



**FOUNDATION INVESTIGATION AND DESIGN REPORT**

for

**HIGHWAY 637 UNDERPASS**

**SITE NO. 46-511**

**HIGHWAY 69 FOUR-LANING**

**W.P. 5265-05-01**

**DISTRICT 54, SUDBURY, ONTARIO**

***PHASE 2: STA. 15+180 TO 22+346.5, TOWNSHIP OF SERVOS  
STA. 10+000 TO 11+300, TOWNSHIP OF BURWASH***

PETO MacCALLUM LTD.  
165 CARTWRIGHT AVENUE  
TORONTO, ONTARIO  
M6A 1V5  
Phone: (416) 785-5110  
Fax: (416) 785-5120

Distribution:

- 3 cc: AECOM for distribution to MTO, Project Manager +  
one digital copy of text (WORD format) and Drawings  
(PDF format)
- 1 cc: AECOM for distribution to MTO, Pavements and  
Foundations Section + one digital copy of text  
(WORD format) and Drawings (PDF format)
- 2 cc: AECOM
- 1 cc: PML Toronto
- 1 cc: PML Kitchener

PML Ref.: 06TF052E  
Index No.: 736FIR and 737FDR  
GEOCRES No.: 41I-232  
May 5, 2009



**FOUNDATION INVESTIGATION REPORT**

for

**HIGHWAY 637 UNDERPASS**

**SITE NO. 46-511**

**HIGHWAY 69 FOUR-LANING**

**W.P. 5265-05-01**

**DISTRICT 54, SUDBURY, ONTARIO**

***PHASE 2: STA. 15+180 TO 22+346.5, TOWNSHIP OF SERVOS  
STA. 10+000 TO 11+300, TOWNSHIP OF BURWASH***

PETO MacCALLUM LTD.  
165 CARTWRIGHT AVENUE  
TORONTO, ONTARIO  
M6A 1V5  
Phone: (416) 785-5110  
Fax: (416) 785-5120  
Email: toronto@petomaccallum.com

Distribution:

- 3 cc: AECOM for distribution to MTO, Project Manager + one digital copy of text (WORD format) and Drawings (PDF format)
- 1 cc: AECOM for distribution to MTO, Pavements and Foundations Section + one digital copy of text (WORD format) and Drawings (PDF format)
- 2 cc: AECOM
- 1 cc: PML Toronto
- 1 cc: PML Kitchener

PML Ref.: 06TF052E  
Index No.: 736FIR  
GEOCRES No.: 41I-232  
May 5, 2009



## TABLE OF CONTENTS

1. INTRODUCTION .....	1
2. SITE DESCRIPTION AND GEOLOGY .....	1
3. INVESTIGATION PROCEDURES .....	2
4. SUMMARIZED SUBSURFACE CONDITIONS .....	5
4.1 Topsoil and Peat .....	6
4.2 Silty Sand/Gravelly Sand (Upper Layer).....	6
4.3 Clayey Silt/Silty Clay/Clay .....	7
4.4 Sand/Gravelly Sand (Lower Layers).....	8
4.5 Bedrock .....	9
4.6 Groundwater .....	12
5. CLOSURE.....	12

Table A – Rock Core Descriptions	
Figures GS-1 to GS-4 – Particle Size Distribution Charts	
Figures PC-1 and PC-3 – Plasticity Charts	
Explanation of Terms Used in Report	
Record of Borehole Sheets	
Drawing 1 – Borehole Locations and Centreline Profile	
Drawing 2 – Soil Strata	
Appendix A – Site Photographs	
Appendix B – Rock Core Photographs	

**FOUNDATION INVESTIGATION REPORT**

for

Highway 637 Underpass  
Site No. 46-511  
Highway 69 Four-Laning  
W.P. 5265-05-01  
District 54, Sudbury, Ontario

*Phase 2: Sta. 15+180 To 22+346.5, Township of Servos  
Sta. 10+000 To 11+300, Township of Burwash*

---

**1. INTRODUCTION**

This report summarizes the results of the foundation investigation carried out for the proposed Highway 637 Underpass at the new alignment of Highway 69 about 41 km south of Sudbury. The investigation was conducted for AECOM on behalf of the Ministry of Transportation of Ontario (MTO).

This report provides subsurface information pertaining to the foundation of the proposed underpass and approach embankments within 20 m of the abutments.

All elevations in this report are expressed in metres.

**2. SITE DESCRIPTION AND GEOLOGY**

The site is located approximately 41 km south of Sudbury and on a new Highway 69 alignment approximately 300 m east of the existing Highway 637 intersection. Site photographs are provided in Appendix A.

The underpass site is generally located in the Precambrian Laurentian peneplane. The local topography is irregular and comprises wooded areas on sloping ground separated by steep rock ridges. Soil cover over the rock outcrops is generally sparse. The bridge is located over an extensive rock outcrop which lies adjacent to a swamp on the east of the proposed structure.

In general, Metasedimentary rocks of the Huronian Supergroup and gneisses of the Grenville Province underlie the new Highway 69 alignment. The area has undergone considerable folding, intrusive activity, regional metamorphism and faulting. The Servos Pluton occurs to the east of the bridge site.



### 3. INVESTIGATION PROCEDURES

The subsurface investigation for the proposed underpass was carried out during the period from August 6 to 14, 2008. A supplementary investigation of the rock slope at the location of the eastern boreholes which included six auger probes was carried out on December 17, 2008.

The scope of this investigation included 36 boreholes in total. Thirty-four boreholes were designated for structure foundation and two boreholes were designated for the west and east approach embankments. Borehole numbers and locations are shown on Drawing E1, appended. Twelve of the 36 boreholes, boreholes E2, E4, E5, E7, E8, E10, E11, E13, E14, E16, E17 and E19, were cored 3.1 to 3.9 m into the bedrock to depths ranging between 3.1 and 9.2 m. Borehole locations, elevations and depths of drilling/coring are summarized in Table below:

<b>BOREHOLE / PROBEHOLE NO.</b>	<b>GROUND SURFACE ELEVATION (m)</b>	<b>DEPTH OF BOREHOLE / PROBEHOLE (m)</b>
E1	236.9	0.1
E2	236.2	3.5
E3	236.0	0.2
E4	236.2	3.5
E5	236.2	4.8
E6	236.0	0.8
E7	235.9	4.0
APW1	236.2	0.6
APW2	236.2	0.0
APW3	236.2	0.8
E8	235.4	4.2
E9	234.6	0.5
E10	236.0	3.4



<b>BOREHOLE / PROBEHOLE NO.</b>	<b>GROUND SURFACE ELEVATION (m)</b>	<b>DEPTH OF BOREHOLE / PROBEHOLE (m)</b>
E11	235.7	3.1
E12	235.3	0.0
E13	233.8	3.6
APP1	235.9	0.0
APP2	235.8	0.0
APP3	235.2	0.0
E14	231.9	4.0
E15	231.4	3.4
E16	231.3	6.4
E17	231.3	7.4
E18	231.4	2.6
E19	231.3	9.2
APE1	231.7	1.0
APE2	231.9	0.0
APE3	231.3	4.1
APE4	231.7	0.0
APE5	231.3	4.6
APE6	231.3	4.7
APE7	231.3	3.8
APE8	231.3	4.3
APE9	231.4	3.2
APE10	231.4	2.1
E20	231.0	3.2



SRQ Ltd. Ontario Land Surveyors (SRQ) staked the alignment and working points of the new Highway 637 underpass at the structure location. Peto MacCallum Ltd. (PML) laid-out the positions of the boreholes along the staked alignment and determined the ground surface elevations at the borehole locations. The ground surface elevations for recently drilled boreholes APE5 to APE10 were referred to the previously drilled borehole ground elevations in the area. SRQ provided the following temporary benchmarks (TBM) established on existing ground level at the working points (WP) for each of the foundation units:

<b>TBM</b>	<b>DESCRIPTION</b>	<b>ELEVATION (*)</b>
TBM1	Existing ground at West abutment W.P.1	236.227
TBM2	Existing ground at East abutment W.P.3	231.273
TBM3	Existing ground at Centre Pier W.P.2	234.637

(\*) Geodetic, metric

The boreholes were advanced by various methods, as required by the site accessibility and prevalent weather limitations. Boreholes E1, E12, APW2, APP1, APP2, APE2, APP3, and APE4 were advanced using manual probing methods. The remaining boreholes were advanced using continuous flight solid and hollow stem augers powered by a track-mounted CME-D50 drill rig also, equipped for rotary diamond drilling, supplied and operated by a specialist drilling contractor. The drilling crews worked under the full-time supervision of a PML field supervisor.

Representative samples of the soils encountered in the boreholes were recovered at frequent depth intervals. In the boreholes advanced with conventional drill rigs, soil samples were obtained using a split spoon sampler in conjunction with standard penetration tests. Where standard penetration tests were not carried out, the consistency/relative density of the encountered soils was estimated from manual examination of the samples or the rate and ease to advance the augers. Penetrometer and field vane tests were performed on cohesive soil samples. The results of penetrometer tests are typically lower than the actual values due to sample disturbance.

Boreholes E2, E4, E5 and E7 drilled west of the future highway median, boreholes E8, E10, E11 and E13 in the area of the new median and boreholes E14, E16, E17 and E19 in the area east of the



median were extended 3.1 to 3.9 m into the bedrock using NQ diamond rock coring equipment. Photographs of rock cores are shown in Appendix B.

The boreholes were backfilled in accordance with the MTO guidelines and MOE Regulation 903 for borehole abandonment procedures using a bentonite/cement mixture grout.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of the soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open boreholes.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. Recovered soil samples were returned to our laboratory for detailed visual examination, soil classification and laboratory testing. The laboratory test program comprised the following tests:

- Atterberg limits determinations (9)
- Grain size analyses (10)
- Natural moisture contents (25)

The results of natural moisture contents, grain size analyses and Atterberg limits are shown on the Record of Borehole sheets. The grain size distribution charts are presented on Figures GS-1 to GS-4 and the plasticity charts are presented on Figures PC-1 to PC-3.

#### **4. SUMMARIZED SUBSURFACE CONDITIONS**

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil and rock classifications, inferred stratigraphy, boundary elevations and groundwater observations.

Bedrock outcrops at the location of test holes E1, E12, APW2, APP1, APP2, APP3, APE2 and APE4. The borehole locations, stratigraphic profile and cross-sections prepared from the borehole data are presented on the appended Drawings E1 and E2.



In the remaining boreholes the depth of the soil cover varies from 0.1 to 6.1 m. The soil cover generally consists of surficial 100 to 1000 mm thick topsoil overlying localized 0.8 to 1.6 m thick an upper layer of silty sand/gravelly sand or bedrock at the west abutment and pier locations. In the eastern boreholes, the topsoil is underlain by discontinuous 0.7 to 4.5 m thick clayey silt/silty clay/clay deposits which in turn cover a localized 0.2 to 1.5 m thick sand/sandy gravel/sand unit (lower layer). Scattered layers of cobbles and boulders are encountered within the upper and lower layers of cohesionless native soils in boreholes E5, E19, APE3, APE5, APE7 through APE10. All test holes encountered bedrock.

In the supplementary auger probes APE5 to APE10 drilled in the eastern area, the depth of the soil cover varies from 2.1 to 4.7 m. The soil cover generally consists of surficial 200 to 300 mm thick peat overlying a 1.9 to 4.4 m thick layer of silty clay with a localized 0.7 m thick sand layer mantling probable bedrock. Scattered layers of cobbles and boulders are encountered within the silty clay deposit.

#### **4.1 Topsoil and Peat**

The surficial topsoil and peat units are present in all boreholes except E11, E12, APW2, APP1, APP2, APP3, APE2 and APE4, where bedrock was found at ground surface. The brown to dark brown topsoil and peat layers are 100 to 600 mm thick and extends to elevations 230.8 to 236.8 with locally thicker deposits of 800 and 1000 mm extending to elevations 235.4 and 235.2 at boreholes APW3 and E5, respectively.

#### **4.2 Silty Sand/Gravelly Sand (Upper Layer)**

An upper layer of cohesionless soils consisting of silty sand/gravelly sand were encountered in boreholes E5, E6 and E8 at depths of 0.3 to 1.0 m below surface grades and extended to 0.7 to 1.7 m depths, elevations 234.5 to 235.2. Cobbles and boulders were encountered in the gravelly sand unit in borehole E5.



### **4.3 Clayey Silt/Silty Clay/Clay**

The cohesive clayey silt/silty clay/clay units were only encountered in the east abutment boreholes E15 to E19, auger probes APE1, APE3, APE5 to APE10, and east approach embankment borehole E20. The 0.7 to 4.1 m thick cohesive materials were encountered below the topsoil and peat units in boreholes E15 to E20, APE1, APE3, APE5 to APE10, at depths of 0.2 to 0.6 m and extended to 1.0 to 4.9 m depths, elevations 226.4 to 230.7. In boreholes E16, E17, E18, APE1 and E20 the clayey soils extended to bedrock that was encountered at 1.0 to 3.5 m depths, elevations 227.8 and 230.7. In boreholes E15 and APE3 the cohesive soils terminated on cohesionless soils (described in the following section). In borehole E19, the clayey soils were interbedded by a 0.8 m thick sand layer between 2.3 and 3.1 m depths, elevations 229.0 and 228.2 and extended to cohesionless soils at 4.9 m depth, elevation 226.4.

