THURBER ENGINEERING LTD.

PRELIMINARY FOUNDATION INVESTIGATION REPORT
HIGHWAY 17 REALIGNMENT AND HEWITSON CREEK CULVERT
9.3 TO 13.3 KM WEST OF TOWNSHIP OF SCHREIBER
NORTHWESTERN REGION, ONTARIO
G.W.P. 6333-14-00

LATITUDE: 48.838205°, LONGITUDE: -87.406618°

GEOCRES Number: 42D-071

Report

to

HATCH

Date: March 27, 2023
File: 34844

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PART A: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a preliminary foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the proposed structural culvert at Hewitson Creek, which is a part of the proposed realignment of Highway 17 from 9.3 km to 13.3 km west of the Schreiber, Ontario. The purpose of the realignment is to improve safety of Highway 17 by eliminating horizontal curves in this section of highway.

The purpose of this investigation was to explore the subsurface conditions at the culvert site and, based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber carried out the investigation as a subconsultant to Hatch, under the Ministry of Transportation, Ontario (MTO), G.W.P. 6333-14-00.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. SITE DESCRIPTION

The proposed site is located at STA 11+008 on proposed realignment of Highway 17 and is approximately 12.7 km west of Schreiber, Ontario. In addition to the proposed structural culvert at Hewitson Creek, the proposed Highway 17 realignment is approximately 4.0 km long will also include two other creek crossing, new highway embankments, rock cuts, side roads, and entrances (see alignment drawing in Appendix A). For orientation purposes, Highway 17 is herein described as orientated east-west and the culvert is described as orientated north-south.

The western half of the proposed Highway 17 realignment, including the proposed structural

culvert at Hewitson Creek, is located within the boundaries of Rainbow Falls Provincial Park. At the proposed crossing, Hewitson Creek flows from north to south, from Whitesand Lake to Lake Superior, and is flanked by steep valley slopes up to 25 m and 18 m high to the east and west, respectively. The east valley slope is interrupted by two terraces at about 14 m and 4 m in height as measured from the creek bed. Immediately beyond the proposed culvert outlet, Hewitson Creek turns 90 degrees towards the east. To the north of the proposed crossing is a Hydro One high voltage transmission line corridor, and to the south is a CPR rail corridor. The valley slopes and surrounding terrain is vegetated with a thick mixed forest and shrubs. Site Photographs #1 through #6 in Appendix A shows the condition on the valley slopes during the initial site visit on October 7, 2022.

Based on Northern Ontario Engineering Geology Terrain Study (NOEGTS) mapping, the site lies in a glaciolacustrine delta and the primary materials are sandy and gravelly soils. Glaciolacustrine (abandoned) beach form with sandy and gravelly soils are also present in the area. The site topography in the immediate vicinity of the proposed culvert is of low relief consisting of slopes and terraces. Visual observation of exposed valley slopes indicates the native overburden consists of sands and gravels containing frequent cobbles, and boulders (refer to Photographs #7 and #8 in Appendix A). The surface of the creek bed was comprised primarily of cobbles and boulders (refer to Photographs #9 and #10 in Appendix A). During an initial site visit on October 7, 2022, the water level in Hewitson Creek was approximately 0.5 m deep.

Based on the OGS Map MRD126 titled “Bedrock Geology of Ontario”, dated 2011, the underlying bedrock at the site consists of massive to foliated granodiorite to granite.

3. INVESTIGATION BACKGROUND

The original scope of the foundation investigation consisted of three 15 m deep boreholes on each side of the creek for a total of six boreholes along the proposed culvert alignment. After project initiation, an initial site visit noted very challenging access conditions, including valley slopes too steep for conventional drill rigs to access the proposed borehole locations. As such, the use of portable drilling equipment was proposed as an option to reasonably access the creek for a subsurface investigation without the need to prepare temporary access roads from the top to the bottom of the valley on each side of the creek. Based on further discussions with MTO and Hatch, it was agreed that the foundation scope would be reduced to a preliminary level investigation involving two boreholes (i.e., one on each side of the creek) advanced using portable drilling equipment and that a more comprehensive investigation will be conducted during detail design.

4. INVESTIGATION PROCEDURES

The field investigation for this project was carried out between January 13 and 27, 2023, and consisted of drilling and sampling two boreholes, designated as Boreholes HEW-01 and HEW-02, to depths of 5.6 m and 4.3 m, corresponding to Elev. 201.0 m and 201.9 m, respectively. Dynamic Cone Penetration Test (DCPT) was conducted through the bottom of Borehole HEW-01 to a depth of 5.8 m prior to encountering refusal. The proposed preliminary investigation was to advance one borehole on each side of Hewitson Creek; however, at the time of investigation, access to the east side of the creek was assessed to be impractical for vehicles to traverse due to the saturated/soft, snow-covered access road leading to the top of the valley slopes, and steep, slippery/icy slopes. As such, after consultation with MTO Foundations Office, it was agreed that both boreholes would be advanced on the west side of Hewitson Creek.

The boreholes were proposed to be advanced as close as practical to the edge of water; however, due to a sudden snowmelt at the time of investigation, there was a temporary increase in water level (observed to vary as much as 0.6 m within a 24-hour period) and as a result, the boreholes were advanced through at the top of creek bank up to about 1.8 m higher in elevation. For the detail design investigation, boreholes should be advanced at the proposed footing location or as close as practical to the edge of water during periods of low water level. Site conditions and site access are presented on Photographs #11 through #16 in Appendix A.

It should be noted that Borehole HEW-01 was originally intended to be advanced near the proposed culvert inlet; however, the ground elevation rises quickly in the area of the culvert inlet and therefore, it was assessed that advancing the borehole at an elevation closer to the creek level, as opposed to a higher elevation, would be more beneficial for the purpose of this investigation using portable drilling equipment. It should also be noted that the proposed culvert inlet is located with the high voltage transmission corridor and that Borehole HEW-01 was to be advanced outside this corridor.

