Peto MacCallum Ltd.
CONSULTING ENGINEERS

# FOUNDATION INVESTIGATION REPORT

**for**

**SUPPLY POST ROAD OVERPASS NORTHBOUND**
**HIGHWAY 69**
**SITE NO. 44-433, W.P. 5275-05-01**
**DISTRICT 54, SUDBURY, ONTARIO**

***PHASE 2, STA. 10+000 TO 15+070 (TOWNSHIP OF BIGWOOD)***
***STA. 20+300 TO 22+485 (TOWNSHIP OF MOWAT)***

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for
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Site No. 44-433, W.P. 5275-05-01
District 54, Sudbury, Ontario

*Phase 2, Sta. 10+000 to 15+070 (Township of Bigwood)*
*Sta. 20+300 to 22+485 (Township of Mowat)*

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## 1. INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the proposed Supply Post Road Overpass Northbound on the realigned Highway 69 to be located about 70 km south of Sudbury. The investigation was conducted for McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation of Ontario (MTO).

The proposed overpass will carry the new Highway 69 northbound lanes (NBL) over the new Supply Post Road alignment between approximate Sta. 10+161 and 10+175, Township of Mowat.

A previous preliminary foundation investigation was carried out by Peto MacCallum Ltd. (PML) (Ref. No.: 04TF020, dated September 3, 2004). The results from the preliminary foundation investigation carried out by PML included one dynamic cone penetration test, SPR-3, and one borehole, SPR-4.

This report provides subsurface information pertaining to the foundation of the proposed new Highway 69 northbound overpass and approaches within about 20 m of the abutments, between approximate Sta. 10+141 and 10+195.

## 2. SITE DESCRIPTION AND GEOLOGY

The site is located approximately 12 km south of existing Highway 69 and Highway 64 intersection and to about 95 m east of the existing Highway 69. The French River is about 250 m south of the site.

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The local topography is irregular and comprises wooded areas separated by steep rock ridges. The terrain has a general rugged topography with numerous rock outcrops. Soil cover over the rock outcrops is generally sparse.

The site is generally located within a structural subdivision of the Canadian Precambrian Shield identified as the Grenville Province. In particular, the study area traverses the western portion of the Central Gneiss Belt within the Grenville Province wherein pink and grey gneisses are predominant.

## 3. INVESTIGATION PROCEDURES

The field work for the NBL overpass was carried out during the period from January 22 to 25, 2009. Site photographs are shown in Appendix A.

The scope of the subsurface investigation comprised 14 boreholes that were advanced through the soil cover to depths of 0.0 to 4.1 m at the locations shown on Drawing SPN-1, appended. Eight of the boreholes, SP-N3 to SP-N6 and SP-N9 to SP-N12, were cored 3.1 to 3.6 m into the bedrock to depths between 3.5 to 4.6 m.

Borehole SPR-4 was cored 3.0 m into the bedrock to a depth of 3.0 m, elevation 204.9. The preliminary data was included in this investigation.

Callon Dietz inc. staked the alignment of Highway 69 at the structure location. Peto MacCallum Ltd. (PML) selected the positions of the boreholes along the staked alignment and determined the ground surface elevations at the borehole locations. Callon Dietz Inc. provided the following temporary benchmarks (TBM) established on existing ground level for each of the foundation units.

| TBM (BH No.) | DESCRIPTION | ELEVATION (*) |
|---|---|---|
| SP-N7 | Existing ground at N5097955.5; E337051.5 | 208.2 |
| SP-N8 | Existing ground at N5097957.8; E337033.5 | 207.2 |
| SP-N12 | Existing ground at N5097961.0; E337031.5 | 206.9 |
| SP-N13 | Existing ground at N5097968.4; E337043.5 | 207.8 |

(*) Geodetic, metric; BH - Borehole

The boreholes were advanced using continuous flight solid stem augers powered by a track mounted CME-55 rig, equipped for rotary core (NQ size) drilling, supplied and operated by a specialist drilling contractor. The drilling crews worked under the full-time supervision of a member of our engineering staff. The rock photographs are shown in Appendix B.

Representative samples of the soils encountered in the boreholes were recovered at 0.75 m 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/relatively density of the encountered soils was estimated from manual examination or the rate (ease) of advances of the augers.

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 and soil classification. The laboratory test program comprised the following tests:

- Natural moisture content determinations (14)
- Grain size analyses (6)
- Atterberg limits tests (6)
- Organic content (2)

The results of the laboratory natural moisture content determinations, grain size analyses, Atterberg limits, and organic content are shown on the Record of Borehole sheets. The grain size distribution charts are presented on Figures SPN-GS-1 and SPN-GS-2. The Atterberg limits are presented on Figures SPN-PC-1 and SPN-PC-2. The Atterberg limits and corresponding sample natural water content determinations are listed in the appended Table 1.

## 4. SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, bedrock descriptions, inferred stratigraphy, boundary elevations and groundwater observations. Site photographs are included in Appendix A.

The borehole locations and stratigraphic profile and cross-sections prepared from the borehole data are presented on the foundation Drawing SPN-1.

The depth of the soil cover revealed in the boreholes varies from 0.0 (at exposed rock outcrop) to 4.1 m, elevation varying from 203.0 to 207.9. The soil cover at the borehole locations generally comprises topsoil over localized deposits of clayey silt, silty sand and silt mantling bedrock.

### 4.1 Topsoil

A surficial layer of topsoil is present in all boreholes, excluding SP-N4, and extends to 0.3 to 0.6 m depths from ground surface, elevations 206.4 to 207.9. Organic content of two topsoil samples were 5.9 and 9.5%. N values ranged from 1 to 9 with one value of 7 blows per 15 cm penetration where the sampler met refusal on probable bedrock. Two moisture contents obtained were about 40 and 78%.

The topsoil in boreholes SP-N5 to SP-N7 and SP-N12 extended to the probable bedrock. These boreholes were terminated below the topsoil at elevations 206.4 to 207.9.

### 4.2 Clayey Silt / Silty Clay

Cohesive clayey silt layer was encountered below the topsoil layer in boreholes SP-N1, SP-N2, SP-N9, SP-N11, SP-N13 and SP-N14 at 0.3 to 0.6 m depths, elevation varying from 206.7 to 207.3 and extended to 0.7 to 3.0 m depths below ground surface, elevation ranging from 204.1 to 206.6. Excluding borehole SP-N14, the clayey silt layer mantled the bedrock/probable bedrock surface at elevations varying from 205.3 to 206.6.

The consistency of the clayey silt typically ranged from stiff to hard with local very soft zones. Two penetrometer tests obtained 150 and 163 kPa of shear stress values in borehole SP-N14. N values typically ranged from 9 to 45 with local 10 and 12 blows per 10 cm penetration where the sampler was refused on probable bedrock.

A grain size distribution enveloped chart of selected clayey silt samples is presented in Figure SPN-GS-1. The clayey silt comprised 21 to 28% clay, 69 to 76% silt, 3 to 6% sand and 0 to 1% gravel sized materials. The plasticity chart of the clayey silt samples is presented in Figure SPN-PC-1. The Atterberg liquid and plastic limits ranged from 27 to 32 and 18 to 20, respectively, with plasticity index ranging from 7 to 12. Moisture contents determined for clayey silt ranged from about 23 to 31%.

A dynamic cone penetration test was carried out in SPR-3 (PML Ref. No.: 04TF022, dated September 3, 2004), to a 0.6 m depth, elevation 205.8, below ground surface, elevation 206.4, and obtained 120 blows for 0 cm penetration in the probable silty clay zone.

### 4.3 Silt

A localized deposit of 0.6 to 1.1 m thick cohesionless compact silt unit underlain the topsoil layer in boreholes SP-N8 and SP-N10 and below clayey silt layer in borehole SP-N14, extending 0.9 to 4.1 m depth, elevation ranging from 203.0 to 206.8, where the boreholes were terminated on probable bedrock. N values ranged from 11 to 29 with 10 blows per 8 cm penetration and 25 blows per 15 cm penetration where sampler was refused on probable bedrock.

Grain size distribution charts of two silt samples are presented in Figure SPN-GS-2. The silt comprised 14 and 16% clay, 67 and 73% silt, 10 and 16% sand and 0 and 3% gravel sized materials. The plasticity chart of the silt samples is presented in Figure SPN-PC-2. The Atterberg liquid and plastic limits were 22 and 27, and 19 and 24, respectively, with plasticity index of 3. Moisture contents determined for silt ranged from about 11 to 25%.

### 4.4 Silty sand

A localized very dense deposit of cohesionless silty sand was encountered below the topsoil at 300 mm depth, elevation 207.8, in borehole SP-N3 and extends to 500 mm depth, elevation 207.6, which is overlying the bedrock surface. One N value obtained was 37 blows per 15 cm.

### 4.5 Bedrock

The presence and quality of the bedrock underlying the site was checked by extracting NQ-size cores from the rock mass. Where rock cores were not obtained, the bedrock surface was inferred by auger and/or split-spoon sampler refusal.

A detailed description of the rock cores retrieved from boreholes SP-N3 to SP-N6, at the south abutment, and SP-N9 to SP-N12, at the north abutment, is provided in Table A and summarized on the record of borehole logs. Bedrock outcrop was encountered at borehole SP-N4 location, elevation 207.9. The bedrock comprises pink and grey granitic gneiss of high strength and slightly weathered to unweathered condition. The rock is typically unweathered and exhibits high strength.

In the previous investigation, the bedrock surface was encountered at 0.6 m depth (elevation 205.8) and at ground surface (elevation 207.9) in boreholes SPR-3 and SPR-4, respectively. A 3.0 m length of rock core which was retrieved from borehole SPR-4 had a measured core recovery ranging from 95 to 98% and was a high strength and good quality (RQD of 87%) granitic gneiss.