The consistency of the clayey silt/silty clay/clay soils is typically stiff to very stiff, except at borehole E19 below depth of about 3.1 m where a 1.8 m thick very soft to soft sandy clayey silt layer is present. Penetrometer tests indicated undrained shear strengths of 65 to 225 kPa. Two field vane tests indicated shear strength of 25 and 55 kPa and sensitivity of 4 and 7. N values typically ranged from 3 to 17. Two N values of 1 were obtained below 3.1 m depth in the very soft to soft layer found in borehole E19.

The grain size distribution charts of seven samples of the clayey silt/silty clay/clay materials are presented on Figures GS-1 to GS-3. Natural moisture content determinations ranged from 20 to 35%.

The plasticity charts for the nine samples are presented in Figures PC-1 to PC-3. The liquid and plastic limits and plastic index for the materials are shown on the corresponding boreholes log sheets and are summarised below.



MATERIAL	BOREHOLE	SAMPLE	DEPTH (m)	WATER CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
Clay	E20	3	1.5 – 2.1	32	52	22	30
Silty Clay	E15	3	1.5 – 2.1	35	48	23	25
	E16	3	1.5 – 2.1	29	45	22	23
	E17	4	2.3 – 2.9	33	38	19	19
	E18	2	0.8 – 1.4	31	48	21	27
	E19	2	0.8 – 1.4	27	46	21	25
	E19	3	1.5 – 2.1	31	46	21	25
	E20	4	2.3 – 2.9	21	42	20	22
Clayey Silt	E19	5	3.0 – 3.6	28	28	15	13

#### 4.4 Sand/Gravelly Sand (Lower Layers)

A localized unit of sand was interbedded in the clayey soils in borehole E19 between 2.3 and 3.1 m depths, elevations 229.0 and 228.2. Cobbles and boulders were encountered in the sand/gravelly sand units in boreholes/probeholes E19, APE3, APE5, APE7, APE8, APE9 and APE10. The relative density of the material is compact with one N value of 14.

A lower layer of cohesionless sand and gravelly sand is present below the clayey soils in boreholes E15, E19 and APE3 at 3.2 and 4.9 m depths from ground surface and extended to 3.4 and 5.7 m depths, elevations 225.6 and 228.0 where bedrock was proved by core drilling or was inferred by refusal to augering.

A 0.7 m thick sand layer was encountered in borehole APE9 at depth of 4.0 m (elevation 227.3) extending to the probable bedrock level.

The grain size distribution chart of one sample is presented on Figure GS-4. Natural moisture content determination on the interbedded layer of borehole E19 was 9%.



#### **4.5 Bedrock**

A detailed description of the rock cores retrieved from boreholes E2, E4, E5, E7, E8, E10, E11, E13, E14, E16, E17 and E19 is provided in Table A and summarized on the record of borehole logs. Rock outcrops were encountered in boreholes E11, E12, APW2, APP1, APP2, APP3, APE2 and APE4 at elevations 231.7 to 235.9.

In the west abutment boreholes E2, E4, E5 and E7, the level of the bedrock surface was confirmed by drilling four 3.1 to 3.6 m long cores from depths of 0.4 to 1.7 m, elevations 234.5 to 235.8. Bedrock was also inferred by refusal in five test holes at depths of 0.0 to 0.8 m, elevations 235.2 to 236.2 indicating a maximum surface level difference of 1.7 m between borehole locations (E5 and APW2). The slope of the bedrock surface within the west abutment footing area is 9 to 18°. Photographs of the rock core taken in boreholes E2, E4, E5 and E7 are shown on the west abutment core photographs 1 to 4.

At the pier boreholes, the level of the bedrock surface was confirmed in boreholes E8, E10, E11 and E13 by drilling four 3.1 to 3.5 m long cores from depths of 0.0 to 0.7 m, elevations 233.7 to 235.9. Bedrock was also interred by refusal in five boreholes at depths of 0.0 to 0.5 m, elevations 234.1 to 235.9. Indicating a maximum bedrock surface relief of 1.8 m between borehole locations. The slope of bedrock surface within the pier footing area is 10° at the north and centre sections, and slopes southerly downward at 22° within the south section. Photographs of the rock core surface taken in boreholes E8, E10, E11 and E13 are shown on the pier core photographs 1 to 6.

In the east abutment boreholes E14, E16, E17 and E19, the bedrock surface was confirmed by drilling four 3.5 to 3.9 m long cores into the rock from depths of 0.3 to 5.7 m, elevations 225.6 to 231.6. Bedrock was also inferred by refusal in two boreholes and 10 auger probes at depths of 0.0 to 4.7 m, elevations 226.2 to 231.9. The bedrock surface within the east abutment footing area generally slopes downward at angles ranging from 15 to 44° from west to east and at flatter slope angles ranging from about 3 to 28° from the north and centre to the southern area. Borehole E19 located at the southeast corner of the abutment yielded a lowest bedrock surface elevation 225.6. It was confirmed by the supplementary auger probes drilled at the east abutment area between Sta. 10+40.5 and 10+043 that the bedrock surface slopes easterly downward at typical slope angles ranging from 14 to 23° with local steeper angels of 49°. The bedrock surface slopes downward at an



overall angle of about 6° from the north to the south areas (APE9 to APE5). A maximum bedrock surface level difference of 6.3 m was measured between auger probe APE2 located at northwest and borehole E19. Photographs of the rock core taken at boreholes E14, E16, E17 and E19 are shown on the east abutment core photographs 1 and 8.

In the west approach embankment borehole E1, the bedrock was encountered below 100 mm of topsoil at elevation 236.8. In the east approach embankment borehole E20, the bedrock surface was inferred by refusal at 3.2 m depth, elevation 227.8.

The table below summarizes the depths and elevations of the probable bedrock, bedrock and rock outcrops encountered in boreholes/probeholes:

<b>BOREHOLE / PROBEHOLE NO.</b>	<b>DEPTH (m)</b>	<b>ELEVATION (m)</b>
E1	0.1	236.9
E2	0.4	235.8
E3	0.2	235.8
E4	0.4	235.8
E5	1.7	234.5
E6	0.8	235.2
E7	0.4	235.5
E8	0.7	234.7
E9	0.5	234.1
E10	0.1	235.9
E11	0.0	235.7
E12	0.0	235.3
E13	0.1	233.7
E14	0.3	231.6
E15	3.4	228.0
E16	2.7	228.6



<b>BOREHOLE / PROBEHOLE NO.</b>	<b>DEPTH (m)</b>	<b>ELEVATION (m)</b>
E17	3.5	227.8
E18	2.6	228.8
E19	5.7	225.6
E20	3.2	227.8
APE1	1.0	230.7
APE2	0.0	231.9
APE3	4.1	227.2
APE4	0.0	231.7
APE5	4.6	226.7
APE6	4.7	226.6
APE7	3.8	227.5
APE8	4.3	227.0
APE9	3.2	228.2
APE10	2.1	229.3
APP1	0.0	235.9
APP2	0.0	235.8
APP3	0.0	235.8
APW1	0.6	235.6
APW2	0.0	236.2
APW3	0.8	236.2



The rock core recovery varied typically between 89 and 100%, with three isolated values of 66, 79 and 83% in boreholes E16, E19 and E13, respectively. The RQD determined from the rock cores is typically greater than 91% (range of 91 to 100%) at the west abutment, indicating excellent quality rock. The range of RQD values for the pier boreholes varies from 64 to 98% indicating fair to excellent quality rock. The RQD values at the east abutment range between 65 and 100%, indicating fair to excellent quality rock. One RQD value of 79% was caused by a lost core piece in the hole.

#### 4.6 Groundwater

Groundwater was observed in the eastern boreholes E15, E16, E19, E20 and APE6 to APE10 at 1.5 to 3.4 m depths, elevations 228.0 to 228.6, during and upon completion of drilling. No groundwater strikes were observed in the remaining boreholes during and upon completion of drilling.

Table below summarizes the groundwater depths and Elevations encountered in boreholes/probeholes:

<b>BOREHOLE / PROBEHOLE NO.</b>	<b>DEPTH (m)</b>	<b>ELEVATION (m)</b>
E15	1.5	229.9
E16	2.7	228.6
E19	1.8	229.5
E20	1.5	229.5
APE5	3.4	227.9
APE6	3.0	228.3
APE7	3.0	228.3
APE8	3.4	227.9
APE9	3.0	228.4

#### 5. CLOSURE

The field work was carried out under the supervision of Mr. F. Portela, Senior Field Supervisor and direction of Mr. C. M. P. Nascimento, P.Eng., Senior Project Engineer. Walker Drilling Ltd. supplied the soil and rock drilling equipment. The laboratory testing was carried out in the PML laboratory in Toronto.



This report was prepared by Mr. I. Sadoun, MSc, P. Eng. and Mr. C. M. P. Nascimento, P.Eng. Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact, carried out an independent review of the report.

Yours very truly,

Peto MacCallum Ltd.

**NOTE: Hard copies signed  
and stamped**

Idib (Adeeb) Sadoun, M. Sc., P. Eng.  
Project Engineer

**NOTE: Hard copies signed  
and stamped**

Carlos M. P. Nascimento, P. Eng.  
Senior Project Engineer

**NOTE: Hard copies signed  
and stamped**

Brian R. Gray, M.Eng., P.Eng.  
MTO Designated Contact

IS/CN/BRG:is-lr-mi



**TABLE A**  
**ROCK CORE DESCRIPTION**

CORE RECOVERY					CORE DESCRIPTION	
BH	RC	DEPTH (m)	Rec (%)	RQD (%)	DEPTH (m)	DESCRIPTION
E2	1	0.4 – 2.0	100	100	0.4 – 3.5	GRANODIORITE GNEISS: Grey, fine to medium grained, high strength, unweathered, close to moderate spaced flat cross joints, rough planar, upper parting open to 1 mm with sand filling, lower partings generally oxidized to slightly altered, purple staining on surface, occasionally friable, some vertical partings, excellent quality.
	2	2.0 – 3.5	100	100		
E4	1	0.4 – 2.0	100	97	0.4 – 3.5	GRANODIORITE GNEISS: Grey, with occasional pink inclusions, fine to medium grained, slight banding, high strength, unweathered, with 10 mm thick dipping layer of friable gneiss/schist at 2.3 m depth, close to moderate spaced flat to dipping cross joints, rough planar, tight, some vertical partings with some silt on partings, excellent quality.
	2	2.0 – 3.5	100	92		
E5	1	1.7 – 2.0	100	100	1.7 – 4.8	GRANODIORITE GNEISS: Grey, fine to medium grained, high strength, slightly weathered to unweathered, close to wide spaced flat to dipping cross joints, rough planar, tight becoming oxidized to slightly altered with brown to black mineralization on parting, minor silt, excellent quality.
	2	2.0 – 3.2	100	91		
	3	3.2 – 4.8	100	100		
E7	1	0.4 – 1.9	100	95	0.4 – 4.0	GRANODIORITE GNEISS: Grey, fine to medium grained, slight banding, high strength, unweathered, close to moderate spaced flat to dipping cross joints, rough planar, tight to oxidized with red, brown and black mineralization on parting, locally open to 1 mm with silt infilling, excellent quality.
	2	1.9 – 3.2	100	96		
	3	3.2 – 4.0	100	100		
E8	1	0.7 – 1.8	100	79	0.7 – 4.2	GRANODIORITE GNEISS: Grey, fine to medium grained, dipping bands, high strength, unweathered, close to moderate spaced flat to dipping cross joints, rough planar, oxidized to slightly altered with red to dark red mineralization on parting surface, locally porous for 0.5 mm, some vertical partings, tight, fair to excellent quality.
	2	1.8 – 3.3	100	83		
	3	3.3 – 4.2	100	91		
E10	1	0.1 – 1.7	92	88	0.1 – 3.4	GRANITE-GRANODIORITE GNEISS: Pink, medium grained, slight banding, sugary texture, high strength, unweathered, close to moderate spaced flat to vertical cross joints, rough planar, oxidized to tight, fair to good quality.
	2	1.7 – 3.4	100	64		