The Record of Borehole sheets for the boreholes are included in Appendix B. The borehole locations are shown on the Borehole Locations and Soil Strata Drawing in Appendix C.

Utility clearances on public properties and permission-to-enter Rainbow Falls Provincial Park were obtained prior to mobilization to the site. The as-drilled borehole elevation for Boreholes HEW-01 and HEW-02 was surveyed and provided by Hatch. The coordinate system MTM NAD 83, Zone 13 was used for the boreholes.

Silt fencing and straw bales were installed along the edge of the creek bank near the location of

the boreholes prior to the commencement of drilling. Boreholes HEW-01 and HEW-02 were advanced using a Hilti DD250 portable drill utilizing wash boring methods with BW casing as the outer casing, and AW casing as the inner casing for coring. Soils samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). In Borehole HEW-01, SPT was carried out using a third-weight hammer lifted manually and as such, the SPT "N" values from Borehole HEW-01 are less reliable. For reporting purposes, a hammer correction has been applied to the "N" values presented on the record of borehole sheets for Borehole HEW-01. At various intervals of depths, AW coring equipment was used to advance borehole through as well as to recover coarse gravels, cobbles, and boulders in the native overburden. Dynamic Cone Penetration Testing was conducted through the bottom of Borehole HEW-01 with a full-weight hammer in conjunction with a tripod setup. Photographs #17 and #18 in Appendix A shows setup of silt fencing and straw bales prior to start of drilling at Borehole HEWA-01, and the portable drill and tripod setup at Borehole HEW-02, respectively.

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

Groundwater conditions observed in open boreholes as noted on the record of borehole sheets are not considered reliable due to the introduction of water throughout the drilling operation.

Borehole	Depth and Elevation of Borehole Base (m)	Depth and Elevation of Piezometer Tip (m)	Completion Details
HEW-01	5.6 / 201.0	None Installed	Borehole was backfilled with bentonite holeplug to surface.
HEW-02	4.3 / 201.9	None Installed	Borehole was backfilled with bentonite holeplug to surface.

5. LABORATORY TESTING

All recovered soil samples were subjected to visual identification (VI) and natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and/or hydrometer); however, it should be noted that limited testing was carried out as a result of split-spoon refusals and poor recovery from the split-spoon sampler. The results of this testing

program are summarized on the Record of Borehole sheets in Appendix B and are shown on the figures included in Appendix D.

6. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix B. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following sections; however, the factual data presented on the Record of Borehole sheets takes precedence over this general description and must be used for interpretation of the site conditions. It must be recognized and expected that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered consisted of a surficial layer of topsoil underlain by a deposit of silty sand to sand and gravel containing frequent cobbles and boulders.

6.1 Topsoil

A 75 mm and 150 mm thick layer of topsoil was encountered at Boreholes HEW-01 and HEW-02, respectively. A moisture content of 54 percent was measured on a sample of the topsoil. The topsoil thickness and moisture content may vary in other areas of the site.

6.2 Silty Sand to Sand and Gravel with Frequent Cobbles and Boulders

A deposit of silty sand to sand and gravel, trace silt, containing frequent cobbles, and boulders, was encountered beneath the topsoil in both boreholes. The deposit extends to the borehole termination depths of 5.6 m and 4.3 m (Elev. 201.0 m and 201.9 m) in Boreholes HEW-01 and HEW-02, respectively.

SPT ‘N’ values in the cohesionless deposit ranged from 14 blows per 0.3 m of penetration to 50 blows per 0 m penetration, indicating a compact to very dense condition. The resulting high “N” values is attributed to the frequent encounters of coarse gravels, cobbles, and boulders throughout the deposit. Coring of coarse gravel (up to 75 mm in diameter), cobbles, and boulders were required at various depths to advance the borehole during the investigation and their locations along with the particle sizes are recorded on the record of borehole sheets. In general, particle sizes up to 230 mm were encountered in the boreholes. Photographs of coarse gravels, cobbles, and boulders recovered from coring are presented in Appendix D.

Measured moisture contents in the sand to sand and gravel from 17 percent to 38 percent.

The results of grain size analyses conducted on selected samples of the silty sand are presented on Figure 1 in Appendix D and summarized as follows:

Soil Particle	Percentage (%)
Gravel	0 to 7
Sand	53 to 77
Silt	21 to 44
Clay	1 to 3

6.3 Groundwater Conditions

Details of the water level observed in the boreholes upon completion of drilling are presented on the record of boreholes and summarized below; however, due to the introduction of water through the wash boring method used to advance the boreholes, these groundwater measurements are not considered representative of stabilized water level.

Borehole	Date of Measurement	Groundwater Level (m)		Remark
		Depth	Elevation	
HEW-01	January 19, 2023	3.1	203.5	Measured upon completion of borehole
HEW-02	January 24, 2023	1.9	204.3	Measured upon completion of borehole

The groundwater level is expected to reflect the water level of Hewitson Creek. It should be noted that seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation during spring and after periods of significant or prolonged precipitation.

7. MISCELLANEOUS

OGS Inc. of Almonte, Ontario supplied and operated the drilling, sampling, and in-situ testing equipment for the foundation investigation. The foundation investigation was supervised on a full-time basis by Mr. George Azzopardi.

Interpretation of the field data and preparation of this report was carried out by Ms. Madisan Chiarotto, EIT, and Mr. Christopher Ng, P.Eng., respectively. The report was reviewed by Mr. P.K. Chatterji, P.Eng., Ph.D., a Designated Principal Contact for MTO Foundations Projects at Thurber.

