expected on top of the silty clay layer.

3.2 9+900 to 10+225 (BH WM-05 to WM-16)

In this section, which includes the highway crossing, the soils encountered in the boreholes were a sequence of sands and silts with occasional clay seams overlying bedrock. Cobbles and boulders were interpreted at various locations throughout this deposit.

The soils are interpreted to be in a generally loose to compact state. Occasionally higher values of SPT were recorded but these are believed to be due to cobbles or boulders in the soil.

Refusal on possible bedrock was encountered at the following depths:

Borehole	WM-07	WM-10	WM-12	WM-13	WM-14	WM-15	WM-16
Depth (m)	5.9	3.7	3.3	1.8	1.5	2.1	2.3
Elevation	303.0	304.5	307.4	308.0	308.6	310.7	314.0

The following boreholes were terminated without encountering refusal:

Borehole	WM-05	WM-06	WM-08	WM-09	WM-11
Depth (m)	3.6	3.6	6.1	5.1	4.3
Elevation	304.5	302.3	302.9	303.6	303.6

With respect to groundwater level, data is reported that ranges from "dry on completion" to water levels ranging from 0.75 to 3.8 m below ground surface on completion of drilling the borehole. It is noted that no piezometers were installed and the groundwater readings were obtained on completion of drilling. It is unlikely that the recorded values are indicative of stabilized groundwater levels and it must be assumed that the groundwater level may lie at a shallow depth at the time of construction.

3.3 10+225 to 10+330 (WM-17 to WM-24)

Boreholes drilled in this section encountered a stratigraphy that generally consisted of topsoil over silt or sand overlying clay that in turn was underlain by soil ranging from silt to sand. Some boreholes encountered refusal on assumed bedrock.

The upper cohesionless soils consisted of discontinuous zones of silt and sand, generally in a compact condition. Occasional higher SPT values, suggesting dense conditions, may be due to the presence of cobbles or boulders.

The clay was described as very stiff to hard and is generally silty.

Below the clay, the boreholes encountered soils ranging from sandy silt to sand. These soils are generally loose to compact. Occasional higher SPT values, suggesting dense conditions, may be due to the presence of cobbles or boulders.

Refusal on possible bedrock was encountered at the following depths:

Borehole	WM-17	WM-18	WM-19	WM-20	WM-21		
Depth (m)	3.8	4.5	4.9	3.2	5.6		
Elevation	312.0	311.0	311.4	313.3	310.7		

The following boreholes were terminated without apparently encountering bedrock:

Borehole	WM-22	W-23	WM-24		
Depth (m)	5.0	5.0	3.5		
Elevation	310.9	310.4	309.0		

All boreholes in this section were described as "dry on completion" and no groundwater levels are given. However, this description is an end-of-drilling condition and no time was allowed for groundwater levels to stabilize.

It is considered to be probable that there will be groundwater perched on top of the clay and that the near surface soils may be saturated in the spring and after heavy rainfall. It is also possible that there is a water table in the cohesionless soils below the clay layer.

3.4 10+330 to 10+493 (WM-25 to WM-32)

The boreholes drilled in this section of the watermain route encountered topsoil over sand and silt (with some clay) overlying a layer of clay.

The topsoil, sand and silt soils ranged in thickness from 0.4 to 2.2 m and the SPT values indicated loose to dense conditions.

The underlying clay is described as very stiff to hard.

The following boreholes were terminated without encountering refusal:

Borehole	WM-25	WM-26	WM-27	WM-28	WM-29	WM-30	WM-31	WM-32
Depth (m)	3.5	3.5	4.3	4.3	4.5	5.3	3.5	3.5
Elevation	309.9	309.4	308.0	307.7	307.0	306.7	308.2	308.2

All but one of the boreholes were described as "dry on completion". In Borehole WM-30, groundwater is recorded as being at a depth of 4.5 m, as is caved soil.

It is considered highly likely that groundwater will become perched on top of the clay layer and that the near surface soils may be saturated in spring or after heavy rainfall.

3.5 Highway Crossing 9+950 to 10+030

Four boreholes, identified as JB-1 to JB-4 were drilled specifically to obtain subsurface information at the highway crossing.

With the exception of the borehole at the west (JB-1) all boreholes encountered cohesionless soils described as layers of material ranging from silt to sand. Borehole JB-1 encountered the same soils but with a clay layer approximately 2 m thick underlying the topsoil.

Based on the SPT values, the soils are described as very loose to compact. However, some of the apparently very loose conditions may be due to sample disturbance caused by unbalanced hydrostatic pressures in the borehole.

All boreholes were terminated, without reaching refusal, at the following depths:

Borehole	JB-1	JB-2	JB-3	JB-4
Depth (m)	8.2	11.7	9.7	9.6
Elevation	297.3	296.4	297.7	298.0

The symbols plotted on the logs indicate groundwater at the following levels:

Borehole	JB-1	JB-2	JB-3	JB-4
Depth (m)	3.2	4.0	3.0	Dry*
Elevation	302.3	304.1	304.4	

* The borehole had caved at a depth of 2.5 m.

The text in the remarks column of Boreholes JB-1 indicates water at the surface and cave at 3.2 m. It is assumed that this is an error and the text should read "Water level and cave @ 3.2 m on completion".

The groundwater data at the highway crossing, therefore, is considered to be short term and higher levels may prevail during construction.

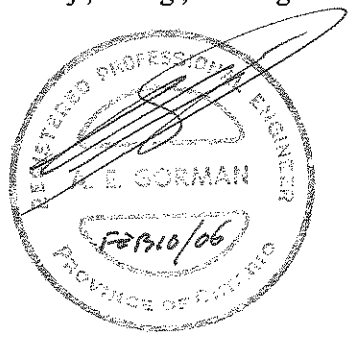
4 MISCELLANEOUS

The site investigation and preparation of the factual Foundation Investigation Report were carried out by DST Consulting Engineers of Thunder Bay in October 2004.

Mr. Alastair E. Gorman, P.Eng. reviewed and interpreted of the data and prepared the report.

The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

5 INTRODUCTION

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team to design the watermain installation and in particular the crossing under the proposed four-lane Highway 11.

The project consists of the design of approximately 650 m of watermain to replace an existing section of watermain that passes through the site of the future Highway 11/Highway 520 Interchange. The existing and proposed watermains are understood to be 150 mm in diameter.

The proposed watermain will be installed at depths ranging from 2.5 to 5 m below existing grade and will be installed under the existing Highway 11, which will form the future SBL of the four-lane highway.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data contained in the DST report. The soil stratigraphy in that report is consistent with the stratigraphy encountered at other sites in the Highway 11 corridor, and consistent within the site. No piezometers were installed and the available groundwater data was obtained on completion of drilling each borehole and, therefore, consists of very short term readings with no time allowed for the groundwater level to stabilize in the borehole. Accordingly, the interpretation and recommendations presented in this report must be treated with caution and allowance made for groundwater levels being higher than reported.

6 WATERMAIN

This section discusses the general watermain design and installation. The specific recommendations relating to the highway crossing are presented in Section 7 of the report.

With exception of the highway crossing, it is assumed that the preferred method of watermain installation will be open-cut.

6.1 Vertical Alignment

Comments regarding the vertical alignment are based on the profile contained in the DST report.

6.1.1 9+835 to 10+135 (BH WM-01 to WM-12)

The proposed watermain invert lies between Elevation 303 and Elevation 309 and is within the soil profile established by the site investigation and field testing program. However, abrupt local changes in the bedrock profile are possible and rock may be encountered locally in areas where the pipe invert lies close to level of the bottom of the boreholes, e.g. from 9+870 to 9+920.

Trench bottom will lie in very stiff to hard silty clay from 9+835 to 9+905, approximately. From 9+905 to 10+135 the trench bottom will lie in cohesionless sandy silts and silty sands and below the water table.

6.1.2 10+135 to 10+240 (BH WM-13 to WM-16)

In this section, the watermain invert varies from Elevation 307 to Elevation 312. Based on the DST Profile, the invert of the pipe lies as much as 2 m below the level of auger refusal on possible bedrock.

6.1.3 10+240 to 10+493 (BH WM-16 to WM-32)

In this section, the invert of the watermain varies between Elevation 309.2 and Elevation 312.3 and lies within the depth of overburden established by the site investigation and field testing program. In some locations, e.g. around 10+335 and 10+455, the invert lies within 1.0 m of the bottom of the borehole. Therefore, the possibility of encountering bedrock locally in the trench cannot be precluded.

From 10+240 to 10+270, approximately, the trench bottom will lie in cohesionless sandy silts and silty sands and below the water table. From 10+270 to 10+493, the trench bottom will lie in very stiff to hard silty clay.

6.2 Excavation

The soils described at this site are considered to be suitable for excavation using trench excavating equipment, such as backhoes, normally used by contractors for watermain installation. Cobbles and boulders are reported at various locations on the boreholes logs and the contract documents must identify this fact to bidders. The frequency of boulders is not considered to be high enough to prevent the use of suitable trenching excavation equipment. Never-the-less, the contract documents should include a NSSP alerting bidders to the fact that cobbles and boulders may be encountered in the soil and suggested wording is included in Appendix C.

Between the stations identified in Section 6.1.2, if the profile of the watermain is maintained where shown in the DST report, rock excavation techniques will be required. If blasting is used for rock excavation, it must be carried out in accordance with the Amendment to OPSS 120, August 1994.

All excavation must be carried out in accordance with the requirements of the Ontario Occupational Health and Safety Act (OHSA). The permitted trench geometry and shoring requirements will be governed by the OHSA soil classification.

6.3 OHSA Soil Classification

For the purposes of OHSA, the sandy silt and silty sand, other cohesionless soils and fills encountered at this site are classed as Type 3 Soils above the water table. If any attempt is made to excavate below the water table, the soils must be treated as Type 4.

The very stiff to hard silty clay is classed as Type 2 Soil.

6.4 Groundwater Control

Where the trench will be excavated to a level below the groundwater level prevailing at the time of construction, the contractor must implement such groundwater control and ground support systems as are required to install the watermain in a safe, stable, unwatered excavation. The assessment of the need for and the design of such systems is the responsibility of the contractor. However, in designing and assessing the constructability of the watermain, the following points must be considered:

1. Where excavation takes place through cohesionless soil, including fill, and the trench base lies in cohesionless soil, it is recommended that the groundwater level be depressed to at least 0.5 m below the base of excavation prior to commencement of the excavation. Failure to implement dewatering prior to the start of excavation may result in sloughing of the sides and heaving of the base of the excavation. Laying the watermain and backfilling on top of heaved, disturbed soil may result in settlement that could result in damage to the watermain.
2. Where excavation takes place through cohesionless soil and the base lies in the very stiff to hard silty clay, groundwater control or ground support is required to stabilize the sides of the excavation, to prevent sloughing and to allow installation of the pipe in an unwatered situation. The base of the trench that lies in the very stiff to hard silty clay should be stable provided it is not exposed to prolonged soaking or to traffic while it is in a wet condition.
3. Where the base of the trench lies in bedrock, the base will remain stable and groundwater control or ground support will be required to prevent sloughing and to allow the installation of the pipe in an unwatered situation.

It is recommended that the contract documents contain a NSSP alerting the contractor to the soil and groundwater conditions and the need for dewatering. Suggested wording is included in Appendix C.

6.5 Bedding

The bedding for the watermain must conform to the requirements of OPSD 802.010 for flexible pipe in earth excavation or OPSD 802.013 for flexible pipe in rock excavation. Additional bedding requirements imposed by the pipe supplier must also be followed.

It is recommended that the bedding material consist of OPSS Granular "A".

6.6 Backfill

At all road crossings, it is recommended that the trench backfill consist of Granular "B" Type I. The backfill should be compacted to a minimum of 98% of the standard Proctor maximum dry density (SPMDD) at a moisture content within 2% of the optimum value.

Elsewhere, the backfill may consist of the excavated soil compacted to 95% SPMMD at a moisture content within 2% of the optimum value.

7 HIGHWAY CROSSING

The proposed watermain has a diameter of 150 mm and the length of the highway crossing is 40 m. These factors limit the range of trenchless installation techniques that would be economically viable at this site. Each method considered was found to have advantages, disadvantages or limitations and these are discussed. The methods that are considered viable are as follows:

1. Open cut trenching
2. Jack and bore
3. Directional drilling
4. Pipe ramming

7.1 Open Cut Trenching

If open cut trenching is selected, the discussion and recommendations presented in Section 6 will apply.

The advantage of the open cut method is that it is a relatively simple method and would be a continuation of the installation of the remainder of the pipe.

The main disadvantage is that the construction would have to be staged to maintain traffic, possibly by utilizing the future NBL as a detour.

This method can be considered for use provided staged construction coupled with excavation and reinstatement of the highway is acceptable.