RQD: Rock Quality Designation

Originated: JFW  
 Compiled: IS  
 Checked: CN

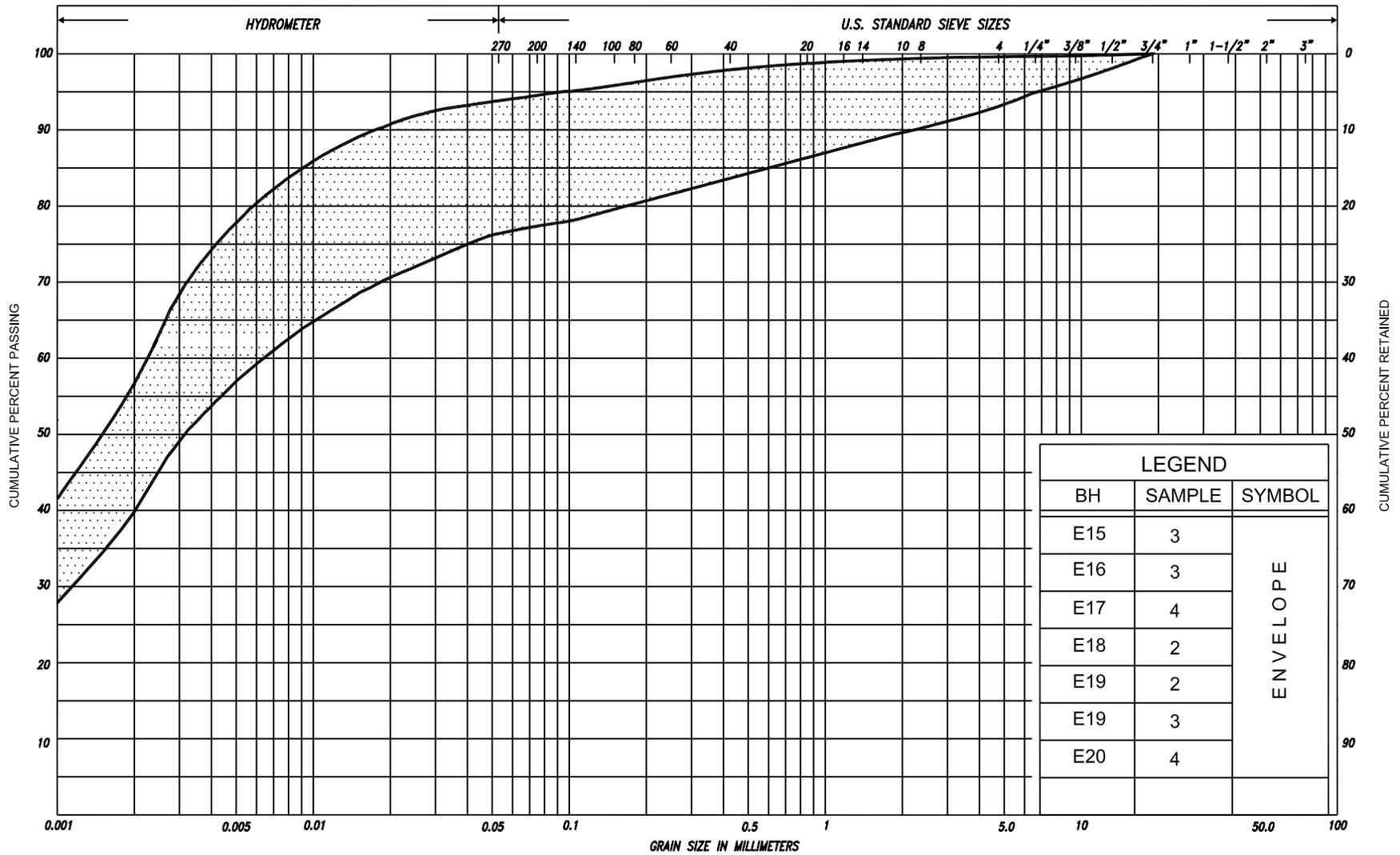


**TABLE A**  
**ROCK CORE DESCRIPTION**

CORE RECOVERY					CORE DESCRIPTION	
BH	RC	DEPTH (m)	Rec (%)	RQD (%)	DEPTH (m)	DESCRIPTION
E11	1	0.0 – 1.6	100	68	0.0 – 3.1	GRANITE-GRANODIORITE GNEISS: Pink, fine grained, high strength, unweathered, close to moderate spaced flat to dipping cross joints, rough planar, tight to oxidized with yellow and brown mineralization on parting, locally with silt, fair to excellent quality.
	2	1.6 – 3.1	98	98		
E13	1	0.1 – 1.7	100	97	0.1 – 3.6	GRANITE-GRANODIORITE GNEISS: Pink, medium grained, slight banding, sugary texture, high strength, unweathered, very close to moderate spaced flat to vertical cross joints, rough planar, tight to oxidized, occasionally with red residue on parting, good to excellent quality.
	2	1.7 – 3.0	100	94		
	3	3.0 – 3.6	83	83		
E14	1	0.3 – 1.8	95	95	0.3 – 4.0	GRANODIORITE GNEISS: Grey, medium grained, slight banding, high strength, unweathered, moderate to wide spaced flat cross joints, rough planar, tight, excellent quality.
	2	1.8 – 3.4	95	94		
	3	3.4 – 4.0	96	96		
E16	5	2.7 – 3.5	66	66	2.7 – 6.4	GRANODIORITE GNEISS: Dark grey, medium grained, dipping bands, high strength, unweathered, close to moderate becoming wide spaced flat to dipping cross joints, rough planar, tight, fair to excellent quality.
	6	3.5 – 4.9	100	95		
	7	4.9 – 6.4	100	100		
E17	5	3.5 – 4.3	89	65	3.5 – 7.4	GRANODIORITE GNEISS: Grey to dark grey, medium grained, dipping bands, high strength, unweathered, very close to moderate becoming wide spaced flat to dipping cross joints, rough planar, tight to oxidized, with occasional vertical partings, oxidized to slightly altered with dark green mineralization on surface, good to excellent quality.
	6	4.3 – 5.7	100	96		
	7	5.7 – 6.1	100	100		
	8	6.1 – 7.4	98	98		
E19	7	5.7 – 6.6	100	100	5.7 – 9.2	GRANODIORITE GNEISS: Grey to dark grey, medium grained, dipping bands, high strength, unweathered, close to moderate becoming wide spaced flat to dipping cross joints, rough planar, tight, excellent quality. [Low recovery and RQD for Run 3 due to piece lost down hole]
	8	6.6 – 7.8	100	100		
	9	7.8 – 9.2	79	79		

RQD: Rock Quality Designation

Originated: JFW  
 Compiled: IS  
 Checked: CN



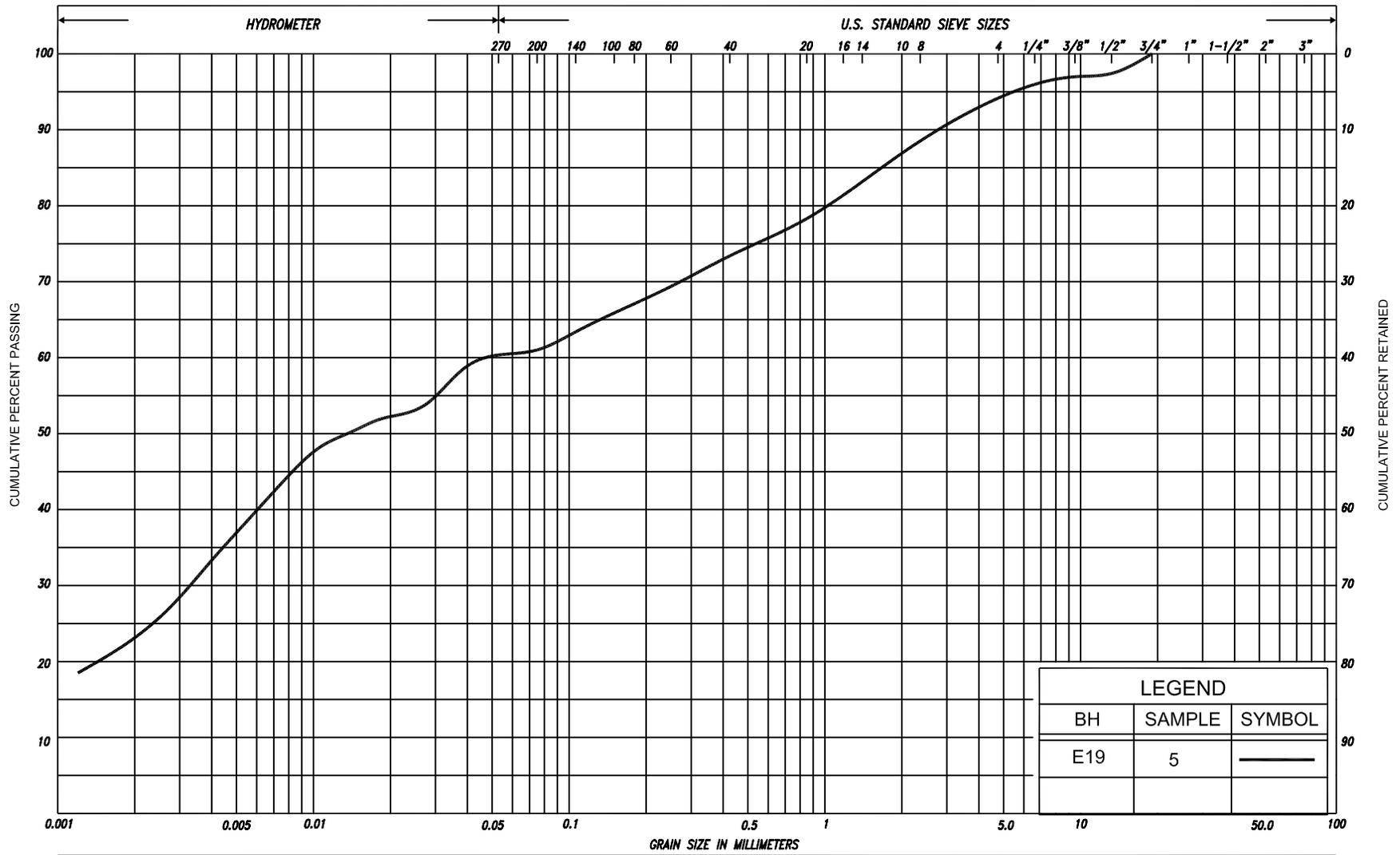
LEGEND		
BH	SAMPLE	SYMBOL
E15	3	ENVELOPE
E16	3	
E17	4	
E18	2	
E19	2	
E19	3	
E20	4	

SILT & CLAY		FINE SAND		MEDIUM SAND	COARSE SAND	GRAVEL	COBBLES	UNIFIED
CLAY	FINE SILT	MEDIUM SILT	COARSE SILT	FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL	COBBLES
CLAY	SILT	V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND	GRAVEL		U.S. BUREAU



**GRAIN SIZE DISTRIBUTION**  
SILTY CLAY, some sand, trace gravel

FIG No. GS-1  
HWY: 69 & 637  
G.W.P. No. 5265-05-01



LEGEND		
BH	SAMPLE	SYMBOL
E19	5	—

SILT & CLAY				FINE SAND			MEDIUM SAND			COARSE SAND			GRAVEL			COBBLES	UNIFIED						
CLAY	FINE SILT			MEDIUM SILT			COARSE SILT			FINE SAND			MEDIUM SAND			COARSE SAND			GRAVEL			COBBLES	M.I.T.
CLAY				SILT				V. FINE SAND	FINE SAND	MED. SAND	COARSE SAND		GRAVEL							U.S. BUREAU			