The bedrock surface was encountered at 0.0 to 2.1 m depth, elevation ranging from 205.3 to 207.9 in boreholes SP-S1 to SP-S7 drilled at the south abutment and approach embankment. The following table summarizes the depth of bedrock surface encountered in each borehole:

| LOCATION | BOREHOLE No. | DEPTH (m) | BEDROCK ELEVATION | ROCK CORE LENGTH (m) |
|---|---|---|---|---|
| South Approach | SP-N1 | 2.1 | 205.3 | - |
| South Abutment | SP-N2 | 1.2 | 205.9 | - |
| | SP-N3 | 0.5 | 207.6 | 3.6 |
| | SP-N4 | 0.0 | 207.9 | 3.6 |
| | SP-N5 | 0.4 | 206.6 | 3.1 |
| | SP-N6 | 0.6 | 206.5 | 3.6 |
| | SP-N7 | 0.3 | 207.9 | - |

At the south abutment boreholes, SP-N3 to SP-N6, the bedrock was confirmed by drilling four core holes of varying lengths 3.1 to 3.6 m into the bedrock. These boreholes were drilled from 0.0 to 0.6 m depth, elevations 206.5 to 207.9 m, indicating a maximum bedrock surface relief of 1.4 m between boreholes, and extended to 3.5 to 4.2 m depths below ground surface, elevations 202.9 to 204.3. The slope of the bedrock surface between boreholes ranged from about $2^{o}$ to $20^{o}$.

At the north end of the overpass, bedrock surface was encountered at 0.5 to 4.1 m depths, elevations 203.0 to 206.8. The table below summarizes the depth of bedrock surface encountered in each borehole:

| LOCATION | BOREHOLE No. | DEPTH (m) | BEDROCK ELEVATION | ROCK CORE LENGTH (m) |
|---|---|---|---|---|
| North Abutment | SP-N8 | 0.9 | 206.3 | - |
| | SP-N9 | 1.5 | 205.9 | 3.1 |
| | SP-N10 | 1.1 | 206.8 | 3.2 |
| | SP-N11 | 0.7 | 206.6 | 3.2 |
| | SP-N12 | 0.5 | 206.4 | 3.3 |
| | SP-N13 | 1.4 | 206.4 | - |
| North Approach | SP-N14 | 4.1 | 203.0 | - |

At the north abutment boreholes, SP-N9 to SP-N12, the bedrock was confirmed by drilling four core holes of 3.1 to 3.3 m length. The rock surface elevations 205.9 to 206.8, indicating maximum bedrock surface relief of 0.9 m between boreholes at the abutment location. The slope of the bedrock surface between boreholes ranged from about 2 to 15$^{o}$.

Photographs of the rock cores taken from boreholes SP-N3 to SP-N6 and SP-N9 to SP-N12 are shown on Photographs 1 to 12 in Appendix B.

In the north and south abutments boreholes, the measured core recovery typically varied from 90 to 100%, with two isolated values of 74 and 86% in boreholes SP-N3 and SP-N5, respectively.

The typical range of RQD for south abutment boreholes is between 57 to 100%, indicating fair to excellent rock quality, with exception of the upper poor quality rock in boreholes SP-N3, SP-N5 and SP-N6 having RQD values ranging from 28 to 41%. The RQD determined from the north abutment rock cores SP-N9 to SP-N12, typically ranges from 76 to 96%, indicating good to excellent rock quality, with two isolated values of 73 and 56%, indicating fair quality, for the upper 0.6 to 1.3 m zone of the bedrock in boreholes SP-N10 and SP-N11, respectively.

### 4.6 Groundwater

Groundwater was not established in the cored boreholes SP-N3 to N6, SP-N9 to N12 and SPR-4 because these boreholes were charged with drilling water. No groundwater was observed in the remaining boreholes, SP-N1, N2, N7, N8, N13 and N14, during and upon completion of drilling. The groundwater is subject to fluctuations at the site due to seasonal conditions and rainfall patterns.

## 5. CLOSURE

The field work was carried out under the supervision of Frank Portela, Senior Technician, and direction of Mr. C. M. P. Nascimento, P.Eng., Senior Project Engineer. Walker Drilling Co. Ltd. supplied the soil and rock drilling equipment.

The report was prepared by Mr. C. M. P. Nascimento, P.Eng. with the assistance of Mr. N. Rahman, BASc and reviewed by 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.


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


Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

CN/BRG/nr-mi

# TABLE 1

## Atterberg Limits

| SOIL TYPE | BOREOLE NO. | SAMPLE NO. | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | MOISTURE CONTENT (%) |
|---|---|---|---|---|---|---|
| Clayey Silt | SP-N1 | 3 | 28 | 19 | 9 | 26 |
| | SP-N2 | 2 | 32 | 20 | 12 | 28 |
| | SP-N14 | 2 | 28 | 18 | 10 | 23 |
| | SP-N14 | 4 | 27 | 20 | 7 | 31 |
| Silt | SP-N10 | 4 | 27 | 24 | 3 | 25 |
| | SP-N14 | 5 | 22 | 19 | 3 | 11 |

# TABLE 2

## ROCK CORE DESCRIPTION

| CORE RECOVERY | | | | | CORE DESCRIPTION | |
|---|---|---|---|---|---|---|
| **HOLE NO.** | **CORE NO.** | **DEPTH (m)** | **RECOVERY (%)** | **RQD (%)** | **DEPTH (m)** | **DESCRIPTION** |
| SP-N3 | 2<br>3<br>4 | 0.5 – 1.4<br>1.4 – 3.0<br>3.0 – 4.1 | 74<br>97<br>99 | 28<br>94<br>99 | 0.5 – 4.1 | GRANITIC GNEISS: Pink and grey with slight banding, fine to medium grained, high strength, slightly weathered to unweathered, very close to close spaced flat cross joints with intersecting vertical fissures to 1.4 m depth, becoming moderate to wide spaced flat cross joints, rough planar, tight to slightly altered with green or red oxidation on partings, poor becoming excellent quality. |
| SP-N4 | 1<br>2<br>3 | 0.0 – 1.6<br>1.6 – 2.8<br>2.8 – 3.6 | 100<br>96<br>91 | 100<br>57<br>91 | 0.0 – 3.6 | GRANITIC GNEISS: Pink and grey with slight banding, fine to medium grained, high strength, slightly weathered to unweathered, close to moderate spaced flat cross joints, rough planar, tight to slightly altered with white scale on partings, locally separating on black biotite seams, with vertical parting at 2.3 to 2.8 m depth, rough planar, with red oxidation and/or silt on parting, fair to excellent quality. |
| SP-N5 | 1<br>2<br>3 | 0.4 – 1.2<br>1.2 – 2.6<br>2.6 – 3.5 | 94<br>95<br>86 | 41<br>75<br>86 | 0.4 - 3.5 | GRANITIC GNEISS: Pink and grey with slight banding, fine to medium grained, high strength, unweathered, close spaced (locally multiple) dipping to vertical cross joints to 2.6 m depth, rough planar, tight to slightly altered with red oxidation on partings, occasionally separates on biotite concentrations, close to moderate spaced flat cross joints, rough planar, tight, poor to good quality. |
| SP-N6 | 1<br>2<br>3 | 0.6 – 1.5<br>1.5 – 3.0<br>3.0 – 4.2 | 94<br>97<br>98 | 29<br>97<br>93 | 0.6 – 4.2 | GRANITIC GNEISS: Pink and grey with slight banding, fine to medium grained, high strength, unweathered, close to moderate (locally wide) spaced flat cross joints, smooth to rough planar, generally tight, locally slightly altered with brown oxidation on partings, with close spaced vertical partings to 1.6 m depth, rough planar, tight, poor becoming excellent quality. |