7.2 Jack and Bore

In the DST report, the invert of the watermain is shown as lying at approximately Elevation 303. At that elevation, the soils encountered in the boreholes range from sand to silt and there is no indication of cobbles or boulders. The reported water table lies approximately 1.0 to 1.5 m above the pipe invert.

Jack and bore installation involves pushing an oversized liner pipe and removing the soil by augering inside the pipe as it is advanced. This method is considered to be unsuitable at this site since the pipe would have to be advanced through cohesionless soils below the groundwater table. Under these conditions, the risk of excessive loss of ground and settlement of the pavement is considered to be unacceptably high.

Dewatering the ground for the full length of the trenchless excavation would improve the performance but such dewatering may not be feasible at this site without disrupting highway operations.

Jack and bore installation is not recommended.

7.3 Directional Drilling

The subsurface conditions described for this site are considered to be suitable for pipe installation by horizontal directional drilling techniques. In this method, a pilot hole filled with mud is drilled using a drill rig capable of advancing a hole in a controlled direction. After a sufficiently large diameter borehole has been develop the service pipe is pulled through.

This method would allow installation of a pipe under the existing highway without disruption to the traffic and could be a cost-effective method of installation.

Typically the watermain would be installed directly by this method and would probably be installed in a shallow vertical curve, i.e. the method is not as suitable for installing a straight, rigid liner through which the service pipe would be pulled at a later date.

On completion of installation, there will be a small, mud-filled annulus between the pipe and the wall of the borehole. Some collapse of the borehole walls will occur with time but the settlement at the pavement surface, approximately 5 m above the pipe, is expected to be less than 5 mm and to be spread over approximately a 10 m distance.

Directional drilling installations can usually break through or work around isolated cobble or boulders.

This is recommended as a technically preferred method of installation at this site and likely to be the most cost-effective.

7.4 Pipe Ramming

Pipe ramming is considered to be a suitable method of installation for this site, particularly if the preferred solution is a steel sleeve installed to a specified grade with the watermain

pulled through later. In this system, the sleeve pipe is driven from the access point to the exit point using an air-powered percussion hammer. After the sleeve has been fully driven, the soil is removed by augering techniques.

This technique has a major advantage in the fact that there is only a small over-cut around the pipe and thus a low potential to cause settlement of the pavement surface.

A potential disadvantage occurs in situations where there is insufficient cover above the pipe and surface heave can occur as the pipe is being rammed. The 5± m cover at this site is considered to be adequate to minimize the risk of surface heave.

This is recommended as a technically preferred method of installation at this site but at this scale probably is not-cost effective.

7.5 Roadway Protection

The design of safe and stable entry and exit pits for the trenchless excavation is the responsibility of the contractor. However, the contract documents should direct the contractor to provide roadway protection if any excavation will encroach into the highway embankment. Protection must be provided in accordance with SSP539S01. Level 2 Protection is considered to be appropriate.

7.6 Settlement Monitoring

The contract documents should require the contractor to monitor the highway surface before, during and after the trenchless installation. If the settlement reaches an alert level, all work must stop and the site be secured until a decision is taken on how to proceed. The recommended alert level is 10 mm of settlement and the corresponding review level should by 6 mm. At the review level, the contractor should advise the Contract Administrator as to how he is improving his methods in order to reduce settlement.

8 EARTH PRESSURE COEFFICIENTS

The recommendations presented in this section apply to the calculation of earth pressures for roadway protection, trench shoring and shoring required for launch pits and receiving pits that may be required for installing the watermain under the existing highway.

Earth pressures acting on the structure may be assumed to be triangular and to be governed by the characteristics of the soil being retained. Computation of earth pressures must take account of the groundwater level. Above the groundwater level, pressures are based on the bulk unit weight of the soil. Below the groundwater level, the pressures must be based on the submerged unit weight of the soil plus the hydrostatic pressure if the retained soil is not fully drained.

The earth pressures must be computed in accordance with the CHBDC and above the groundwater level the following expression applies:

$$p_h = K^*(\gamma h + q)$$

Below the groundwater level, the pressure must be computed from the expression:

$$P_h = K*(\gamma' h_w + H\gamma + q) + h_w*\gamma_w$$

Where:

p_h = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see below)

γ = unit weight of retained soil (see table below)

γ' = submerged unit weight of soil =(γ-10) kN/m^3

γ_w = unit weight of water, use 10 kN/m^3

h = depth below top of fill, but above water level, where pressure is computed (m)

h_w = depth below the groundwater level (m)

H = total depth from surface of retained material to the groundwater level

q = value of any surcharge (kPa)

If the retaining structure is retaining compacted backfill, in accordance with Clause 6.9.3 of the CHBDC a compaction surcharge must be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or 1.7 m for Granular A or Granular B Type II.

The factors in Table 12.1 are "ultimate" values and require certain movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the Canadian Highway Bridge Design Code.

Table 12.1 – Earth Pressure Coefficient (K)

Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35°, \gamma = 22.8$ kN/m^3		OPSS Granular B Type I $\phi = 32°, \gamma = 21.2$ kN/m^3		Native Soil $\phi = 28°, \gamma = 20$ kN/m^3	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall(2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall(2H:1V)
Active (Unrestrained Wall)	0.27	0.40	0.31	0.43	0.36	0.50
At rest (Restrained Wall)	0.43	-	0.47	-	0.53	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-	2.8	-

9 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

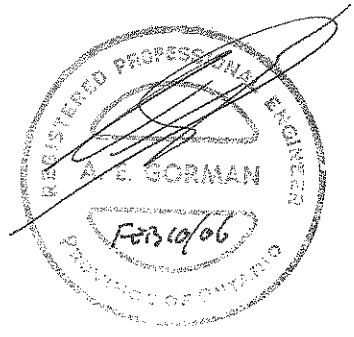
- The impact of the groundwater level on the stability of excavations in the absence of effective groundwater control
- The potential for groundwater levels to be higher at the time of construction than those recorded in the DST report.
- The potential for encountering rock ridges in the trench at locations not identified by the site investigation program
- The potential for encountering boulders or other obstructions, particularly during trenchless installation under the existing highway.

10 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



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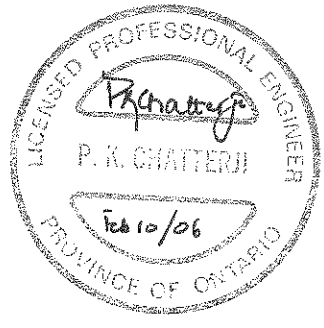

Report reviewed by:
P.K. Chatterji, P.Eng., Ph.D.
Review Principal

Appendix A

Foundation Investigation Report

By

DST Consulting Engineers

FOUNDATION INVESTIGATION REPORT
WATER MAIN RELOCATION AND
PROPOSED JACK & BORE ROUTE
HIGHWAY 11, BURK'S FALLS, ONTARIO
AGREEMENT #5005-A-000433
(ASSIGNMENT #1 & #2)

~~January 31, 2006~~
TG04271

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APPENDICES

ENCLOSURES

DRAWING

1.0 INTRODUCTION

DST Consulting Engineers Inc. (DST) has been retained by the Ministry of Transportation to conduct an investigation under Agreement # 5005-A-000433, various Locations within Northeastern Region– Highway 17 and South of Hwy 17, Assignment No.: 1 and 2. Assignments include field investigation, laboratory testing and a foundation investigation report for a water main relocation to be carried out as part of Hwy 11 four laning (assignment No. 1) and to investigate the soil and groundwater conditions along the proposed jack and bore route (assignment No. 2). The project involved drilling boreholes at 36 individual locations along the proposed new alignment, south of the intersection of Ferguson Rd. / Highway 520 and Highway 11, south of the Village of Burk's Falls.

The purpose of this investigation was to determine the soil and groundwater conditions and to provide a foundation investigation report with field and laboratory test results.

2.0 SITE DESCRIPTION

The subject property is located south of the intersection of Ferguson Rd. / Highway 520 and Highway 11, south of the Village of Burk's Falls (Drawings 1 and 2).

The subject property has been mostly cleared of trees and has a rolling topography and is characterized by hummocky topography with gentle slopes. The northeast corner of the proposed site is covered by scrubby brush. The landscape along the southwest area of the proposed watermain alignment is characterised by brush trees with trunk diameters ranging from 100 to 300 mm which follows the contour of the rock ridge at the southwest of the project location.

The area under analysis exhibit existing underground utilities, overhead wires and access constrains along a portion of the proposed alignment of the watermain. WM borehole 23 was moved 0.5 m left due to access constrain, WM borehole 25, 26 and 27 were moved 1.0, 3.5 and 5.0 m right respectively, due to utility services access restriction and overhead services limitations, WM borehole 31 and 32 were moved 0.3 m left and 1.9 m right respectively, due to underground services constrain.

3.0 FIELD INVESTIGATION AND LABORATORY TESTING:

Site work was carried out from October 13th to 22nd, 2004, utilizing a CME 750 drill rig equipped for geotechnical testing. Jack and bore (JB) boreholes were drilled utilizing hollow stem augers with detailed sampling to depths ranging between 8.2 and 11.7 m below existing ground surface. Watermain (WM) boreholes 1, 3 to 6, 7 to 9, 11 and 13 to 32 were drilled utilizing hollow stem augers with detailed sampling to depths of 1.5 to 6.1 m to define the subsurface conditions at the proposed watermain alignment. WM boreholes 7, 10 and 12 to 21 were drilled utilizing solid stem augers as auger probes to confirm the fill depths on site. All boreholes were backfilled with a bentonite grout mixture. The soil strata are included in Drawing 3.

Soil samples were obtained from the auger flights and from the split spoon sampler used for the standard penetration test (SPT). The SPT involves driving a 50 mm diameter thick-walled sampler into the soil under the energy of a 63.5 kg weight falling through 760 mm. The number of blows required to drive the sampler 300 mm is known as the standard penetration blow count (N) which provides an indication of the condition or consistency of the soil. Representative soil samples are obtained from within the sampler. In addition, field vane shear tests were performed to determine the undrained shear strength of cohesive soil. Due to the very stiff condition of the cohesive soil, the DST tapered vane 'B' was used at the site (tapered vane dimension 50.8 mm by 101.6 mm). Using this vane, a factor of 2.7 was used to determine the shear strength of the soil. The borehole logs detailing the subsurface conditions are presented as Enclosures 1 through 37.

Classification and index tests were subsequently performed in the laboratory on samples collected from the JB and WM boreholes to aid in the selection of engineering properties. Laboratory tests included natural moisture contents, gradation analyses and Atterberg limits. Laboratory test results for the JB boreholes are presented on the borehole Logs, Enclosures 1 to 5 and Enclosures 38 to 39. Laboratory test results for the WM are presented on the borehole Logs, Enclosures 6 to 37 and Enclosures 40 to 42.

The groundwater and sloughing level measured on completion of drilling are indicated on the individual borehole Logs and on Groundwater Measurements tables under section 4.6 (Table 1) and 5.8 (Table 2).

4.0 DESCRIPTION OF SUBSURFACE CONDITIONS FOR 'JB' BOREHOLES

4.1 General

Details of the subsurface conditions of the site are given in the borehole Logs, Enclosures 1 to 5 and are further discussed below.

The generalized stratigraphy of the site based on the conditions at JB borehole Locations 1 to 4 consists of topsoil overlying alternating layers of sand and silt. At borehole JB-1, a layer of clay 1.9 m in thickness exists beneath the topsoil. At borehole JB-2 a granular fill replaced the topsoil and a clay layer exists at 6.1 m depth.

4.2 Fill

The fill within the existing Highway 11 embankment at JB borehole 2 consists of sand with trace of silt and overlying intermittent clay fills. The sand and gravel comprises the base and subbase materials. The base materials vary in thickness from 95 mm to 230 mm. The subbase varies in thickness from 845 mm to 1400 mm. The bottom of the fill elevation is 0.5 m.

Gradation analyses (Enclosure 39) conducted on samples from JB borehole 2 at 0.3 m indicate that the percent fines (silt and clay fraction) is 8% silt, 1% clay, 66% sand and 25% gravel.

4.3 Topsoil

A topsoil layer is present on the surface in the JB boreholes 1, 3, and 4 locations varying in thickness from 100 to 400 mm.

4.4 Sand and Silt

Interbedded sand and silt strata exist thought the depth of penetration of the boreholes. The sand varies in thickness from 0.5 to 2.8 m while the silt varies in thickness from 3.8 to 11.2 m. Gradation analyses conducted on samples from JB boreholes 1 to 4 are shown in Enclosure 38. The condition of the sand and silt as indicated by the 'N' value from the standard penetration test is loose to compact. The 'N' value varies from 3 to 12 blows/0.3m.