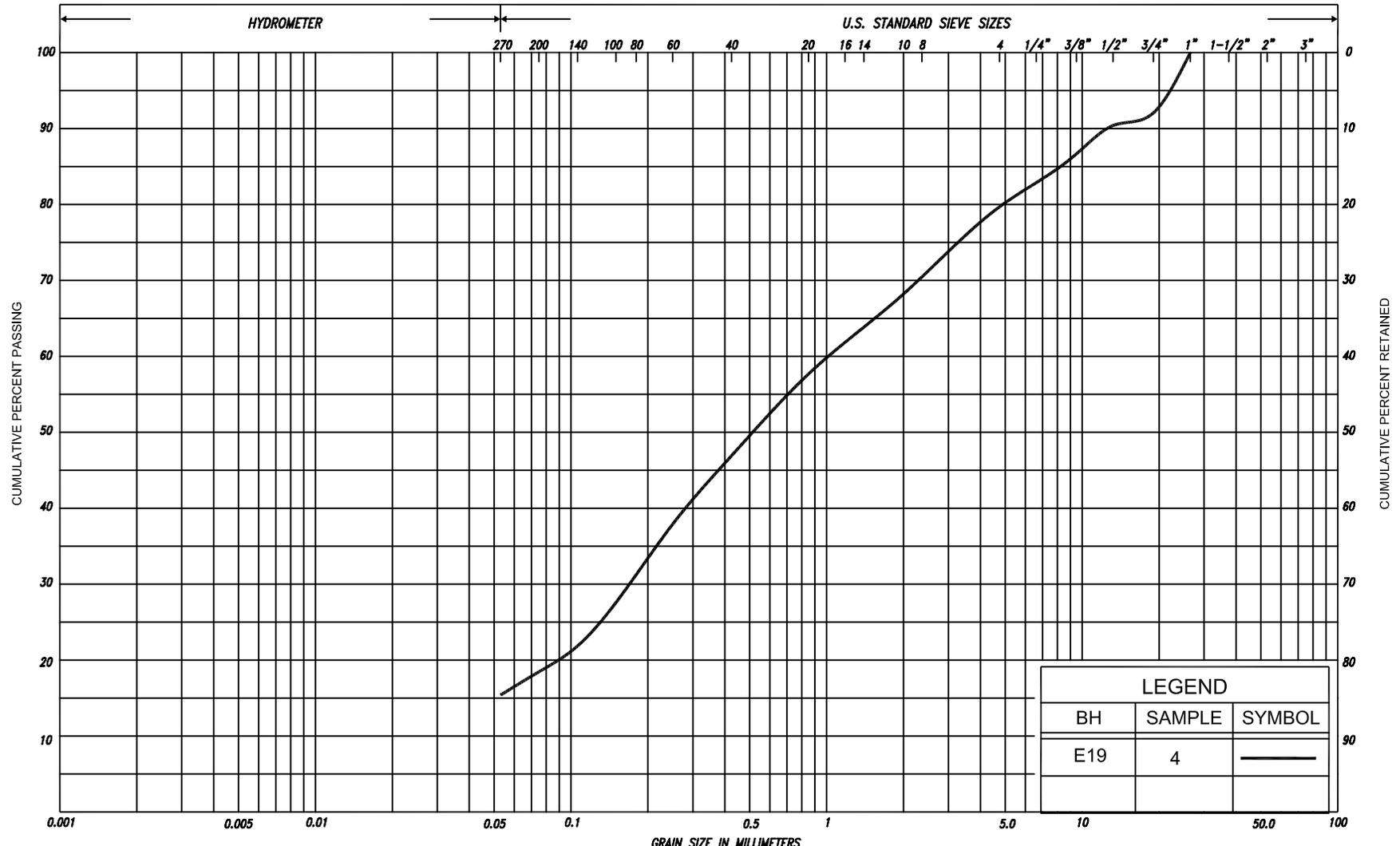


## GRAIN SIZE DISTRIBUTION

### SANDY CLAYEY SILT, trace gravel

FIG No. GS-2  
 HWY: 69 & 637  
 G.W.P. No. 5265-05-01



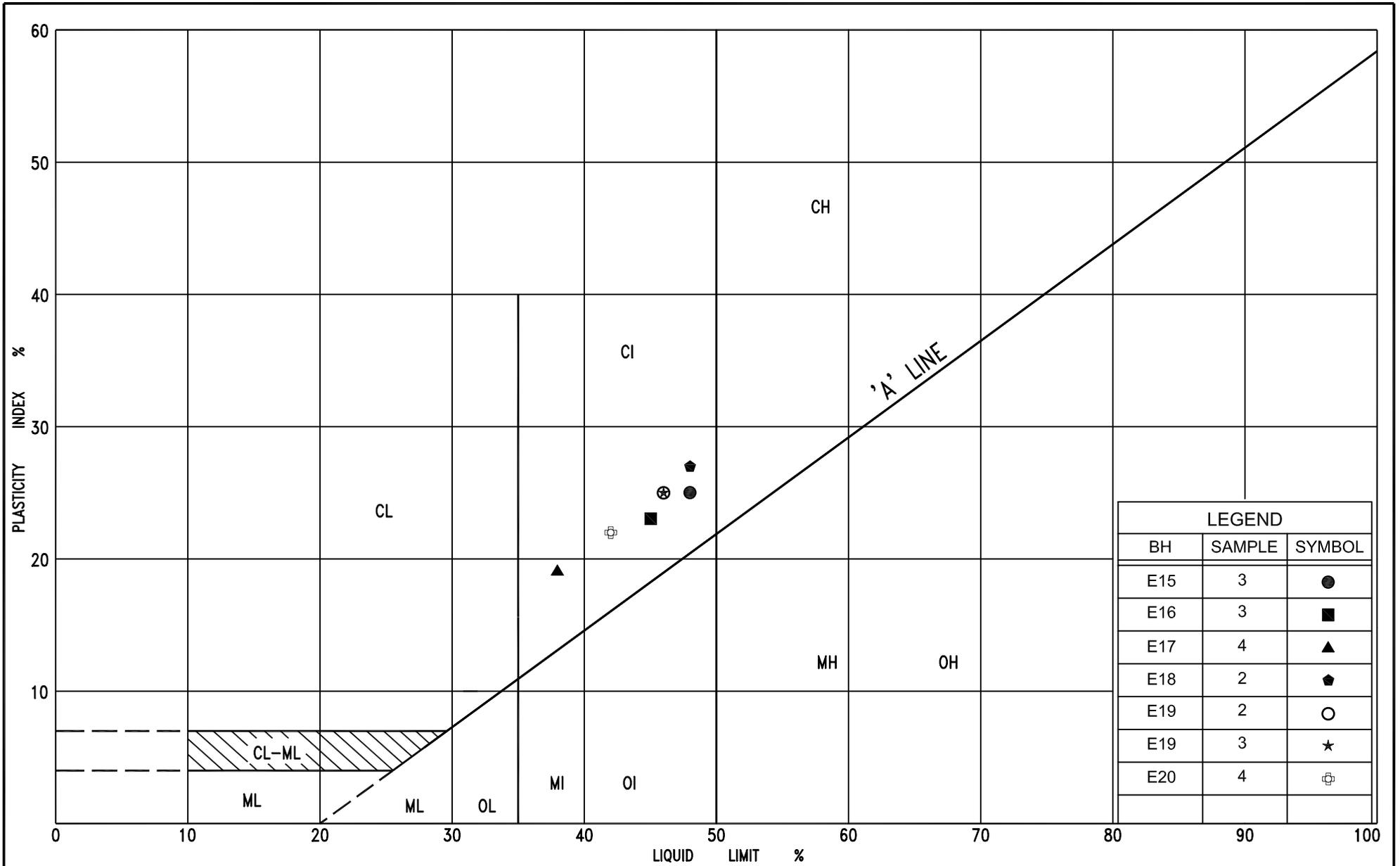


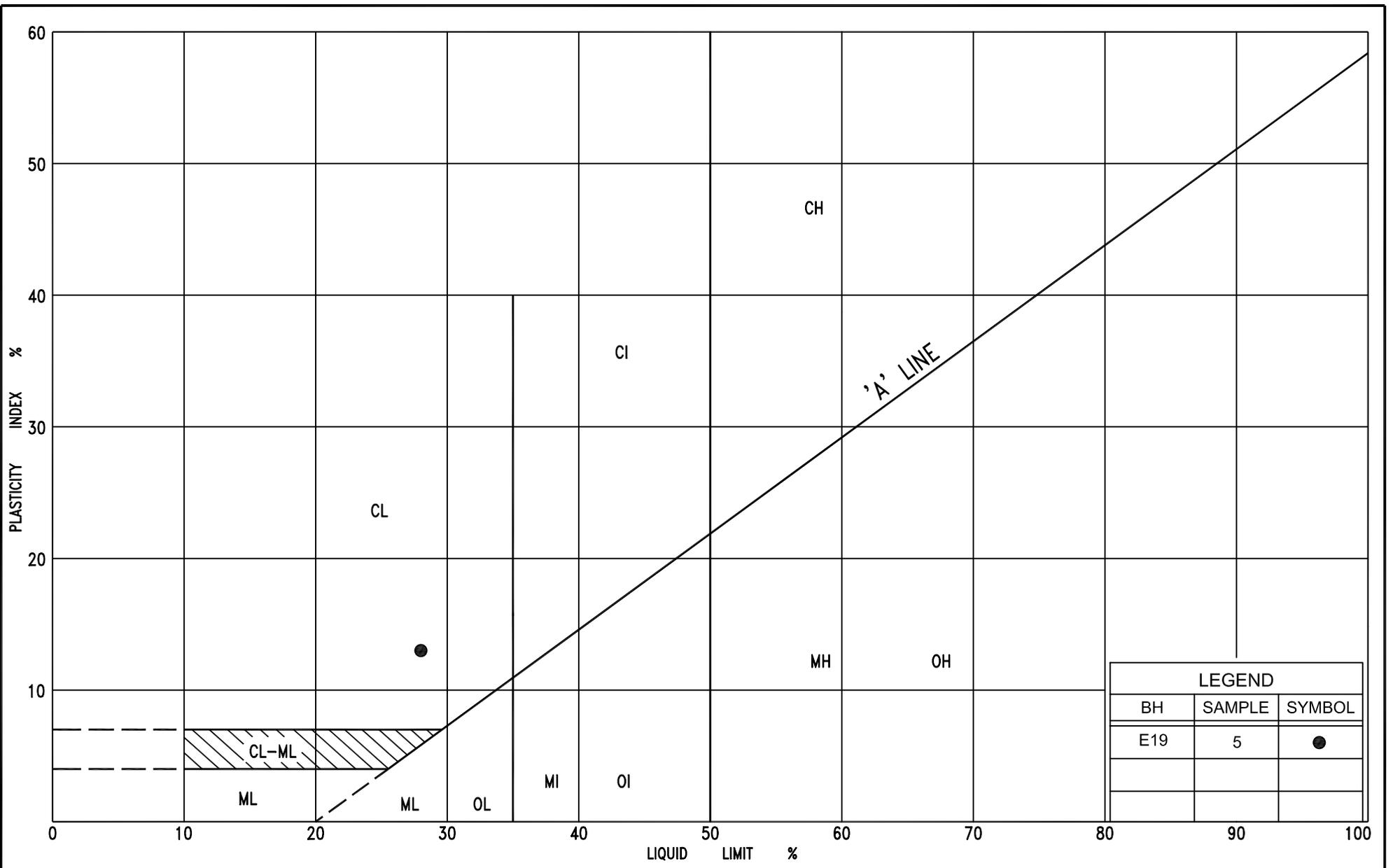
SILT & CLAY			FINE SAND			MEDIUM SAND			COARSE SAND			GRAVEL			COBBLES	UNIFIED
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE	GRAVEL			COBBLES	M.I.T.	
	SILT			SAND			GRAVEL			COBBLES						
CLAY		SILT			V. FINE	FINE	MED.	COARSE	GRAVEL						U.S. BUREAU	
					SAND											