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PART B: ENGINEERING DISCUSSION AND RECOMMENDATIONS

8. GENERAL

This report provides an interpretation of the geotechnical data in the foundation investigation report and presents discussions on preliminary foundation options for the proposed Hewitson Creek culvert located at Station 11+008 of the realigned Highway 17, approximately 12.7 km west of Schreiber, Ontario. This preliminary report is intended for the use of the Ministry of Transportation, Ontario, and its designers for the planning of the next detailed phase of investigation and design and shall not be used or relied upon for any other purposes or by any other parties including Contractors. The readers must make their own interpretation based on the data provided in factual portion of this report. The purpose of this report is to provide qualitative foundation alternatives that maybe considered for further studies, and to provide recommendations for a detail design foundation investigation program.

The proposed design is to construct a new structural culvert for Hewitson Creek as part of the overall realignment of Highway 17. Based on the attached preliminary General Arrangement (GA) drawing, dated June 4, 2021, the proposed structure will be a single span precast concrete arch culvert consisting of 56 arch segments. Details of the proposed arch culvert is summarized below.

Invert Elevation (m)	Culvert Length (m)	Culvert Width (m)	Culvert Rise (m)	Height of Embankment above Obvert (m)
205.93 (inlet) 203.45 (outlet)	Approx. 101.6 (overall) 1.816 (per segment)	Approx. 14.6	Approx. 8.0	Approx. 12.7

As noted above, there is a significant height of fill above the large span culvert.

9. CULVERT FOUNDATION ALTERNATIVES

The site is underlain by a topsoil layer overlying a deposit of dense to very dense silty sand to sand and gravel containing frequent cobbles and boulders. The cobbles and boulders were observed on the exposed valley slopes and were encountered throughout the boreholes. Bedrock was not encountered within the depths of investigation.

Considering the length and width of the structure as well as a height of fill above the culvert, the foundation supporting the culvert is expected to require a high geotechnical resistance to satisfy the load demand. A brief discussion on the potential foundation options is provided in the following sections.

9.1 Spread Footings on Rockfill

Considering the proximity of the footings to the creek, the high permeability of the native soils, the presence of frequent cobbles and boulders, and the difficulty of dewatering excavations for footings construction in dry conditions, placement of precast footings on compacted small size rock fill (i.e., with particle sizes less than 150 mm) could be considered as an option to establish the top of the footing level above the water level. The rockfill would be placed underwater.

The rock fill must be a minimum 1 m thick and be placed on the dense to very dense silty sand to sand and gravel deposit. A conceptual footing design on rock fill is depicted in Appendix E.

9.2 Driven and Drilled-In Steel Piles

The native overburden is typically very dense and contains frequent cobble and boulders and as such, the use of driven steel piles is not recommended in these conditions. Drilled-in pipe piles socketed into bedrock may be considered as a viable deep foundation option. The follow-up detailed foundation investigation should address the depth to bedrock.

9.3 Drilled Shafts

Installation of drilled shafts maybe feasible but is not recommended due to potential difficulties advancing drilled shaft throughs frequent cobbles and boulders within native overburden. In addition, the use of temporary or permanent liners as well as drilling slurry will be required to mitigate against sidewall and basal instability during installation, which will introduce complexity and further risk of adopting drilled shafts as a foundation alternative.

10. RECOMMENDATIONS FOR DETAIL DESIGN FOUNDATION INVESTIGATION

There are two important factors that should be considered when proceeding with the detail foundation investigation:

1. The subsurface conditions the investigation drilling equipment will need to overcome, and,
2. Challenging access to the bottom of the creek valley.

Due to difficulties advancing boreholes using portable drilling equipment and the limited capability to penetrate and obtain samples of coarse gravels, cobbles, and boulder during the preliminary investigation, drilling using Hilti drill or equivalent drilling systems is not recommended for detail design. As such, it is recommended that an appropriately sized motorized power drilling rig be secured for the foundation investigation during detail design. The drilling rig to be used must be capable of advancing boreholes by coring through frequent coarse gravel, cobbles, and boulders and into bedrock.

To gain access to the proposed culvert location with a drill rig, construction of temporary access roads, one on each side of Hewitson Creek, will be required. In addition to the removal of trees along the access roads, it is anticipated the construction of access roads be may in the form of switchbacks to reduce the inclination/grade of the access road for ingress and egress of a drill rig and/or an excavator. Furthermore, adequately sized platforms will also need to be constructed at each investigation location for the drill rig.

In lieu of constructing temporary access roads, consideration could be given to the use of heli-portable and/or skid-mounted drill rigs that is transported into the valley by helicopter. These specialized drill rigs are typically used in mining/exploration applications and may not be equipped with traditional geotechnical investigation equipment such as a 140 lb hammer necessary to conduct standard penetration testing. As such, foundation engineering service provider must ensure that the selected heli-portable and/or skid-mounted drill rig is equipped to carry out foundation investigation as required by MTO. It is expected that the heli-portable/skid-mounted drill rigs will need a stable platform to operate on during the investigation, and as such, tree removal and construction drilling platform will be necessary at each investigation location. Depending how the drilling platform is constructed, the access between each drilling platform, and the drill rig selected, it is anticipated the drill rig will require a helicopter to transport it from one location to another. Furthermore, it is important to note that the proposed culvert inlet is located within the high voltage transmission line corridor and therefore, it may be difficult to transport the heli-portable and/or skid-mounted drill rig for an investigation at the inlet.

It is highly recommended that a site visit of Hewitson Creek be conducted by the foundation engineering service provider during the detail design proposal stage and immediately prior to the mobilization of drilling equipment to site for the purpose of assessing accessibility of drill rigs and/or other heavy equipment into and out of the steep terrain.

A detailed design investigation for Hewitson Creek culvert should consist of a minimum of six boreholes to the depth of 15 m below the base of the culvert, or 3 m into bedrock, whichever is less, and that each borehole should be located at the proposed footing location or as close as practical to the edge of water. A borehole location plan showing the as-drilled preliminary investigation boreholes and recommended investigation locations during detail design is presented in Appendix C.