4.5 Clay

A clay layer exists at 0.4 m depth below of the surface in the JB borehole 1 with elevation of 302.7 to 304.6 m. The clay layer thickness is 1.9 m. The consistency of the clay layer is firm with in situ

vane shear strengths of 40 kPa. In addition, a clay layer with a thickness of 1.6 m exists at a depth of 6.10 m below the surface in the JB borehole 2, between the elevations 302.2 and 300.6 m. The clay layer has a plasticity index of 13, liquid limit of 33 and water content of 30. An Atterberg limit conducted on sample from JB borehole 2 is shown as Enclosure 39.

4.6 Groundwater

The groundwater level measured on completion of drilling is indicated on the individual borehole Logs, Enclosures 1 to 5 and on the Groundwater Measurement Table (Table 1). Groundwater conditions may fluctuate seasonally and in response to climatic conditions.

Table 1

Groundwater Measurements

borehole No.	Ground Elevation	Station	Water Level *	Cave * (m)
JB-1	305.47	9+955	Water at Surface	3.20
JB-2	308.10	9+975	Water at Surface	4.00
JB-3	307.39	9+995	Water at Surface	3.00
JB-4	307.62	10+015	Dry on completion	2.50

* Depth below existing grade

5.0 DESCRIPTION OF SUBSURFACE CONDITIONS FOR 'WM' BOREHOLES

5.1 General

Details of the subsurface conditions of the site are given in the borehole Logs, Enclosures 6 to 37 and are further discussed below.

The generalized stratigraphy of the site based on the conditions at WM borehole Locations 1 to 32 varies in composition but generally consists of topsoil or fill overlying alternating layers of sand, silt and/or clay.

5.2 Fill

The fill within the Highway 520/Fergunson Road embankment at WM borehole 1 consists of sand with trace of silt and gravel. The bottom of the fill elevation is 0.3 m below the top of the existing grade.

5.3 Topsoil

A topsoil layer is present on the surface in the WM boreholes 2 to 12, 14 to 29, and 31 to 32 locations and varies in thickness from 0.1 to 0.4 m.

5.4 Sand

Sand exists at WM boreholes 1, 4, 6 to 24, and 29 to 32 beneath the above noted layers and extends to a maximum depth of 6.1 m. The sand varies in thickness from 0.5 to 4.5 m. The condition of the sand as indicated by the 'N' value from the standard penetration test is loose to dense. The 'N' value varies from 4 to 50 blows/0.3m. Gradation analyses conducted on samples from WM boreholes 2, 5, 8, 10, 14, 16, 17, 20, 24, 26 and 30 are shown as Enclosures 40 and 41.

5.5 Silts

The silt varies in thickness from 0.5 to 2.8 m at the WM boreholes 2 to 8, 10 to12, 14 to15, 17, 19 to 22, 24 to 30 and 32. The condition of the silt as indicated by the 'N' value from the standard penetration test is very loose to dense. The 'N' values varies from 3 to 44 blows/0.3m

5.6 Clay

Clay exists beneath the above noted layers at WM boreholes 1 to 5, 17 to 32 and extends to a maximum of 5.3 m at elevation 306.7 m. The clay consistency is generally very stiff to hard with in situ vane shear strengths varying between 110 and higher than 270 kPa. Atterberg Limits conducted on samples from WM boreholes 1, 21, 23, 24, 28, 30 and 32 are shown as Enclosure 42. The description of the clay layers are listed below:

- Borehole WM-1, a clay layer exists at 0.8 m depth below the surface. The clay layer thickness is 3.0 m and the consistency of layer is very stiff with in situ vane shear strengths of 270 kPa and plasticity index of 22, liquid limit of 46 and water content of 38%.
- Borehole WM-2, a clay layer exists at 1.4 m depth below the surface between the elevations 307.9 and 310.3 m. The clay layer thickness is 2.4 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 162 to 270 kPa.
- Borehole WM-3, a clay layer exists at 1.2 m depth below the surface. The clay layer thickness is 2.6 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 135 to 270 kPa.
- Borehole WM-4, a clay layer exists at 0.7 m depth below the surface between the elevations

306.9 and 309.3 m. The clay layer thickness is 2.4 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 162 to 270 kPa.

- Borehole WM-5, a clay layer exists at 0.8 m depth below the surface between the elevations 306.8 and 307.3 m. The clay layer thickness is 0.5 m and the consistency of layer is hard with in situ vane shear strengths of 270 kPa.
- Borehole WM-17, a clay layer exists at 1.3 m depth below the surface between the elevations 312.8 and 314.5 m. The clay layer thickness is 1.7 m and the consistency of layer is very stiff with in situ vane shear strengths of 194 kPa.
- Borehole WM-18, a clay layer exists at 0.5 m depth below the surface between the elevations 312.5 and 315.0 m. The clay layer thickness is 2.5 m and the consistency of layer is hard with in situ vane shear strengths of 270 kPa.
- Borehole WM-19, a clay layer exists at 2.0 m depth below the surface between the elevations 312.3 and 314.3 m. The clay layer thickness is 2.0 m and the consistency of layer is hard with in situ vane shear strengths of 189 to 221 kPa.
- Borehole WM-20, a clay layer exists at 2.0 m depth below the surface between the elevations 313.5 and 314.5 m. The clay layer thickness is 1.0 m and the consistency of layer is hard with in situ vane shear strengths of 270 kPa.
- Borehole WM-21, a clay layer exists at 1.2 m depth below the surface between the elevations 311.4 and 315.1 m. The clay layer thickness is 3.7 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 162 to 270 kPa with a plasticity index of 17, liquid limit of 40 and water content of 37%.
- Borehole WM-22, a clay layer exists at 2.3 m depth below the surface. The clay layer thickness is 2.0 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 162 to 238 kPa.
- Borehole WM-23, a clay layer exists at 0.1 m depth below the surface between the elevations 311.3 and 315.3 m. The clay layer thickness is 4.0 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 167 to 270 kPa with a plasticity index of 13, liquid limit of 37 and water content of 38%.
- Borehole WM-24, a clay layer exists at 1.4 m depth below the surface between the elevations 309.5 and 311.1 m. The clay layer thickness is 1.6 m and the consistency of layer is hard with in situ vane shear strengths of 270 kPa with a plasticity index of 20, liquid limit of 44 and water content of 36%.
- Borehole WM-25, a clay layer exists at 0.4 m depth below the surface between the elevations

309.9 and 313.0 m. The clay layer thickness is 3.1 m and the consistency of layer is hard with in situ vane shear strengths of 216 to 270 kPa.

- Borehole WM-26, a clay layer exists at 1.3 m depth below the surface between the elevations 309.4 and 311.6 m. The clay layer thickness is 2.2 m and the consistency of layer is hard with in situ vane shear strengths of 238 to 270 kPa.
- Borehole WM-27, a clay layer exists at 0.7 m depth below the surface between the elevations 308.0 and 311.6 m. The clay layer thickness is 3.6 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 140 to 270 kPa.
- Borehole WM-28, a clay layer exists at 1.4 m depth below the surface between the elevations 307.7 and 310.6 m. The clay layer thickness is 2.9 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 167 to 270 kPa with a plasticity index of 17, liquid limit of 41 and water content of 34%.
- Borehole WM-29, a clay layer exists at 1.2 m depth below the surface between the elevations 307.0 and 310.3 m. The clay layer thickness is 3.3 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 130 to 211 kPa.
- Borehole WM-30, a clay layer exists at 2.2 m depth below the surface between the elevations 306.7 and 309.8 m. The clay layer thickness is 3.1 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 135 to 270 kPa with a plasticity index of 22, liquid limit of 43 and water content of 35%.
- Borehole WM-31, a clay layer exists at 1.4 m depth below the surface between the elevations 308.2 and 310.3 m. The clay layer thickness is 1.6 m and the consistency of layer is hard with in situ vane shear strengths of 270 kPa.
- Borehole WM-32, a clay layer exists at 0.9 m depth below the surface between the elevations 308.2 and 310.9 m. The clay layer thickness is 2.7 m and the consistency of layer is very stiff to hard with in situ vane shear strengths of 189 to 270 kPa with a plasticity index of 22, liquid limit of 45 and water content of 36%.

5.7 Cobbles and Boulders

At WM boreholes 7, 9 to 12, and 16 to 19, occasional cobbles and boulders were noted, and extend to a maximum depth of 5.9 m. These observations were from the drillers' comments and the size of the boulders encountered where not noted.

5.8 Groundwater

The groundwater level measured on completion of drilling is indicated on the individual borehole Logs, Enclosures 6 to 37 and on the Groundwater Measurement Table (Table 2). Groundwater conditions may fluctuate seasonally and in response to climatic conditions.

Table 2

Groundwater Measurements

borehole No.	Ground Elevation	Station	Water Level (m) *	Cave * (m)
WM-1	312.21	9+835	Dry on completion	3.00
WM-2	311.66	9+855	Dry on completion	3.00
WM-3	310.72	9+875	Dry on completion	3.00
WM-4	310.03	9+895	Dry on completion	2.30
WM-5	308.09	9+915	1.50	2.50
WM-6	305.86	9+935	0.75	1.40
WM-7	308.89	10+035	3.70	4.00
WM-8	309.04	10+053	3.30	3.60
WM-9	308.67	10+075	2.00	3.00
WM-10	308.17	10+095	3.00	3.00
WM-11	307.94	10+115	3.00	3.00
WM-12	310.66	10+135	Dry on completion	2.00
WM-13	309.81	10+155	Dry on completion	1.50
WM-14	310.11	10+175	Dry on completion	1.00
WM-15	312.77	10+195	Dry on completion	1.50
WM-16	316.30	10+215	Dry on completion	2.00
WM-17	315.77	10+235	Dry on completion	3.60
WM-18	315.49	10+245	Dry on completion	3.20
WM-19	316.32	10+255	Dry on completion	4.20
WM-20	316.47	10+265	Dry on completion	3.00
WM-21	316.34	10+275	Dry on completion	5.00
WM-22	315.91	10+285	Dry on completion	4.50
WM-23	315.43	10+292	Dry on completion	4.30
WM-24	312.49	10+322	Dry on completion	3.00
WM-25	313.45	10+335	Dry on completion	3.00
WM-26	312.89	10+355	Dry on completion	3.00
WM-27	312.30	10+375	Dry on completion	3.80
WM-28	312.02	10+395	Dry on completion	3.80
WM-29	311.51	10+415	Dry on completion	3.80
WM-30	312.01	10+435	4.50	4.50
WM-31	311.67	10+455	Dry on completion	3.00
WM-32	311.72	10+475	Dry on completion	3.00

* Depth below existing grade

6.0 CLOSURE

A description of limitations that are inherent in carrying out site investigation studies is given in Appendix A and this forms an integral part of this report.

We trust that this satisfies your present needs. If you have any further questions or comments, please contact the undersigned at your convenience.

Prepared by

Reviewed by

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Sr. Project Engineer

David Shaw
Sr. Geotechnical Technician

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APPENDIX 'A'

LIMITATIONS OF REPORT

LIMITATIONS OF REPORT

GEOTECHNICAL STUDIES

The data, conclusions and recommendations which are presented in this report, and the quality thereof, are based on a scope of work authorized by the Client. Note that no scope of work, no matter how exhaustive, can identify all conditions below ground. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the specific locations tested, and conditions may become apparent during construction which were not detected and could not be anticipated at the time of the site investigation. Conditions can also change with time. It is recommended practice that DST Consulting Engineers be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavation, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

Unless otherwise noted, the information contained herein in no way reflects on environmental aspects of either the site or the subsurface conditions.

The comments given in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs, e.g. the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusion as to how the subsurface conditions may affect their work.

Any results from an analytical laboratory or other subcontractor reported herein have been carried out by others, and DST Consulting Engineers Inc. cannot warranty their accuracy. Similarly, DST cannot warranty the accuracy of information supplied by the client.