**GRAIN SIZE DISTRIBUTION**  
 SAND some gravel, some silt, trace clay

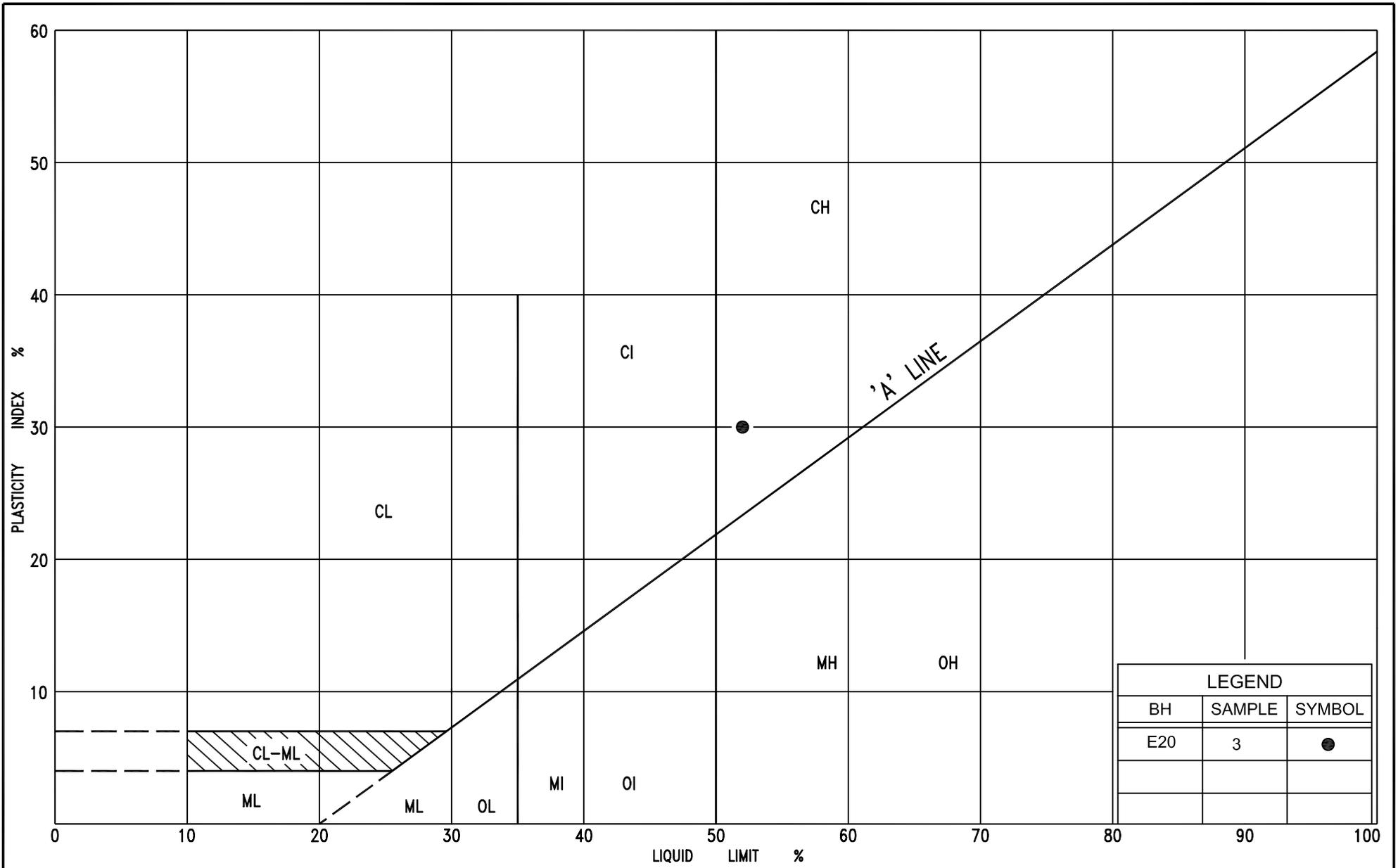


FIG No. GS-4  
 HWY: 69 & 637  
 G.W.P. No. 5265-05-01





LEGEND		
BH	SAMPLE	SYMBOL
E19	5	●



LEGEND		
BH	SAMPLE	SYMBOL
E20	3	●

## EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE
F V	FIELD VANE		

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$m^2/s$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$kg/m^3$	DENSITY OF SOLID PARTICLES	n	1, %	POROSITY	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE
$\gamma_s$	$kn/m^3$	UNIT WEIGHT OF SOLID PARTICLES	w	1, %	WATER CONTENT	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\rho_w$	$kg/m^3$	DENSITY OF WATER	$S_r$	%	DEGREE OF SATURATION	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\gamma_w$	$kn/m^3$	UNIT WEIGHT OF WATER	$w_L$	%	LIQUID LIMIT	D	mm	GRAIN DIAMETER
$\rho$	$kg/m^3$	DENSITY OF SOIL	$w_p$	%	PLASTIC LIMIT	$D_n$	mm	n PERCENT - DIAMETER
$\gamma$	$kn/m^3$	UNIT WEIGHT OF SOIL	$w_s$	%	SHRINKAGE LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\rho_d$	$kg/m^3$	DENSITY OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	h	m	HYDRAULIC HEAD OR POTENTIAL
$\gamma_d$	$kn/m^3$	UNIT WEIGHT OF DRY SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	q	$m^3/s$	RATE OF DISCHARGE
$\rho_{sat}$	$kg/m^3$	DENSITY OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	v	m/s	DISCHARGE VELOCITY
$\gamma_{sat}$	$kn/m^3$	UNIT WEIGHT OF SATURATED SOIL	DTPL		DRIER THAN PLASTIC LIMIT	i	1	HYDRAULIC GRADIENT
$\rho'$	$kg/m^3$	DENSITY OF SUBMERGED SOIL	APL		ABOUT PLASTIC LIMIT	k	m/s	HYDRAULIC CONDUCTIVITY
$\gamma'$	$kn/m^3$	UNIT WEIGHT OF SUBMERGED SOIL	WTPL		WETTER THAN PLASTIC LIMIT	j	$kn/m^3$	SEEPAGE FORCE
e	1, %	VOID RATIO						

**RECORD OF BOREHOLE No E 1**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 120 999 N; 322 292 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Manual Probe      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 14, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
236.9 0.0	Ground Surface															
236.8 0.1	Topsoil End of borehole Refusal on bedrock outcrop															
	* Borehole dry															

**RECORD OF BOREHOLE No E 2**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 011 N; 322 306 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 12, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT <b>γ</b> kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100
236.2	Ground Surface																
0.0	Topsoil					236											
235.8	Granodiorite Gneiss bedrock Unweathered High strength Excellent quality		1	RC NQ	REC 100%	235										RQD 100%	
0.4						234											
			2	RC NQ	REC 100%	233											
232.7	End of borehole																
3.5	* Borehole dry  C.F.H.S.A. Denotes Continuous Flight Hollow Stem Augers																

**RECORD OF BOREHOLE No E 3**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 120 999 N; 322 311 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Continuous Flight Solid Stem Augers      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 14, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
236.0	Ground Surface															
0.0	Topsoil	~	1	SS	3/15cm											
235.8	End of borehole															
0.2	Refusal on probable bedrock															
	Sample 1: Sampler bouncing															
	* Borehole dry															

**RECORD OF BOREHOLE No E 4**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 006 N; 322 310 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 13, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100
236.2	Ground Surface																
0.0	Topsoil					236											
235.8	Granodiorite Gneiss bedrock Unweathered High strength Excellent quality		1	RC NQ	REC	100%	235									RQD 97%	
0.4							234										RQD 92%
								233									
232.7	End of borehole																
3.5	* Borehole dry  C.F.H.S.A. Denotes Continuous Flight Hollow Stem Augers																

**RECORD OF BOREHOLE No E 5**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 011 N; 322 310 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 13, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
236.2 0.0	Ground Surface Topsoil															
235.2 1.0	Gravelly sand cobbles and boulders															
234.5 1.7	Loose Granodiorite Gneiss bedrock Slightly weathered to unweathered High strength Excellent quality		1	RC NQ	REC 100%											RQD 100%
			2	RC NQ	REC 100%											RQD 91%
			3	RC NQ	REC 100%											RQD 100%
231.4 4.8	End of borehole															

\* Borehole charged with  
drilling water  
  
C.F.H.S.A. Denotes  
Continuous Flight  
Hollow Stem Augers

**RECORD OF BOREHOLE No E 6**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 013 N; 322 309 E      ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637      BOREHOLE TYPE Continuous Flight Hollow Stem Augers      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 13, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
236.0	Ground Surface															
0.0	Topsoil															
235.7																
0.3	Silty sand		1	SS	2											
235.2	Loose Brown Moist															
0.8	End of borehole															
	Refusal on probable bedrock															
	* Borehole dry															

**RECORD OF BOREHOLE No E 7**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 000 N; 322 315 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 14, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
235.9	Ground Surface															
0.0	Topsoil															
235.5	Granodiorite Gneiss bedrock															
0.4	Unweathered High strength Excellent quality		1	RC NQ	REC 100%	235										RQD 95%
			2	RC NQ	REC 100%	234										RQD 96%
			3	RC NQ	REC 100%	233										RQD 100%
231.9	End of borehole					232										
4.0	* Borehole dry  C.F.H.S.A. Denotes Continuous Flight Hollow Stem Augers															

**RECORD OF BOREHOLE No E 8**

1 of 1

**METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 027 N; 322 339 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling COMPILED BY A.S.  
 DATUM Geodetic DATE August 12, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
											○ UNCONFINED	+	FIELD VANE			
											● QUICK TRIAXIAL	×	LAB VANE			
											WATER CONTENT (%)					
											20	40	60			
235.4	Ground Surface															
0.0	Topsoil															
235.1																
0.3	Silty sand															
234.7																
0.7	Loose Brown Moist Granodiorite Gneiss bedrock															
	Unweathered		1	RC NQ	REC	100%										RQD 79%
	High strength															
	Fair to excellent quality		2	RC NQ	REC	100%										RQD 83%
			3	RC NQ	REC	100%										RQD 91%
231.2																
4.2	End of borehole															
	* Borehole dry															
	C.F.H.S.A. Denotes Continuous Flight Hollow Stem Augers															

**RECORD OF BOREHOLE No E 9**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 014 N; 322 345 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Continuous Flight Hollow Stem Augers      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 11, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
234.6	Ground Surface																
0.0	Topsoil																
234.1	End of borehole																
0.5	Refusal on probable bedrock																
	* Borehole dry																



**RECORD OF BOREHOLE No E 11**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 025 N; 322 345 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 12, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT <b>γ</b> kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
235.7	Ground Surface															
0.0	Granite-granodiorite Gneiss bedrock  Unweathered High strength Fair to excellent quality		1	RC NQ	REC 100%											RQD 68%
			2	RC NQ	REC 98%											RQD 98%
232.6	End of borehole															
3.1	* Borehole dry  C.F.H.S.A. Denotes Continuous Flight Hollow Stem Augers															

**RECORD OF BOREHOLE No E 12**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 028 N; 322 343 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Manual Probe      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 12, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
					20	40	60	80	100								
235.3	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																



**RECORD OF BOREHOLE No E 14**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 043 N; 322 375 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 06, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	SHEAR STRENGTH kPa
											○ UNCONFINED	+	FIELD VANE					
											● QUICK TRIAXIAL	x	LAB VANE					
											WATER CONTENT (%)							
											20	40	60					
231.9	Ground Surface																	
0.0	Topsoil		1	SS	3/15cm													
231.6	Granodiorite Gneiss Bedrock Unweathered High strength Excellent quality		2	RC NQ	REC 95%	231										RQD 95%		
0.3			3	RC NQ	REC 95%	230											RQD 94%	
			4	RC NQ	REC 96%	229												RQD 96%
							228											
227.9	End of borehole																	
4.0	Sample 1: Sampler bouncing																	
	* Borehole dry																	
	C.F.H.S.A. Denotes Continuous Flight Hollow Stem Augers																	

**RECORD OF BOREHOLE No E 15** 1 of 1 **METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 030 N; 322 381 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY A.S.  
 DATUM Geodetic DATE August 06, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
											○ UNCONFINED	+ FIELD VANE	WATER CONTENT (%)			
											● QUICK TRIAXIAL	× LAB VANE				
231.4 0.0	Ground Surface Topsoil		1	SS	5											
230.9 0.5	Silty clay some sand, trace gravel rootlets Stiff Brown Moist		2	SS	12					225						
	thin layers of sand		3	SS	8											1 13 36 50
	Wet trace gravel		4	SS	4											
228.2 3.2			5	SS	12/15cm											
228.0 3.4	Sand trace silt, trace gravel Compact Grey Wet End of borehole Refusal on probable bedrock  Sample 5: Sampler bouncing															

2008 08 06

- ▽ Water level observed during drilling
- ▼ Water level measured after drilling
- Penetrometer test

**RECORD OF BOREHOLE No E 16** 1 of 1 **METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 037 N; 322 379 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling COMPILED BY A.S.  
 DATUM Geodetic DATE August 06, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
231.3 0.0	Ground Surface Topsoil		1	SS	3											
230.8 0.5	Silty clay, some sand trace gravel, rootlets Stiff Mottled Moist grey/brown		2	SS	15					213						
	thin layers of sand		3	SS	10					163					1 10 47 42	
228.6 2.7	Granodiorite Gneiss Bedrock Unweathered High strength Fair to excellent quality		4	SS	8											
			5	RC NQ	REC 66%										RQD 66%	
			6	RC NQ	REC 100%										RQD 95%	
			7	RC NQ	REC 100%										RQD 100%	
224.9 6.4	End of borehole Refusal on probable bedrock															

**RECORD OF BOREHOLE No E 17**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 036 N; 322 383 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 08, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	SHEAR STRENGTH kPa
231.3	Ground Surface																	
0.0	Topsoil		1	SS	5													
230.8	Silty clay some sand, trace gravel rootlets  Stiff      Mottled Moist grey/ brown		2	SS	11													
0.5																		
					3	SS	13											
					4	SS	3											2 11 47 40
						FV												
227.8	Granodiorite Gneiss Bedrock Unweathered High strength Good to excellent quality		5	RC NQ	REC 89%													
3.5																	RQD 65%	
					6	RC NQ	REC 100%											RQD 96%
					7	RC NQ	REC 100%											RQD 100%
			8	RC NQ	REC 98%												RQD 98%	
223.9	End of borehole																	
7.4																		

\* Borehole charged with drilling water  
  
C.F.H.S.A. Denotes Continuous Flight Hollow Stem Augers

**RECORD OF BOREHOLE No E 18**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 045 N; 322 378 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Continuous Flight Hollow Stem Augers      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 06, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	SHEAR STRENGTH kPa	
											○ UNCONFINED	+	FIELD VANE						
											● QUICK TRIAXIAL	×	LAB VANE						
											WATER CONTENT (%)								
231.4	Ground Surface																		
0.0	Topsoil		1	SS	2														
230.8	Silty clay, trace sand trace gravel, rootlets Stiff to Mottled Moist very stiff grey/brown		2	SS	10														
0.6																			
			3	SS	17					225									
228.8	thin layers of sand		4	SS	4/15cm					138									
2.6	Moist																		
	End of borehole Refusal on probable bedrock																		
	Sample 4: Sampler bouncing																		
	* Borehole dry																		
	■ Penetrometer test																		

**RECORD OF BOREHOLE No E 19**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 032 N; 322 384 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE C.F.H.S.A. and Rotary Diamond Drilling      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 06, 2008      CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
231.3	Ground Surface																	
0.0	Topsoil		1	SS	6													
230.9																		
0.4	Silty clay some sand, trace gravel rootlets		2	SS	15													1 12 39 48
	Stiff Mottled Moist grey/brown		3	SS	8													1 4 41 54
229.0																		
2.3	Sand, some gravel some silt, trace clay		4	SS	14													20 62 (18)
228.2	Compact Grey Wet																	
3.1	Sandy clayey silt trace gravel		5	SS	1													6 33 38 23
	Very soft Grey Wet to soft		6	SS	1													
226.4																		
4.9	Gravelly sand cobbles and boulders																	
225.6	Grey Wet																	
5.7	Granodiorite Gneiss Bedrock Unweathered High strength Excellent quality		7	RC NQ	REC 100%													RQD 100%
			8	RC NQ	REC 100%													RQD 100%
			9	RC NQ	REC 79%													RQD 79%
222.1	End of borehole																	
9.2																		