11. CLOSURE

Engineering analysis and preparation of this report was carried out by Ms. Madisan Chiarotto, E.I.T., and Mr. Christopher Ng, P.Eng. The report was reviewed by Mr. P.K. Chatterji, P.Eng., Ph.D., a Designated Principal Contact for MTO Foundations Projects at Thurber.

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

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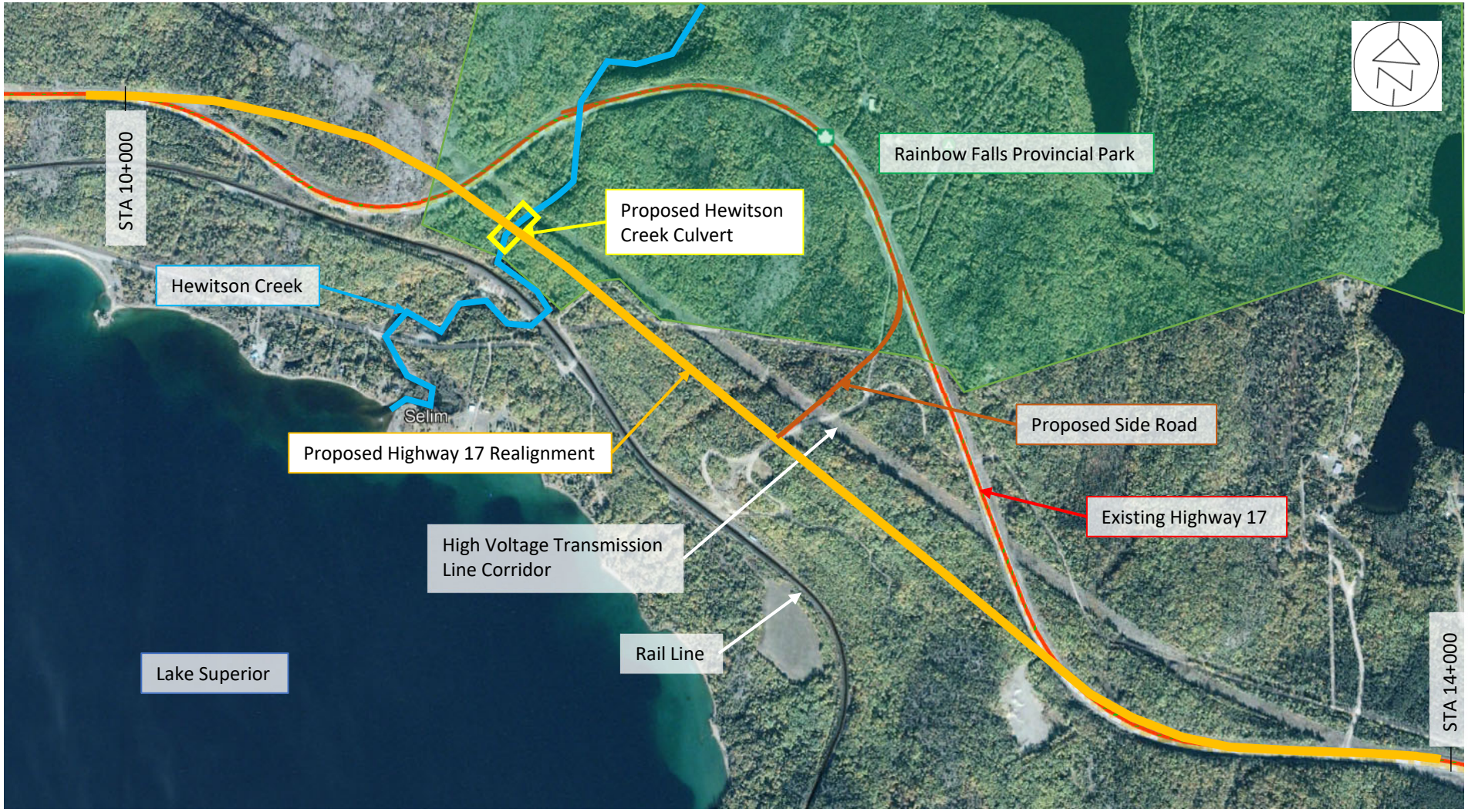
Appendix A

Alignment Drawing and Site Photographs

Appendix A – Alignment Drawing

To Rossport



To Schreiber

Not To Scale

Project No.: 34844

Photograph #1 – Heavily treed upper terrace of east valley slope facing west (October 2022)

Photograph #2 – Steep valley slope from upper terrace of east valley slope facing east looking up the valley (October 2022)

Photograph #3 – Heavily treed valley slope from lower terrace of east valley slope facing west looking into the valley (October 2022)

Photograph #4 – West valley slope facing east looking into the valley (October 2022)

Photograph #5 – West valley slope at STA 10+987.6 looking east towards Hewitson Creek (October 2022)

Photograph #6 – Vegetation on west valley slope at STA 10+937.6 (October 2022)

Photograph #7 – Exposed valley slope on east side of Hewitson Creek showing coarse gravel, cobbles, and boulder within the native overburden (January 2023)

Photograph #8 – Exposed valley slope on east side of Hewitson Creek showing frequent boulders within the native overburden (January 2023)

Photograph #8 – Hewitson Creek and west creek bank (October 2022)

Photograph #10 – Hewitson Creek facing south looking towards proposed culvert outlet (October 2022)

Photograph #11 – Access point from Highway 17 to west side of Hewitson Creek (January 2023)

Photograph #12 – Tree clearing from embankment toe of Highway17 to about STA 10+940 along the proposed highway realignment to access west side of Hewitson Creek. (January 2023)