ENCLOSURES

RECORD OF BOREHOLE No JB-1 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+955 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
305.5											
0.0 / 305.1	TOPSOIL - 400mm										Water at surface. Cave @ 3.2m on completion.
0.4	CLAY - Silty, grey, firm		1	AS			305				
			2	SS	3						0 9 76 15
							304	✕			
	- silty sand layers		3	SS	2						
303.2								✕			
2.3	SILT - some sand, trace clay, brown, loose to compact		4	SS	15		303				0 15 77 9
			5	SS	8	▽					
300.9							302				
4.6	SAND - Silty, brown, loose		6	SS	4		301				
299.4											
6.1	SAND & SILT - trace clay, very loose to loose		7	SS	1		300				0 53 46 1
							299				
							298				
			8	SS	8						
297.3											
8.2	End of Borehole @ 8.2m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 1

RECORD OF BOREHOLE No JB-2 1 OF 2 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+975 ORIGINATED BY PR

DIST ____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
308.1							308				
0.0 / 307.6	FILL - SAND - Gravelly, trace silt, trace clay										
			1	AS							25 66 8 1
0.5 / 305.3	SAND - trace to some silt, trace gravel, trace clay, loose to compact		2	SS	18		307				Water level and cave @ 4.0m on completion.
			3	SS	9						10 82 7 1
			4	SS	3		306				8 72 17 2
2.8 / 304.0	SAND - Silty, grey, loose		5	SS	1	▽	305				
4.1 / 300.6	SAND & SILT - brown, loose to compact - 300mm clay layer		6	SS	3		304				
			7	SS	12		303				
7.5 / 298.1	SAND - some silt, brown, loose		8	SS	7		302				
			9	SS	8		301				
							300				
							299				

Continued Next Page

$\times^3$, $\star^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 2

RECORD OF BOREHOLE No JB-2 2 OF 2 METRIC

W.P. Agmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+975 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
10.0	SAND & SILT - brown, loose						298				
			10	SS	6		297				0 62 38 0
296.4											
11.7	End of Borehole @ 11.7m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○3% STRAIN AT FAILURE

ON_MOT-HIGH VANES_TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

RECORD OF BOREHOLE No JB-3 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+996.3 ORIGINATED BY PR

DIST ____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
307.4											
0.0 / 307.1	TOPSOIL - 300mm										
0.3 / 306.6	SAND - some silt, some gravel, trace clay, grey		1	AS			307				11 69 17 2
0.8 / 306.0	SILT - Sandy, grey/brown, loose to compact		2	SS	10						Water level and cave @ 3.0m on completion.
1.4	SAND - some silt to silty, brown/grey, loose		3	SS	5		306				0 35 64 1
			4	SS	7	▽	305				
			5	SS	6		304				
			6	SS	9		303				
301.4							302				
6.0 / 300.0	SAND & SILT - brown/grey, loose to compact		7	SS	9		301				0 53 (47)
7.4	SAND - some silt, trace gravel, brown/grey, compact		8	SS	16		300				
							299				
297.7			9	SS	15		298				
9.7	End of Borehole @ 9.7m.										

$\times^3$, $\star^3$ Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES_TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 4

RECORD OF BOREHOLE No JB-4 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+015 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
307.6	TOPSOIL - 100mm		1	AS							
307.5 / 0.1	SAND - Silty, some gravel, brown										Dry on completion. Cave @ 2.5m on completion.
307.0 / 0.6	SILT - some clay, trace sand, brown, loose		2	SS	6		307				0 6 82 11
	- Sandy		3	SS	3		306				
304.7 / 3.0	SAND - Silty, brown, loose		4	SS	6		305				
			5	SS	7		304				
			6	SS	8		303				
301.8 / 5.8	SAND & SILT - brown, loose		7	SS	9		302				0 39 60 1
300.5 / 7.1	SAND - some to Silty, brown, loose to compact		8	SS	9		301				
			9	SS	16		300				
298.0 / 9.6	End of Borehole @ 9.6m.						299				

$\times^{3}$, $\star^{3}$ Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 5

RECORD OF BOREHOLE No WM-01 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+835 O/S 3.0 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 21.10.04 CHECKED BY YM

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED □ QUICK TRIAXIAL × FIELD VANE ★ LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
312.2								20 40 60 80 100 / 50 100 150 200 250	10 20 30		
0.0 / 311.9	FILL - SAND - trace gravel, trace silt, brown		1	AS			312				Dry on completion. Cave @ 3.0m on completion.
0.3 / 311.5	SAND - Silty, brown										
0.8	CLAY - Silty, brown, very stiff to hard		2	SS	11		311	×	●		
	- trace sand		3	SS	10			×	●		
	- layered silt, trace sand		4	SS	9		310	×	●		
			5	SS	8		309	×	◆—▲ 46		
308.4											
3.8	End of Borehole @ 3.8m.										

×³, ★³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 6

RECORD OF BOREHOLE No WM-02 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+855 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 21.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, □ QUICK TRIAXIAL, × FIELD VANE, ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
311.7											
311.6	TOPSOIL - 100mm										
0.1	SILT - trace to Sandy, brown, compact		1	AS							Dry on completion. Cave @ 3.0m on completion.
							311				
			2	SS	26						0 21 56 23
310.3											
1.4	CLAY - Silty, trace sand, brown/grey, very stiff to hard		3	SS	9		310				
			4	SS	10		309				
	- layered silty clay		5	SS	8						
307.9							308				
3.8	End of Borehole @ 3.8m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES_TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 7

RECORD OF BOREHOLE No WM-03 1 OF 1 METRIC

W.P. Agmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+875 ORIGINATED BY PR

DIST ____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 21.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100; 50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
310.7	TOPSOIL - 80mm										
310.6 / 0.1	SILT - Sandy, trace clay, brown, dense		1	AS							Dry on completion. Cave @ 3.0m on completion.
			2	SS	32		310				
309.5 / 1.2	CLAY - Silty, trace sand, brown, very stiff to hard										
			3	SS	17		309				
	- layered silty clay, brown/grey		4	SS	10		308				
			5	SS	17						
306.9 / 3.8	End of Borehole @ 3.8m.						307				

$\times^3$, $\star^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

RECORD OF BOREHOLE No WM-04 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+895 ORIGINATED BY PR

DIST ____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE 50 100 150 200 250	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
310.0											
310.0 / 0.1	TOPSOIL - 80mm										
	SAND & SILT - trace rootlets, brown		1	AS							Dry on completion. Cave @ 2.3m on completion.
309.3											
0.7	CLAY - Silty, brown, very stiff to hard		2	SS	16		309	✕			
			3	SS	9		308	✕			
			4	SS	5		307	✕			
306.9											
3.1	End of Borehole @ 3.1m.										

$\times^3$, $\star^3$. Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES_TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 9

RECORD OF BOREHOLE No WM-05 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+915 ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
308.1											
308.0	TOPSOIL - 80mm						308				
0.1	SILT - trace clay, brown		1	AS							
307.3											
0.8	CLAY - Silty, brown/grey, stiff, hard		2	SS	15		307	✕			
306.8											
1.3	SILT - trace clay, trace sand, grey/brown, loose		3	SS	9	▽					
							306	✕			
			4	SS	7						
							305				0 8 88 4
			5	SS	8						
304.5											
3.6	End of Borehole @ 3.6m.										

Water level @ 1.5m on completion.
Cave @ 2.5m on completion.

✕³, ★³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 10

RECORD OF BOREHOLE No WM-06 1 OF 1 METRIC

W.P. Agmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 9+935 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, □ QUICK TRIAXIAL, × FIELD VANE, ★ LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
305.9								20 40 60 80 100 / 50 100 150 200 250	10 20 30		
0.0 / 305.6	TOPSOIL - 300mm										
0.3 / 305.3	SAND - Silty, grey, trace layered clay, grey		1	AS							
0.6 / 304.5	SILT - Sandy, brown/grey, compact		2	SS	30	▽	305				Water level @ 0.75m on completion. Cave @ 1.4m on completion.
1.4 / 303.8	SILT - layered sand, brown, loose		3	SS	9		304				
2.1 / 302.9	SAND & SILT - brown, loose		4	SS	7		303				
3.0 / 302.3	SAND - Silty, brown, loose		5	SS	5						
3.6	End of Borehole @ 3.6m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 11

RECORD OF BOREHOLE No WM-07 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+036 1.0 Rt ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
308.9											
308.8 / 0.1	TOPSOIL - 50mm										
	SILT - Sandy, brown		1	AS							Water level @ 3.7m on completion. Cave @ 4.0m on completion.
308.5 / 0.4	SILT - with clay, brown, very stiff										
			2	SS	25		308				
307.5 / 1.4	SAND - Silty, brown/grey, loose										
			3	SS	6		307				
	- trace clay		4	SS	8						
			5	SS	9		306				
						▽	305				
			6	SS	9		304				
	- occasional cobbles & boulders										
303.0			7	AS			303				
5.9	End of Borehole @ 5.9m. Auger Refusal.										

✕³, ★³ Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 12

RECORD OF BOREHOLE No WM-08 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+053 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ✱ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.0											
~~309.0~~	~~TOPSOIL - 80mm~~										
0.1	SILT - Sandy, brown		1	AS							Water level @ 3.3m on completion. Cave @ 3.6m on completion.
308.3											
0.8	SILT - Sandy, brown, compact		2	SS	19		308				
	- - - - - - grey/brown, loose to compact		3	SS	13						0 7 80 14
306.1			4	SS	9		307				
2.9	SAND - Silty, brown/grey, loose to compact		5	SS	11	▽	306				
			6	SS	9		305				
			7	SS	9		304				
302.9							303				
6.1	End of Borehole @ 6.1m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 13

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

RECORD OF BOREHOLE No WM-09 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+075 0.6 Rt ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 19.10.04 CHECKED BY YM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, □ QUICK TRIAXIAL, × FIELD VANE, ★ LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
308.7											
308.6 / 0.1	TOPSOIL - 60mm										
	SAND - Silty, brown, compact		1	AS							Water level @ 2.0m on completion. Cave @ 3.0m on completion. Auger bending from boulders.
			2	SS	11		308				
			3	SS	12	▽	307				
			4	SS	23		306				
			5	SS	11		305				
	- occasional cobbles & boulders						304				
303.6 / 5.1	End of Borehole @ 5.07m.										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: 50 100 150 200 250

WATER CONTENT (%): 10 20 30

$\times^3$, $\star^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 14

RECORD OF BOREHOLE No WM-10 1 OF 1 METRIC

W.P. Agmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+094 ORIGINATED BY PR

DIST ____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 18.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
308.2											
~~308.1~~	TOPSOIL - 60mm										
~~308.0~~ 0.2	SILT - Sandy, brown SAND & SILT - trace gravel, trace clay, brown, compact		1	AS			308				Water level @ 3.0m on completion. Cave @ 3.0m on completion.
			2	SS	30		307				
			3	SS	15		306				
			4	SS	12	▽					1 61 36 2
	- occasional cobbles & boulders		5	SS	11		305				
304.5											
3.7	End of Borehole @ 3.7m. Auger Refusal.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 15

RECORD OF BOREHOLE No WM-11 1 OF 1 METRIC

W.P. Agmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+115 1.0 Lt ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 18.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, □ QUICK TRIAXIAL, × FIELD VANE, ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
307.9											
307.8	TOPSOIL - 150mm										
0.2	SILT - Sandy, brown, compact		1	AS							Water level @ 3.0m on completion. Cave @ 3.0m on completion.
			2	SS	16		307				
306.6											
1.3	SAND - trace to some silt, brown, loose to dense		3	SS	32		306				
			4	SS	9						
	- - - - - - occasional cobbles		5	SS	50	▽	305				
	- - - - - - some gravel, trace silt, brown, dense		6	SS	31		304				
303.6											
4.3	End of Borehole @ 4.3m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 16

RECORD OF BOREHOLE No WM-12 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+136 ORIGINATED BY PR

DIST ____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 18.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, □ QUICK TRIAXIAL, × FIELD VANE, ★ LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
310.7								20 40 60 80 100 / 50 100 150 200 250	10 20 30		
310.6	TOPSOIL - 80mm										
0.1	SILT - Sandy, brown/grey, compact		1	AS							Dry on completion. Cave @ 2.0m on completion.
							310				
			2	SS	22						
309.4											
1.3	SAND - Silty, trace clay, trace sand leans, brown/grey, loose to compact										
			3	SS	7		309				
	- - - - -										
	- trace cobble		4	SS	19						
307.9							308				
2.8	SAND - some silt, some gravel, occasional cobble, brown										
307.4			5	SS							
3.3	End of Borehole @ 3.3m. Auger Refusal. Possible Bedrock.										

$\times^{3}$, $\star^{3}$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 17

RECORD OF BOREHOLE No WM-13 1 OF 1 METRIC

W.P. Agmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+156 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 16.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, □ QUICK TRIAXIAL, × FIELD VANE, ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
309.8											
0.0	SAND - Silty, brown		1	AS							Dry on completion. Cave @ 1.5m on completion.
	- dense		2	SS	34		309				
308.0	- trace gravel		3	SS	101						
1.8	End of Borehole @ 1.8m. Auger Refusal. Possible Bedrock.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES_TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 18

RECORD OF BOREHOLE No WM-14 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+175 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 18.10.04 CHECKED BY YM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
310.1											
310.0	TOPSOIL - 100mm										
309.9	Silt - Sandy, brown						310				Dry on completion. Cave @ 1.0m on completion.
0.2	SAND & SILT - layers, brown/grey		1	AS					●		
			2	SS	29		309		●		0 53 (47)
308.6											
1.5	End of Borehole @ 1.5m. Auger Refusal. Possible Bedrock.										