**RECORD OF BOREHOLE No E 20**      1 of 1      **METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 046 N; 322 398 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Continuous Flight Hollow Stem Augers      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 06, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
231.0	Ground Surface																	
0.0	Topsoil																	
230.7			1	SS	4													
0.3	Clay trace sand, trace gravel Stiff Brown Moist		2	SS	12					213								
			3	SS	8													1 3 29 67
228.7			4	SS	10													7 16 34 43
2.3	Silty clay some sand, trace gravel		5	SS	10/1cm													
227.8	Stiff Mottled Moist grey/brown																	
3.2	thin layers of silty sand End of borehole Refusal on probable bedrock  Sample 5: Sampler bouncing																	

2008 08 06

- ▽ Water level observed during drilling
- ▼ Water level measured after drilling
- Penetrometer test

**RECORD OF BOREHOLE No APE 1 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 044 N; 322 377 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.  
 DATUM Geodetic DATE August 14, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
231.7	Ground Surface																
0.0	Topsoil																
231.4	Silty clay, trace sand Brown Moist																
0.3																	
230.7	End of borehole																
1.0	Refusal on probable bedrock																
	Auger probes were not sampled. Soil boundaries were estimated from auger cuttings																
	* Borehole dry																

**RECORD OF BOREHOLE No APE 2 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 038 N; 322 377 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Manual Probe COMPILED BY A.S.  
 DATUM Geodetic DATE August 14, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
							20	40	60	80	100						
231.9	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

**RECORD OF BOREHOLE No APE 3 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 031 N; 322 382 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.  
 DATUM Geodetic DATE August 14, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
231.3 0.0	Ground Surface Topsoil															
231.1 0.2	Silty clay, trace sand Brown Moist					231										
						230										
						229										
						228										
227.7 3.6	Sand trace silt, trace gravel cobbles															
227.2 4.1	Brown Wet End of borehole Refusal on probable bedrock  Auger probes were not sampled. Soil boundaries were estimated from auger cuttings  * Borehole dry															

**RECORD OF BOREHOLE No APE 4 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 037 N; 322 378 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Manual Probe COMPILED BY A.S.  
 DATUM Geodetic DATE August 14, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
							20	40	60	80	100						
231.7	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

**RECORD OF BOREHOLE No APE 5      1 of 1      METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords; 5 121 033 N; 322 386 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Continuous Flight Solid Stem Augers      COMPILED BY A.S.  
 DATUM Geodetic      DATE December 17, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
231.3	Ground Surface																	
0.0 231.0	Peat, fine fibrous Dark brown																	
0.3	Silty clay trace sand, trace gravel  Brown Moist		1	CS	-													
226.7 4.6	End of borehole Refusal on probable bedrock  Auger probes were not sampled. Soil boundaries were estimated from auger cuttings  * 2008 12 17  ▽ Water level observed during drilling ▼ Water level measured after drilling																	



**RECORD OF BOREHOLE No APE 7 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords; 5 121 039 N; 322 383 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.  
 DATUM Geodetic DATE December 17, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
231.3	Ground Surface															
0.0 231.0	Peat, fine fibrous Dark brown															
0.3	Silty clay trace sand, trace gravel Brown Moist															
	with sand cobbles Grey Wet															
227.5 3.8	End of borehole Refusal on probable bedrock  Auger probes were not sampled. Soil boundaries were estimated from auger cuttings  * 2008 12 17  ▽ Water level observed during drilling ▼ Water level measured after drilling															

**RECORD OF BOREHOLE No APE 8 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords; 5 121 042 N; 322 381 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.  
 DATUM Geodetic DATE December 17, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
231.3	Ground Surface															
0.0	Peat, fine fibrous															
231.0	Dark brown															
0.3	Silty clay, trace sand															
	Brown Moist															
	with sand															
	Grey Wet															
	cobbles and boulders															
227.0																
4.3	End of borehole															
	Refusal on probable bedrock															
	Auger probes were not sampled. Soil boundaries were estimated from auger cuttings															
	* 2008 12 17															
	▽ Water level observed during drilling															
	▼ Water level measured after drilling															

**RECORD OF BOREHOLE No APE 9 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords; 5 121 045 N; 322 380 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.  
 DATUM Geodetic DATE December 17, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
231.4	Ground Surface																	
0.0	Peat, fine fibrous																	
231.1	Dark brown																	
0.3	Silty clay trace sand, trace gravel																	
	Brown Moist		1	CS	-													
	with sand																	
	Grey Wet		2	CS	-													
	cobbles and boulders																	
228.2	End of borehole																	
3.2	Refusal on probable bedrock																	
	Auger probes were not sampled. Soil boundaries were estimated from auger cuttings																	
	* 2008 12 17																	
	▽ Water level observed during drilling																	
	▼ Water level measured after drilling																	

**RECORD OF BOREHOLE No APE 10 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords; 5 121 041 N; 322 380 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.  
 DATUM Geodetic DATE December 17, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
231.4 0.0	Ground Surface															
231.2 0.2	Peat, fine fibrous Dark brown															
	Silty clay trace sand, trace gravel Brown Moist					231										
	_____					230										
229.3 2.1	End of borehole Refusal on probable bedrock															
	Auger probes were not sampled. Soil boundaries were estimated from auger cuttings															
	* Borehole dry on completion of drilling															

**RECORD OF BOREHOLE No APP 1      1 of 1      METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 028 N; 322 341 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Manual Probe      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 14, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
							20	40	60	80	100						
235.9	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

**RECORD OF BOREHOLE No APP 2 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 023 N; 322 343 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Manual Probe COMPILED BY A.S.  
 DATUM Geodetic DATE August 14, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
							20	40	60	80	100						
235.8	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

**RECORD OF BOREHOLE No APP 3 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 018 N; 322 345 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Manual Probe COMPILED BY A.S.  
 DATUM Geodetic DATE August 14, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
							20	40	60	80	100						
235.2	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

**RECORD OF BOREHOLE No APW 1      1 of 1      METRIC**

G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 003N; 322 309 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Continuous Flight Solid Stem Augers      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 14, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT <b>γ</b> kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
											○ UNCONFINED	+	FIELD VANE				
											● QUICK TRIAXIAL	×	LAB VANE				
											WATER CONTENT (%)						
											20	40	60				
236.2	Ground Surface																
0.0	Topsoil						236										
235.6	End of borehole																
0.6	Refusal on probable bedrock																
	* Borehole dry																

**RECORD OF BOREHOLE No APW 2      1 of 1      METRIC**

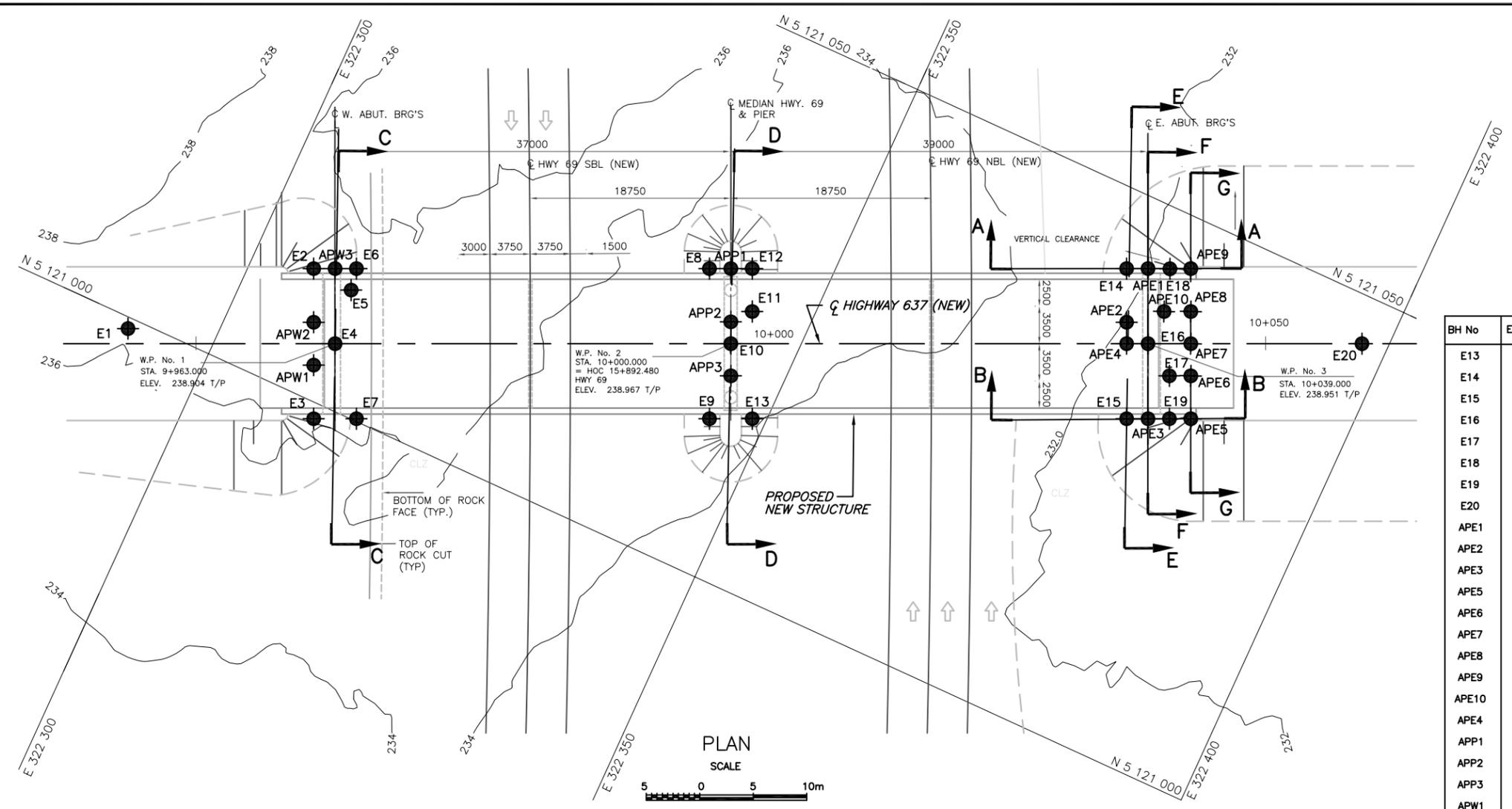
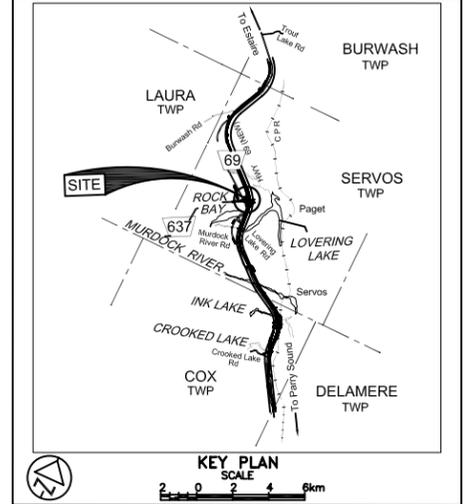
G.W.P. 5265-05-01      LOCATION Co-ords: 5 121 007 N; 322 308 E      ORIGINATED BY F.P.  
 DIST 54      HWY 69 & 637      BOREHOLE TYPE Manual Probe      COMPILED BY A.S.  
 DATUM Geodetic      DATE August 14, 2008      CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
					20	40	60	80	100								
236.2	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

**RECORD OF BOREHOLE No APW 3 1 of 1 METRIC**

G.W.P. 5265-05-01 LOCATION Co-ords: 5 121 012 N; 322 307 E ORIGINATED BY F.P.  
 DIST 54 HWY 69 & 637 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY A.S.  
 DATUM Geodetic DATE August 14, 2008 CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
											○ UNCONFINED	+	FIELD VANE				
											● QUICK TRIAXIAL	×	LAB VANE				
											WATER CONTENT (%)						
236.2	Ground Surface																
0.0	Topsoil						236										
235.4	End of borehole																
0.8	Refusal on probable bedrock																
	* Borehole dry																



(Legend Continued)