Photograph #13 – Steep valley slope on the west side of Hewitson Creek (January 2023)

Photograph #14 – Top of east valley slope at STA 11+137.6 facing east towards Hewitson Creek (January 2023)

Photograph #15 – Hewitson Creek looking north from the west bank with high voltage transmission lines overhead (January 2023)

Photograph #16 – Snow and ice over creek bed at the time of investigation (January 2023)

Photograph #17 – Location of Borehole HEW-01 prior to portable drill setup (January 2023)

Photograph #18 – Hilti drilling and tripod setup at Borehole HEW-02 (January 2023)

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Appendix B

Record of Borehole Sheets

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No HEW-01 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM Zone 14: N 5 411 156.3 E 274 917.7 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AN

DATUM Geodetic DATE 2023.01.14 - 2023.01.19 LATITUDE 48.838051 LONGITUDE -93.407109 CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.6	GROUND SURFACE										
0.0	**TOPSOIL:** (75 mm)										
0.1	Silty **SAND**, some gravel to **SAND** and **GRAVEL**, trace silt, frequent cobbles and boulders Compact to Very Dense Brown Wet		1	SS	17		206				
			2	SS	35/0.150						
	AW coring intervals: 0.6 - 0.9 1.1 - 1.2 1.2 - 1.3		3	SS	25		205				
	1.7 - 2.0		4	SS	35/0.100						
	2.1 - 2.2 2.4 - 2.7		5	SS	35/0.150						
			6	SS	35/0.150		204				
			7	SS	14						1 77 21 1
			8	SS	56		203				
			9	SS	35/0.150		202				0 53 44 3
	AW coring from a depth of 4.9 to 5.3 m										
201.0			10	SS	35/0.150		201				
200.8	End of borehole at 5.6 m and start of DCPT										
5.6											
5.8	END OF DCPT AT 5.8 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

NOTES:

1. A third-weight hammer was used to advance the split spoon sampler. The "N" values presented above have been adjusted to provide an estimate of the "N" value that would have been obtained with a standard hammer.

2. Water level after drilling was 3.1 m. Due to the introduction of water through the drilling methods, it is not representative of a stabilized water level.

3. The cored depth intervals and particle sizes of recovered gravels, cobbles and boulders are summarized as fellows:

Depth (m)	Recovered
0.6 - 0.9	1 x 190 mm, 1 x 70 mm
1.1 - 1.2	Gravels up to 75 mm
1.2 - 1.3	1 x 100 mm, and gravels up to 25 mm

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HEW-01 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM Zone 14: N 5 411 156.3 E 274 917.7 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AN

DATUM Geodetic DATE 2023.01.14 - 2023.01.19 LATITUDE 48.838051 LONGITUDE -93.407109 CHECKED BY CN

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	1.7 - 2.0 1 x 230 mm, 1 x 100 mm 2.1 - 2.2 Gravels and cobbles up to 100 mm 2.4 - 2.7 1 x 220 mm, 1 x 100 mm, and gravels 4.9 - 5.3 Cobbles up to 120 mm 5.3 - 5.5 Gravels up to 20 mm										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

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Ontario

THURBER

RECORD OF BOREHOLE No HEW-02 1 OF 1 METRIC

GWP# 6333-14-00 LOCATION MTM Zone 14: N 5 411 141.4 E 274 903.6 ORIGINATED BY GA

DIST Thunder Bay HWY 17 BOREHOLE TYPE Portable Drilling, Wash Boring, BW Casing Advance, AW Coring COMPILED BY AN

DATUM Geodetic DATE 2023.01.20 - 2023.01.24 LATITUDE 48.837916 LONGITUDE -93.407300 CHECKED BY CN

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa: UNCONFINED (○), FIELD VANE (+), QUICK TRIAXIAL (●), LAB VANE (×)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.2	GROUND SURFACE										
0.0	**TOPSOIL:** (150 mm)		1	SS	50/0.150		206				
0.2	Silty **SAND**, some gravel to **SAND** and **GRAVEL**, trace silt, frequent cobbles and boulders Dense to Very Dense Brown Wet		2	SS	50/0.0						
			3	SS	50/0.0		205				
	AW coring intervals: 0.3 - 0.6		4	SS	50/0.50						
	0.6 - 0.8 0.9 - 1.1 1.3 - 1.5		5	SS	50/0.150						
	1.8 - 2.1 2.1 - 2.3 2.3 - 2.5 2.5 - 2.6		6	SS	50/0.0		204				
			7	SS	33						
							203				
			8	SS	49						
	AW coring intervals: 3.8 - 4.0 4.2 - 4.3		9	SS	50/0.075		202				
201.9											
4.3	END OF BOREHOLE AT 4.3 m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

NOTES:

1. Water level after drilling was 1.9 m. Due to the introduction of water through the drilling methods, it is not representative of a stabilized water level.

2. The cored depth intervals and particle sizes of recovered gravels and cobbles are summarized as follows:

Depth (m)	Recovered
0.3 - 0.6	Gravels up to 75 mm
0.6 - 0.8	1 x 200 mm
0.9 - 1.1	Gravels up to 75 mm
1.3 - 1.5	1 x 140 mm, 1 x 100 mm, and 1 x 60 mm
1.8 - 2.1	Gravels up to 50 mm
2.1 - 2.3	1 x 130 mm, 1 x 80 mm
2.3 - 2.5	Gravels up to 75 mm
2.5 - 2.6	Gravels up to 30 mm
3.8 - 4.0	Gravels up to 40 mm
4.2 - 4.3	1 x 100 mm

$+^3$, $\times^3$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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Appendix C

Borehole Locations Plan

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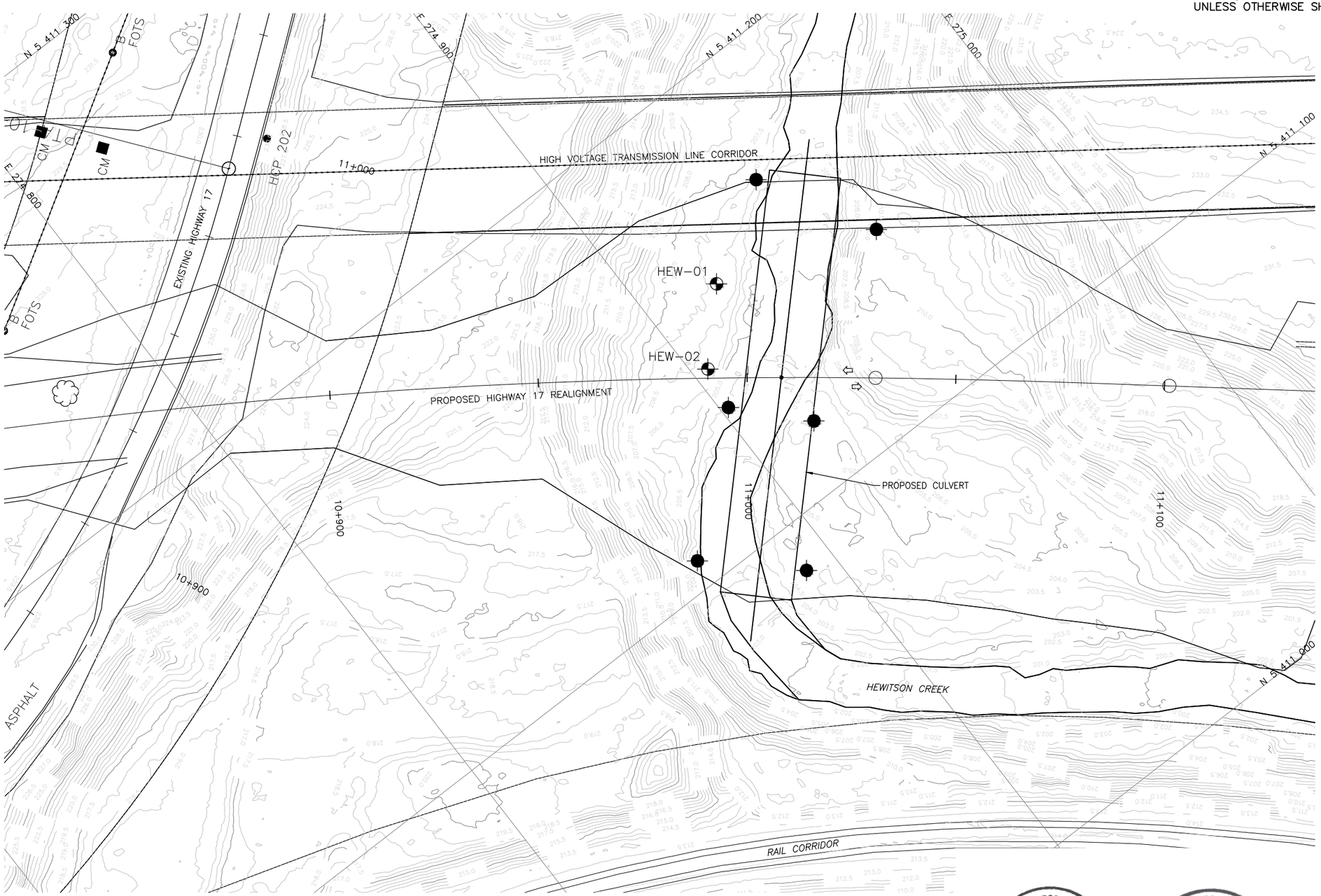
METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



PLAN

20 0 20 40m

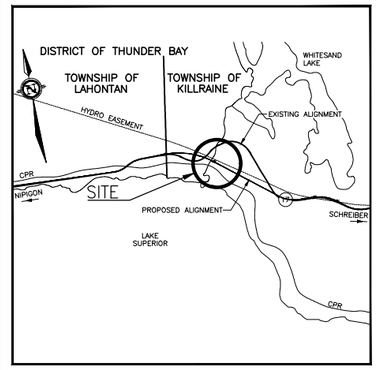
SCALE 1:1000

CONT No
WP No

HIGHWAY 17
REALIGNMENT AT
HEWITSON CREEK CULVERT
BOREHOLE LOCATION PLAN

SHEET

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

Preliminary Borehole Locations (Current)

Recommended Borehole Location For Detail Design

NO	ELEVATION	NORTHING	EASTING
HEW-01	206.6	5 411 156.3	274 917.7
HEW-02	206.2	5 411 141.4	274 903.6

-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.
3) Coordinate system is MTM NAD 83 Zone 14.

GEOCRES No. 42D-071

LICENSED PROFESSIONAL ENGINEER
C.C. NG
100086170
03/27/2023
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
03/27/2023
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MC	CHK	CN	CODE	LOAD
DRAWN	MFA	CHK	PKC	SITE	STRUCT