✕³, ★³. Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 19

RECORD OF BOREHOLE No WM-15 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+193 ORIGINATED BY PR

DIST ____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 18.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✖ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE; 50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
312.8											
312.8 / 0.0	TOPSOIL - 100mm										
312.7 / 0.1	SILT - Sandy, brown		1	AS							Dry on completion. Cave @ 1.5m on completion.
312.5 / 0.3	SAND - Silty, brown, loose						312				
			2	SS	8						
	- - - - - - trace gravel, trace silt, dense		3	SS	49		311				
310.7 / 2.1	End of Borehole @ 2.3m. Auger Refusal. Possible Bedrock.										

✖³, ★³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 20

RECORD OF BOREHOLE No WM-16 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+215 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 17.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
316.3											
316.0	TOPSOIL - 100mm										
0.1	SAND - Silty, brown, compact		1	AS			316				Dry on completion. Cave @ 2.0m on completion.
			2	SS	10						
315.0							315				
1.3	SAND AND SILT - trace gravel, brown, compact		3	SS	15						2 52 (45)
	- occasional cobbles & boulders										
314.0							314				
2.3	End of Borehole @ 2.3m. Auger Refusal.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES_TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 21

RECORD OF BOREHOLE No WM-17 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+236 ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 17.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, □ QUICK TRIAXIAL, × FIELD VANE, ★ LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
315.8								20 40 60 80 100 / 50 100 150 200 250	10 20 30		
315.8	TOPSOIL - 100mm										
0.1 / 315.5	SAND - Silty, some gravel, brown		1	AS							Dry on completion. Cave @ 3.6m on completion.
0.3	SILT - brown, compact										
			2	SS	30		315				
314.5											
1.3	CLAY - some silt, trace sand, brown, very stiff										
			3	SS	8		314				
								×			
			4	SS	11						0 5 81 14
312.8							313				
3.0	SILT - Sandy, brown/grey		5	SS	4						
312.0	- occasional large cobbles						312				
3.8	End of Borehole @ 3.8m. Auger Refusal. Possible Bedrock.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 22

RECORD OF BOREHOLE No WM-18 1 OF 1 METRIC

W.P. Agmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+245 ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 17.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
315.5											
315.4	TOPSOIL - 100mm										
0.1	SAND & SILT - brown		1	AS							Dry on completion. Cave @ 3.2m on completion.
315.0							315				
0.5	CLAY - Silty, brown, hard		2	SS	29						
	- trace sand		3	SS	15		314				
	- boulders small		4	SS	7		313				
312.5											
3.0	SAND - some silt, brown/grey, compact		5	SS	22		312				
	- occasional cobbles & boulders										
311.0							311				
4.5	End of Borehole @ 4.5m. Auger Refusal. Possible Bedrock.										

$\times^{3}$, $\star^{3}$: Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 23

RECORD OF BOREHOLE No WM-19 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+255 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 17.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS
316.3						
316.0	TOPSOIL - 100mm					
0.1	SAND - Silty, brown		1	AS		
315.6						
0.7	SILT - trace to some clay, brown, hard		2	SS	17	
			3	SS	20	
314.3						
2.0	CLAY - Silty, trace sand, brown, hard		4	SS	9	
			5	SS	10	
312.3						
4.0	SAND - trace gravel, occasional cobbles, brown					
311.4						
4.9	End of Borehole @ 4.9m. Auger Refusal. Possible Bedrock.					

ELEVATION SCALE: 316, 315, 314, 313, 312

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED × FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE; 50 100 150 200 250

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Dry on completion. Cave @ 4.2m on completion.

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 24

RECORD OF BOREHOLE No WM-20 1 OF 1 METRIC

W.P. Agmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+265 ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 17.10.04 CHECKED BY YM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
316.5											
316.4 0.1	TOPSOIL - 100mm										
	SILT - trace sand, brown		1	AS			316		●		Dry on completion. Cave @ 3.0m on completion.
315.8 0.7	SAND - Silty, brown, compact		2	SS	22				●		
315.2 1.3	SILT - trace clay, trace sand, brown, compact		3	SS	20		315		●		0 17 68 15
314.5 2.0	CLAY - Silty, brown, hard		4	SS	11		314	✕	●	●	
313.5 3.0	SAND - some gravel, some silt, brown		5	SS							
313.3 3.2	End of Borehole @ 3.2m. Auger Refusal. Possible Bedrock.										

$\times^3$, $\star^3$ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 25

RECORD OF BOREHOLE No WM-21 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+275 ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 16.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (50 100 150 200 250) ○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
316.3											
316.0	TOPSOIL - 100mm										
0.1	SILT - trace sand, trace organics, brown, compact		1	AS			316				Dry on completion. Cave @ 5.0m on completion.
315.1			2	SS	22						
1.2	CLAY - Silty, occasional sand seams, brown, very stiff to hard		3	SS	78		315				
			4	SS	13		314				
			5	SS	7		313				
311.4							312				
4.9	SAND - trace silt, trace gravel, occasional cobbles, brown/grey, dense		6	SS	37		311				
310.7											
5.6	End of Borehole @ 5.6m. Auger Refusal. Possible Bedrock.										

$\times^{3}$, $\star^{3}$: Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 26

RECORD OF BOREHOLE No WM-22 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+285 1.1 Rt ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 16.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
315.9											
315.8 / 0.1	TOPSOIL - 100mm										
	SILT - Sandy, brown, compact		1	AS							Dry on completion. Cave @ 4.5m on completion.
			2	SS	15		315				
314.5 / 1.4	SILT - brown, compact		3	SS	13		314				
313.6 / 2.3	CLAY - Silty, trace sand, very stiff to hard		4	SS	11		313	✕			
			5	SS	8			✕			
311.6 / 4.3	SAND - Silty, brown/grey, compact		6	SS	19		312				
310.9 / 5.0	End of Borehole @ 5.0m.						311				

$\times^3$, $\star^3$ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES_TGD4271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 27

RECORD OF BOREHOLE No WM-23 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+292 0.5 Lt ORIGINATED BY PR

DIST ____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 16.10.04 CHECKED BY YM

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
315.4											
315.0	TOPSOIL - 100mm										
0.1	CLAY - Silty, brown		1	AS							Dry on completion. Cave @ 4.3m on completion.
							315				
			2	SS	18						
	- trace sand, very stiff to hard										
							314				
			3	SS	12						
			4	SS	8		313				
			5	SS	3						
							312				
311.3											
4.1	SAND - Silty, grey, compact										
			6	SS	15		311				
310.4											
5.0	End of Borehole @ 5.0m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 28

RECORD OF BOREHOLE No WM-24 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+322 ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 16.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED □ QUICK TRIAXIAL × FIELD VANE ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
312.5											
312.0	TOPSOIL - 100mm		1	AS							Dry on completion. Cave @ 3.0m on completion.
0.1	SILT - Clayey, brown						312				
	- trace sand, dense		2	SS	43						0 6 67 27
311.1											
1.4	CLAY - Silty, brown, hard		3	SS	21		311	×			
	- brown/grey		4	SS	10		310	×	44		
309.5											
3.0	SAND - Silty, brown, compact		5	SS	11						
309.0							309				
3.5	End of Borehole @ 3.5m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity $\circ^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 29

RECORD OF BOREHOLE No WM-25 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+335 1.0m Rt ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 16.10.04 CHECKED BY YM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100; ○ UNCONFINED ✕ FIELD VANE; □ QUICK TRIAXIAL ★ LAB VANE; 50 100 150 200 250	W_P W W_L; WATER CONTENT (%) 10 20 30	γ kN/m³	GR SA SI CL
313.4											
313.0 / 0.1	TOPSOIL - 60mm										
	SILT - trace gravel, brown		1	AS							Dry on completion. Cave @ 3.0m on completion.
313.0 / 0.4	CLAY - Silty, trace sand layers, brown/grey, hard						313				
			2	SS	14						
							312	✕			
			3	SS	16						
								✕			
			4	SS	7		311				
			5	SS	11						
309.9							310				
3.5	End of Borehole @ 3.5m.										

✕³, ★³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 30

RECORD OF BOREHOLE No WM-26 1 OF 1 METRIC

W.P. Agmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+355 3.5m Rt ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 15.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
312.9											
312.8 / 0.1	TOPSOIL - 60mm										
312.6	CLAY - Silty, brown										
0.3	SILT - trace clay, brown, compact		1	AS							Dry on completion. Cave @ 3.0m on completion.
			2	SS	26		312				
311.6											
1.3	CLAY & SILT - brown/grey, hard										
			3	SS	14						0 2 59 39
							311	✕			
	- trace sand		4	SS	16						
							310	✕			
			5	SS	8						
309.4											
3.5	End of Borehole @ 3.5m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 31

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

RECORD OF BOREHOLE No WM-27 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+375 5.0m Rt ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 15.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ✱ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
312.3											
312.2 / 0.1	TOPSOIL - 60mm										
	SILT - trace clay, brown		1	AS			312				Dry on completion. Cave @ 3.8m on completion.
311.6 / 0.7	CLAY - Silty, brown, very stiff to hard		2	SS	28						
			3	SS	11		311				
	- - - - - - trace sand layer		4	SS	12		310				
			5	SS	7		309				
308.0			6	SS	6						
4.3	End of Borehole @ 4.3m.						308				

✕[3], ✱[3]. Numbers refer to Sensitivity ○[3%] STRAIN AT FAILURE

ON_MOT-HIGH VANES_TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 32

RECORD OF BOREHOLE No WM-28 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+395 2.0m Lt ORIGINATED BY PR

DIST ____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 15.10.04 CHECKED BY YM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
312.0											
311.9 / 0.1	TOPSOIL - 60mm										
	SILT - Sandy, brown, dense		1	AS							Dry on completion. Cave @ 3.8m on completion.
			2	SS	33		311				
310.6 / 1.4	CLAY - Silty, brown, very stiff to hard										
			3	SS	18						
							310				
			4	SS	9						
	- trace sand						309				
			5	SS	9						
307.7			6	SS	7		308				
4.3	End of Borehole @ 4.3m.										

$\times^{3}$, $\star^{3}$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

RECORD OF BOREHOLE No WM-29 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+415 ORIGINATED BY PR

DIST HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 15.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
311.5											
311.4 / 0.1	TOPSOIL - 60mm										
	SAND - Silty, trace cobbles, brown		1	AS							Dry on completion. Cave @ 3.8m on completion.
310.8 / 0.8	SILT - Sandy, brown/grey, dense		2	SS	43		311				
310.3 / 1.2	CLAY - Silty, grey/brown, very stiff to hard										
			3	SS	11		310				
			4	SS	7		309				
	- trace sand		5	SS	7		308				
			6	SS	6						
307.0 / 4.5	End of Borehole @ 4.5m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○$^{3\%}$ STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 34

RECORD OF BOREHOLE No WM-30 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+435 ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 15.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
312.0											
0.0 / 311.3	SAND - some gravel, trace silt, brown		1	AS							Water level @ 4.5m on completion. Cave @ 4.5m on completion.
0.8 / 310.6	SILT - Sandy, organics, black, very loose		2	SS	4		311				
1.4 / 309.8	SILT - some sand, some clay, grey/brown, compact		3	SS	18		310				0 14 66 20
2.2 / 306.7	CLAY - Silty, brown, very stiff to hard - sand layer		4	SS	14	▽	309	✕	43		
			5	SS	9		308	✕	45		
			6	SS	5		307	✕			
5.3	End of Borehole @ 5.3m.										