BH No	ELEVATION	CO-ORDINATES NORTHINGS	EASTINGS
E13	233.8	5 121 016	322 349
E14	231.9	5 121 043	322 375
E15	231.4	5 121 030	322 381
E16	231.3	5 121 037	322 379
E17	231.3	5 121 036	322 383
E18	231.4	5 121 045	322 378
E19	231.3	5 121 032	322 384
E20	231.0	5 121 046	322 398
APE1	231.7	5 121 044	322 377
APE2	231.9	5 121 038	322 377
APE3	231.3	5 121 032	322 384
APE5	231.3	5 121 033	322 386
APE6	231.3	5 121 036	322 384
APE7	231.3	5 121 039	322 383
APE8	231.3	5 121 042	322 381
APE9	231.4	5 121 045	322 380
APE10	231.4	5 121 041	322 380
APE4	231.7	5 121 037	322 378
APP1	235.9	5 121 028	322 341
APP2	235.8	5 121 023	322 343
APP3	235.2	5 121 018	322 345
APW1	236.2	5 121 003	322 309
APW2	236.2	5 121 007	322 308
APW3	236.2	5 121 012	322 307

LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- Blows/0.3m (Std. Pen Test, 475 J / blow)
- Blows/0.3m (60 Cone, 475 J / blow)
- W L at time of investigation Aug 2008
- Head
- ARTESIAN WATER
- Encountered
- PIEZOMETER

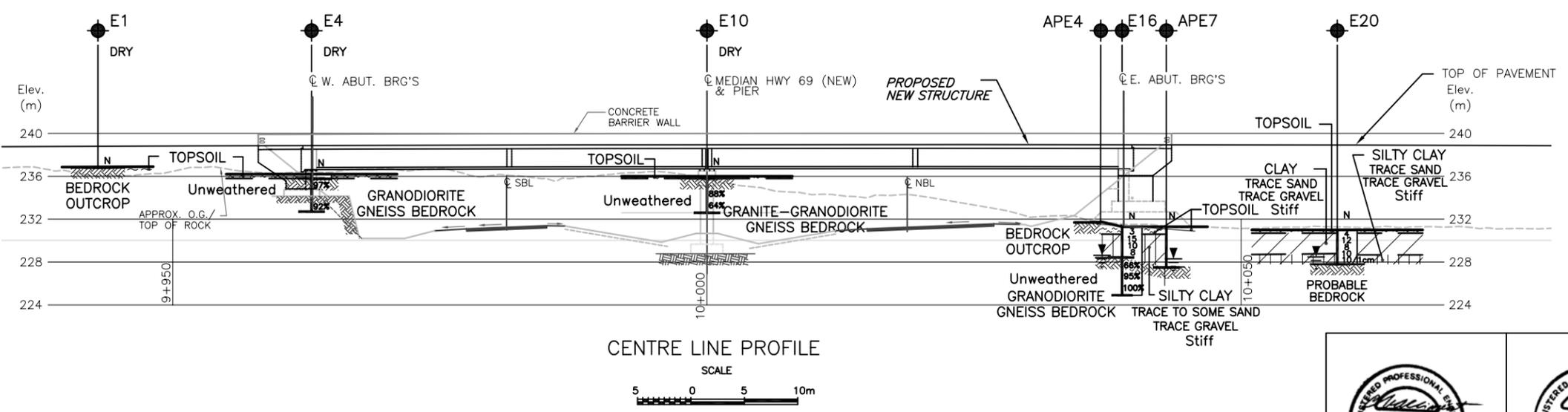
BH No	ELEVATION	CO-ORDINATES NORTHINGS	EASTINGS
E1	236.9	5 120 999	322 292
E2	236.2	5 121 011	322 306
E3	236.0	5 120 999	322 311
E4	236.2	5 121 006	322 310
E5	236.2	5 121 011	322 310
E6	236.0	5 121 013	322 309
E7	235.9	5 121 000	322 315
E8	235.4	5 121 027	322 339
E9	234.6	5 121 014	322 345
E10	236.0	5 121 021	322 344
E11	235.7	5 121 025	322 345
E12	235.3	5 121 028	322 343

(Legend Continues)

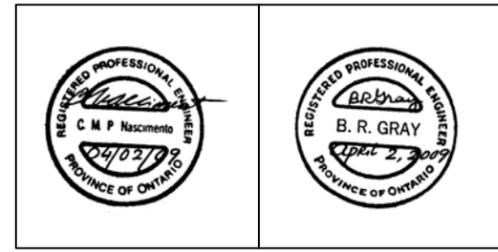
- NOTE -  
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

Geocres No. 411-232  
HWY No 69 & 637  
SUBM'D AS CHECKED CN DATE APRIL 02, 2009 SITE 46-511  
DRAWN NA CHECKED CN APPROVED BRG DWG E 1



CENTRE LINE PROFILE  
SCALE  
5 0 5 10m



- NOTES:
- REFER TO DRAWING E2 FOR SECTIONS A-A, B-B, C-C, D-D, E-E AND F-F.
  - THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
  - ELEVATIONS OF AUGER PROBES APE5 TO APE10 ARE APPROXIMATE

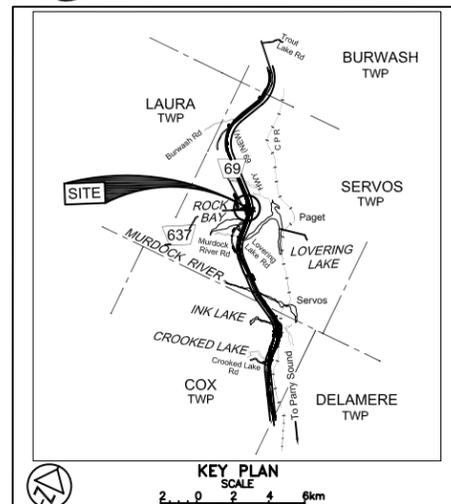
REF. TSH Drawings; Hwy 69 Servos Contract 2 Lidar Contours.dwg dated December 19, 2007; and 91088-HWY637-1-GA.dwg; Received August 27, 2008

**METRIC**

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No 2009-5131  
GWP No 5265-05-01

HIGHWAY 637 UNDERPASS  
HIGHWAY 69 FOUR-LANING  
SOIL STRATA



**LEGEND**

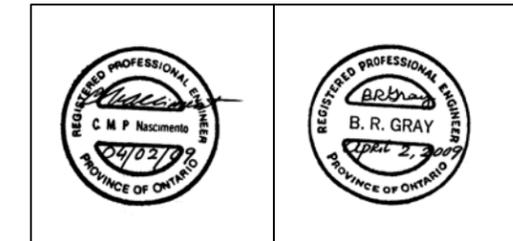
- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J / blow)
- CONE Blows/0.3m (60 Cone, 475 J / blow)
- W L at time of investigation Aug 2008
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	CO-ORDINATES	
		NORTHINGS	EASTINGS
SEE DRAWING E 1 FOR DETAILS			

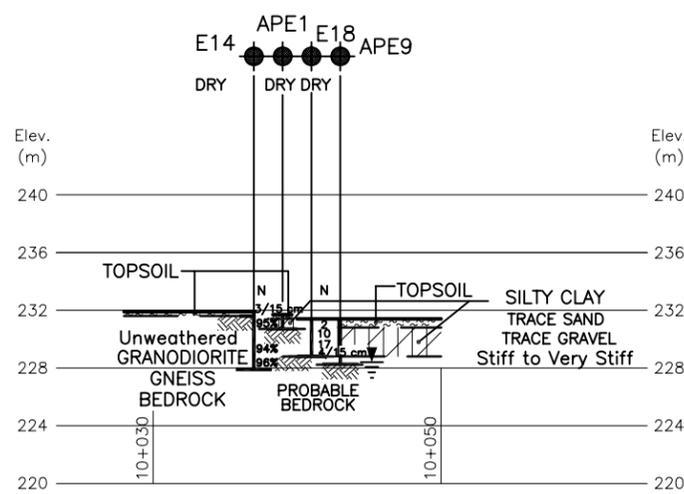
**NOTE -**  
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

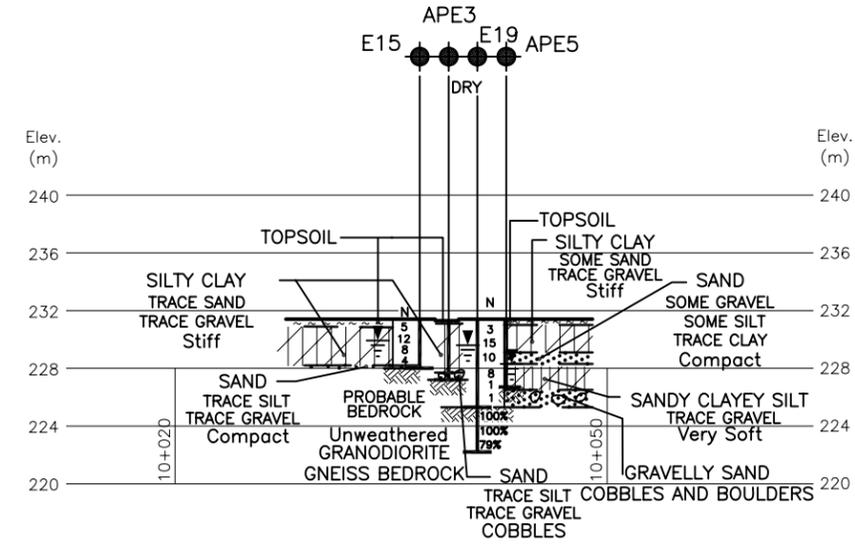
Geocres No. 411-232			
HWY No	69 & 637	DIST	54
SUBM'D	AS	CHECKED	CN
DATE	APRIL 02, 2009	SITE	46-511
DRAWN	NA	CHECKED	CN
APPROVED	BRG	DWG	E 2



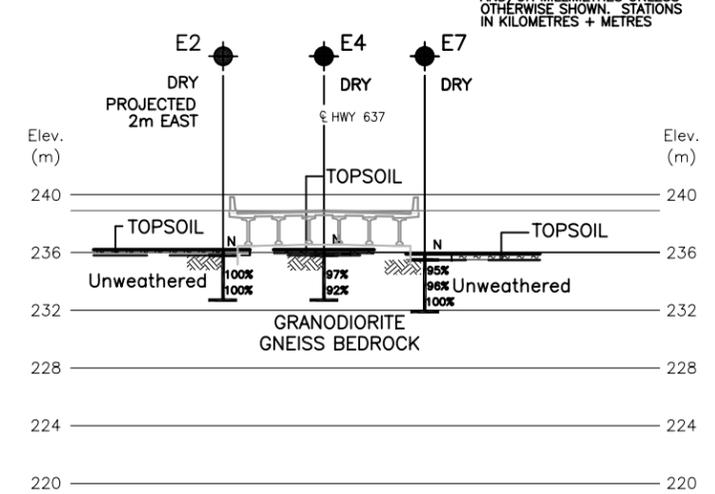
REF. TSH Drawings; Hwy 69 Servos Contract 2 Lidar Contours.dwg dated December 19, 2007; and 91088-HWY637-1-GA.dwg; Received August 27, 2008