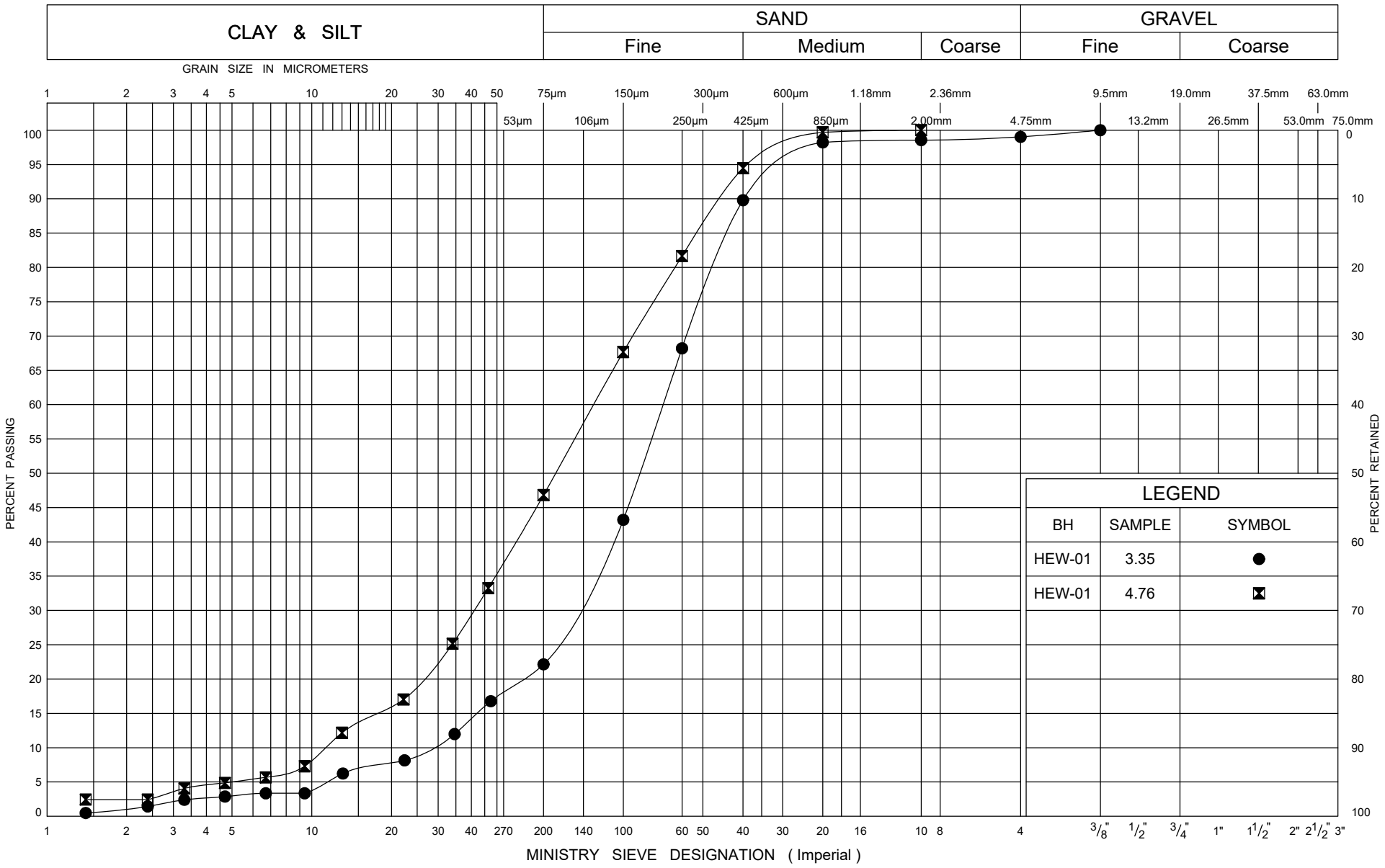
DATE MAR 2023
DWG 1

FILENAME: H:\Drafting\34000\34844\TED-34844-BHPL.dwg
PLOTDATE: 3/27/2023 11:34 AM

THURBER

Appendix D

Geotechnical Laboratory Test Results, and Core Photographs



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Ontario

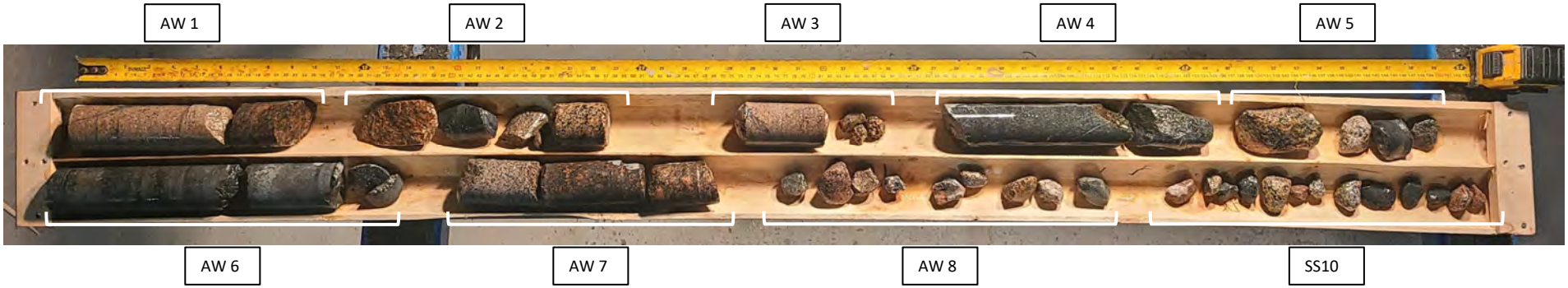
GRAIN SIZE DISTRIBUTION

SILTY SAND

FIG No 1

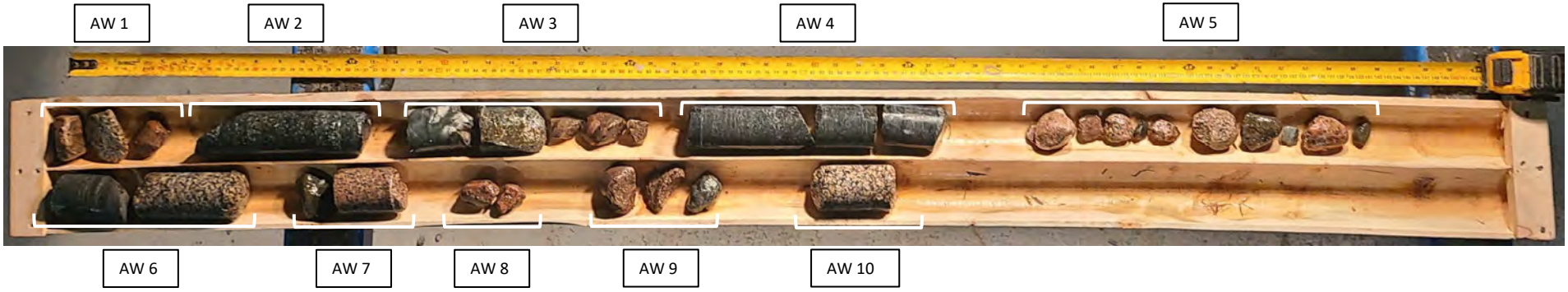
GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 2 MTO-34844.GPJ ONTARIO MOT.GDT 2/22/23



Borehole HEW-01 - Cored Coarse Gravels, Cobbles, and Boulders

AW 1 – 0.6 m to 0.9 m – 1x 190 mm and 1 x 70 mm Cobbles
AW 2 – 1.1 m to 1.2 m – Gravels up to 75 mm
AW 3 – 1.2 m to 1.3 m – 1 x 100 mm Cobble, and Gravels up to 25 mm
AW 4 – 1.7 m to 2.0 m – 1 x 230 mm Boulder, 1 x 100 mm Cobble
AW 5 – 2.1 m to 2.2 m – Gravels and Cobbles up to 100 mm
AW 6 – 2.4 m to 2.7 m – 1 x 220 mm Boulder, 1 x 100 mm Cobble, and gravels
AW 7 – 4.9 m to 5.3 m – Cobbles up to 120 mm
AW 8 – 5.3 m to 5.5 m – Gravels up to 20 mm
SS 10 – 5.5 m to 5.6 m – Gravels up to 20 mm



Borehole HEW-02 - Cored Coarse Gravels, and Cobbles

AW 1 – 0.3 m to 0.6 m – Gravels up to 75 mm
AW 2 – 0.6 m to 0.8 m – 1 x 200 mm Cobble
AW 3 – 0.9 m to 1.1 m – Gravels up to 75 mm
AW 4 – 1.3 m to 1.5 m – 1 x 140 mm Cobble, 1 x 100 mm, and 1 x 60 mm Gravels
AW 5 – 1.8 m to 2.1 m – Gravels up to 50 mm
AW 6 – 2.1 m to 2.3 m –1 x 130 mm and 1 x 80 mm Cobbles
AW 7 – 2.3 m to 2.5 m – Gravels up to 75 mm
AW 8 – 2.5 m to 2.6 m – Gravels up to 30 mm
AW 9 – 3.8 m to 4.0 m – Gravels up to 40 mm
AW 10 – 4.2 m to 4.3 m – 1 x 100 mm Cobble

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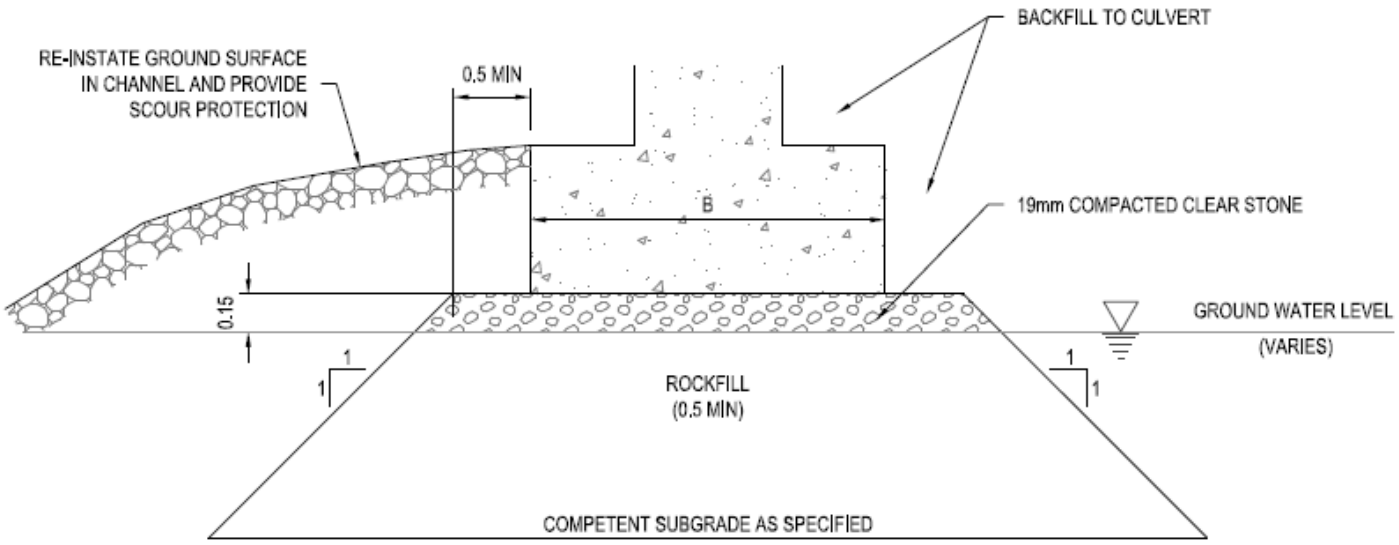
Appendix E

Typical Cross Section of Footings on Rockfill



CROSS-SECTION

NOTES:

1. Remove any topsoil and soft/loose soils under area of rockfill to competent subgrade level as specified.
2. Place rockfill to above groundwater level. Rockfill to have particle size no greater than 150 mm.
3. Rockfill surface should be compacted after rockfill is constructed above water level.
4. Place concrete footing.
5. Re-instate ground surface in channel and provide scour protection.