$\times^{3}$, $\star^{3}$ Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ENCLOSURE 35

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

RECORD OF BOREHOLE No WM-31 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+455 0.3m Lt ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 15.10.04 CHECKED BY YM

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✕ FIELD VANE □ QUICK TRIAXIAL ★ LAB VANE) (50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
311.7											
311.6 / 0.1	TOPSOIL - 50mm										
	SAND - some silt, trace gravel, occasional cobble, brown		1	AS							Dry on completion. Cave @ 3.0m on completion.
310.9											
0.8	SAND - Silty, trace silt, brown, loose		2	SS	9		311				
310.3											
1.4	CLAY - Silty, brown, hard		3	SS	14		310				
			4	SS	16		309				
	----- - trace sand		5	SS	8						
308.2											
3.5	End of Borehole @ 3.5m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

RECORD OF BOREHOLE No WM-32 1 OF 1 METRIC

W.P. Agrmnt # 5005-A-000433 - Assign. 1 & 2 LOCATION 10+475, 1.9m Rt ORIGINATED BY PR

DIST _____ HWY 11 BOREHOLE TYPE HS Auger COMPILED BY TG

DATUM Geodetic DATE 14.10.04 CHECKED BY YM

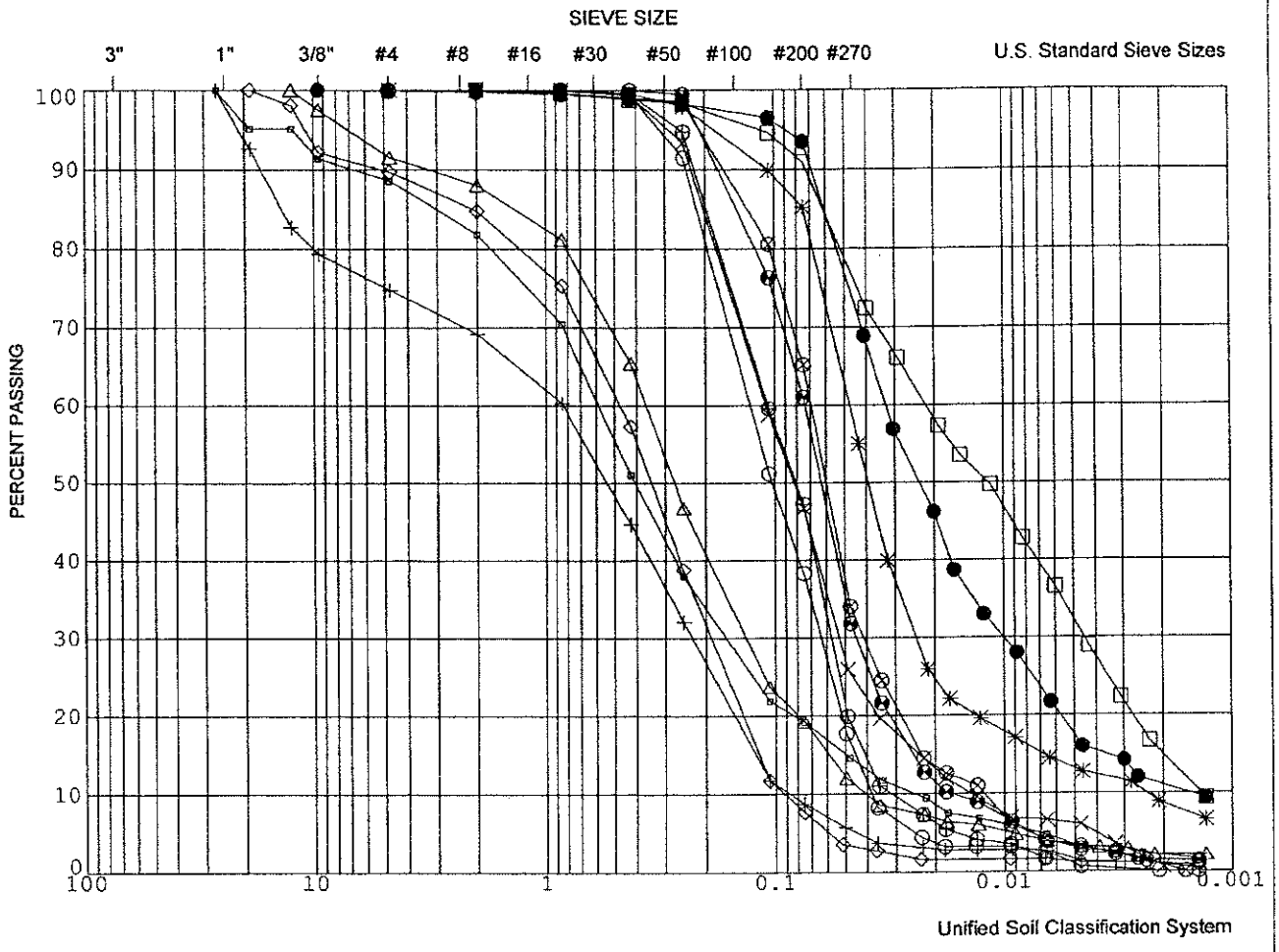
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (20 40 60 80 100; 50 100 150 200 250)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
311.7											
311.6 / 0.1	TOPSOIL - 50mm										
311.3 / 0.4	SAND - some gravel, trace silt, brown		1	AS							Dry on completion. Cave @ 3.0m on completion.
311.1 / 0.6	SAND - Silty, trace gravel, brown										
310.9 / 0.9	SILT - Sandy, trace clay, grey/brown, loose										
	CLAY - Silty, brown/grey, very stiff to hard		2	SS	7		311	×	•		
			3	SS	15		310	×	• 45		
			4	SS	7						
	- - - - - - layered sand		5	SS	7		309	×	•		
308.2 / 3.5	End of Borehole @ 3.5m.										

$\times^3$, $\star^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT-HIGH VANES_TG04271-MOT-LOGS-1.GPJ ON_MOT.GDT 22/12/04

ENCLOSURE 37

GRAINSIZE ANALYSIS



COB'L	GRAVEL		SAND			SILT & CLAY
	Coarse	Fine	Coarse	Medium	Fine	

LEGEND:

- □ BOREHOLE JB-1 DEPTH 0.8
- ✳ BOREHOLE JB-1 DEPTH 2.3
- × BOREHOLE JB-1 DEPTH 6.1
- + BOREHOLE JB-2 DEPTH 0.3
- ◇ BOREHOLE JB-2 DEPTH 1.5
- △ BOREHOLE JB-2 DEPTH 2.3
- ○ BOREHOLE JB-2 DEPTH 10.7
- ▫ BOREHOLE JB-3 DEPTH 0.3
- ⊗ BOREHOLE JB-3 DEPTH 1.5
- ⊕ BOREHOLE JB-3 DEPTH 6.1
- ● BOREHOLE JB-4 DEPTH 0.8
- ⊖ BOREHOLE JB-4 DEPTH 6.1

December 2004

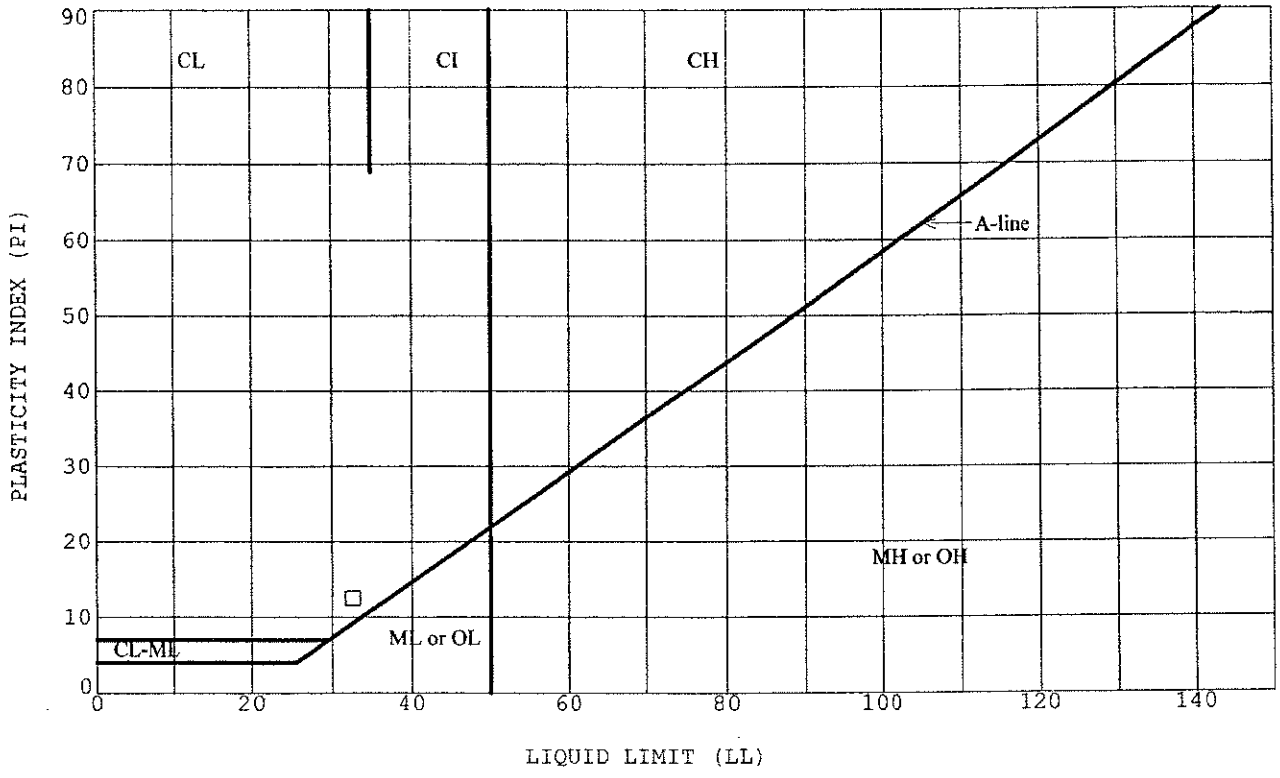
Reference No.:

Hwy 11, South of Ferguson Road/Hwy 520 and Hwy 11 Ass # 1 & 2

DST CONSULTING ENGINEERS INC.

ENCLOSURE 38

ATTERBERG LIMIT TEST RESULTS



LEGEND:

	W_L	W_P	PI	W
□ BOREHOLE JB-2 DEPTH 6.10	33	20	13	30

December 2004

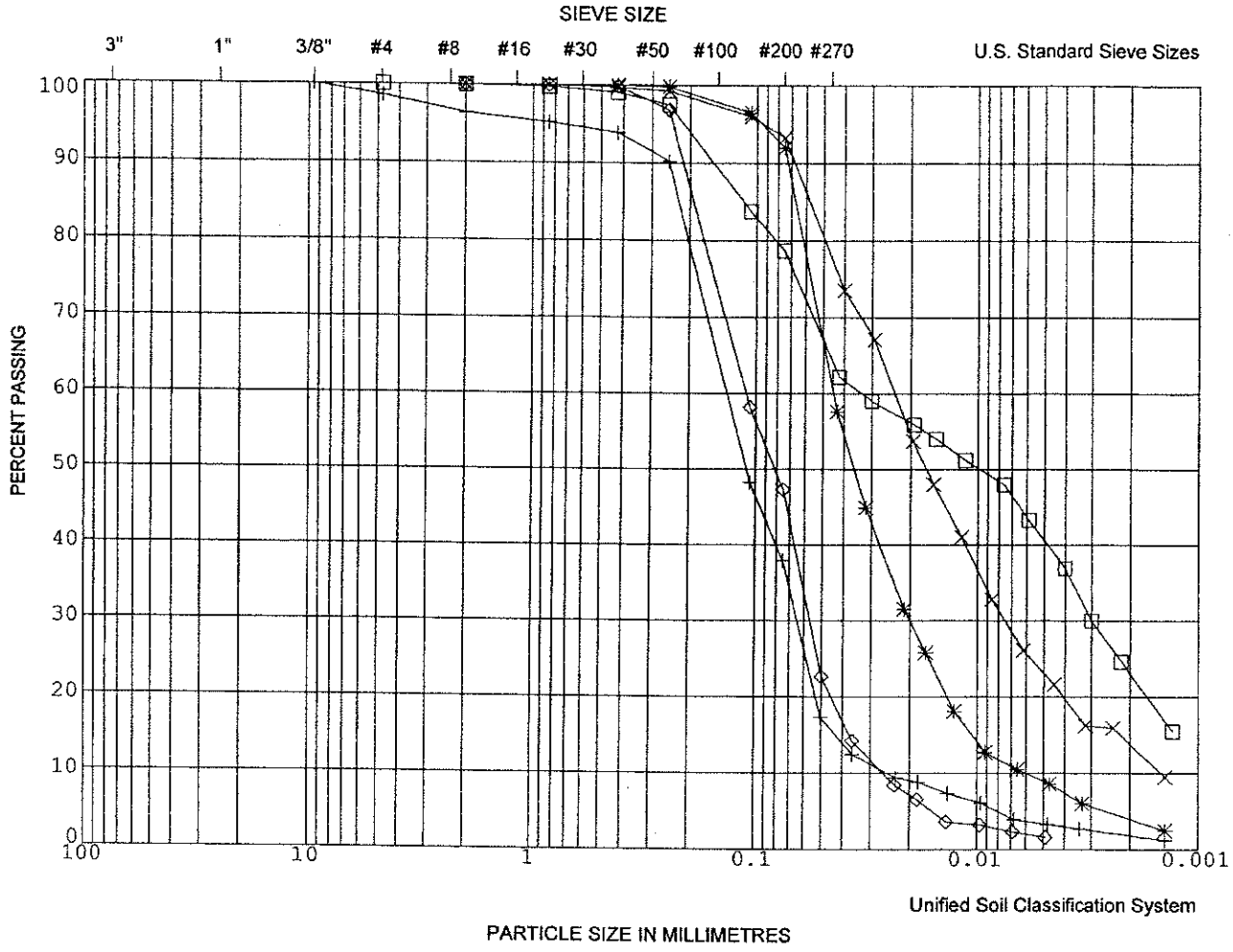
Reference No.:

Hwy 11, South of Ferguson Road/Hwy 520 and Hwy 11 Ass # 1 & 2

DST CONSULTING ENGINEERS INC.