NOTE: RQD = Rock Quality Designation

Originated: FP
Compiled: PML
Checked: CN

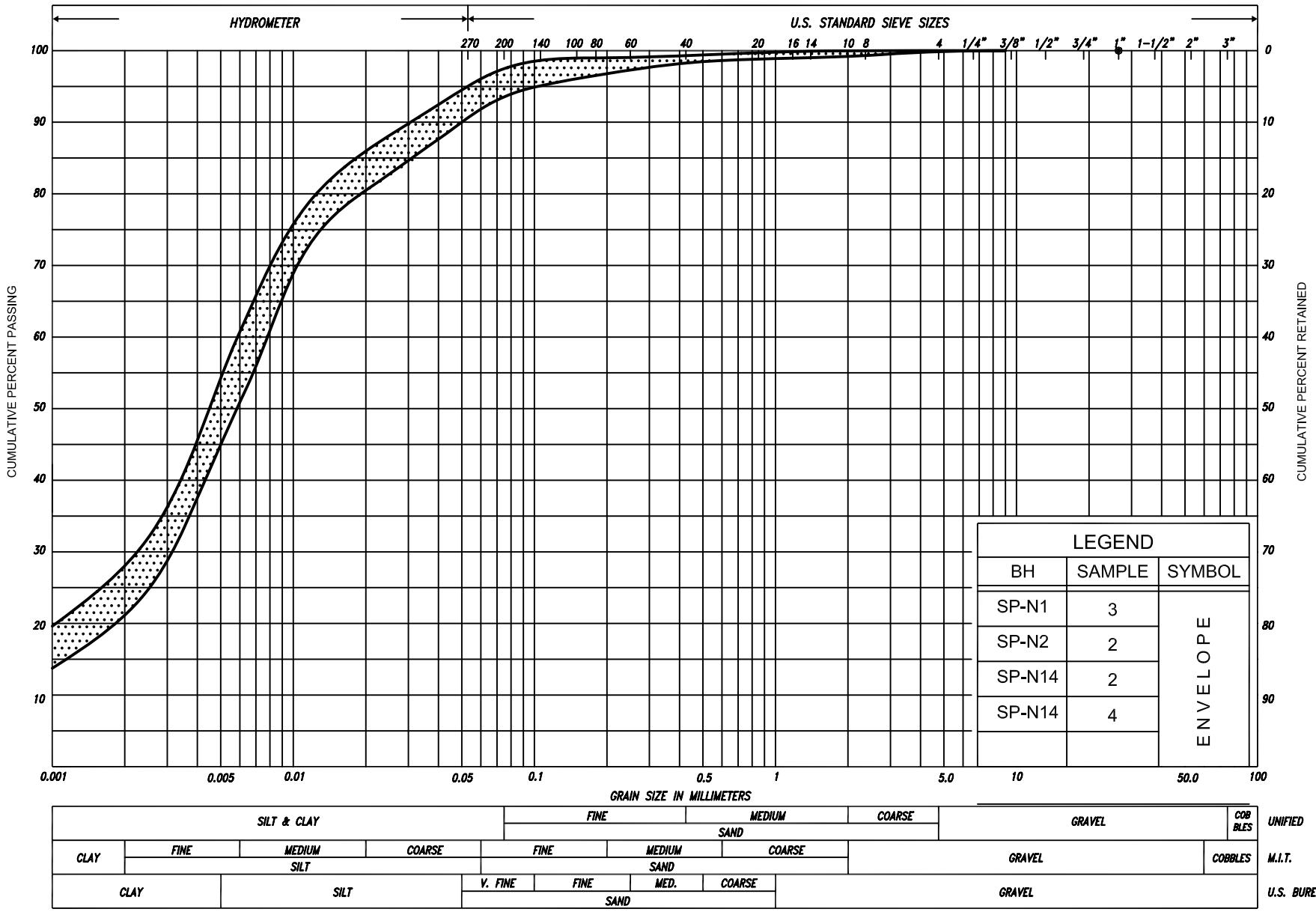
# TABLE 2

## ROCK CORE DESCRIPTION

| HOLE NO. | CORE RECOVERY | | | | CORE DESCRIPTION | |
|---|---|---|---|---|---|---|
| | CORE NO. | DEPTH (m) | RECOVERY (%) | RQD (%) | DEPTH (m) | DESCRIPTION |
| SP-N9 | 3<br>4<br>5 | 1.5 – 3.0<br>3.0 – 3.9<br>3.9 – 4.6 | 92<br>100<br>100 | 79<br>89<br>96 | 1.5 – 4.6 | GRANITIC GNEISS: Pink and grey with slight banding, fine to medium grained, high strength, unweathered, moderate spaced vertical partings to 3.4 m depth, rough planar, slightly altered with red or brown oxidation on partings, occasionally separates on biotite concentrations, close to moderate spaced flat cross joints, rough planar, tight, good to excellent quality. |
| SP-N10 | 3<br>4<br>5 | 1.1 – 2.6<br>2.6 – 2.9<br>2.9 – 4.3 | 96<br>95<br>100 | 73<br>95<br>88 | 1.1 – 4.3 | GRANITIC GNEISS: Pink and grey with slight banding, changing to pink with black biotite concentrations, fine to medium grained, high strength, slightly weathered to unweathered, very close to close becoming close to moderate spaced flat cross joints, rough planar, tight, with moderate spaced vertical cross joints, rough planar, tight to slightly altered with red oxidation and/or white/light grey scale on parting, fair to excellent quality. |
| SP-N11 | 2<br>3<br>4 | 0.7 – 0.9<br>0.9 – 2.5<br>2.5 – 3.9 | 94<br>94<br>92 | 56<br>94<br>83 | 0.7 - 3.9 | GRANITIC GNEISS: Pink and grey with occasional pink bands, fine to medium grained, high strength, unweathered, close to moderate (locally very close) spaced flat to dipping cross joints, rough planar, tight to slightly altered with red oxidation on partings, fair to excellent quality. |
| SP-N12 | 1<br>2<br>3 | 0.5 – 1.4<br>1.4 – 2.9<br>2.9 – 3.8 | 90<br>97<br>100 | 80<br>76<br>91 | 0.5 - 3.8 | GRANITIC GNEISS: Pink and grey with slight banding, occasional 10 mm thick dark layers, fine to medium grained (locally coarse grained at depth), high strength, unweathered, close to moderate spaced flat to dipping cross joints, occasional vertical, rough planar, tight to slightly altered with red or brown oxidation on partings, good to excellent quality. |

NOTE: RQD = Rock Quality Designation

| | |
|---|---|
| Originated: | FP |
| Compiled: | PML |
| Checked: | CN |

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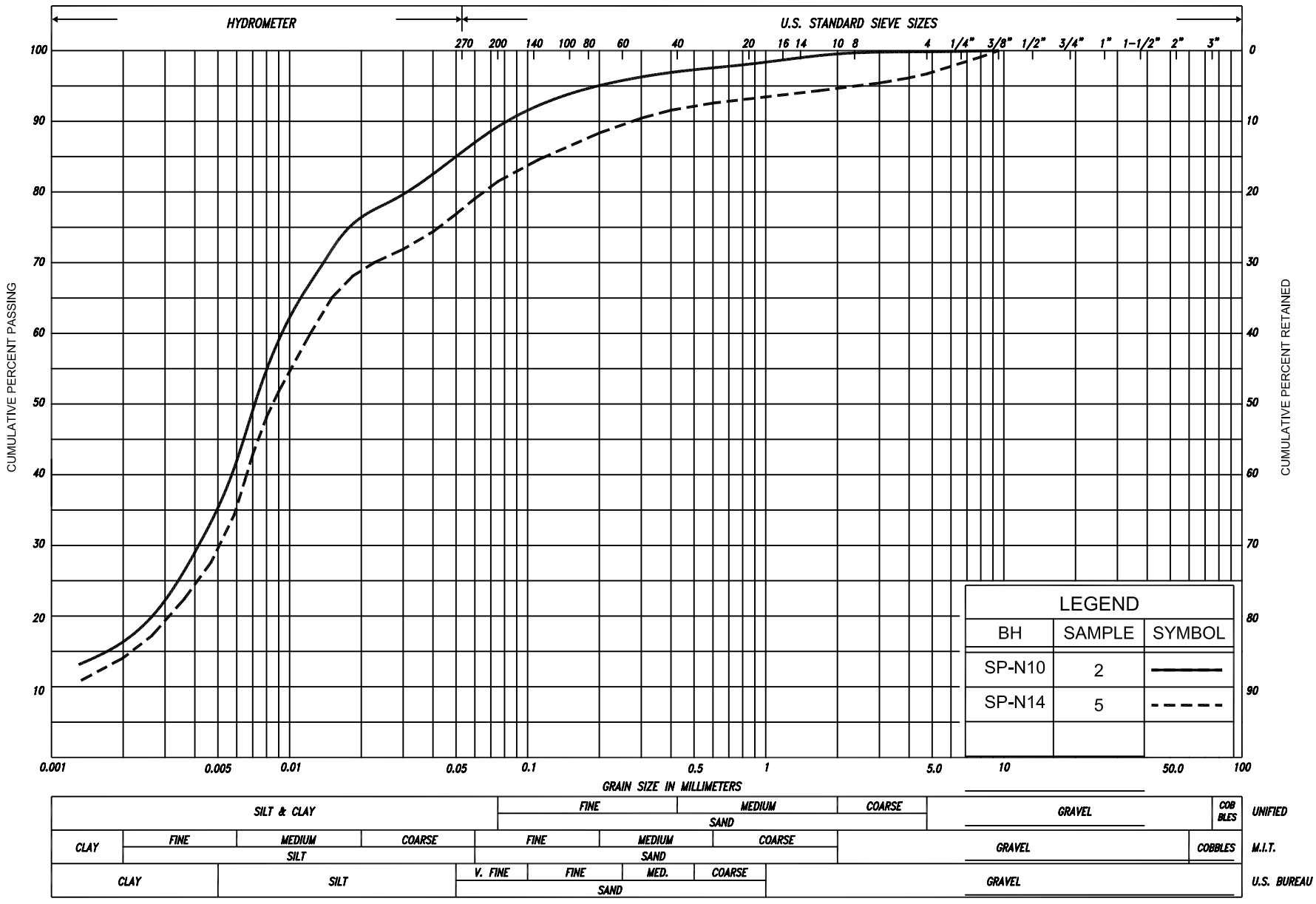
# GRAIN SIZE DISTRIBUTION

CLAYEY SILT, trace sand, trace gravel

| | |
|---|---|
| FIG No. | SPN-GS-1 |
| HWY: | 69 |
| W.P. No. | 5275-05-01 |

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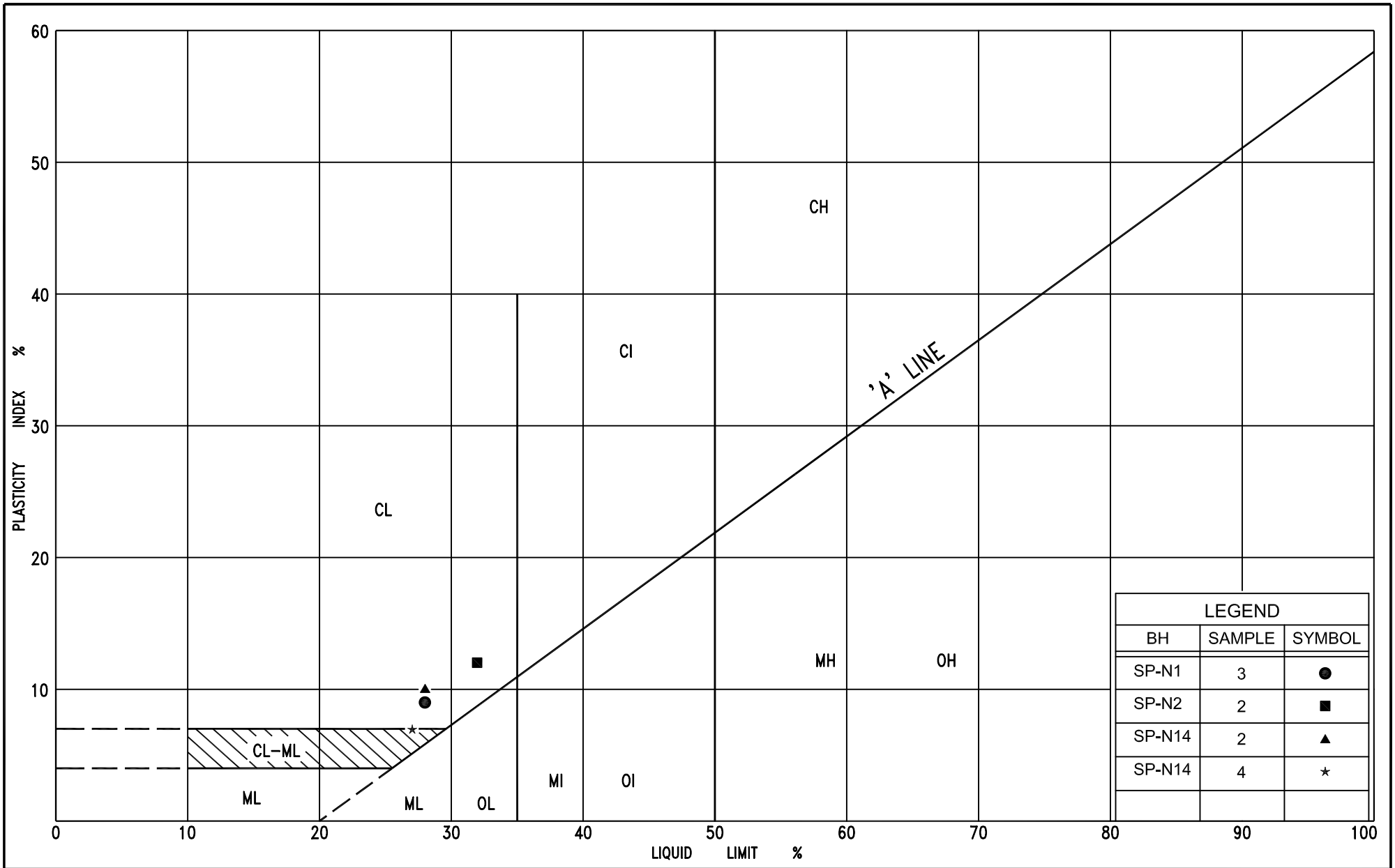
# GRAIN SIZE DISTRIBUTION

SILT, some clay, some sand, trace gravel

| | |
|---|---|
| FIG No. | SPN-GS-2 |
| HWY: | 69 |
| W.P. No. | 5275-05-01 |

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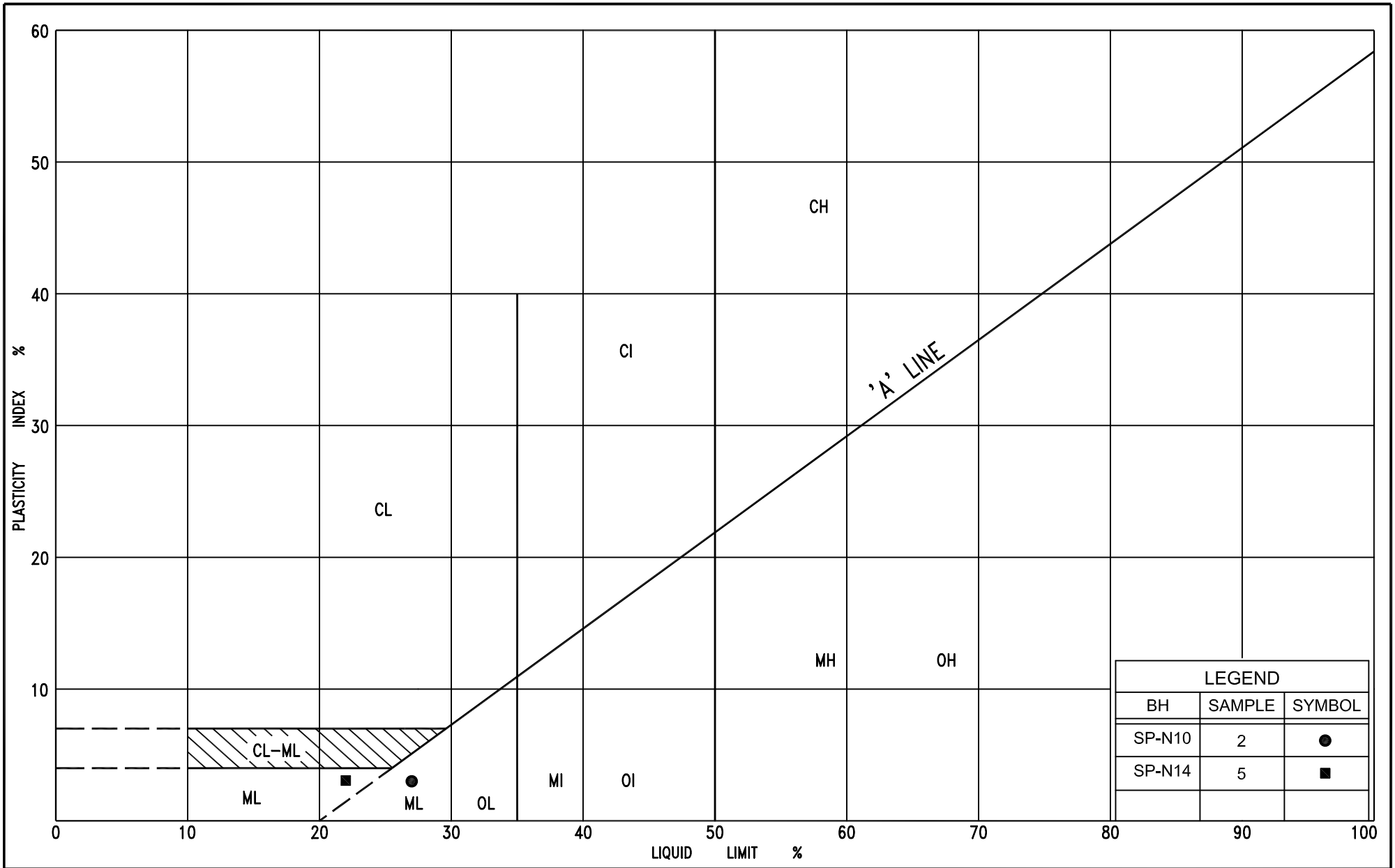
# PLASTICITY CHART

CLAYEY SILT, trace sand, trace gravel

| | |
|---|---|
| FIG No. | SPN-PC-1 |
| HWY: | 69 |
| W.P. No. | 5275-05-01 |

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# PLASTICITY CHART

SILT, some clay, some sand, trace gravel

| | |
|---|---|
| FIG No. | SPN-PC-2 |
| HWY: | 69 |
| W.P. No. | 5275-05-01 |

# 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 $\tilde{N}$.

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

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# RECORD OF BOREHOLE No SP-N1 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 933.6 N; 337 056.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.R.

DATUM Geodetic DATE January 25, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 207.4 | Ground Surface | | | | | | | | | | |
| 0.0 / 207.1 | Topsoil | | 1 | SS | 12 | | 207 | | ○ | | |
| 0.3 | Clayey silt<br>trace sand, trace gravel<br>Stiff to Brown Moist<br>hard | | 2 | SS | 23 | | 206 | | ○ | | |
| 205.3 | | | 3 | SS | 45 | | | | ⊖ | | 1 5 69 25 |
| 2.1 | End of borehole<br>Refusal on probable bedrock<br><br>* Borehole dry | | | | | | | | | | |



+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N2 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 944.8 N; 337 041.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.R.

DATUM Geodetic DATE January 25, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 207.1 | Ground Surface | | | | | * | | | | | |
| 0.0 / 206.7 | Topsoil | | 1 | SS | 9 | | 207 | | | | |
| 0.4 | Clayey silt trace sand, trace gravel | | | | | | | | | | |
| 205.9 | Stiff to hard Brown Moist | | 2 | SS | 10/10cm | | 206 | | | | 0 3 69 28 |
| 1.2 | End of borehole | | | | | | | | | | |
| | Refusal on probable bedrock | | | | | | | | | | |
| | Sample 2: Sampler bouncing | | | | | | | | | | |
| | * Borehole dry | | | | | | | | | | |



+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N3 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 952.3 N; 337 053.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. AND NW CORE COMPILED BY N.R.

DATUM Geodetic DATE January 22, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT w / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | * | | | | | GR SA SI CL |
| 208.1 | Ground Surface | | | | | | | | | | |
| 0.0 / 207.8 | Topsoil | | 1 | SS | 37/15cm | | 208 | | | | |
| 0.3 | Silty sand, trace gravel | | | | | | | | | | |
| 207.6 / 0.5 | Very dense Brown Moist | | 2 | RC NQ | REC 74% | | | | | | RQD 28% |
| | Granitic Gneiss bedrock | | | | | | 207 | | | | |
| | Slightly weathered to unweathered | | | | | | | | | | |
| | High strength | | | | | | | | | | |
| | Poor becoming excellent quality | | 3 | RC NQ | REC 97% | | 206 | | | | RQD 94% |
| | | | | | | | 205 | | | | |
| | | | 4 | RC NQ | REC 99% | | | | | | RQD 99% |
| 204.0 | | | | | | | 204 | | | | |
| 4.1 | End of borehole | | | | | | | | | | |

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers



+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N4 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 950.6 N; 337 046.0 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE NW CORE COMPILED BY N.R.

DATUM Geodetic DATE January 22, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | * | | | | | GR SA SI CL |
| 207.9 | Ground Surface | | | | | | | | | | |
| 0.0 | Granitic Gneiss bedrock<br>High strength<br>Slightly weathered to unweathered<br>Fair to excellent quality | | 1 | RC NQ | REC 100% | | 207 | | | | RQD 100% |
| | | | 2 | RC NQ | REC 96% | | 206 | | | | RQD 57% |
| | | | 3 | RC NQ | REC 91% | | 205 | | | | RQD 91% |
| 204.3 | | | | | | | | | | | |
| 3.6 | End of borehole | | | | | | | | | | |

* Borehole charged with drilling water



+7, ×5: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N5 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 948.1 N; 337 039.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. AND NW CORE COMPILED BY N.R.

DATUM Geodetic DATE January 23, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | * | | | | | GR SA SI CL |
| 207.0 | Ground Surface | | | | | | | | | | |
| 0.0 / 206.6 | Topsoil | | | | | | | | | | |
| 0.4 | Granitic Gneiss bedrock<br>High strength<br>Unweathered<br>Poor to good quality | | 1 | RC NQ | REC 94% | | 206 | | | | RQD 41% |
| | | | 2 | RC NQ | REC 95% | | 205 | | | | RQD 75% |
| 203.5 | | | 3 | RC NQ | REC 86% | | 204 | | | | RQD 86% |
| 3.5 | End of borehole | | | | | | | | | | |

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers



+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N6 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 949.7 N; 337 042.1 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. AND NW CORE COMPILED BY N.R.

DATUM Geodetic DATE January 23, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | * | | | | | GR SA SI CL |
| 207.1 | Ground Surface | | | | | | | | | | |
| 0.0 / 206.5 | Topsoil | | | | | | 207 | | | | |
| 0.6 | Granitic Gneiss bedrock<br>High strength<br>Unweathered<br>Poor becoming excellent quality | | 1 | RC NQ | REC 94% | | 206 | | | | RQD 29% |
| | | | 2 | RC NQ | REC 97% | | 205 | | | | RQD 97% |
| | | | 3 | RC NQ | REC 98% | | 204 | | | | RQD 93% |
| 202.9 | | | | | | | 203 | | | | |
| 4.2 | End of borehole | | | | | | | | | | |

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers



+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N7 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 955.5 N; 337 051.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.R.

DATUM Geodetic DATE January 25, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 208.2 | Ground Surface | | | | | | | | | | |
| 0.0 / 207.9 | Topsoil | | 1 | SS | 7/15cm | | 208 | | | | |
| 0.3 | End of borehole<br>Refusal on probable bedrock | | | | | | | | | | |
| | Sample 1: Sampler bouncing | | | | | | | | | | |
| | * Borehole dry | | | | | | | | | | |



+7, ×5: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N8 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 957.8 N; 337 033.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.R.

DATUM Geodetic DATE January 25, 2009 CHECKED BY C.N.

| SOIL PROFILE | | | SAMPLES | | | 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 207.2 | Ground Surface | | | | | | | | | | |
| 0.0 / 206.9 | Topsoil | | 1 | SS | 11 | | 207 | | ○ | | |
| 0.3 | Silt trace clay, trace sand | | | | | | | | | | |
| 206.3 | Compact Brown Moist | | 2 | SS | 10/8cm | | | | | | |
| 0.9 | End of borehole | | | | | | | | | | |

Refusal on probable bedrock

Sample 2: Sampler bouncing

* Borehole dry



+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N9 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 963.3 N; 337 042.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. AND NW CORE COMPILED BY N.R.

DATUM Geodetic DATE January 25, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 207.4 | Ground Surface | | | | | | | | | | |
| 0.0 / 206.8 | Topsoil | | 1 | SS | 1 | | 207 | | | | |
| 0.6 / 205.9 | Clayey silt trace sand, trace gravel<br>Very soft Mottled Moist grey/brown | | 2 | SS | 1 | | 206 | | | | |
| 1.5 | Granitic Gneiss bedrock<br>High strength<br>Unweathered<br>Good to excellent quality | | 3 | RC NQ | REC 92% | | 205 | | | | RQD 79% |
| | | | 4 | RC NQ | REC 100% | | 204 | | | | RQD 89% |
| 202.8 | | | 5 | RC NQ | REC 100% | | 203 | | | | RQD 96% |
| 4.6 | End of borehole | | | | | | | | | | |

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers



+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N10 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 965.2 N; 337 045.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. AND NW CORE COMPILED BY N.R.

DATUM Geodetic DATE January 25, 2009 CHECKED BY C.N.

| 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 (20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 207.9 | Ground Surface | | | | | | | | | | |
| 0.0 / 207.6 | Topsoil | | 1 | SS | 3 | | | | ○ | | Org. 5.9% |
| 0.3 | Silt, some clay some sand, trace gravel | | | | | | | | | | |
| 206.8 | Compact Grey/brown Moist | | 2 | SS | 22 | | 207 | | H | | 1 10 73 16 |
| 1.1 | Granitic Gneiss bedrock<br>High strength<br>Slightly weathered to unweathered<br>Fair to excellent quality | | 3 | RC NQ | REC 96% | | 206 | | | | RQD 73% |
| | | | 4 | RC NQ | REC 95% | | 205 | | | | RQD 95% |
| | | | 5 | RC NQ | REC 100% | | 204 | | | | RQD 88% |
| 203.6 | | | | | | | | | | | |
| 4.3 | End of borehole | | | | | | | | | | |

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers



+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N11 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 962.5 N; 337 038.6 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. AND NW CORE COMPILED BY N.R.

DATUM Geodetic DATE January 23, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 207.3 | Ground Surface | | | | | | | | | | |
| 0.0 / 207.0 | Topsoil | | 1 | SS | 1 | | 207 | | | | |
| 0.3 / 206.6 | Clayey silt trace sand, trace gravel | | | | | | | | | | |
| 0.7 | Very soft Mottled Moist grey/brown | | 2 | RC NQ | REC 94% | | | | | | RQD 56% |
| | Granitic Gneiss bedrock<br>High strength<br>Unweathered<br>Fair to excellent quality | | 3 | RC NQ | REC 94% | | 206<br>205 | | | | RQD 94% |
| 203.4 | | | 4 | RC NQ | REC 92% | | 204 | | | | RQD 83% |
| 3.9 | End of borehole | | | | | | | | | | |

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers



+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N12 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 961.0 N; 337 031.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE C.F.S.S.A. AND NW CORE COMPILED BY N.R.

DATUM Geodetic DATE January 23, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | * | | | | | GR SA SI CL |
| 206.9 | Ground Surface | | | | | | | | | | |
| 0.0 / 206.4 | Topsoil | | | | | | | | | | |
| 0.5 | Granitic Gneiss bedrock<br>High strength<br>Unweathered<br>Good to excellent quality | | 1 | RC NQ | REC 90% | | 206 | | | | RQD 80% |
| | | | 2 | RC NQ | REC 97% | | 205 | | | | RQD 76% |
| | | | 3 | RC NQ | REC 100% | | 204 | | | | RQD 91% |
| 203.1 | | | | | | | | | | | |
| 3.8 | End of borehole | | | | | | | | | | |

* Borehole charged with drilling water

C.F.S.S.A. denotes Continuous Flight Solid Stem Augers



+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

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Foundation Design

# RECORD OF BOREHOLE No SP-N13 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 968.4 N; 337 043.5 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.R.

DATUM Geodetic DATE January 25, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 207.8 | Ground Surface | | | | | | | | | | |
| 0.0 / 207.3 | Topsoil | | 1 | SS | 2 | | | | | | Org. 9.5% |
| 0.5 | Clayey silt<br>trace sand, trace gravel<br>Hard Mottled grey/ brown Moist | | 2 | SS | 12/10cm | | 207 | | | | |
| 206.4 / 1.4 | End of borehole<br>Refusal on probable bedrock | | | | | | | | | | |

* Borehole dry



+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SP-N14 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Coords: 5 097 979.5 N; 337 028.1 E ORIGINATED BY F.P.

DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.R.

DATUM Geodetic DATE January 25, 2009 CHECKED BY C.N.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 207.1 | Ground Surface | | | | | * | 207 | | | | |
| 0.0 / 206.8 | Topsoil | | 1 | SS | 9 | | | | | | |
| 0.3 | Clayey silt, trace sand<br>Stiff to very stiff Mottled grey/brown Moist to wet | | 2 | SS | 16 | | 206 | | | | 0 6 70 24 |
| | | | 3 | SS | 18 | | 205 | 163 | | | |
| 204.1 | | | 4 | SS | 10 | | | 150 | | | 0 3 76 21 |
| 3.0 | Silt, some sand some clay, trace gravel<br>Compact Brown Moist to wet | | 5 | SS | 29 | | 204 | | | | 3 16 67 14 |
| 203.0 | | | 6 | SS | 25/15cm | | 203 | | | | |
| 4.1 | End of borehole<br>Refusal on probable bedrock<br><br>* Borehole dry | | | | | | | | | | |



+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF PENETRATION TEST No SPR-3 1 of 1 METRIC

Supply Post Road Overpass

W.P. 5275-05-01 LOCATION Co-ords. 5 097 952 N; 337 036 E ORIGINATED BY M.R.

DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY M.R.

DATUM Geodetic DATE May 28, 2004 CHECKED BY D.W.K.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | | | | GR SA SI CL |
| 206.4 | Ground Surface | | | | | | | | | | |
| 0.0 | Possible silty clay | | | | | | 206 | | | | |
| 205.8 | | | | | | | | | | | |
| 0.6 | End of dynamic cone penetration test<br>Refusal on probable bedrock | | | | | | | 120/0cm | | | |



+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No SPR-4 1 of 1 METRIC

W.P. 5275-05-01 LOCATION Supply Post Road Overpass Co-ords. 5 097 961 N; 337 049 E ORIGINATED BY M.R.

DIST 54 HWY 69 BOREHOLE TYPE NQ Rock Coring COMPILED BY M.R.

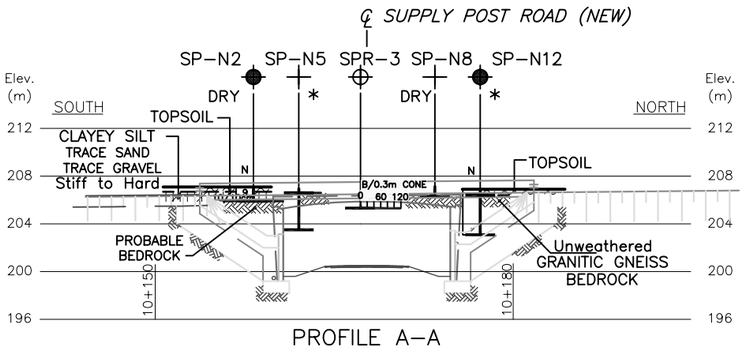
DATUM Geodetic DATE May 28, 2004 CHECKED BY D.W.K.

| 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 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT $\gamma$ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | * | | | | | GR SA SI CL |
| 207.9 | Ground Surface | | | | | | | | | | |
| 0.0 | Bedrock<br>Granitic Gneiss<br>High strength<br>Good quality | | 1 | RC NQ | REC 98% | | 207 | | | | RQD 87% |
| | | | 2 | RC NQ | REC 95% | | 206 | | | | RQD 87% |
| 204.9 | | | | | | | 205 | | | | |
| 3.0 | End of borehole<br>Borehole charged with drilling water | | | | | | | | | | |

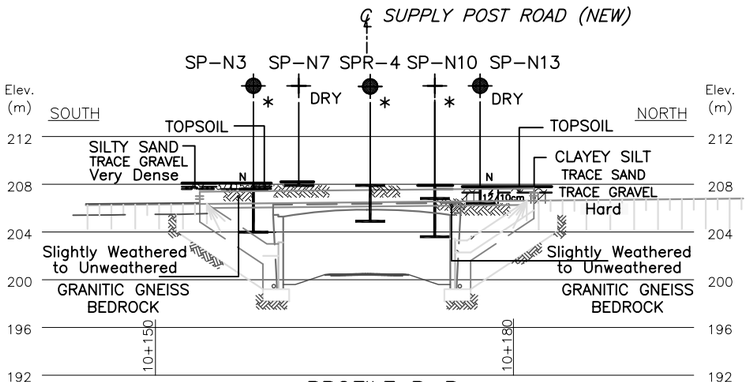
ON_MOT VER 3A 06TF032D_NBL.GPJ ON_MOT.GDT 8/25/2009 2:42:29 PM

+7 , ×5 : Numbers refer to Sensitivity

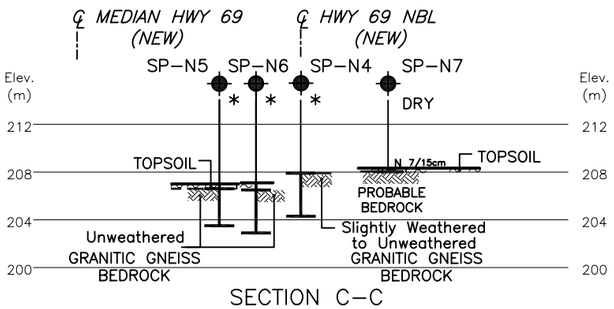
20 / 15 5 / 10 (%) STRAIN AT FAILURE



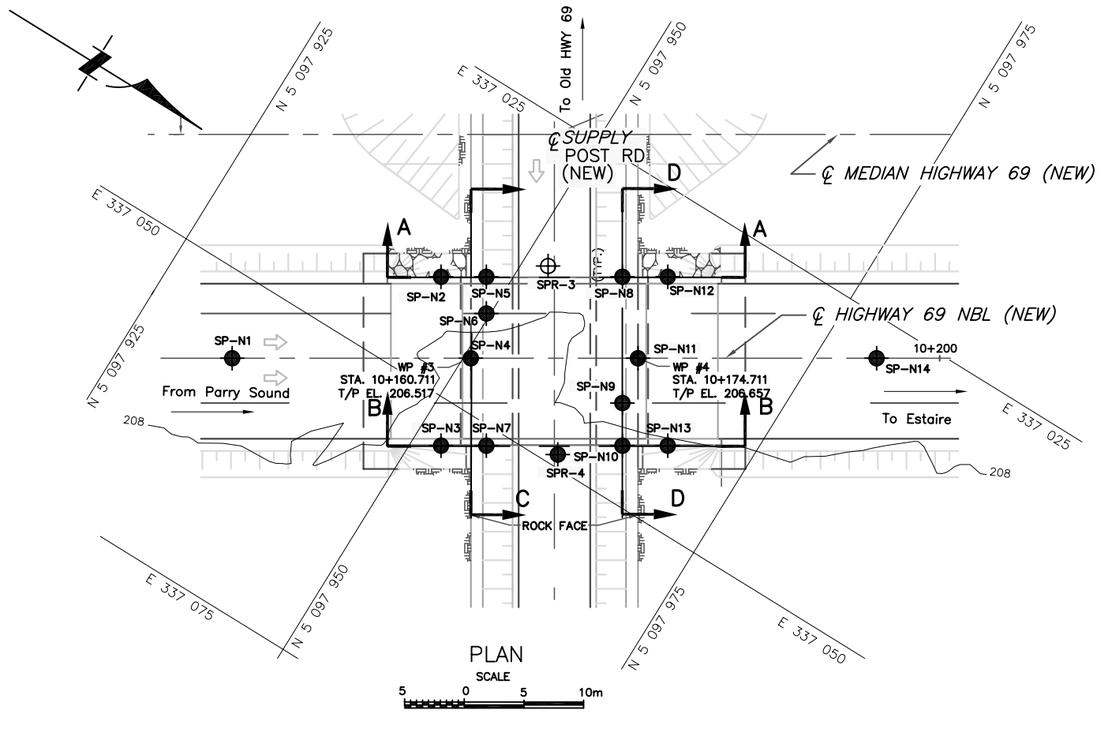

PROFILE A–A




PROFILE B–B

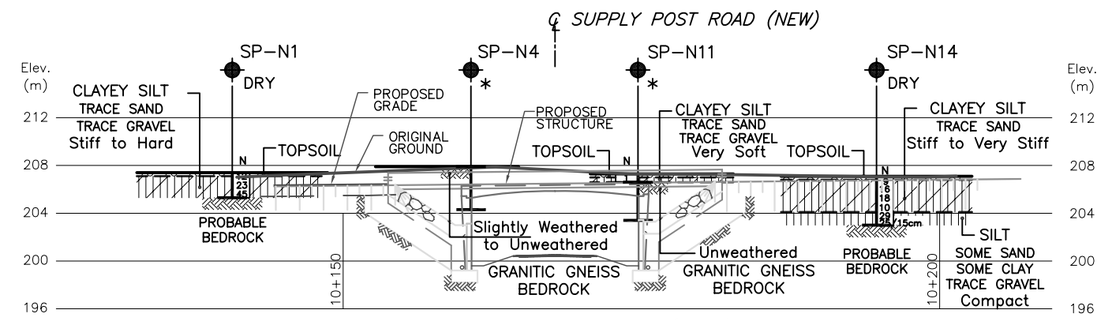



SECTION C–C

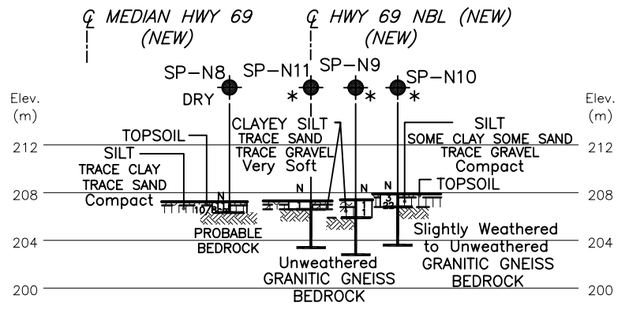



PLAN

SCALE
5 0 5 10m




PROFILE ℄ HWY 69 NBL (NEW)




SECTION D–D

SCALE
5 0 5 10m

NOTES:

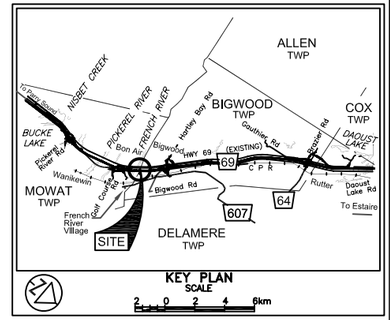
1. THE DRAWING SPN–1 SHOULD BE READ IN CONJUNCTION WITH THE TEXT AND THE RECORD OF BOREHOLE LOGS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
3. BOREHOLES SPR–3 AND SPR–4 WERE DRILLED FOR THE PRELIMINARY INVESTIGATION IN 2004.
4. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.

CONT No
WP No 5275–05–01

SUPPLY POST ROAD NB OVERPASS
HIGHWAY 69
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS




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 Jan 2009; May 2004 (SPR–4)
- * W L not established
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

| BH No | ELEVATION | CO–ORDINATES NORTHINGS | CO–ORDINATES EASTINGS |
|---|---|---|---|
| SP–N1 | 207.4 | 5 097 933.6 | 337 056.5 |
| SP–N2 | 207.1 | 5 097 944.8 | 337 041.5 |
| SP–N3 | 208.1 | 5 097 952.3 | 337 053.5 |
| SP–N4 | 207.9 | 5 097 950.6 | 337 046.0 |
| SP–N5 | 207.0 | 5 097 948.1 | 337 039.5 |
| SP–N6 | 207.1 | 5 097 949.7 | 337 042.1 |
| SP–N7 | 208.2 | 5 097 955.5 | 337 051.5 |
| SP–N8 | 207.2 | 5 097 957.8 | 337 033.5 |
| SP–N9 | 207.4 | 5 097 963.3 | 337 042.5 |
| SP–N10 | 207.9 | 5 097 965.2 | 337 045.5 |
| SP–N11 | 207.3 | 5 097 962.5 | 337 038.6 |
| SP–N12 | 206.9 | 5 097 961.0 | 337 031.5 |
| SP–N13 | 207.8 | 5 097 968.4 | 337 043.5 |
| SP–N14 | 207.1 | 5 097 979.5 | 337 028.1 |
| SPR–3 | 206.4 | 5 097 952.0 | 337 036.0 |
| SPR–4 | 207.9 | 5 097 961.0 | 337 049.0 |

REGISTERED PROFESSIONAL ENGINEER C M P Nascimento Aug. 26, PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER B. R. GRAY Aug. 26, 20 PROVINCE OF ONTARIO

REF No. MRC Drawing; S6454–324–001GA.dwg; dated July 2008 (Modified on February 17, 2009)

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

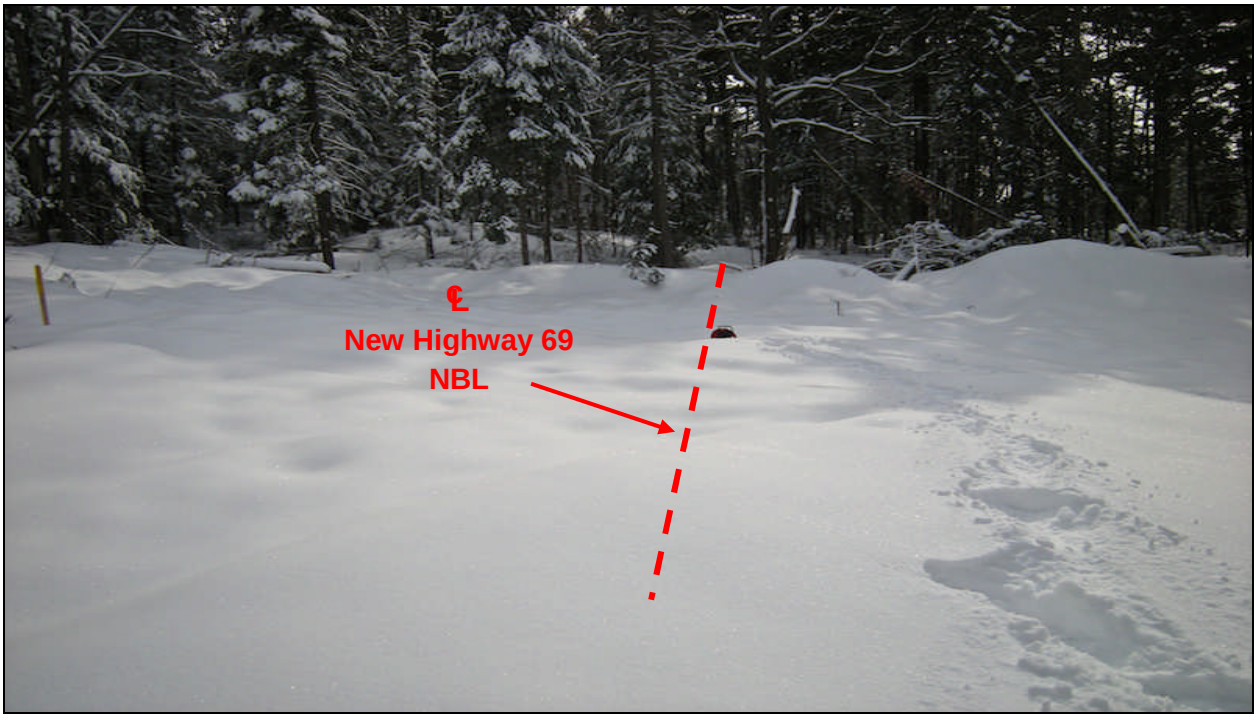
| REVISIONS | DATE | BY | DESCRIPTION |
|---|---|---|---|
| | | | |

Geocres No. 41I–237

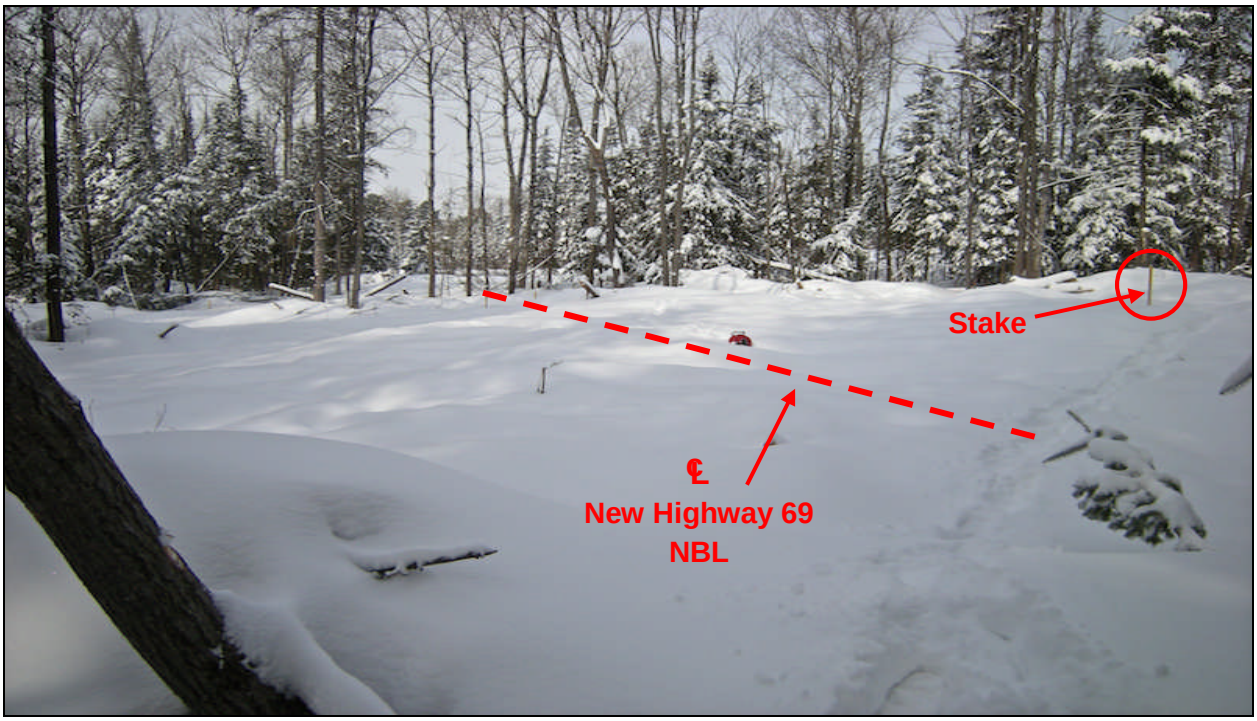
| | | | | | |
|---|---|---|---|---|---|
| HWY No | 69 | | | DIST | 54 |
| SUBM'D | NR | CHECKED | NR | DATE AUG. 26, 2009 | SITE 44–433 |
| DRAWN | NA | CHECKED | CN | APPROVED BRG | DWG SPN–1 |

# APPENDIX A

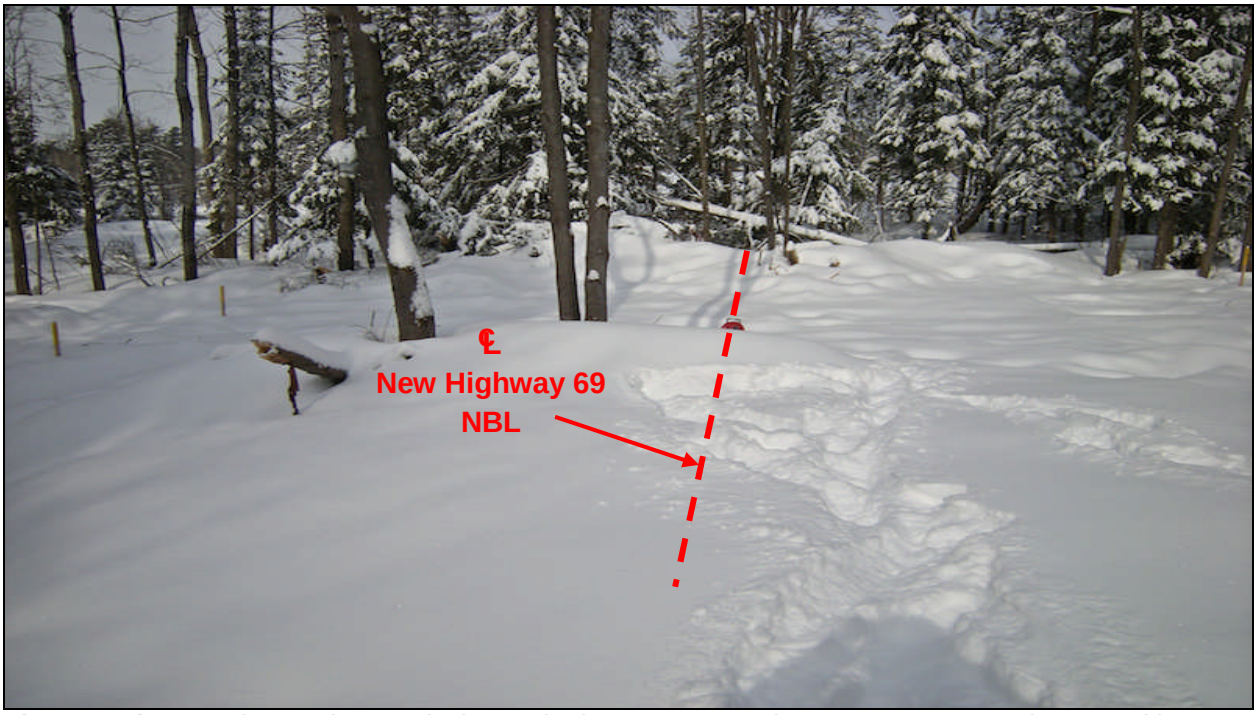
Site Photographs



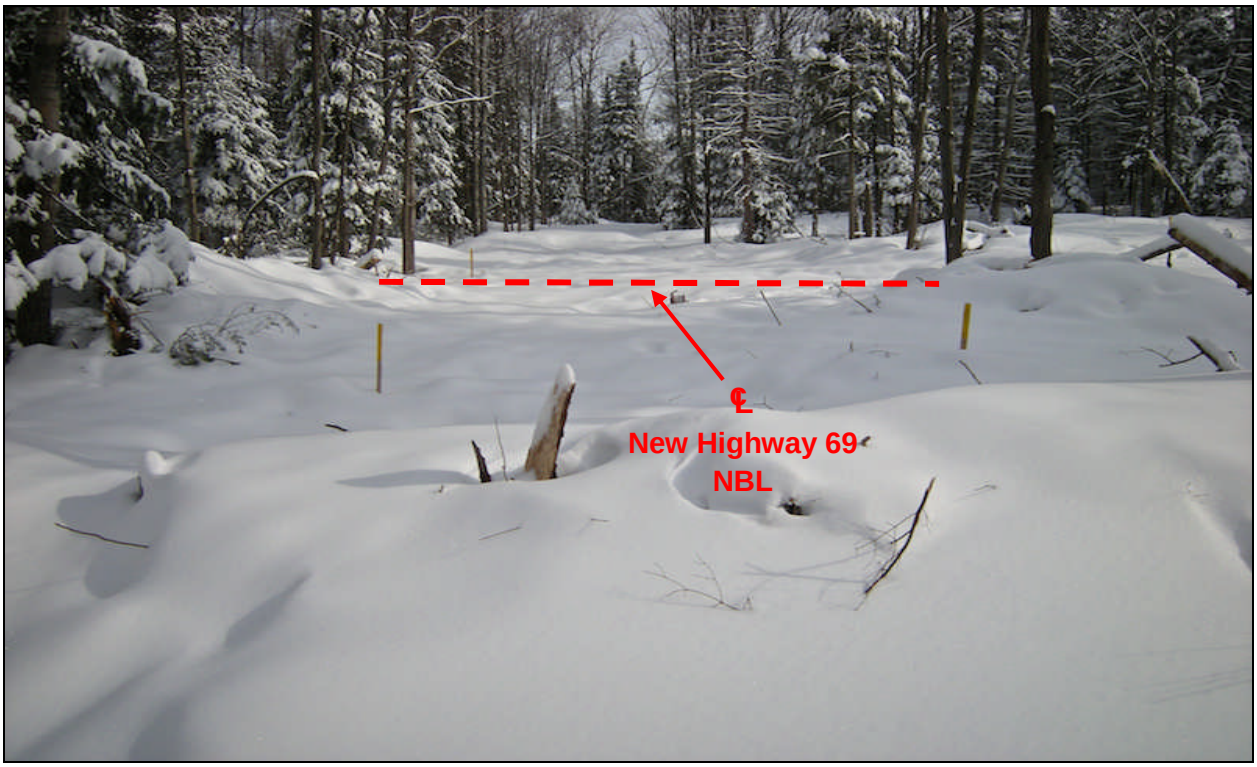

**Photograph 1**: Looking south towards the south abutment, approximate Sta. 10+161. The ground is covered in snow. Wooded area in view of the background of the photograph. Note that the red water level meter has been placed in the middle of the south abutment. (February, 2009)



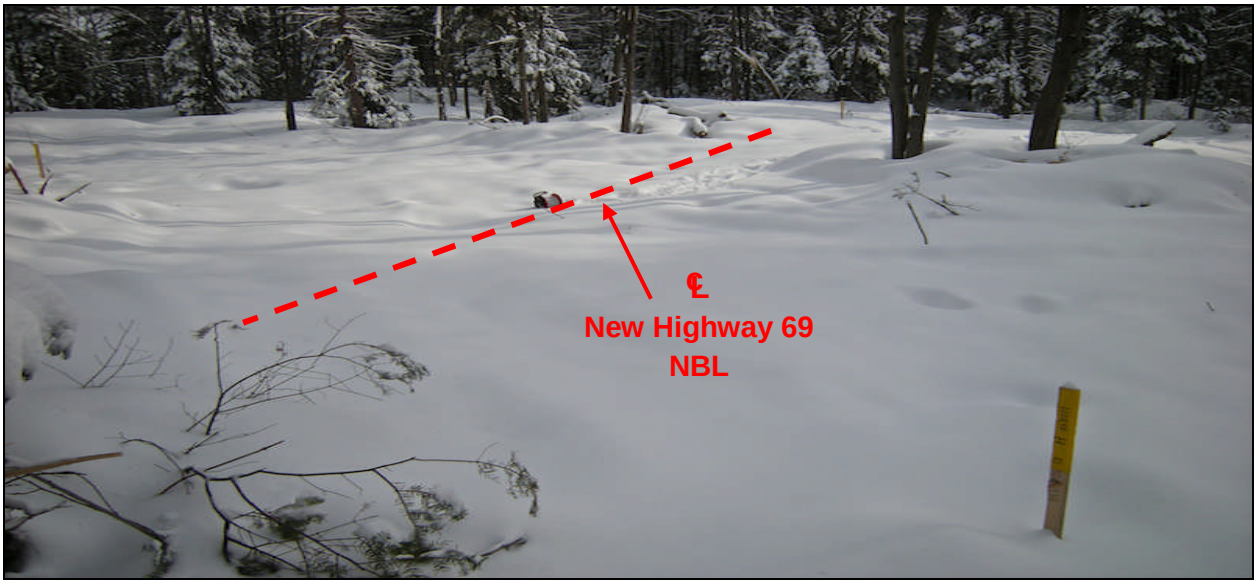

**Photograph 2**: Looking northeast towards the south abutment, approximate Sta. 10+161. The ground is covered in snow. Looking at the wooded area in the background of the photograph. Note that the red water level meter has been placed in the middle of the south abutment. (February, 2009)




**Photograph 3**: Facing north towards the north abutment, approximate Sta. 10+175. The ground is covered in snow. Lightly dense wooded area in view of the background of the photograph. Note that the red water level meter has been placed in the middle of the north abutment. (February, 2009)




**Photograph 4**: Looking east towards the north abutment, approximate Sta. 10+175. The ground is covered in snow. Wooded areas flanking an open area on both sides. Note that the red water level meter has been placed in the middle of the north abutment. (February, 2009)

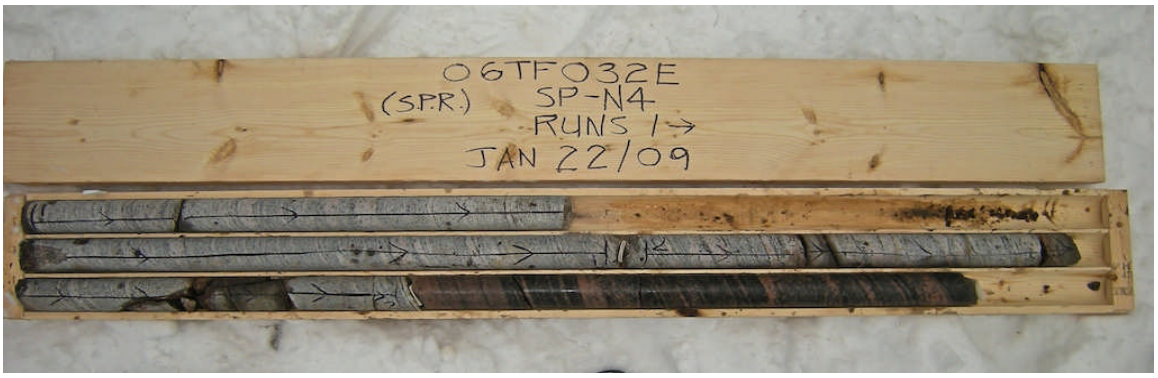



**Photograph 5**: Viewing southeast towards the north abutment, approximate Sta. 10+175. The ground is covered in snow. Densely wooded area in view in the background of the photo. Note that the red water level meter has been placed in the middle of the north abutment. (February, 2009)

# APPENDIX B

Rock Core Photographs

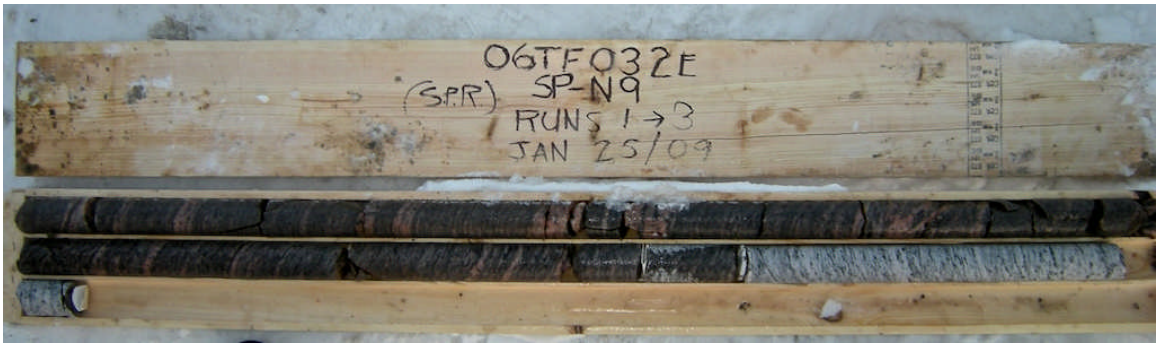

**Photograph 1**: Rock cores retrieved from borehole SP-N3. Samples RC-2 to RC-4.



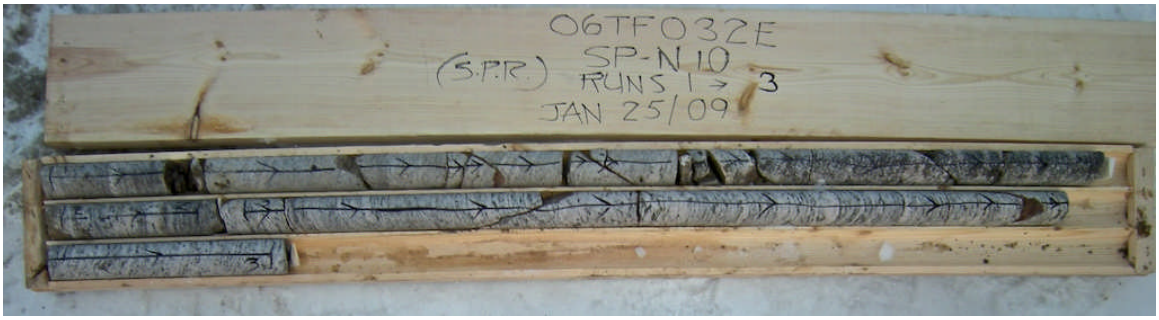

**Photograph 2**: Rock cores retrieved from borehole SP-N4. Samples RC-1 to RC-3.


**Photograph 3**: Rock cores retrieved from borehole SP-N5. Samples RC-1 to RC-3.


**Photograph 4**: Rock cores retrieved from borehole SP-N6. Samples RC-1 to RC-3.




**Photograph 5**: Rock cores retrieved from borehole SP-N9. Samples RC-3 to RC-5.




**Photograph 6**: Rock cores retrieved from borehole SP-N10. Samples RC-3 to RC-5.


**Photograph 7**: Rock cores retrieved from borehole SP-N11. Samples RC-2 to RC-4.


**Photograph 8**: Rock cores retrieved from borehole SP-N12. Sample RC-1 to RC-3.