

**FOUNDATION INVESTIGATION AND DESIGN REPORT
STRAWBERRY CREEK BRIDGE 2 REHABILITATION
HIGHWAY 102
THUNDER BAY DISTRICT, ONTARIO**

G.W.P. 6073-09-00, SITE NO. 48W-2

Geocres Number: 52A-186

Report to:

MMM GROUP LIMITED

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the existing Strawberry Creek Bridge 2 along Highway 102, in the District of Thunder Bay, Ontario.

The purpose of this investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, records of boreholes, stratigraphic profile and cross-sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited, under the Ministry of Transportation Ontario (MTO) Agreement Number 6010-E-0011.

2 SITE DESCRIPTION

The existing Strawberry Creek Bridge 2 is located on Highway 102 in the community of Kaministiquia, approximately 6 km east of the intersection of Highways 102 and 11/17, and 25 km northwest of Thunder Bay. The existing bridge is a single-span structure with a concrete deck and steel girders supported on concrete abutments and steel H-piles. The bridge spans a length of approximately 21.3 m and is 11 m wide.

Strawberry Creek flows from south to north at this bridge site, but flows in an overall northeast to southwest direction in the area crossing Highway 102 at three locations before draining into the Kaministiquia River. The creek channel is approximately 10 m wide and 1.5 m deep at the site. The surrounding lands are heavily wooded with occasional clearings for some residential and commercial usage along the highway. An active gravel pit is located approximately 500 m to the east.

Photographs in Appendix C show the general nature of the site and the existing bridge.

The site lies within the physiographic region known as the Wawa Subprovince of the Superior Province of the Canadian Shield. The soil deposits in the area comprise glaciofluvial outwash gravel. Bedrock at depth is formed of mafic to metavolcanic rocks.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between July 16 and 21, 2013 and consisted of drilling and sampling four boreholes, identified as Boreholes SBC2-01 to SBC2-04, through the highway embankment in the area of the existing west and east abutments and approaches. Boreholes SBC2-02 and SBC2-03 were drilled near the abutments to depths of 27.6 to 29.4 m, and Boreholes SBC2-01 and SBC2-04 were drilled through the approach embankments to depths of 9.8 m.

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix E.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling. The coordinates and ground surface elevations for the boreholes were derived from topographic plans provided to Thurber by MMM Group Limited.

A truck-mounted CME 75 drill rig was used to advance the boreholes using NW casing/wash boring techniques. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). Dynamic Cone Penetration Tests (DCPTs) were conducted adjacent to Boreholes SBC2-02 and SBC2-03 on completion of drilling.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transporting to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Groundwater conditions observed after completion of drilling were not representative of site conditions as water was used during wash boring operations. Standpipe piezometers were installed in two boreholes to monitor the groundwater level after drilling. The piezometers were subsequently decommissioned and the boreholes without piezometers were backfilled in general accordance with MOE Regulation 903. Completion details of the piezometers and boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

| Foundation Unit | Boreholes | Piezometer Tip Depth/ Elevation (m) | Completion Details |
|------------------------|------------------|--|--|
| West Approach | SBC2-01 | None installed | Borehole backfilled with bentonite holeplug from 9.8 m to 0.15 m, then asphalt to surface. |
| West Abutment | SBC2-02 | 27.3/ 291.5 | Sand from 27.6 m to 23.2 m, bentonite holeplug from 23.2 m to 0.5 m, sand from 0.5 m to 0.15 m, then asphalt to surface. |
| East Abutment | SBC2-03 | 28.5/ 290.2 | Sand from 29.4 m to 24.4 m, bentonite holeplug from 24.4 m to 0.15 m, then asphalt to surface. |
| East Approach | SBC2-04 | None installed | Borehole backfilled with bentonite holeplug from 9.8 m to 0.15 m, then asphalt to surface. |

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and Atterberg Limits tests. The results of this testing program are summarized on the Record of Borehole sheets included in Appendix A and on the figures presented in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented in these sheets and on the “Borehole Locations and Soil Strata” drawing included in Appendix E. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond the borehole locations.

The soil stratigraphy typically comprises a gravelly sand to sand and gravel embankment fill, underlain by native sand and gravel over sand. More detailed descriptions of the individual strata are presented below.

5.1 Asphalt and Concrete

Asphalt was encountered in all the boreholes, which were drilled from the existing Highway 102 roadway. The asphalt layer was 125 mm thick at the four borehole locations. A concrete slab (125 to 250 mm thick) with steel rebar was encountered below the asphalt in Boreholes SBC2-02 and SBC2-03 near the bridge abutments.

5.2 Embankment Fill

The existing highway embankment fill beneath the asphalt typically comprised a brown sand and gravel ranging to sandy gravel and containing trace silt and occasional cobbles. The lower

portion of the embankment fill at the bridge approaches (below 2.3 to 2.6 m depth at Boreholes SBC2-01 and SBC2-04) transitioned to clayey sand with some silt and trace gravel. The embankment fill has a total thickness of 3.9 to 4.3 m with a lower boundary at depths of 4.0 to 4.6 m (Elev. 314.7 to 314.1).

SPT 'N' values recorded in the sand and gravel fill typically ranged from 14 to 53 blows per 0.3 m penetration, indicating a compact to very dense relative density. The clayey sand fill was loose to compact, based on SPT 'N' values of 4 to 13 blows per 0.3 m penetration.

Measured moisture contents of the fill ranged from 1% to 12% in the sand and gravel and from 20% to 50% in the clayey sand.

The results of grain size analysis tests conducted on the embankment fill are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are shown on Figures B1 and B2 of Appendix B.

Sandy Gravel to Sand and Gravel Fill:

| | |
|---------------|----------|
| Gravel % | 54 to 78 |
| Sand % | 21 to 42 |
| Silt & Clay % | 1 to 5 |

Clayey Sand Fill:

| | |
|----------|----------|
| Gravel % | 0 to 1 |
| Sand % | 50 to 53 |
| Silt % | 14 to 17 |
| Clay % | 32 to 35 |

Atterberg Limits testing conducted on one sample of the clayey sand indicate that the fill has intermediate plasticity, with a group symbol of CI. The results are plotted on Figure B5 of Appendix B.

5.3 Sand and Gravel

A native deposit of brown to grey sand and gravel containing occasional cobbles and boulders and trace to some silt was encountered below the embankment fill in Boreholes SBC2-01, SBC2-02 and SBC2-03. Where fully penetrated, the sand and gravel deposit had a thickness of 13.7 and 7.6 m, with lower boundary at depths of 18.3 and 12.2 m (Elev. 300.5 and 306.5). Borehole SBC2-01 was terminated within the sand and gravel deposit at a depth of 9.8 m (Elev. 309.0).

SPT 'N' values obtained in the sand and gravel ranged from 14 blows for 0.3 m penetration to 50 blows for 0.05 m penetration, indicating a compact to very dense relative density. Measured moisture contents ranged from 8% to 16%.

Selected samples of sand and gravel underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are shown on Figure B3 of Appendix B.

| | |
|---------------|----------|
| Gravel % | 44 to 56 |
| Sand % | 38 to 50 |
| Silt & Clay % | 3 to 14 |

5.4 Sand

A native deposit of brown sand with trace to some gravel, trace silt to silty and occasional cobbles and boulders was encountered below the sand and gravel in Boreholes SBC2-02 and SBC2-03, and below the embankment fill in Borehole SBC2-04. The boreholes were each terminated within the sand deposit at depths of 9.8 to 29.4 m (Elev. 308.8 to 289.3).

SPT 'N' values obtained in the sand typically ranged from 17 blows for 0.3 m penetration to 100 blows for 0.025 m penetration, indicating a compact to very dense relative density. A loose zone with 'N' values of 8 and 6 blows for 0.3 m penetration was encountered between 13.0 and 16.0 m depths in Borehole SBC2-03. Measured moisture contents ranged from 14% to 35%.

Selected samples of the sand underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are shown on Figure B4 of Appendix B.

| | |
|---------------|----------|
| Gravel % | 0 to 19 |
| Sand % | 70 to 94 |
| Silt & Clay % | 4 to 30 |

5.5 Water Levels

Where possible, water levels were monitored in the open boreholes during drilling operations. Wash boring methods were used to advance the boreholes and therefore water levels recorded during or upon completion of drilling may not reflect natural groundwater levels. Standpipe piezometers were installed in two boreholes to monitor the groundwater level after completion. The water levels observed in the open boreholes upon completion and measured in the piezometers are summarized in Table 5.1.

Table 5.1 – Water Level Measurements

| Borehole | Date | Water Level | | Comment |
|----------|----------------|-------------|-----------|---------------|
| | | Depth (m) | Elev. (m) | |
| SBC2-02 | July 21, 2013 | 4.7 | 314.1 | Open Borehole |
| | August 1, 2013 | 5.3 | 313.5 | In piezometer |
| | May 2, 2014 | 3.6 | 315.2 | In piezometer |
| SBC2-03 | July 19, 2013 | 4.6 | 314.1 | Open borehole |
| | August 1, 2013 | 5.0 | 313.7 | In piezometer |
| | May 2, 2014 | 3.7 | 315.0 | In piezometer |

The preliminary General Arrangement drawings provided by MMM Group Limited indicates a water level at approximate Elev. 314.5 in Strawberry Creek in February 1972. In general, the groundwater level is expected to be at or slightly above the water level in the creek.

The above values are short-term readings and seasonal fluctuations of the groundwater and creek level are to be expected. In particular, the water levels may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. The coordinates and the ground surface elevations for the boreholes were established based on topographic survey information provided by MMM Group Limited.

Thurber obtained utility clearances for the borehole locations prior to drilling.

Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied a truck-mounted CME-75 drill rig and conducted the drilling, sampling and in-situ testing operations for the boreholes. The drilling operations were supervised by Ms. Eckie Siu of Thurber.

Overall supervision of the field program, interpretation of the data, and preparation of the report were carried out by Mr. Mark Farrant P.Eng.

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

Thurber Engineering Ltd.

Mark Farrant, M.Eng., P.Eng.
Geotechnical Engineer



Murray R. Anderson, M.Eng., P.Eng.
Senior Foundations Engineer



Dr. P.K. Chatterji, P.Eng.
Review Principal



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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the geotechnical data in the factual report and provides geotechnical recommendations for the proposed rehabilitation of the existing Strawberry Creek Bridge 2 on Highway 102, in the District of Thunder Bay, Ontario.

At present, the bridge carries Highway 102 over Strawberry Creek on a single-span structure with a span length of 21.3 m and a deck width of 11 m. Archive drawings dated May 1973 indicate that the existing bridge abutments are supported on two rows of battered steel HP310x79 piles driven to a design load of 70 tons (700 kN) per pile based on the Hiley Formula. The existing approach fill heights above the surrounding ground are approximately 3 m at both abutments.

Based on the GA drawing dated August 2014, rehabilitation of the bridge will consist of replacement of the existing deck slab with a new precast concrete deck. The rehabilitation will include modification of the tops of the abutments and wingwalls, and replacement of the approach slabs. Grade raises of 120 mm and 170 mm are proposed at the west and east approaches, respectively. Widening of the bridge deck is not proposed.

The discussion and recommendations presented in this report are based on the information provided by MMM Group Limited and on the factual data obtained in the course of the investigation.

8 ASSESSMENT OF EXISTING ABUTMENT FOUNDATIONS

The subsurface stratigraphy encountered at this site generally consists of sand and gravel fill to clayey sand fill underlain by a layer of compact to very dense native sand and gravel overlying loose to very dense sand. The fill and native deposits contain occasional cobbles and boulders. Bedrock

was not encountered within the drilling depths of 27.6 and 29.4 m (Elev. 291.2 and 289.3) at the abutments.

The archive drawings for the existing bridge indicate that each abutment is supported on ten HP310x79 piles battered at inclinations varying from 1H: 4V to 1H: 6V. Pile lengths of 25.3 and 27.4 m are indicated for the west and east abutment, respectively. The pile caps are 760 mm thick with a top at elevation 314.9 m, and the top of pile is embedded 300 mm into the bottom of the pile cap.

Assuming installation of the full length of supplied pile, the design pile tip levels would be at approximate elevation 289.4 to 289.9 at the west abutment and elevation 287.3 to 287.8 m at the east abutment. Pile driving records were not available to confirm the actual pile tip elevations as driven. Based on the borehole data, it is likely that the piles were driven into very dense sand encountered below approximate elevations 295 and 292 m at the west and east abutments, respectively.

As the depth of pile penetration cannot be confirmed and the design allowable pile capacity for pile driving was 700 kN per pile, it is recommended that resistances of 1,000 kN per pile at factored ULS and 800 kN per pile at SLS be employed to assess the capability of the existing piles to support the rehabilitated bridge loads.

It is understood from MMM that the loads on the foundations may be increased slightly (less than 10% of the existing load) due to the deck replacement. Supporting the new deck on the existing pile foundations is therefore considered to be acceptable from a geotechnical viewpoint. The Structural Designer must verify that the structural capacity of the existing foundations is adequate to carry the foundation loads.

Resistance to lateral loads will be provided by the horizontal component of the batter piles.

In view of the cohesionless soil conditions at this site, downdrag on the piles due to the slight grade raise is not an issue.

The design depth of frost penetration at this site is 2.2 m. Existing pile caps constructed over the native sand and gravel are not considered to be susceptible to frost action.

9 ABUTMENT BACKFILL AND LATERAL EARTH PRESSURES

Any new backfill behind the modified abutment and wing walls should be placed in accordance with OPSS 902. All backfill material should consist of Granular A, Granular B Type II or Granular B Type III material meeting the specifications of OPSS.PROV 1010. Compaction equipment to be used adjacent to the walls should be restricted in accordance with OPSS 501.

Lateral earth pressures acting on the abutment walls may be assumed to be distributed triangularly and to be governed by the characteristics of the wall backfill. For a fully drained condition, the pressures should be computed in accordance with the CHBDC but generally are given by the expression:

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

Where:

- p_h = horizontal pressure on the wall at depth h (kPa)
- K = earth pressure coefficient (see Table 9.1)
- γ = unit weight of retained soil (see Table 9.1)
- h = depth below top of fill where pressure is computed (m)
- q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the abutment wall are dependent on the material used as backfill and the existing material adjacent to the wall. Typical values are given in Table 9.1.

Table 9.1 – Earth Pressure Coefficients (K)

| Condition | OPSS Granular A or Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$ | | OPSS Granular B Type I, Granular B Type III or Existing Granular Fill $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$ | |
|----------------------------|---|-----------------------------|--|-----------------------------|
| | Horizontal Surface Behind Wall | Sloping Backfill (2H:1V) | Horizontal Surface Behind Wall | Sloping Backfill (2H:1V) |
| Active (Unrestrained Wall) | 0.27 | 0.38* | 0.31 | 0.46* |
| At Rest (Restrained Wall) | 0.43 | - | 0.47 | - |
| Passive | 3.7 | - | 3.3 | - |

* For wing walls.

The use of a material with a high friction angle and low active pressure coefficient (Granular A, Granular B Type II) is preferred as it results in lower earth pressures acting on the wall.

The earth pressure coefficients in Table 9.1 are “ultimate” values and require certain movements for the respective conditions to be mobilized. The values to use in design may be estimated from Figure C6.16 in the Commentary to the Canadian Highway Bridge Design Code.

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or III, or at a depth of 1.7 m for Granular A or Granular B Type II.

10 SEISMIC CONSIDERATIONS

The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 0
- Zonal Velocity Ratio 0.0
- Acceleration Related Seismic Zone 0
- Zonal Acceleration Ratio 0.0
- Peak Horizontal Acceleration 0.036

The soil profile type at this site has been classified as Type I. Therefore, according to Table 4.4 of the CHBDC, a Site Coefficient “S” (ground motion amplification factor) of 1.0 should be used in seismic design.

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading. The coefficients of horizontal earth pressure for seismic loading presented in Table 10.1 may be used.

Based on review of the SPT data, the foundation soils at this site are assessed as not being prone to liquefaction.

Table 10.1 – Earth Pressure Coefficients for Earthquake Loading (K_E)

| Conditions | OPSS Granular A or Granular B Type II $\phi = 35^\circ; \gamma = 22.8 \text{ kN/m}^3$ | | OPSS Granular B Type I or Existing Granular Fill $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$ | |
|------------------------|---|-----------------------------|--|-----------------------------|
| | Horizontal Surface Behind Wall | Sloping Backfill (2H:1V) | Horizontal Surface Behind Wall | Sloping Backfill (2H:1V) |
| Active (K_{AE})* | 0.28 | 0.42 | 0.32 | 0.51 |
| Passive (K_{PE}) | 3.6 | - | 3.2 | - |
| At Rest (K_{OE})** | 0.47 | - | 0.52 | - |

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.

** After Woods

11 SCOUR AND EROSION CONTROL

Erosion protection must be provided along any soil surfaces that may be in contact with the river flow. In particular, erosion should be provided along the toe of the embankment slopes where not protected by wingwalls.

A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion, in general accordance with OPSS 804.

12 EXCAVATION AND GROUNDWATER CONTROL

Excavation to carry out modifications to the existing abutments is expected to be limited to the existing granular embankment fill above the river and groundwater levels. Based on the preliminary General Arrangement drawing provided by MMM, the depth of excavation at the abutments is anticipated to be less than 1.5 m below the existing grade.

All excavations must be carried out in accordance with OPSS 902 and the requirements of the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the approach fill within the depth of excavation may be classed as Type 3 soil above the water table.

The selection of the method of excavation is the responsibility of the Contractor and must be based on his equipment, experience and interpretation of the site conditions. It is anticipated that a

hydraulic excavator will be suitable. Provision must be made for the handling of pavement materials, potential obstructions in the fill, and cobbles and boulders.

Bridge rehabilitation will be carried out in stages to maintain one traffic lane operational at all times. Roadway protection will be required to facilitate staging. Roadway protection should be provided in accordance with OPSS 539 and designed for Performance Level 2.

Conventional steel soldier pile and timber lagging walls or continuous sheet pile walls are two options to provide temporary support to the roadway during excavation. However, the existing embankment fill and underlying native soils contain occasional cobbles and possible boulders which may interfere with installation of soldier piles or sheet piles. The Contractor should be advised of potential obstructions in the fill during installation. Suggested text for an NSSP on “Installation of Roadway Protection System” is included in Appendix D.

Design of any road protection or dewatering system that may be required is the responsibility of the Contractor. All shoring systems should be designed by a Professional Engineer experienced in such designs.

13 APPROACH EMBANKMENTS

Grade raises of 120 mm and 170 mm are planned at the west and east abutment, respectively. In view of the soil conditions at this site, settlement or stability issues are not anticipated for the existing approach embankments.

14 CONSTRUCTION CONCERNS

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

- The existing embankment fill contains occasional cobbles which may interfere with excavation or installation of temporary roadway protection systems.
- Water levels in the creek may fluctuate during construction.

15 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Keli Shi, P.Eng. The report was reviewed by Mr. Murray Anderson, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Keli Shi, P.Eng.
Geotechnical Engineer



Murray R. Anderson, P.Eng.
Associate, Senior Foundations Engineer



Dr. P.K. Chatterji, P.Eng.
Review Principal



Appendix A
Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

| CLASSIFICATION | PARTICLE SIZE | VISUAL IDENTIFICATION |
|----------------|--------------------|---|
| Boulders | Greater than 200mm | same |
| Cobbles | 75 to 200mm | same |
| Gravel | 4.75 to 75mm | 5 to 75mm |
| Sand | 0.075 to 4.75mm | Not visible particles to 5mm |
| Silt | 0.002 to 0.075mm | Non-plastic particles, not visible to the naked eye |
| Clay | Less than 0.002mm | Plastic particles, not visible to the naked eye |

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

| TERMINOLOGY | PROPORTION |
|---------------------------------|---------------|
| Trace or Occasional | Less than 10% |
| Some | 10 to 20% |
| Adjective (e.g. silty or sandy) | 20 to 35% |
| And (e.g. sand and gravel) | 35 to 50% |

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

| DESCRIPTIVE TERM | UNDRAINED SHEAR STRENGTH (kPa) | APPROXIMATE SPT ⁽¹⁾ 'N' VALUE |
|------------------|--------------------------------|--|
| Very Soft | 12 or less | Less than 2 |
| Soft | 12 to 25 | 2 to 4 |
| Firm | 25 to 50 | 4 to 8 |
| Stiff | 50 to 100 | 8 to 15 |
| Very Stiff | 100 to 200 | 15 to 30 |
| Hard | Greater than 200 | Greater than 30 |

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

| DESCRIPTIVE TERM | SPT "N" VALUE |
|------------------|-----------------|
| Very Loose | Less than 4 |
| Loose | 4 to 10 |
| Compact | 10 to 30 |
| Dense | 30 to 50 |
| Very Dense | Greater than 50 |

5. LEGEND FOR RECORDS OF BOREHOLES

| SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE | SS Split Spoon Sample | WS Wash Sample | AS Auger (Grab) Sample |
|---|---|--|------------------------|
| | TW Thin Wall Shelby Tube Sample | TP Thin Wall Piston Sample | |
| | PH Sampler Advanced by Hydraulic Pressure | PM Sampler Advanced by Manual Pressure | |
| | WH Sampler Advanced by Self Static Weight | RC Rock Core | SC Soil Core |

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$



Water Level

C_{pen}

Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

EXPLANATION OF ROCK LOGGING TERMS

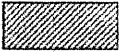




ROCK WEATHERING CLASSIFICATION

| | |
|----------------------------------|---|
| Fresh (FR) | No visible signs of weathering. |
| Fresh Jointed (FJ) | Weathering limited to the surface of major discontinuities. |
| Slightly Weathered (SW) | Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material. |
| Moderately Weathered (MW) | Weathering extends throughout the rock mass, but the rock material is not friable. |
| Highly Weathered (HW) | Weathering extends throughout the rock mass and the rock is partly friable. |
| Completely Weathered (CW) | Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved. |

DISCONTINUITY SPACING

| Bedding | Bedding Plane Spacing |
|---------------------|------------------------------|
| Very thickly bedded | Greater than 2m |
| Thickly bedded | 0.6 to 2m |
| Medium bedded | 0.2 to 0.6m |
| Thinly bedded | 60mm to 0.2m |
| Very thinly bedded | 20 to 60mm |
| Laminated | 6 to 20mm |
| Thinly Laminated | Less than 6mm |

SYMBOLS

| | |
|--|-----------|
|  | CLAYSTONE |
|  | SILTSTONE |
|  | SANDSTONE |
|  | COAL |
|  | BEDROCK |

STRENGTH CLASSIFICATION

| Rock Strength | Approximate Uniaxial Compressive Strength | | Field Estimation of Hardness* |
|-----------------------|--|---------------------|--|
| | (MPa) | (psi) | |
| Extremely Strong | Greater than 250 | Greater than 36,000 | Specimen can only be chipped with a geological hammer |
| Very Strong | 100-250 | 15,000 to 36,000 | Requires many blows of geological hammer to break |
| Strong | 50-100 | 7,500 to 15,000 | Requires more than one blow of geological hammer to break |
| Medium Strong | 25.0 to 50.0 | 3,500 to 7,500 | Breaks under single blow of geological hammer. |
| Weak | 5.0 to 25.0 | 750 to 3,500 | Can be peeled by a pocket knife with difficulty |
| Very Weak | 1.0 to 5.0 | 150 to 750 | Can be peeled by a pocket knife, crumbles under firm blows of geological pick. |
| Extremely Weak (Rock) | 0.25 to 1.0 | 35 to 150 | Indented by thumbnail |

TERMS

| | |
|-------------------------------------|---|
| Total Core Recovery: (TCR) | Core recovered as a percentage of total core run length |
| Solid Core Recovery: (SCR) | Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run |
| Rock Quality Designation: (RQD) | Total length of sound core recovered in pieces 0.1m in length or larger as a % of total core run length. |
| Uniaxial Compressive Strength (UCS) | Axial stress required to break the specimen |
| Fracture Index: (FI) | Frequency of natural fractures per 0.3m of core run. |

UNIFIED SOILS CLASSIFICATION

| MAJOR DIVISIONS | | GROUP SYMBOL | TYPICAL DESCRIPTION |
|----------------------|---------------------------------|--------------|---|
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | GW | Well-graded gravels or gravel-sand mixtures, little or no fines. |
| | | GP | Poorly-graded gravels or gravel-sand mixtures, little or no fines. |
| | | GM | Silty gravels, gravel-sand-silt mixtures. |
| | | GC | Clayey gravels, gravel-sand-clay mixtures. |
| | SAND AND SANDY SOILS | SW | Well-graded sands or gravelly sands, little or no fines. |
| | | SP | Poorly-graded sands or gravelly sands, little or no fines. |
| | | SM | Silty sands, sand-silt mixtures. |
| | | SC | Clayey sands, sand-clay mixtures. |
| FINE GRAINED SOILS | SILTS AND CLAYS $W_L < 50\%$ | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity. |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$). |
| | | CI | Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$). |
| | | OL | Organic silts and organic silty-clays of low plasticity. |
| | SILTS AND CLAYS $W_L > 50\%$ | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts. |
| | | CH | Inorganic clays of high plasticity, fat clays. |
| | | OH | Organic clays of medium to high plasticity, organic silts. |
| HIGHLY ORGANIC SOILS | | Pt | Peat and other highly organic soils. |
| CLAY SHALE | | | |
| SANDSTONE | | | |
| SILTSTONE | | | |
| CLAYSTONE | | | |
| COAL | | | |

RECORD OF BOREHOLE No SBC2-01

1 OF 2

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 446.0 E 336 480.3 ORIGINATED BY ES
HWY 102 BOREHOLE TYPE NW Casing COMPILED BY AN
DATUM Geodetic DATE 2013.07.19 - 2013.07.19 CHECKED BY MEF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|--------------|----------------------------|-----------------|--|--|--|--|---|---|---|--|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | WATER CONTENT (%) | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | W P W W L | | | | |
| | | | | | | | | 20 40 60 80 100 | | | | 20 40 60 | | | | |
| 318.8 | GROUND SURFACE | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT: (125mm) | | | | | | | | | | | | | | | |
| 0.1 | SAND and GRAVEL, trace silt Compact to Very Dense Brown Moist (FILL) | | 1 | SS | 19 | | 318 | | | | | | ○ | | 54 42 4 (SI+CL) | |
| | Wet | | 2 | SS | 51 | | 317 | | | | | | ○ | | | |
| 316.2 | | | 3 | SS | 50 | | 316 | | | | | | | ○ | 0 53 15 32 | |
| 2.6 | Clayey SAND, some silt, trace gravel Loose Brown Wet (FILL) | | 4 | SS | 4 | | 315 | | | | | | ○ | | 1 50 14 35 | |
| 314.7 | | | | | | | 314 | | | | | | | | | |
| 4.1 | SAND and GRAVEL, trace silt, occasional cobbles Very Dense to Dense Brown Wet | | 5 | SS | 50/ 0.125 | | 313 | | | | | | | | | |
| | | | 6 | SS | 30 | | 312 | | | | | | ○ | | | |
| | Cobbles | | | | | | 311 | | | | | | ○ | | | |
| | | | 7 | SS | 32 | | 310 | | | | | | ○ | | | |
| | Cobbles (150mm) | | | | | | | | | | | | | | | |
| | | | 8 | SS | 38 | | | | | | | | ○ | | | |
| 309.0 | | | | | | | | | | | | | | | | |
| 9.8 | END OF BOREHOLE AT 9.8m. | | | | | | | | | | | | | | | |

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity 20
15 10 5 0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SBC2-01

2 OF 2

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 446.0 E 336 480.3 ORIGINATED BY ES
 HWY 102 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.07.19 - 2013.07.19 CHECKED BY MEF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|--------------|--|------------|---------|------|------------|-------------------------|-----------------|--|-----|---|-----|-------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | W P | W | W L | WATER CONTENT (%) | | |
| | Continued From Previous Page BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.15m, THEN ASPHALT TO SURFACE. | | | | | | | | | | | | | |

RECORD OF BOREHOLE No SBC2-02

1 OF 3

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 455.0 E 336 492.1 ORIGINATED BY ES
HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
DATUM Geodetic DATE 2013.07.19 - 2013.07.21 CHECKED BY MEF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT W _p | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|---|------------|---------|------|--------------|----------------------------|-----------------|---|-------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | WATER CONTENT (%) | | | | | |
| 318.8 | GROUND SURFACE | | | | | | | | | | | | | |
| 0.0 | ASPHALT: (125mm) | | | | | | | | | | | | | |
| 318.5 | CONCRETE: (125mm) | | | | | | | | | | | | | |
| 0.3 | Sandy GRAVEL to SAND and GRAVEL, trace silt, occasional cobbles Very Dense to Compact Brown (FILL) | | 1 | SS | 50/ 0.125 | | 318 | | | | | | | |
| | | | 2 | SS | 18 | | 317 | | | | | | | 73 25 2 (SI+CL) |
| | | | 3 | SS | 14 | | 316 | | | | | | | |
| | | | 4 | SS | 19 | | 315 | | | | | | | |
| 314.2 | | | | | | | 314 | | | | | | | |
| 4.6 | SAND and GRAVEL, trace silt, occasional cobbles Very Dense to Compact Brown Wet | | 5 | SS | 50/ 0.050 | | 313 | | | | | | | |
| | | | 6 | SS | 17 | | 312 | | | | | | | 47 50 3 (SI+CL) |
| | | | 7 | SS | 14 | | 311 | | | | | | | |
| | Becoming grey | | 8 | SS | 21 | | 310 | | | | | | | |
| | | | | | | | 309 | | | | | | | |

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity 20
15 10 5 0
(%) STRAIN AT FAILURE

METRIC

[illegible]

ONTMT4S 1197.GPJ 2012TEMPLATE(MTO).GDT 10/6/14

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No SBC2-03

1 OF 4

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 457.6 E 336 517.9 ORIGINATED BY ES
 HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2013.07.16 - 2013.07.19 CHECKED BY MEF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|--|--------------------------------|-----------------|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | WATER CONTENT (%) | | | |
| 318.7 | GROUND SURFACE | | | | | | 20 40 60 80 100 | PLASTIC LIMIT | NATURAL MOISTURE CONTENT | LIQUID LIMIT | | |
| 0.0 | ASPHALT: (125mm) | | | | | | | W _P | W | W _L | | |
| 0.1 | CONCRETE SLAB, steel rebar: (250mm) | | | | | | | | | | | |
| 318.3 | | | | | | | | | | | | |
| 0.4 | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | Sandy GRAVEL to SAND and GRAVEL, trace silt, occasional cobbles Very Dense to Compact Brown Moist (FILL) | | 1 | SS | 53 | | 318 | | | | | 64 31 5 (SI+CL) |
| | | | 2 | SS | 17 | | 317 | | | | | |
| | | | 3 | SS | 17 | | 316 | | | | | |
| | | | 4 | SS | 20 | | 315 | | | | | |
| 314.1 | | | | | | | | | | | | |
| 4.6 | SAND and GRAVEL, some silt Very Dense to Compact Brown Wet | | 5 | SS | 53 | | 314 | | | | | 44 42 14 (SI+CL) |
| | Boulder (350mm) at 5.6m | | 6 | SS | 24 | | 313 | | | | | |
| | | | | | | | 312 | | | | | |
| | | | 7 | SS | 28 | | 311 | | | | | |
| | Occasional cobbles | | | | | | 310 | | | | | |
| | | | 8 | SS | 16 | | 309 | | | | | |
| | | | | | | | | | | | | |

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity 20
15 10 5 0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SBC2-03

2 OF 4

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 457.6 E 336 517.9 ORIGINATED BY ES
HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
DATUM Geodetic DATE 2013.07.16 - 2013.07.19 CHECKED BY MEF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | | PLASTIC LIMIT W _P | NATURAL MOISTURE CONTENT W | LIQUID LIMIT W _L | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|---|---------|------|------------|----------------------------|-----------------|--|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | |
| | Continued From Previous Page | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| | SAND and GRAVEL , some silt Compact Brown Wet | ◊ | | | | | | | | | | | | | | | |

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity 20
15 10 5 0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SBC2-03

3 OF 4

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 457.6 E 336 517.9 ORIGINATED BY ES
 HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2013.07.16 - 2013.07.19 CHECKED BY MEF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|------|---------------|----------------------------|-----------------|---|-----|---|-----|-------------------|---|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | W P | W | W L | WATER CONTENT (%) | | |
| | Continued From Previous Page | | | | | | | | | | | | | |
| | SAND, trace to some gravel, trace silt, trace clay Loose to Very Dense Brown Wet | | 15 | SS | 24 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | Becoming silty | | 16 | SS | 78 | | | | | | | | | 0 70 27 3 |
| | | | | | | | | | | | | | | |
| | Boulders (485mm) | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 17 | SS | 100/ 0.025 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 289.3 | | | | | | | | | | | | | | |
| 29.4 | END OF BOREHOLE UPON REFUSAL TO DCPT AT 29.4m. WATER LEVEL AT 4.6m UPON COMPLETION. | | | | | | | | | | | | | |

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 5 10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SBC2-03

4 OF 4

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 457.6 E 336 517.9 ORIGINATED BY ES
 HWY 102 BOREHOLE TYPE NW Casing/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2013.07.16 - 2013.07.19 CHECKED BY MEF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|-----|---|-----|-------------------|---|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | W P | W | W L | WATER CONTENT (%) | | |
| | Continued From Previous Page | | | | | | | | | | | | | |
| | Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Aug. 01/13 5.0 313.7 May 02/14 3.7 315.0 | | | | | | | | | | | | | |

RECORD OF BOREHOLE No SBC2-04

1 OF 2

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 466.5 E 336 529.7 ORIGINATED BY ES
HWY 102 BOREHOLE TYPE NW Casing COMPILED BY AN
DATUM Geodetic DATE 2013.07.21 - 2013.07.21 CHECKED BY MEF

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | | |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|--------------------------------|--------------------------------------|----------------|---|--|--|---|---|--|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | 20 40 60 80 100 | ○ UNCONFINED + FIELD VANE | W _P W W _L | 20 40 60 | GR SA SI CL | | | | | | | |
| 318.6 | GROUND SURFACE | | | | | | | | | | | | | | | | | | |
| 0.0 | ASPHALT: (125mm) | | | | | | | | | | | | | | | | | | |
| 0.1 | Sandy GRAVEL to SAND and GRAVEL , trace silt, occasional cobbles Compact to Dense Brown Wet (FILL) | | 1 | SS | 16 | | | | | | | | | | 78 21 1 (SI+CL) | | | | |
| | | | 2 | SS | 36 | | | | | | | | | | | | | | |
| 316.3 | | | | | | | | | | | | | | | | | | | |
| 2.3 | Clayey SAND , some silt, trace gravel Compact to Loose Brown (FILL)(CI) | | 3 | SS | 13 | | | | | | | | | | | | | | |
| | | | 4 | SS | 6 | | | | | | | | | | 1 50 17 32 | | | | |
| 314.6 | | | | | | | | | | | | | | | | | | | |
| 4.0 | SAND , some gravel, trace silt, occasional cobbles Dense to Compact Brown Moist | | 5 | SS | 39 | | | | | | | | | | 17 74 9 (SI+CL) | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 32 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| | | | 7 | SS | 23 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| 308.8 | | | 8 | SS | 31 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |
| 9.8 | END OF BOREHOLE AT 9.8m. | | | | | | | | | | | | | | | | | | |

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SBC2-04

2 OF 2

METRIC

WP# 6073-09-00 LOCATION Strawberry Creek Bridge 2 N 5 377 466.5 E 336 529.7 ORIGINATED BY ES
 HWY 102 BOREHOLE TYPE NW Casing COMPILED BY AN
 DATUM Geodetic DATE 2013.07.21 - 2013.07.21 CHECKED BY MEF

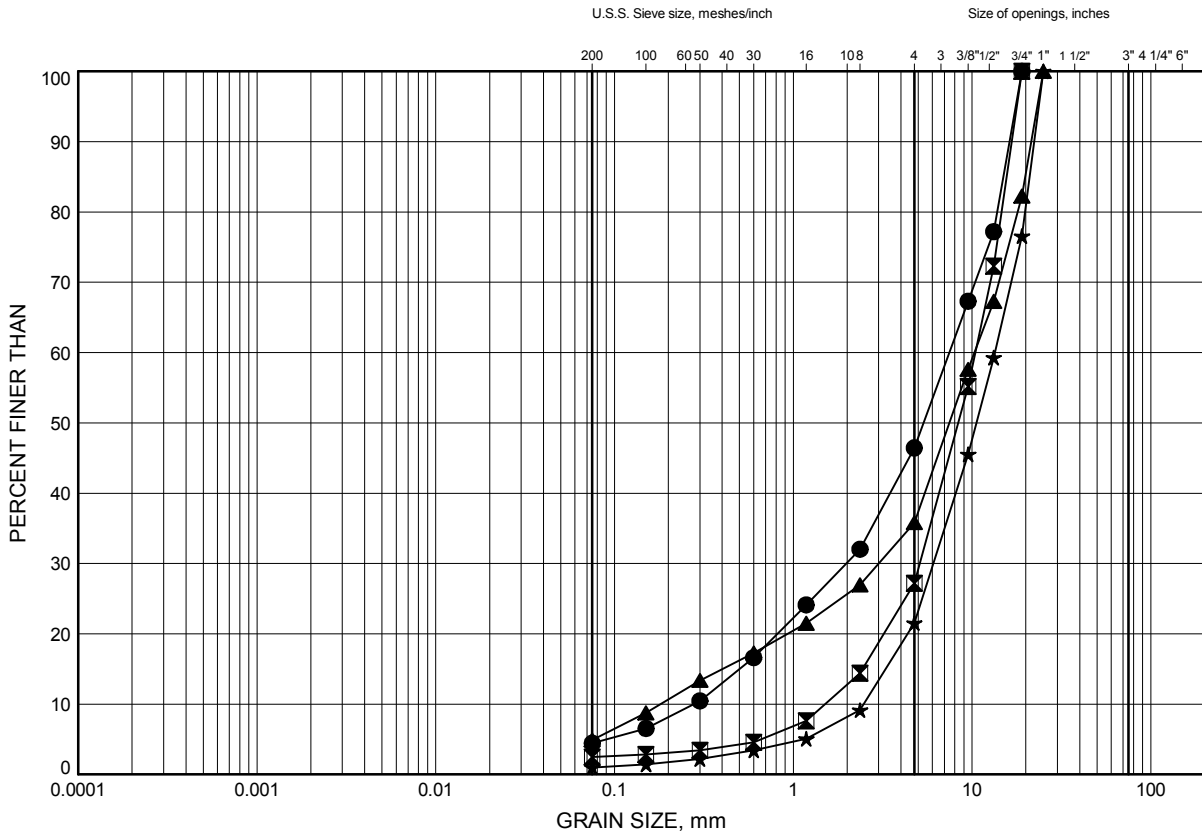
| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|---|---|----------------|---|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | W _p | W | W _L | | |
| | Continued From Previous Page | | | | | | | | | | | | | |
| | BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.15m, THEN ASPHALT TO SURFACE. | | | | | | | | | | | | | |

Appendix B
Laboratory Test Results

Strawberry Creek Bridge 2 GRAIN SIZE DISTRIBUTION

FIGURE B1

SANDY GRAVEL TO SAND & GRAVEL FILL



| | | | | | | |
|---------------|------|--------|--------|--------|--------|-------------|
| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | SAND | | | GRAVEL | | |

LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | SBC2-01 | 1.07 | 317.73 |
| ⊠ | SBC2-02 | 1.83 | 316.97 |
| ▲ | SBC2-03 | 1.07 | 317.63 |
| ★ | SBC2-04 | 1.07 | 317.53 |

Date September 2014
WP# 6073-09-00

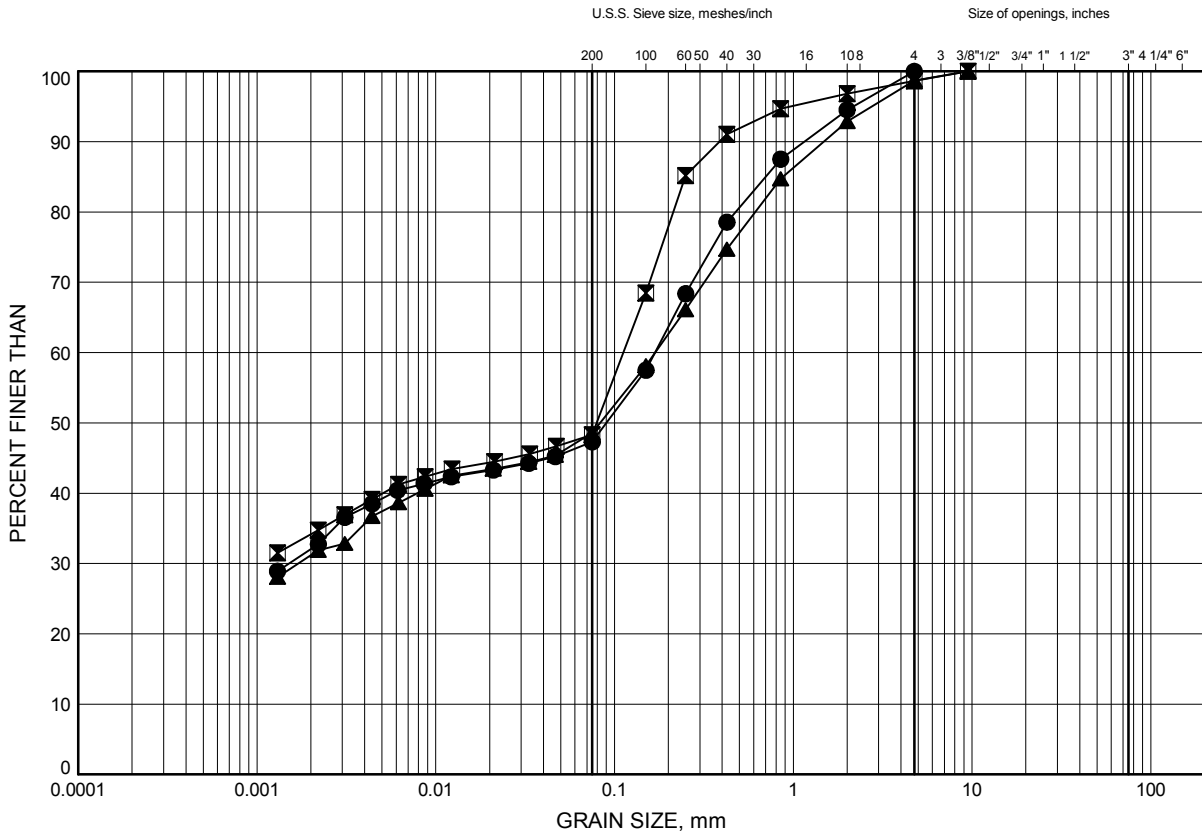


Prep'd AN
Chkd. MEF

Strawberry Creek Bridge 2 GRAIN SIZE DISTRIBUTION

FIGURE B2

CLAYEY SAND FILL



| | | | | | | |
|---------------|------|--------|--------|--------|--------|-------------|
| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | SAND | | | GRAVEL | | |

LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | SBC2-01 | 2.59 | 316.21 |
| ⊠ | SBC2-01 | 3.35 | 315.45 |
| ▲ | SBC2-04 | 3.35 | 315.25 |

Date September 2014
WP# 6073-09-00

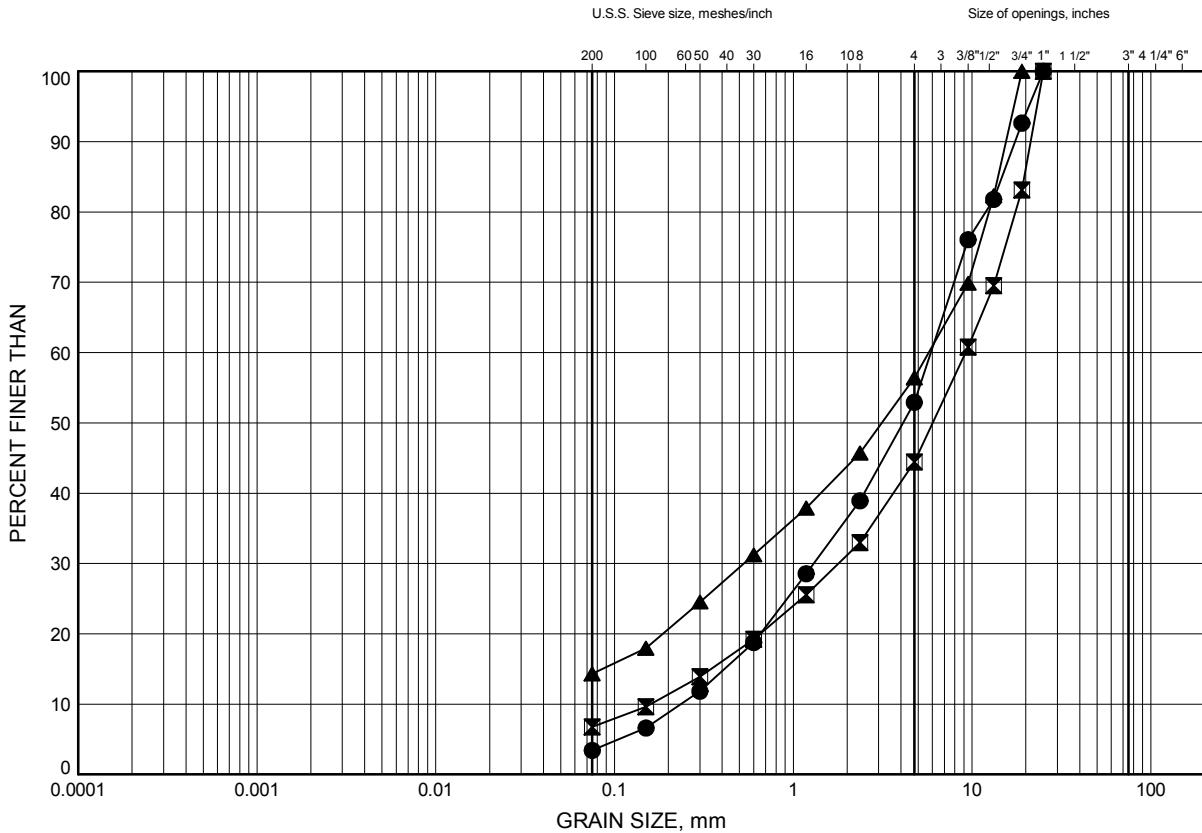


Prep'd AN
Chkd. MEF

Strawberry Creek Bridge 2 GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND & GRAVEL



| | | | | | | |
|---------------|------|--------|--------|--------|--------|-------------|
| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | SAND | | | GRAVEL | | |

LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | SBC2-02 | 6.40 | 312.40 |
| ⊠ | SBC2-02 | 14.02 | 304.78 |
| ▲ | SBC2-03 | 4.80 | 313.90 |

Date September 2014
WP# 6073-09-00

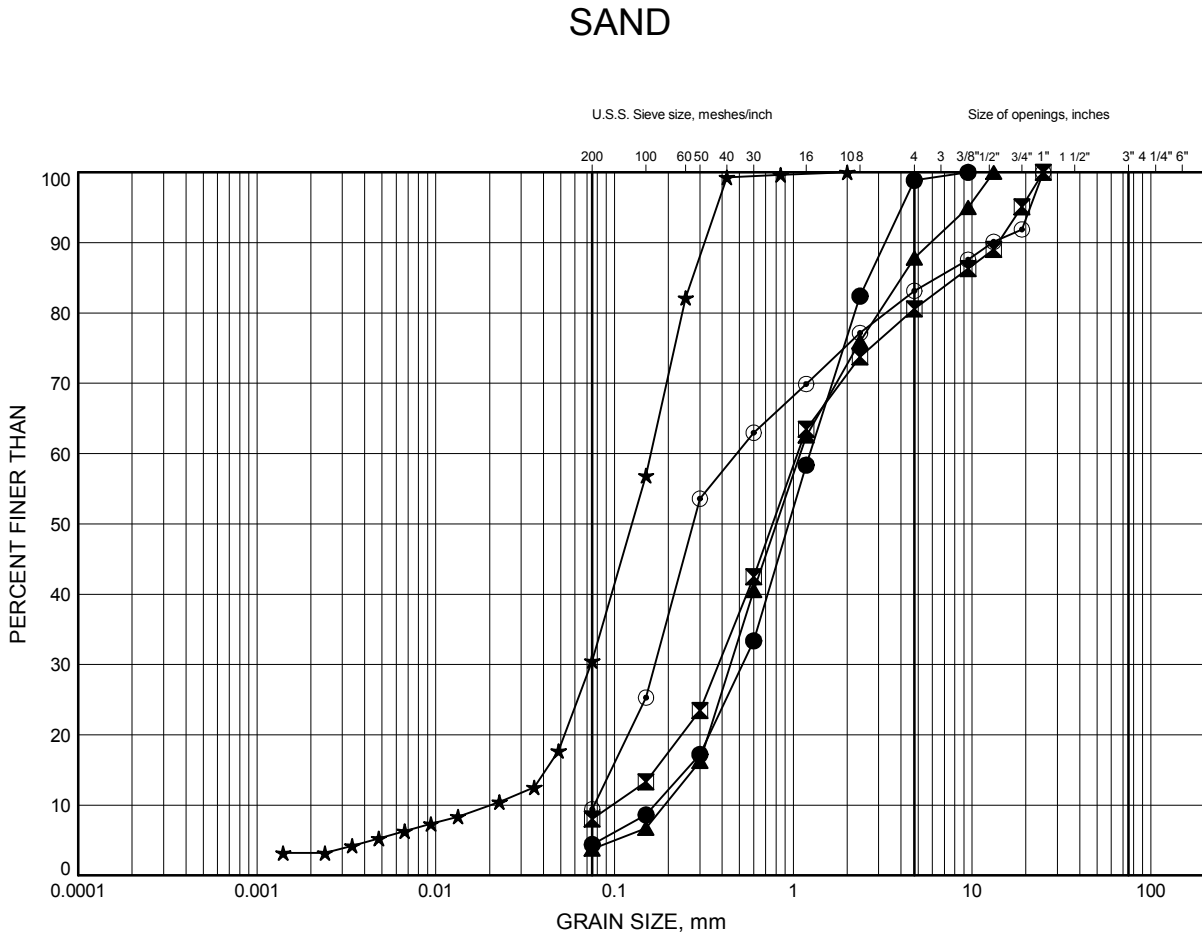


Prep'd AN
Chkd. MEF

Strawberry Creek Bridge 2

GRAIN SIZE DISTRIBUTION

FIGURE B4



| | | | | | | |
|---------------|------|--------|--------|--------|--------|-------------|
| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | SAND | | | GRAVEL | | |

LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | SBC2-02 | 18.59 | 300.21 |
| ⊠ | SBC2-03 | 12.50 | 306.20 |
| ▲ | SBC2-03 | 17.07 | 301.63 |
| ★ | SBC2-03 | 24.65 | 294.05 |
| ⊙ | SBC2-04 | 4.88 | 313.72 |

Date September 2014

WP# 6073-09-00



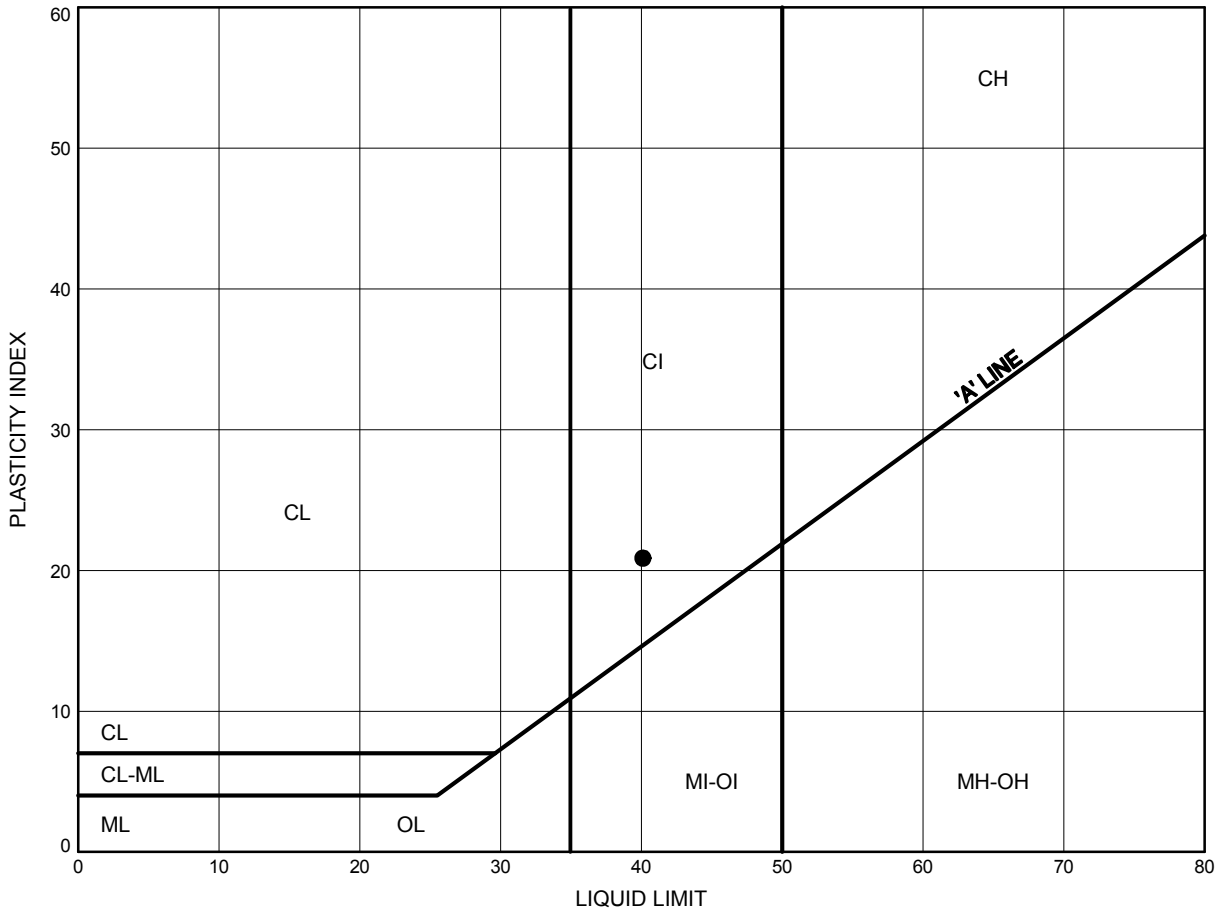
Prep'd AN

Chkd. MEF

Strawberry Creek Bridge 2
ATTERBERG LIMITS TEST RESULTS

FIGURE B5

CLAYEY SAND FILL



LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | SBC2-04 | 3.35 | 315.25 |

Date September 2014
 WP# 6073-09-00



Prep'd AN
 Chkd. MEF

Appendix C
Site Photographs



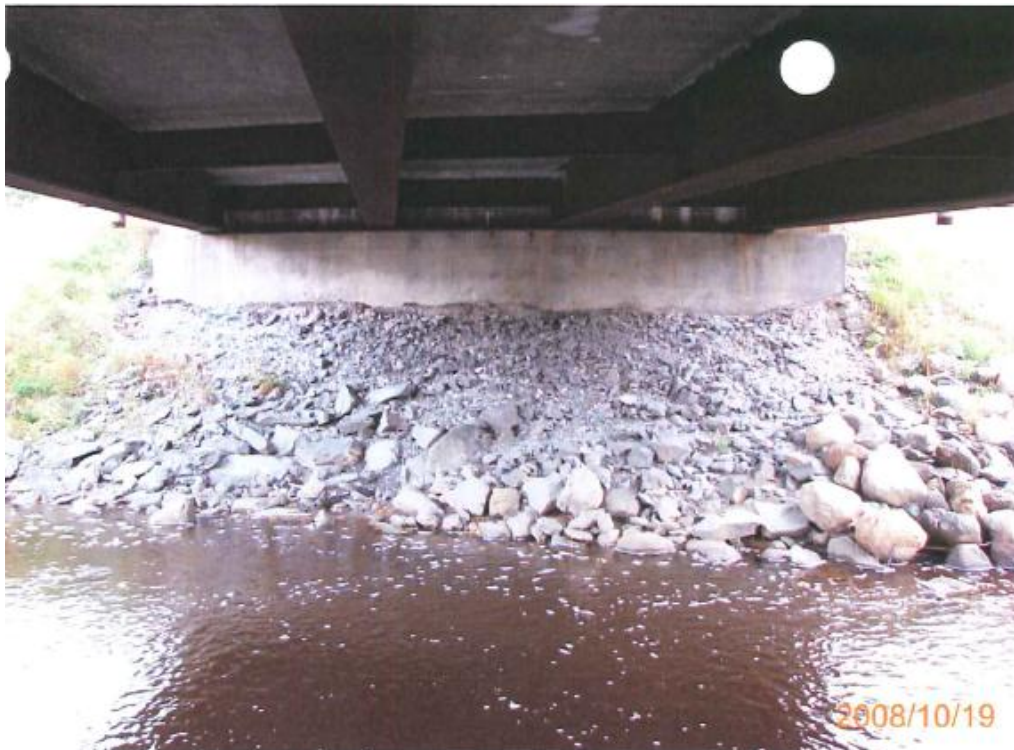
Photograph 1 – East approach, looking west



Photograph 2 – West approach, looking east



Photograph 3 – North Elevation



Photograph 4 – East Abutment

Appendix D
List of SPs and OPSS, and Suggested Text for Selected NSSP

1. List of Special Provisions and OPSS Documents Referenced in this Report

- OPSS 501
- OPSS 539
- OPSS 804
- OPSS 902
- OPSS.PROV 1010

2. Suggested text for NSSP on “Installation of Roadway Protection System”

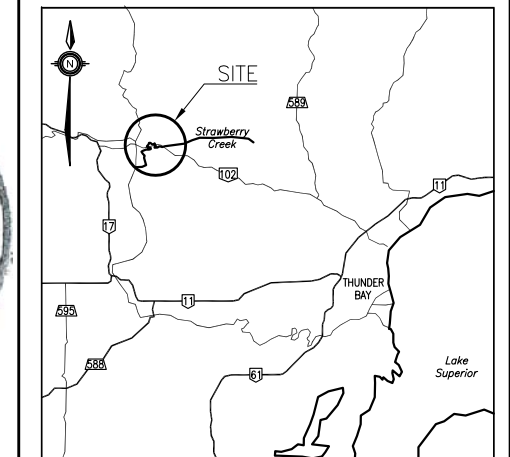
Cobbles and possible boulders are present within the existing embankment fill and underlying native soils at this site. These cobbles and boulders may impede the installation of the roadway protection system. At some locations, the installation may not be able to penetrate the obstructions and reach the design depth. The Contractor shall be prepared to remove, drill through and/or penetrate these obstructions and extend the protection system to the design depth.

Appendix E
Borehole Locations and Soil Strata Drawing

5 DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN







| | |
|--|--|
| HIGHWAY 102 STRAWBERRY CREEK BRIDGE 2 REHABILITATION BOREHOLE LOCATIONS AND SOIL STRATA | |
|--|--|



KEYPLAN

LEGEND

- | | |
|---|---------------------------------------|
|  | Borehole |
|  | Borehole and Cone |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| PH | Pressure, Hydraulic |
|  | Water Level In Open Borehole |
|  | Water Level In Piezometer |
| 90% | Rock Quality Designation (RQD) |
| A/R | Auger Refusal |

| NO | ELEVATION | NORTHING | EASTING |
|---------|-----------|-------------|-----------|
| SBC2-01 | 318.8 | 5 377 446.0 | 336 480.3 |
| SBC2-02 | 318.8 | 5 377 455.0 | 336 492.1 |
| SBC2-03 | 318.7 | 5 377 457.6 | 336 517.9 |
| SBC2-04 | 318.6 | 5 377 466.5 | 336 529.7 |

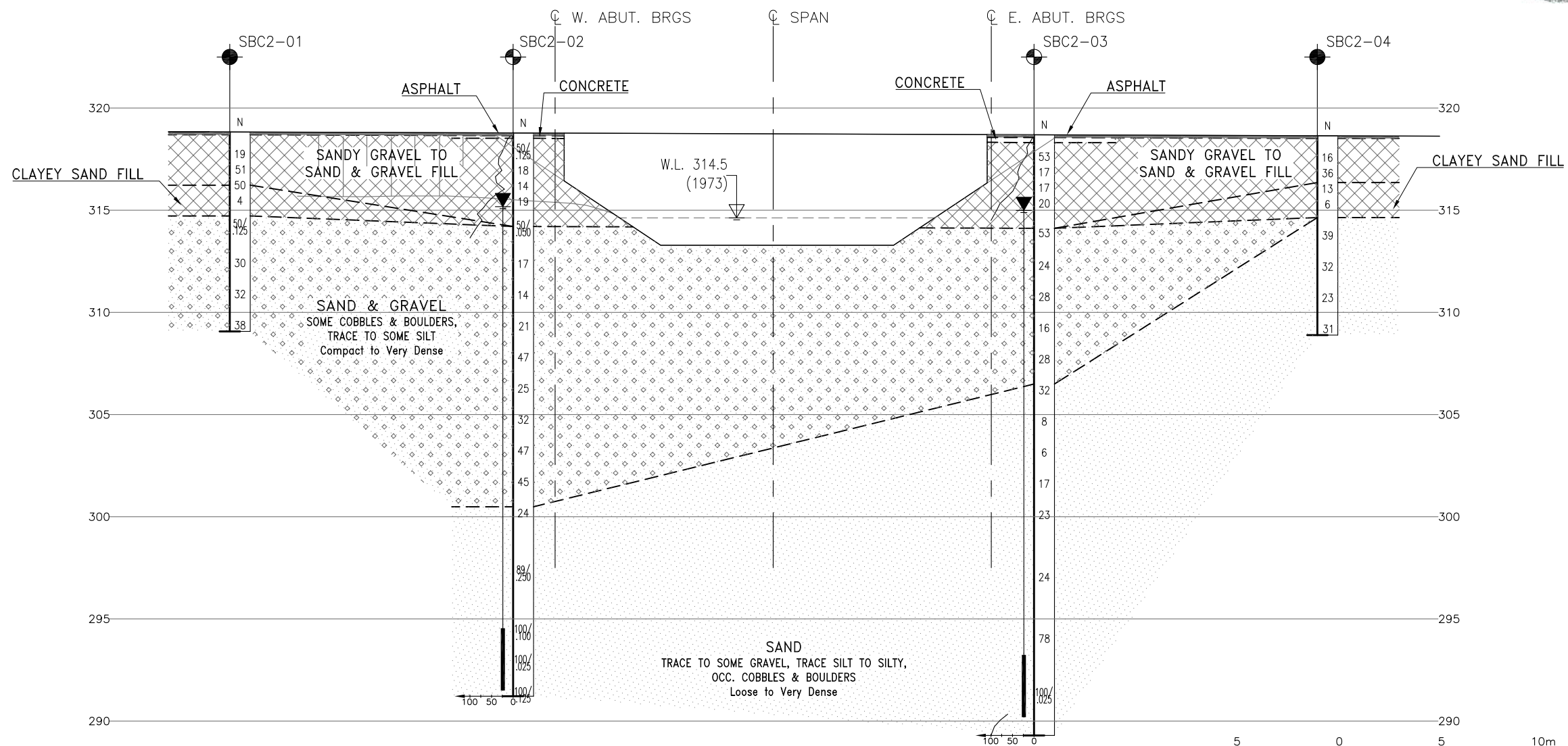
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 52A-186

[illegible]

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PROFILE ALONG C HWY. 102