Enclosure 39

GRAINSIZE ANALYSIS



COB'L	GRAVEL		SAND			SILT & CLAY
	Coarse	Fine	Coarse	Medium	Fine	

LEGEND:

□ BOREHOLE WM-02 DEPTH 0.8
✳ BOREHOLE WM-05 DEPTH 3.0
× BOREHOLE WM-08 DEPTH 1.5
\+ BOREHOLE WM-10 DEPTH 2.3
◇ BOREHOLE WM-14 DEPTH 0.8

December 2004

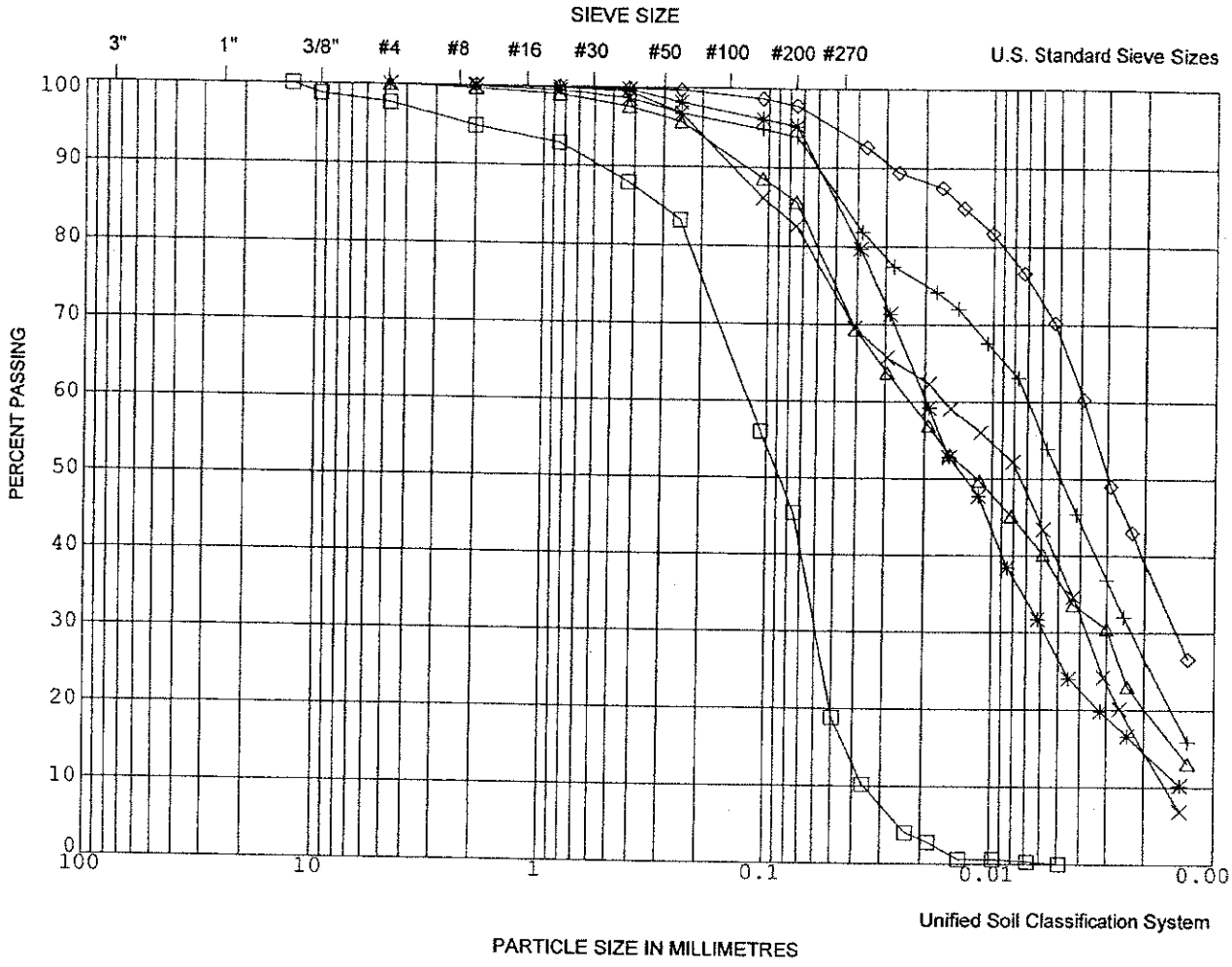
Reference No.:

Hwy 11, South of Ferguson Road/Hwy 520 and Hwy 11 Ass # 1 & 2

DST CONSULTING ENGINEERS INC.

ENCLOSURE 40

GRAINSIZE ANALYSIS



COB'L	GRAVEL		SAND			SILT & CLAY
	Coarse	Fine	Coarse	Medium	Fine	

LEGEND:

- □ BOREHOLE WM-16 DEPTH 1.5
- ✳ BOREHOLE WM-17 DEPTH 2.3
- × BOREHOLE WM-20 DEPTH 1.5
- + BOREHOLE WM-24 DEPTH 0.8
- ◇ BOREHOLE WM-26 DEPTH 1.5
- △ BOREHOLE WM-30 DEPTH 1.5

December 2004

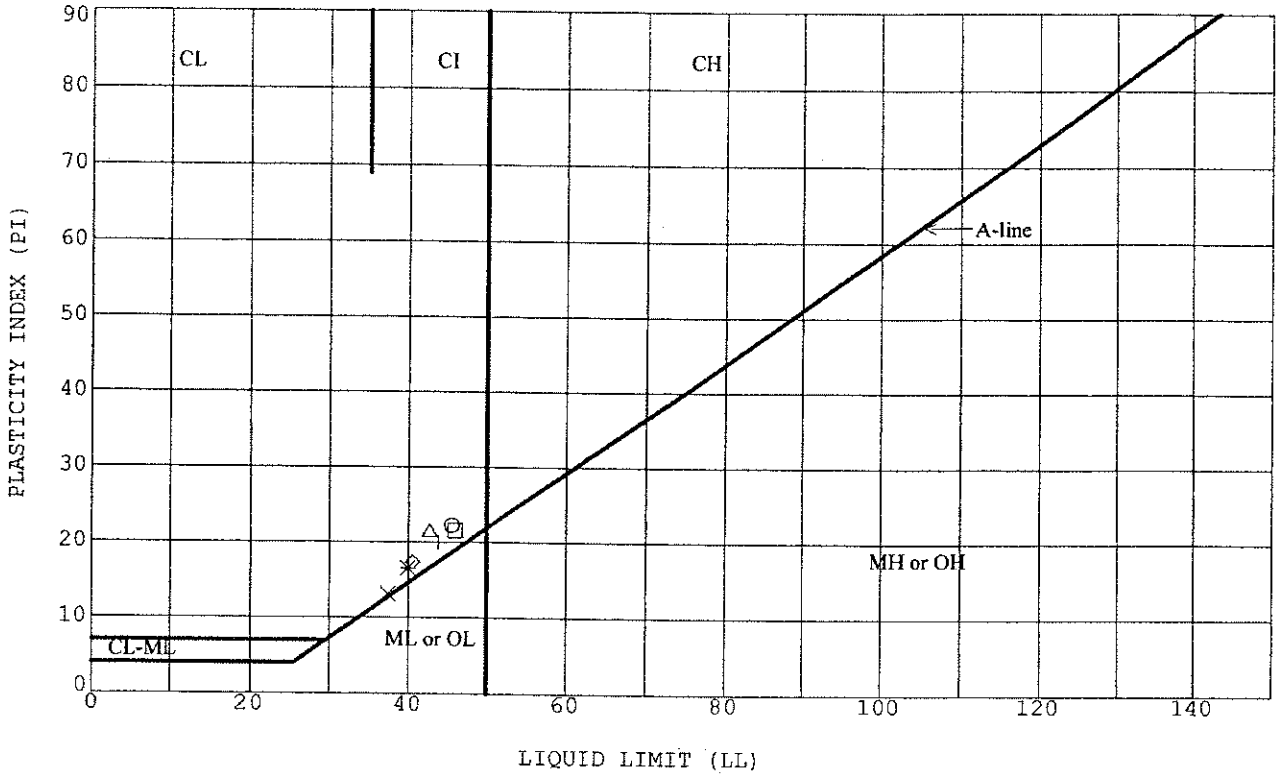
Reference No.:

Hwy 11, South of Ferguson Road/Hwy 520 and Hwy 11 Ass # 1 & 2

DST CONSULTING ENGINEERS INC.

ENCLOSURE 41

ATTERBERG LIMIT TEST RESULTS



LEGEND:

				W_L	W_P	PI	W
□	BOREHOLE WM-01	DEPTH 3.00		46	24	22	38
✳	BOREHOLE WM-21	DEPTH 3.00		40	23	17	37
×	BOREHOLE WM-23	DEPTH 3.00		37	24	13	38
+	BOREHOLE WM-24	DEPTH 2.30		44	24	20	36
◇	BOREHOLE WM-28	DEPTH 2.30		41	23	17	34
△	BOREHOLE WM-30	DEPTH 3.00		43	21	22	35
○	BOREHOLE WM-32	DEPTH 2.30		45	23	22	36

December 2004

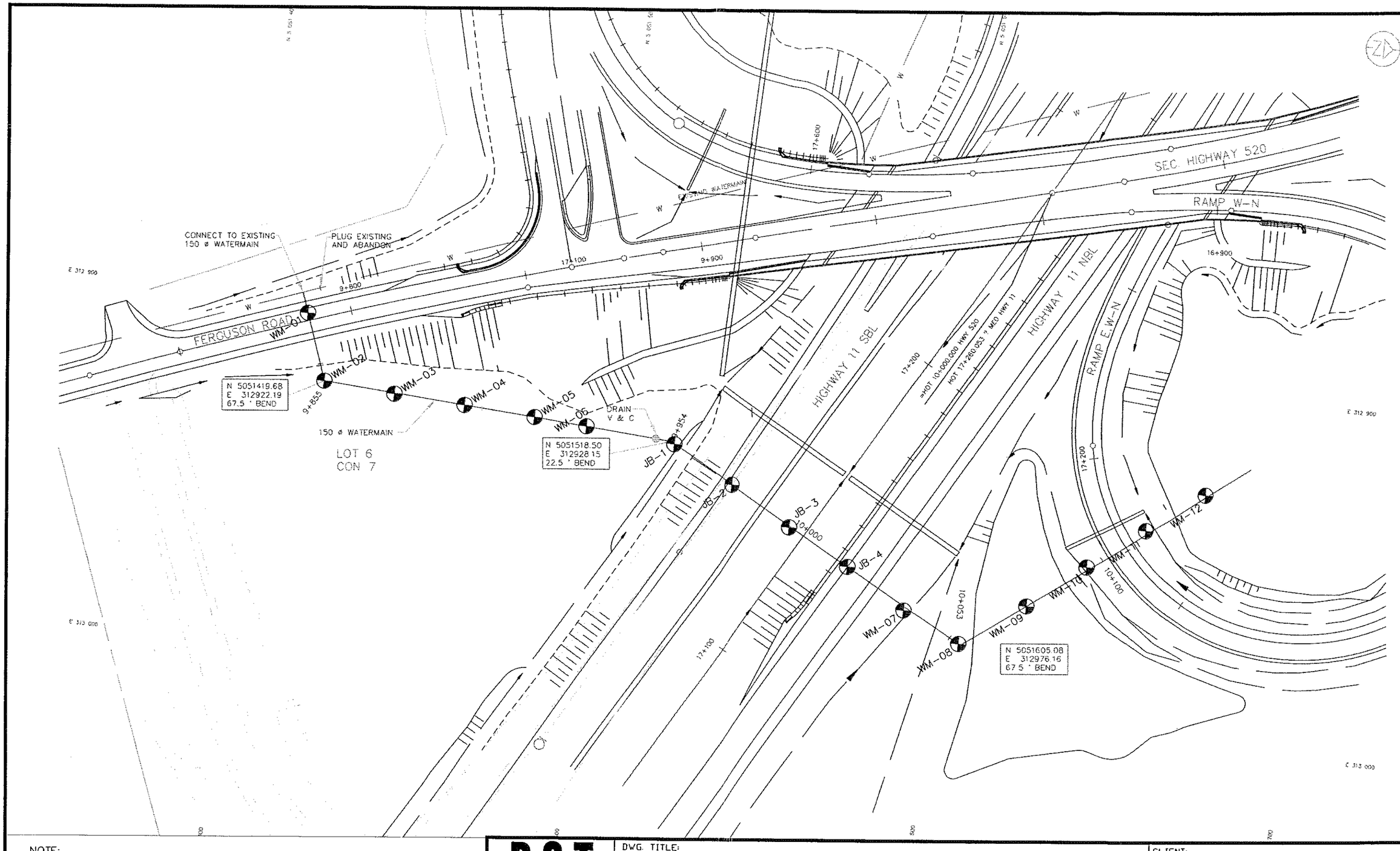
Reference No.:

Hwy 11, South of Ferguson Road/Hwy 520 and Hwy 11 Ass # 1 & 2

DST CONSULTING ENGINEERS INC.

Enclosure 42

DRAWINGS



NOTE:

1) DRAWING SUPPLIED BY CLIENT

DST CONSULTING ENGINEERS
605 Hewitson Street
Thunder Bay, Ontario P7B 5V5
Tel: 807-623-2929
Fax: 807-623-1792
www.dstgroup.com

DWG. TITLE: **BOREHOLE LOCATION PLAN**

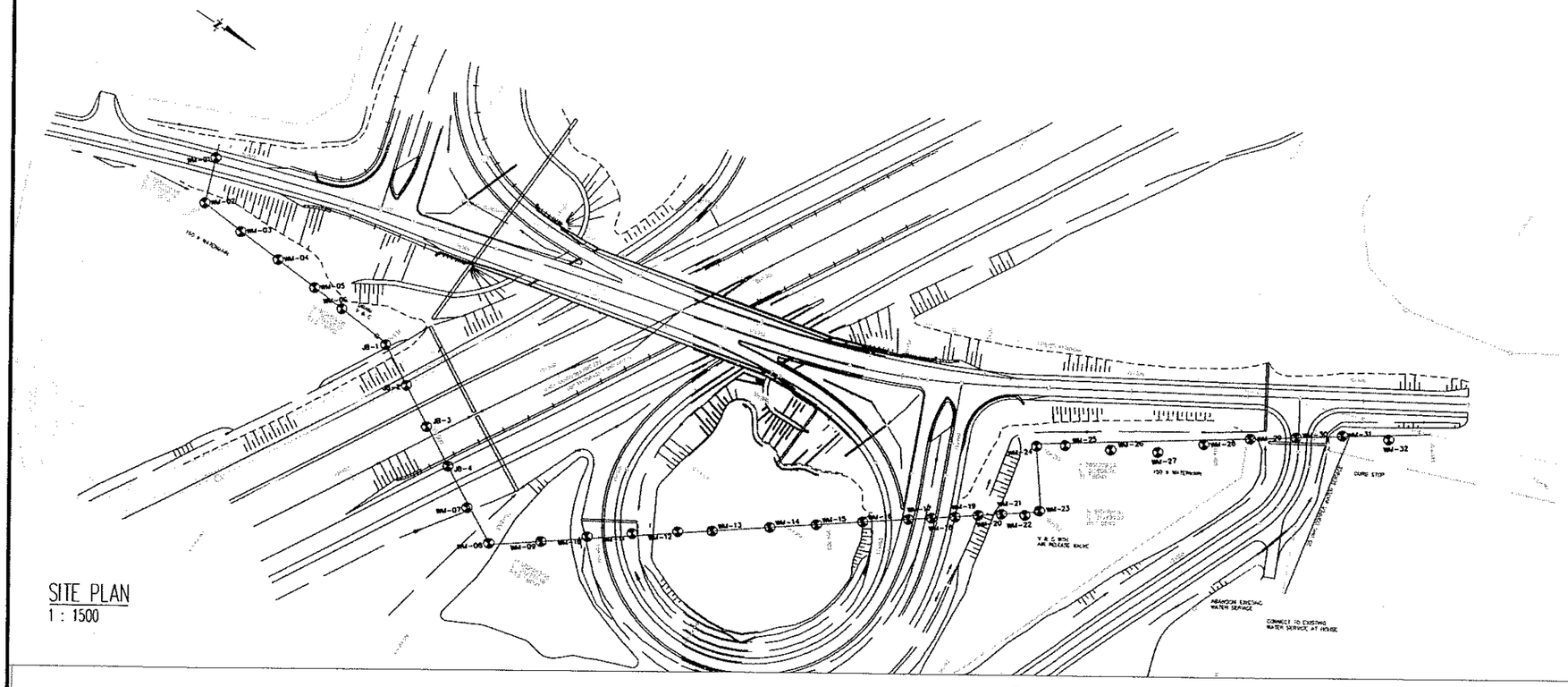
PROJECT: **AGREEMENT # 5005-A-000433**
HWY 11, SOUTH OF FERGUSON ROAD/HWY 520 AND HWY 11 ASSIGNMENT # 1 &2
BURK'S FALLS, ONTARIO

CLIENT: **MINISTRY OF TRANSPORTATION**

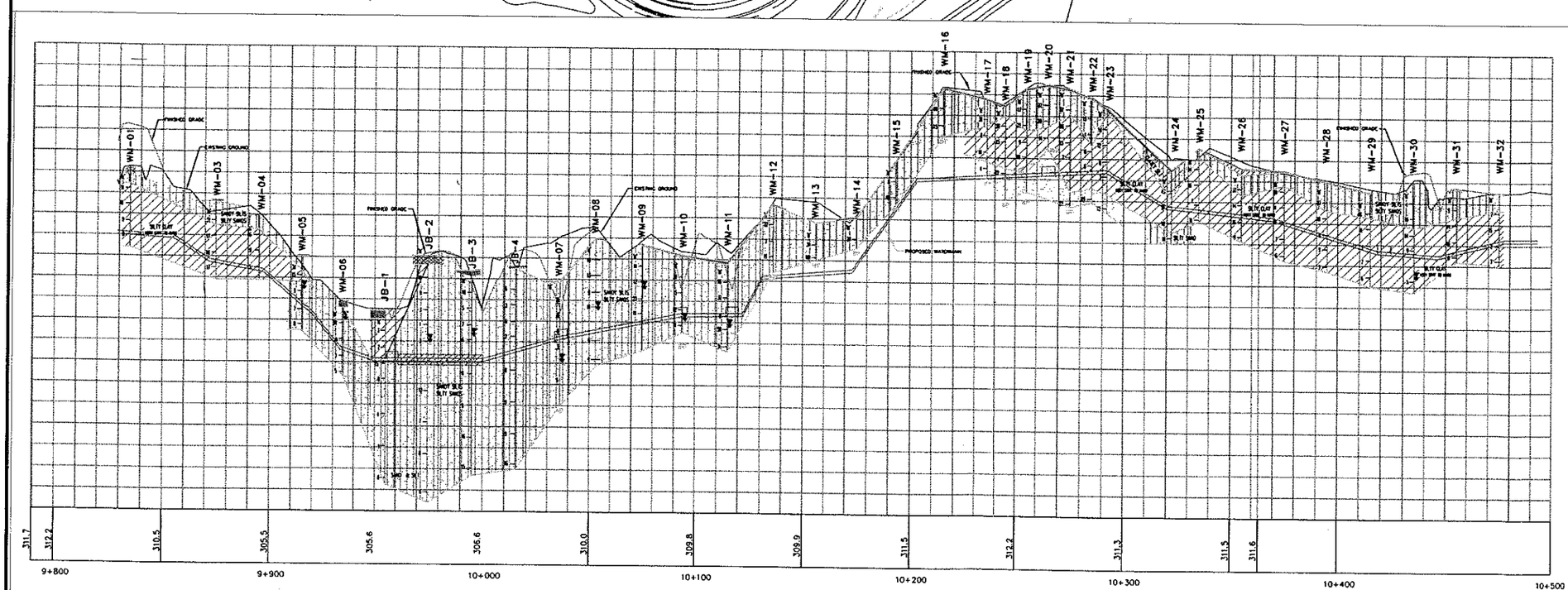
DATE: DECEMBER 2005	PROJECT NO.: TG04271	
DWG BY: T.GUNN		DRAWING 1
CH'K BY: Y.MEJIAS	SCALE: 1 : 1000	

KATUTIL-1

PROPOSED WATERMAIN
9+835 TO 10+475
TOWNSHIP OF ROLF
GWP 5005-A-000433
BOREHOLE LOCATIONS & SOIL STRATA



SITE PLAN
1 : 1500



PROFILE
1 : 1500h
1 : 500v

LEGEND

- Borehole
- 'N' Blows/0.3m (Std. Pen Test, 475 J/Blow)
- Water level at time of investigation.
- NFP No Further Progress
- Fill
- Topsoil
- Clay
- Interbedded Sands & Silts

No.	Elevation	Station	Offset
JB-01	305.5	9+955	0
JB-02	308.1	9+975	0
JB-03	307.4	9+995	0
JB-04	307.6	10+015	0
WM-01	312.2	9+835	3.0
WM-02	311.7	9+855	0
WM-03	310.7	9+875	0
WM-04	310.0	9+895	0
WM-05	308.1	9+915	0
WM-06	305.9	9+935	0
WM-07	308.9	10+035	1.0 Rt
WM-08	309.0	10+053	0
WM-09	308.7	10+075	0.6 Rt
WM-10	308.2	10+095	0
WM-11	307.9	10+115	1.0 Lt
WM-12	310.7	10+135	0
WM-13	309.8	10+155	0
WM-14	310.1	10+175	0
WM-15	312.8	10+195	0
WM-16	316.3	10+215	0
WM-17	315.8	10+235	0
WM-18	315.5	10+245	0
WM-19	316.3	10+255	0
WM-20	316.5	10+265	0
WM-21	316.3	10+275	0
WM-22	315.9	10+285	1.1 Rt
WM-23	315.4	10+292	0.5 Lt
WM-24	312.5	10+322	0
WM-25	313.4	10+335	1.0 Rt
WM-26	312.9	10+355	3.5 Rt
WM-27	312.3	10+375	5.0 Rt
WM-28	312.0	10+395	2.0 Rt
WM-29	311.5	10+415	0
WM-30	312.0	10+435	0
WM-31	311.7	10+455	0.3 Lt
WM-32	311.7	10+475	1.9 Rt

NOTE:
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed by interpolation and may not represent actual conditions.

DST CONSULTING ENGINEERS
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Email: thunderbay@dstgroup.com

Appendix B

Comparison of Installation Methods

COMPARISON OF WATERMAIN INSTALLATION TECHNIQUES

Open Cut Trench	Jack and Bore	Directional Drilling	Pipe Ramming
Advantages: i. Well known, readily available technology. ii. Continuation of work required for installation of the remainder of the watermain.. ***Disadvantages:*** i. Requires staging, i.e. closure of existing highway. ii. It introduces an unnecessary cut in the existing highway. **.....continued**	***Advantages:*** i. Avoids open cut. ii. Does not require staging. iii. Relatively well known technology and readily available. iv. Permits installation of a sleeve on line and grade. ***Disadvantages:*** i. The cohesionless soil and high groundwater level at this site are not considered suitable for this method. ii. Potential for unacceptable loss of ground and settlement of the highway. iii. Dewatering to improve the ground for this method would be difficult to implement under the highway and is expected to cost in excess of $50,000.00 **.....continued**	***Advantages:*** i. Avoids open cut. ii. Does not require staging. iii. Well tested technology at 150 mm pipe diameter. iv. Can operate with smaller pits than jack and bore. v. Relatively good control of potential settlement of pavement but less than the control available by pipe ramming. ***Disadvantages:*** i. Does not permit installation of a sleeve on grade. Line can be well maintained, but normally service pipe is pulled through on a shallow vertical curve. **.....continued**	***Advantages:*** i. Avoids open cut. i. Does not require staging. ii. Suitable for installing a sleeve pipe on line and grade. iii. Perhaps best control over potential settlement of pavement. ***Disadvantages:*** i. Technology less available in local area.. **.....continued**

THURBER

Cost: The estimated cost of installation by trenching is $12,000.00, not including the cost of pipe and the possible requirement for dewatering. **NOT RECOMMENDED**	***Cost:*** The cost is estimated to be in the order of $10,000, plus possible dewatering and shoring for the pits. **NOT RECOMMENDED**	***Cost:*** The estimated cost is $10,000, not including the cost of the pipe. **RECOMMENDED**	***Cost:*** Estimated cost for this project is $35,000, not including cost of pipe. **NOT RECOMMENDED (on basis of cost)**

Appendix C

Special Provisions

The following Special Provision is referenced in this report:

- Amendment to OPSS 120, August 1994

The contract documents should contain a NSSP containing the following, or similar, wording:

Cobbles and Boulders

"The Contractor is notified that the soils at this site may contain cobbles and boulders that may impede the progress of trenching or trenchless installation. The soil conditions are described in the Foundation Investigation Report prepared for the site. Reference should be made to that document for a description of soil conditions."

Groundwater and Dewatering

"The Contractor is notified that the site may be prone to high groundwater levels and that these levels may be higher than the water levels shown in the Foundation Investigation Report prepared for this site. While reference should be made to that report for a description of the encountered conditions, the Contractor must satisfy himself regarding the groundwater levels likely to prevail at the time of construction and be prepared to implement dewatering procedures.

The Contractor is further notified that failure to implement dewatering in advance of excavating below the groundwater table may result in sloughing and boiling of the soil in the excavation and a loss in stability and bearing resistance."