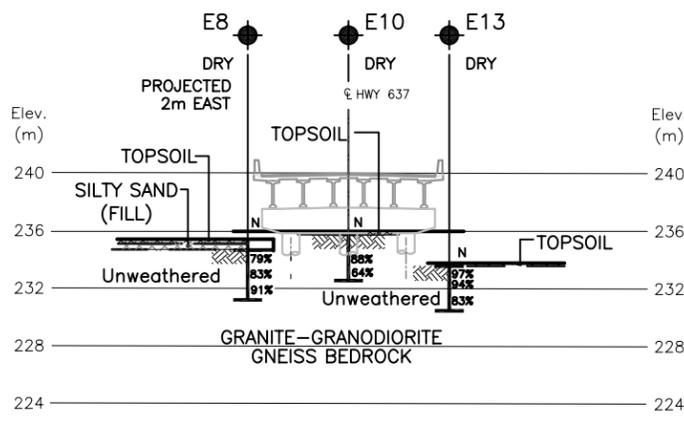
SECTION A-A



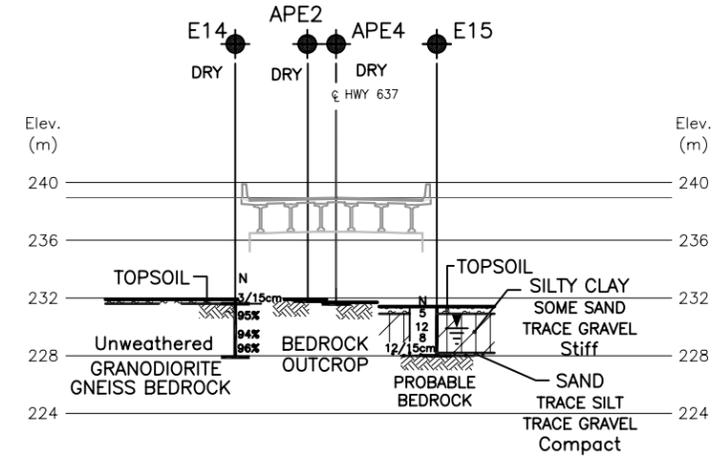
SECTION B-B



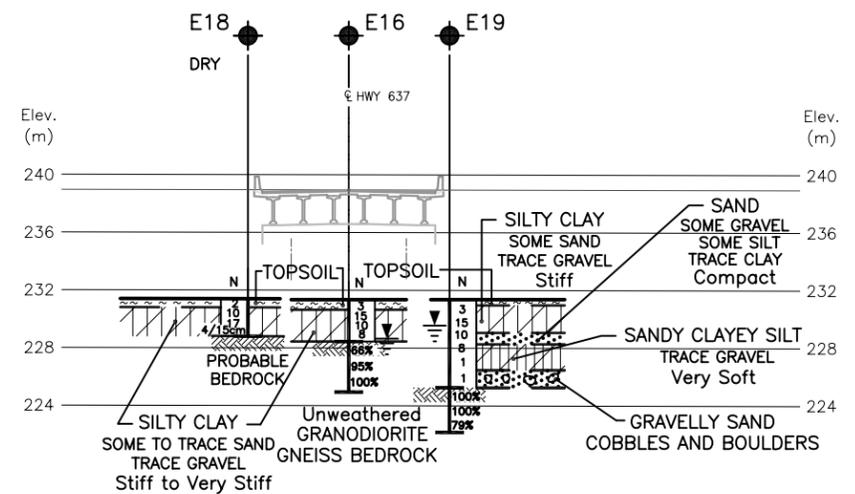
SECTION C-C



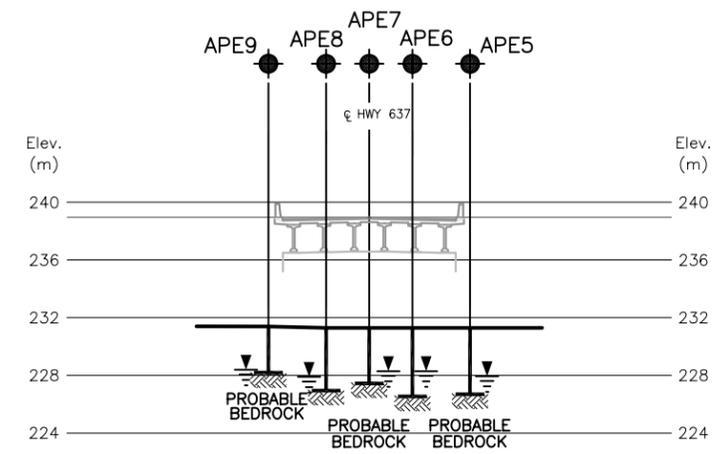
SECTION D-D



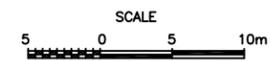
SECTION E-E



SECTION F-F



SECTION G-G



- NOTES:**
- REFER TO DRAWING E1 FOR BOREHOLE LOCATIONS PLAN AND CENTRE LINE PROFILE.
  - THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
  - ELEVATIONS OF AUGER PROBES APE5 TO APE10 ARE APPROXIMATE.

Highway 637 Underpass  
Highway 69 Four-Laning, Phase 2, Site No. 46-511  
W.P. 5265-05-01, Index No.: 736FIR  
PML Ref.: 06TF052E, May 5, 2009

---



## **APPENDIX A**

### **SITE PHOTOGRAPHS**



**Photograph 1:** Viewing Centre Pier location. Note the rock outcrop at the middle and bottom of the photograph.



**Photograph 2:** Viewing East Abutment location. Note stakes at borehole locations.

Highway 637 Underpass  
Highway 69 Four-Laning, Phase 2, Site No. 46-511  
W.P. 5265-05-01, Index No.: 736FIR  
PML Ref.: 06TF052E, May 5, 2009

---



## **APPENDIX B**

### ROCK CORE PHOTOGRAPHS

**WEST ABUTMENT**



West Abutment Core Photograph 1 : Rock core from borehole E2 - RC-1 and RC-2

**WEST ABUTMENT**



West Abutment Core Photograph 2 : Rock core from borehole E4 - RC-1 and RC-2

**WEST ABUTMENT**



West Abutment Core Photograph 3: Rock core from borehole E5 - RC-1 to RC-3

**WEST ABUTMENT**



West Abutment Core Photograph 4: Rock core from borehole E7 - RC-1, RC-2 and RC-3

**CENTRE PIER**



Centre Pier Core Photograph 1 : Rock core from borehole E8 - RC-1, RC-2 and RC-3

**CENTRE PIER**



Centre Pier Core Photograph 2 : Rock core from borehole E10 - RC-1

**CENTRE PIER**



Centre Pier Core Photograph 3: Rock core from borehole E10 - RC-2 and RC-3

**CENTRE PIER**



Centre Pier Core Photograph 4: Rock core from borehole E11 - RC-1 and RC-2

CENTRE PIER



Centre Pier Core Photograph 5: Rock core from borehole E13 - RC-1

CENTRE PIER



Centre Pier Core Photograph 6: Rock core from borehole E13 - RC-2 and RC-3

**EAST ABUTMENT**



East Abutment Core Photograph 1: Rock core from borehole E14 - RC-2

**EAST ABUTMENT**



East Abutment Core Photograph 2: Rock core from borehole E14 - RC-3 and RC-4

**EAST ABUTMENT**



East Abutment Core Photograph 3: Rock core from borehole E16 - RC-5 and RC-6

**EAST ABUTMENT**



East Abutment Core Photograph 4: Rock core from borehole E16 - RC-7

**EAST ABUTMENT**



East Abutment Core Photograph 5: Rock core from borehole E17 - RC-5 and top of RC-6

**EAST ABUTMENT**



East Abutment Core Photograph 6: Rock core from borehole E17, bottom of RC-6, RC-7 and RC-8

**EAST ABUTMENT**



East Abutment Core Photograph 7: Rock core from borehole E19 - RC-7 and RC-8

**EAST ABUTMENT**



East Abutment Core Photograph 8: Rock core from borehole E19 - RC-9



**TABLE 1**  
**LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT**

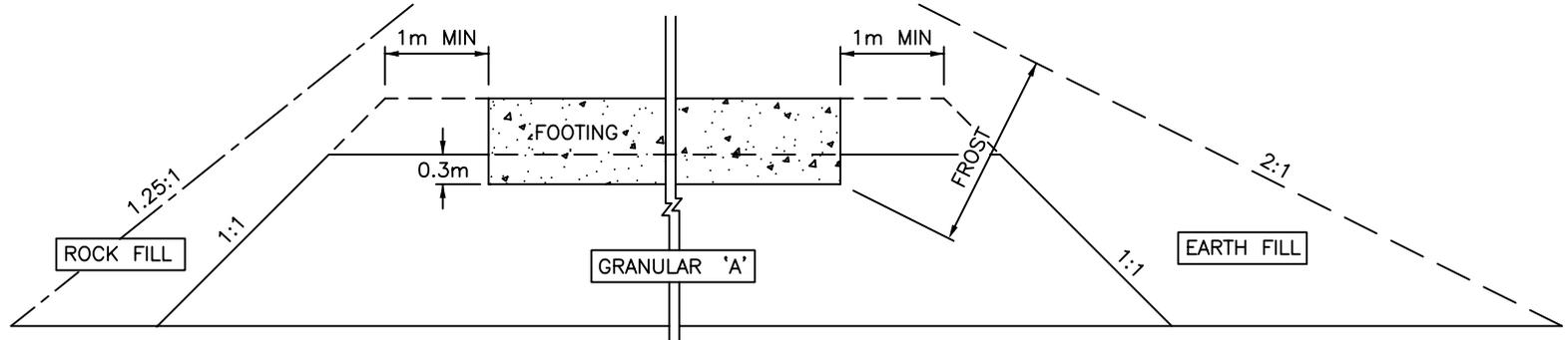
DOCUMENT	
OPSS 120	General Specification for the Use of Explosives
OPSS 501	Construction Specification for Compacting
OPSS 571	Construction Specification for Sodding
OPSS 572	Construction Specification for Seed and Cover
SP 105S10	Construction Specification for Compaction
SP 206S03	Construction Specification for Grading
SP 299F06	Rock Excavation (Controlled Blasting)
SP 405F03	Construction Specification for Pipe Subdrains
SP 599S22	Requirements for The Design, Supply and Construction of Retaining Soil Systems (RSS)
SP 902S01	Excavation and Backfilling of Structures
SP 903S01	Construction Specification for Piling
SP 999S26	Requirements for Design, Installation and Testing of Temporary and Permanent Pre-Stressed Anchors in Soil and Rock
OPSD 201.020	Rock Grading-Divided Rural
OPSD 202.010	Slope Flattening Using Excess Material on Earth or Rock Embankment
OPSD 202.020	Drainage Gap for Slope Flattening on Rock or Granular Embankment
OPSD 203.020	Embankments Over Swamp – Existing Slope Excavated to 1H:1V
OPSD 208.010	Benching of Earth Slopes
OPSD 3101.150	Minimum Granular Backfill Requirements - Abutments
OPSD 3101.200	Rock Backfill Requirements - Abutments
OPSD 3102.100	Walls Abutment Backfill Drain
OPSD 3121.150	Minimum Granular Backfill Requirements - Walls Retaining
OPSD 3190.100	Retaining Wall and Abutment Wall Drain Detail
NRE 98-200	Northeastern Region Directive - Platform Widening
NSSP	Dowels Into Concrete
NSSP	Shear Keys



TABLE 2

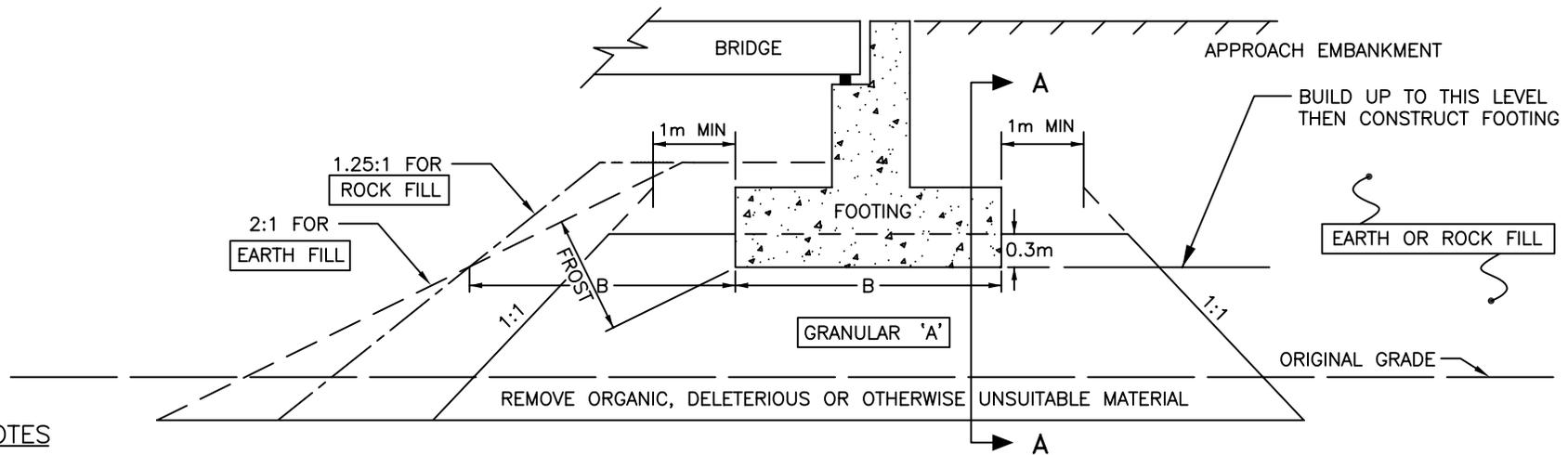
GRADATION SPECIFICATION FOR SAND FILL IN  
PRE-AUGERED HOLES AT INTEGRAL ABUTMENTS

MTO SIEVE DESIGNATION		PERCENTAGE PASSING BY MASS
2 mm	#10	100
600 $\mu\text{m}$	#30	80 – 100
425 $\mu\text{m}$	#40	40 – 80
250 $\mu\text{m}$	#60	5 – 25
150 $\mu\text{m}$	#100	0 – 6



**CROSS SECTION A-A**

NOT TO SCALE



**LONGITUDINAL SECTION**

NOT TO SCALE

**NOTES**

1. CONCEPT SHOWN DOES NOT INCLUDE A MIDHEIGHT BERM.
2. LIMITS OF GRANULAR 'A' CORE TO BE DEFINED BY A SITE SPECIFIC SURVEY.
3. REMOVE ORGANIC, DELETERIOUS OR OTHERWISE UNSUITABLE MATERIAL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH OR ROCK FILL AS NOTED IN TEXT OF REPORT.
4. PLACE GRANULAR 'A' AND EARTH OR ROCK FILL ON APPROVED SUBGRADE TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.O. STANDARDS.
5. CONSTRUCT CONCRETE FOOTING.
6. PLACE REMAINDER OF GRANULAR 'A' AND EARTH OR ROCK FILL INCLUDING MIDHEIGHT BENCHES, AS REQUIRED.
7. REFER TO TEXT OF REPORT FOR FROST DEPTH.

**FIGURE 1: ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE**