

February 24, 2020

File No. 1-18-0347-46

Associated Engineering (Ont.) Ltd.
509 Glendale Avenue East, Suite 300
Niagara-on-the-Lake, Ontario
L0S 1J0

Attention: Mr. Mark Torrie, P.Eng., Manager Transportation-Highways

**RE: HYDROGEOLOGICAL INVESTIGATION
OUSE RIVER BRIDGE REPLACEMENT, HIGHWAY 7
MINISTRY OF TRANSPORTATION, ONTARIO
DB-2017-4000, SITE 26-00
GEOCRES NO.**

Dear Sir:

Terraprobe was retained by Associated Engineering (Ont.) Ltd. (AE) on behalf of Aecon Group Inc. (Aecon) to complete a hydrogeological investigation for the replacement of the Ouse River Bridge on Highway 7, Township of Asphodel-Norwood, Peterborough County, Ontario.

The purpose of the hydrogeological investigation is to review the subsurface stratigraphy and shallow ground water conditions in relation to the envisaged construction works and to estimate dewatering volumes during construction. An impact assessment of dewatering on surrounding private water supply wells and natural features was completed. Recommendations are provided for monitoring, mitigation and contingency measures in order to limit the potential impacts of construction dewatering.

1.0 INTRODUCTION

The site (with MTM coordinates of N 4,913,025; E 418,490) is located on Highway 7 approximately 1.1 km east of Peterborough County Road 38 and 280 m west of Asphodel 3rd Line. The existing structure is a $9.1 \pm$ m long and $11.5 \pm$ m wide single-span concrete rigid frame structure. This bridge carries Highway 7 east bound and west bound traffic over the Ouse River. Ouse River meanders through the site flowing from north to south across and below the highway. The site location is shown on the attached Figure 1.

Construction of the new bridge will require excavations for both the east and west bridge abutments. The proposed working point elevations of Highway 7 at the bridge abutments are $198.2 \pm$ m and the underside elevations of the abutments are $194.92 \pm$ m.

Terraprobe Inc.

Greater Toronto:
11 Indell Lane
Brampton, ON L6T 3Y3
Tel: (905) 796-2650
Fax: (905) 796-2250
brampton@terraprobe.ca

Hamilton-Niagara:
903 Barton Street, #22
Stoney Creek, ON L8E 5P5
Tel: (905) 643-7560
Fax: (905) 643-7559
stoneycreek@terraprobe.ca

Central Ontario:
220 Bayview Drive, #25
Barrie, ON L4N 4Y8
Tel: (705) 739-8355
Fax: (705) 739-8369
barrie@terraprobe.ca

Northern Ontario:
1012 Kelly Lake Rd., #1
Sudbury, ON P3E 5P4
Tel: (705) 670-0460
Fax: (705) 670-0558
sudbury@terraprobe.ca

www.terraprobe.ca

2.0 SITE GEOLOGY AND HYDROGEOLOGY

The subsurface soil and ground water conditions were investigated and the results are provided in Terraprobe's report titled *Foundation Investigation and Design Report, Ouse River Bridge Replacement, Highway 7, Ministry of Transportation, Ontario, DB-2017-4000, Site 26-090 Geocres No*, dated November 25, 2019. The investigation consisted of drilling and sampling fifteen boreholes to depths of 3.8 to 12.6 m below ground surface. The approximate borehole locations are provided as Figure 2 and the Record of Borehole Sheets are provided in Appendix A.

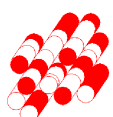
Ground water conditions in the open boreholes were observed throughout the drilling operations and standpipe piezometers were installed in Boreholes 1, 2, 4, 8, 10 and 14 to permit longer term ground water level monitoring. The remaining boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 903 (as amended).

Preliminary subsurface investigations were carried out in May 2014 consisting of six boreholes (BH13-221 to BH13-226). Two additional boreholes (BH17-233 and BH17-235) were completed in January 2017 to supplement the preliminary investigation. A summary of subsurface conditions encountered at the site on the basis of the above noted drilling is summarized below:

2.1 Borehole Locations

A summary of the completed borehole locations are provided in the table below:

Borehole No.	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
Current Investigation				
BH1	4 913 031.1	418 498.3	198.0	12.6
BH2	4 913 028.1	418 471.3	196.7	7.7
BH3	4 912 924.0	418 264.8	196.4	6.6
BH4	4 912 942.0	418 311.6	196.5	6.4
BH5	4 912 960.4	418 358.7	196.6	8.5
BH6	4 912 977.9	418 405.4	196.5	9.6
BH7	4 912 995.8	418 451.3	196.4	7.8
BH8	4 913 020.9	418 514.2	196.7	7.5
BH9	4 913 049.2	418 592.0	196.5	8.9
BH10	4 913 067.9	418 639.1	196.7	5.3
BH11	4 913 086.5	418 685.5	197.2	6.1
BH12	4 913 099.2	418 726.8	197.7	4.9
BH13	4 913120.5	418 778.2	198.9	5.7
BH14	4 913 138.5	418 825.4	200.1	3.8
BH15	4 913 034.2	418 530.2	198.0	9.6
Previous Investigation (Golder 2017)				
BH13-221	4 913 030.9	418 500.7	198.1	9.3
BH13-222	4 913 028.8	418 495.9	198.1	9.9



Borehole No.	MTM NAD 83 Coordinates		Ground Surface Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
BH13-223	4 913 024.3	418 497.9	198.2	12.3
BH13-224	4 913 016.6	418 478.8	198.1	11.9
BH13-225	4 913 021.4	418 476.5	198.1	12.4
BH13-226	4 913 011.5	418 470.0	198.1	7.7
BH17-233	4 913 009.0	418 481.1	196.9	10.4
BH17-235	4 913 034.9	418 492.5	196.8	6.9

The site is located in the physiographic region of Southern Ontario known as the Peterborough Drumlin Fields (Map 2715, Chapman & Putnam, 1984). The drumlins in this area are generally composed of Newmarket Till.

Locally the topography is gently rolling with higher elevations situated both to the east and west of the Ouse River floodplain. The Ouse River floodplain consists of glaciolacustrine and modern deposits of laminated silts and clays as well as interbedded layers of sand. These deposits are generally overlain by variable thicknesses of peat. Based on geologic mapping in the area (Map 2441, Ontario Geological Survey, Ministry of Natural Resources 1979), the local bedrock consists of limestone with minor dolostone and shale of the Trenton and Black River Group.

2.2 Subsurface Conditions

The stratigraphic conditions reported on the attached Record of Borehole Sheets are inferred from non-continuous soil sampling and represent transitions between soil types rather than exact planes of geological change. It is expected that the subsurface conditions will vary between and beyond the borehole locations.

2.2.1 Flexible Pavement

Terraprobe BH1 and Golder BH13-221 to BH13-226 were drilled through the Highway 7 lanes and shoulders. These boreholes encountered a flexible pavement consisting of 100 mm to 300 mm thick asphaltic concrete (where measured) underlain by granular fill consisting of sand and gravel and crushed stone. Crushed stone ranged in thickness between 0.3 m to 1.0 m (encountered to elevations between 196.7 m and 194.4 m). Crushed stone fill was observed to have a loose to compact relative density.

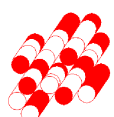
2.2.2 Topsoil & Peat

Topsoil layers ranging in thickness from 85 mm to 255 mm were encountered at the site. Topsoil thickness will vary between and beyond the borehole locations.

Fibrous peat was encountered within Terraprobe boreholes BH3 through to BH10 and BH15. The thickness of peat deposits ranged from 0.7 m to 1.4 m (encountered to elevations ranging from 196.0 m to 194.8 m),

2.2.2 Fill – Sandy Gravel to Gravelly Sand

Deeper layers of fill material ranging in composition from sandy gravel to gravelly sand were encountered



at the site below the flexible pavement. Sandy gravel to gravelly sand fill deposits ranged in thickness from 0.5 m to 1.7 m (extending to elevations between 197.3 m to 195.2 m). Penetration testing indicated sandy gravel to gravelly sand fill was loose to compact in relative density.

2.2.3 Fill – Clayey Silt

Clayey silt fill was encountered at this site within Terraprobe boreholes BH2 and BH15 with thicknesses of 0.4 m and 1.1 m respectively (elevations of 196.0 m and 196.2 m). Standard penetration testing performed in clayey silt fill indicated a very soft to firm relative density.

2.2.4 Organic Silty Sand to Organic Sandy Silt

Deposits ranging in composition from organic silty sand to organic sandy silt were encountered within Terraprobe boreholes BH1 and BH2 and Golder boreholes BH12-221 through to BH13-224 and BH17-233. The thickness of organic silty sand to organic sandy silt ranged from 0.5 m to 1.5 m (extending to elevations between 196.3 m to 194.5 m). Standard penetration testing indicated a very loose to compact relative density.

2.2.5 Silty Clay to Clayey Silt

Underlying fill deposits generally towards the western and eastern extents of the project area soils consisted of silty clay to clayey silt. The site is underlain by a varved silty clay to clay deposit. Silty clay to clayey silt deposits were encountered within Terraprobe boreholes BH1 through to BH5, BH8, BH9, BH11 and BH15 and Golder boreholes BH13-221 through to BH13-223 and BH17-233. The thickness of silty clay to clayey silt deposits ranged from 0.8 m to 2.3 m extending to elevations ranging from 196.5 m to 192.8 m.

Based on the results of Standard Penetration testing the relative density of silty clay to clayey silt deposits is described as very soft to stiff.

2.2.6 Sandy Silt Till to Sandy Gravel Till

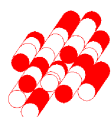
Overlying bedrock at depth soils at the site generally consisted of sandy silt till to sandy gravel till. All boreholes with the exception of Terraprobe borehole BH1 and Golder boreholes BH13-223 to BH13-225 and BH17-233, which were cored into underlying bedrock, encountered sandy silt till to sandy gravel till. Boreholes were generally completed to refusal. The thickness of glacial till soils ranged from 2.9 m to 7.5 m and were encountered to elevations ranging from 196.3 m to 187.6 m.

Completed Standard Penetration testing generally indicated sandy silt till to sandy gravel till had a relative density ranging from compact to very dense.

Hydraulic conductivity testing was carried out on Terraprobe BH2 which was screened within silty sand till deposit. The hydraulic conductivity of this unit was calculated at 1.3×10^{-7} m/s. The well screen for BH3 extended from an elevation of 193.7 m to 192.2 m.

2.2.7 Bedrock

The overburden soils are underlain by limestone bedrock. Summarized below are the depths to bedrock



and the top of bedrock elevations.

Borehole No.	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
BH1	9.2	188.8
BH13-223	9.2	189.0
BH13-224	8.9	189.2
BH13-225	9.4	188.7
BH17-233	8.1	188.8

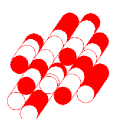
The limestone bedrock is described as slightly weathered to unweathered (fresh) and the bedrock is grey with black shale partings.

2.2.8 Ground Water Levels

The ground water conditions were observed in the boreholes during and upon completion of drilling. Standpipe piezometers were installed in Terraprobe Boreholes 1, 2, 4, 8, 10, and 14, and Golder had installed piezometers in Boreholes 13-226 and 17-233. The recorded water levels as reported on the Record of Borehole sheets are tabulated below.

Borehole No.	Date	Water Levels	
		Depth (m)	Elevation (m)
BH1	August 23, 2018	2.1	195.9
	September 05, 2018	1.9	196.1
BH2	September 05, 2018	0.7	196.0
	October 01, 2018	0.6	196.1
	October 20, 2018	0.5	196.2
BH4	October 01, 2018	0.5	196.0
	October 20, 2018	0.3	196.2
BH8	October 01, 2018	0.7	196.0
	October 20, 2018	0.4	196.3
BH10	October 01, 2018	0.6	196.1
	October 20, 2018	0.4	196.3
BH14	October 01, 2018	2.4	197.7
	October 20, 2018	2.1	198.0
BH13-226	June 03, 2013	1.4	196.7
BH17-233	January 12, 2017	0.1	196.8

In addition to the piezometric water levels, the creek water level reported by AE's surveyors in July 2018 is at elevation 196.0 m. The ground water levels are expected to follow the ground surface topography and can be expected to fluctuate seasonally as well as in response to major weather events. The ground water level will also be controlled by the free water level in the creek and is expected to rise during wet periods of the year.



3.0 LOCAL WATER RESOURCES

The area surrounding the site consists of natural areas including woodlots, the Ouse River floodplain and wetlands, and privately serviced rural residential dwellings. A review of the Ministry of the Environment Conservation and Parks (MECP) well record data base was completed. Three well records were identified along Highway 7 and Asphodel 3rd Line, within a 500 m radius of the site. Based on completed well log data, the soils consisted of clay gravel and sand to depths between 2.1 to 4.3 m overlying limestone bedrock. The table below summarizes the well records located within a 500 m radius of the site:

Well ID	Northing (m)	Easting (m)	Well Depth (m)	Water Level (m)	Pumping Rate (L/min)	Stratigraphy (Depth in m)
5111492	4 914 282.0	732 952.0	20.1	6.4	15.1	Overburden (3.6) Limestone (20.1)
5100084	4 914 736.0	733 429.0	5.2	3.4	11.4	Clay/Gravel (2.1) Limestone (5.2)
7162439	4 914 640.0	733 473.0	4.9	2.0	75.7	Sand/Silt/Clay (4.3) Limestone (4.9)

A review of aerial photography for the site and surrounding vicinity indicated approximately 8 rural residential properties are situated within 500 m of the proposed Ouse River bridge replacement. A map showing locations of the surrounding wells is attached as Figure 3 and the well records are provided in Appendix B.

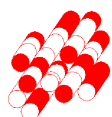
4.0 REQUIREMENTS FOR GROUND WATER CONTROL

It is anticipated that excavations for the Ouse River bridge replacement will extend below the shallow ground water level and active temporary dewatering will be required for construction. It is anticipated that the base of excavations will consist of very loose to soft silt to clayey silty clay deposits. Dewatering requirements for the bridge replacement were analyzed following a Darcy's Law approach. Detailed calculations are provided in Appendix C.

4.1 Dewatering Requirements

Daily ground water taking volumes for open cut excavations at the bridge abutments and approach embankments were estimated based on the following assumptions:

- Estimated hydraulic conductivity values of:
 - 1.0 e-08 m/s for loose/soft silt to clayey silt overlying consolidated glacial till; and
 - 1.3 e-07 m/s for silty sand glacial till.
- A surface water elevation of 196.0 m± in the Ouse River and a ground water elevation of 196.8 m± in the footprint area of the east and west bridge abutments (as measured within BH17-233 in January 2017). The ground elevation in the area of the bridge abutments is 198.2 ± m;
- Open cut excavations extending to elevation 194.92 m± at the east and west bridge abutments. Abutment dimensions are proposed at a length of 15.0 ± m and a width of 1.65 ± m covering an area of 24.75 m². It is expected that a 1.0 m clearance surrounding the abutments will be required for a basal area for abutments of approximately 62.05 m²; and



- The hydraulic gradient was conservatively assumed at 1.0 based on the observed upward gradient between measured ground water and surface water in the vicinity of the Ouse River bridge replacement.

Engineering drawings for the proposed bridge replacement are provided in Appendix D.

Hydraulic conductivity for soils was conservatively assumed at a rate of 1.3×10^{-7} m/s for underlying silty sand till soils. It was considered that loose silt deposits would not significantly reduce the flow of upwelling ground water from the deeper sandy till formations.

Based on the above parameters it is estimated that the ground water dewatering for excavations will be approximately 6,100 L/day for both the east and west bridge abutments. Accounting for rainfall (30 mm daily event), the total daily dewatering volume is estimated at 17,600 L/day for the Ouse River Bridge abutments. Given that excavations will be within loose to soft silt dewatering is recommended to be carried out from a series of well points/eductors completed within the underlying sand till soils around the perimeter of excavations for the abutments to drain silt deposits prior to excavation.

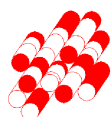
Based on the estimated dewatering volume, a Permit to Take Water (PTTW) will not be required from the Ministry of the proximity of excavations to surface water. Environment Conservation and Parks, (MECP) since for the purposes of construction dewatering, the ground water taking volumes are not expected to exceed 400,000 L/day. An Environmental Activity and Sector Registry (EASR) registration is not expected to be required for the dewatering activities since the ground water taking volumes are not estimated in excess of 50,000 L/day. Notwithstanding, consideration should be given to posting to the MECP EASR as a precaution given the proximity of excavations to the Ouse River. The above dewatering assessment assumes surface water flows will be managed and cut off from entering open excavations through the use of a temporary impervious cut-off all (i.e. cofferdam structure).

The EASR is a registry for dewatering activities managed by the MECP. All information pertaining to the dewatering activities would be available to the MECP through the registry. The EASR posting would be active until which time it is requested to be removed by the applicant. It is anticipated that this Hydrogeological Investigation will form the basis of the supporting documentation required for the EASR application.

It is recommended that the specifications and estimates outlined in this report be reviewed by a dewatering contractor to ensure that the dewatering system is designed appropriately and has sufficient capacity to achieve the target dewatering rates, commensurate with the excavation depths and lateral extent of the excavations.

5.0 IMPACT ASSESSMENT

The following impact assessment is based on the current design information for the Ouse River Bridge replacement provided in this report, and the results of the subsurface investigation. The purpose of the impact assessment is to determine the potential ground water flow that may be encountered during construction, along with potential impacts to surrounding features.



5.1 Radius of Influence

The potential radius of influence arising from ground water taking activities was calculated based on the anticipated drawdown and hydraulic conductivity determined for the site. The calculated radius of influence is estimated to extend a maximum distance of $3.1 \pm \text{m}$ beyond the perimeter of the excavations. The radius of influence will be influenced by the hydraulic conductivity of soils and the upward vertical hydraulic ground water gradients. The radius of influence is limited in extent and structures (other than the existing bridge) and private wells are not located within the estimated radius of influence. Calculations for the radius of influence are provided in Appendix C.

5.2 Geotechnical Impacts of Dewatering

The lowering of ground water levels has the potential to induce ground settlement within the radius of influence. The results of the geotechnical investigation indicate that the site is underlain by a major and relatively impermeable silty clay to clay deposit. Settlement of the subsurface soils due to dewatering operations is expected to be negligible. Since the new bridge will be supported on end bearing H-piles founded either on bedrock or very dense silty sand till, any minimal settlement due to dewatering activities will not adversely affect the performance of the structure.

Settlement can also occur in the event of loss of ground triggered by pumping fines or suspended materials through the dewatering system. Therefore, the dewatering system must be properly designed to ensure that there is no pumping of fines or suspended material.

5.3 Dewatering Impacts on Local Ground Water Resource

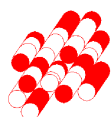
As summarized in Section 3.0 above, private water supply wells are completed within limestone bedrock. The maximum excavation depth subjected to dewatering operations at the bridge site is anticipated to be 4.3 m below ground surface. Since private ground water supply wells are not known to be located within the anticipated zone of influence of the dewatering work, impacts to ground water supply wells are not expected.

5.4 Dewatering Impacts on Surface Water

Ground water from dewatering operations is expected to be discharged to the Ouse River. It is anticipated that dewatering will be temporary in nature and not result in long term impacts to surface water features. The dewatering discharge shall be directed to surface water features downstream of the bridge crossing. During construction, inspection of the river channel downstream of the site is recommended for signs of erosion due to the discharge of ground water.

5.5 Discharge of Water

Dewatering discharge from ground water control activities shall be directed overland to the Ouse River. Regular inspection and water quality sampling at the point where discharge enters surface water is required to confirm compliance of ground water discharge quality with the Provincial Water Quality Objectives (PWQO). Ground water discharge shall be clear and free of sediment, sheen or foam. Measures shall be implemented such as rock check dams and hay bales to prevent erosion and channelization of discharge flows. In the event that erosion is noted the discharge location shall be



changed.

6.0 MONITORING AND CONTINGENCY PLAN

The results of the study and impact analysis indicate significant impacts are not anticipated as a result of ground water control activities for the Ouse River Bridge replacement. Nonetheless, it is important to maintain records to ensure that any unforeseen impacts are properly identified and appropriate contingency measures can be implemented.

Record keeping shall be conducted over the duration of the ground water control activities. Records shall include the following:

- Daily records of the current location, depth and extent of all excavations on the site;
- Daily records of water taking including time and rate of pumping;
- Inspection of discharge from the ground water control system on an hourly basis for evidence of visible suspended solids or silt; and,
- Daily inspection of excavation activities for the potential presence of deleterious materials which may result in an impact to water quality.

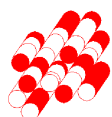
In the event that significant fines are noted in the ground water discharge, the pumping shall be stopped immediately and proper control measures shall be implemented to prevent the movement of fines.

Dewatering volumes include pumping to remove accumulated precipitation runoff from open excavations for the daily maximum of 30 mm. In the event that daily precipitation exceeds this amount it is recommended to stop construction work and pump excavations at the maximum allowed rate (i.e. 50,000 L/day without EASR, 400,000 L/day with EASR) until which time standing water within open excavations are removed.

7.0 SUMMARY

Based on the results of the study, the following summary and conclusions are made:

- Excavations for the east and west bridge abutments are proposed at a length of $15.0 \pm \text{m}$ and a width of $1.65 \pm \text{m}$ covering an area of 24.75 m^2 . It is expected that a 1.0 m clearance surrounding the abutments will be required resulting in a basal area of $62.05 \pm \text{m}^2$ for abutment excavations.
- Shallow ground water levels are expected at an elevation of $196.8 \pm \text{m}$. The dewatering target for construction dewatering is approximately 1.0 m below the base of excavations at an elevation of $193.92 \pm \text{m}$ for bridge abutments.
- It is anticipated that excavations will be completed within loose silt deposits with a hydraulic conductivity estimated at $1.3 \times 10^{-7} \text{ m/s}$.
- Land use in the vicinity of the site consists of rural residential properties privately serviced. Three well records were identified within a 500 m radius of the site. The private wells are reported to be completed to depths between 4.9 m to 20.1 m within limestone bedrock.
- Dewatering estimates were calculated based on a Darcy approach given the observed site conditions and construction requirements. Including removal of precipitation (30 mm rainfall event) falling excavated areas, the total dewatering volume (including precipitation) is anticipated at 17,600 L/day.



- It is recommended that the project be posted to the Ministry of the Environment Conservation and Parks Environmental Activity and Sector Registry as a precaution given the proximity of excavations to the Ouse River. Dewatering estimates assume that surface water flows will be managed and cut-off from entering open excavations.
- The radius of influence associated with the ground water control activities is estimated at approximately 3.1 m. Significant structures and private water supply wells are not expected to be situated within the predicted radius of influence for construction dewatering.
- It is expected that the dewatering discharge will be directed overland to Ouse River downstream of the site. Regular inspection and water quality sampling is recommended at the point of discharge to surface water. Discharge should be appropriately managed to limit erosion at the point of discharge and within the river channel.
- Impacts of dewatering including ground settlement, impacts to private wells and surface water features are not anticipated.
- A program of monitoring during construction is recommended. The monitoring should include frequent inspection of the excavation and discharge water. Detailed records should be maintained regarding excavation progress and pumping rates and volumes.

We trust this information is sufficient for your present purposes. Should you have any questions concerning the above, please do not hesitate to contact the undersigned.

Yours truly,

Terraprobe Inc.



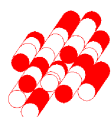
Paul L. Raepple, P.Geo.
Hydrogeologist



Rehman Abdul, M.S., P.Eng.
Principal, Transportation &
Infrastructure



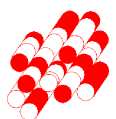
Michael Tanos, P.Eng.
MTO Designated Contact



Enclosures

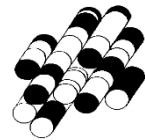
Figure 1 – Site Location Plan
Figure 2 – Borehole Location Plan
Figure 3 – Dewatering and Private Well Location Plan

Appendix A – Borehole Logs
Appendix B –Ministry of the Environment Conservation and Parks Well Records
Appendix C – Dewatering Analysis
Appendix D - Engineering Drawings



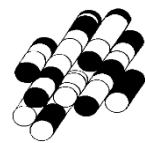
ENCLOSURES

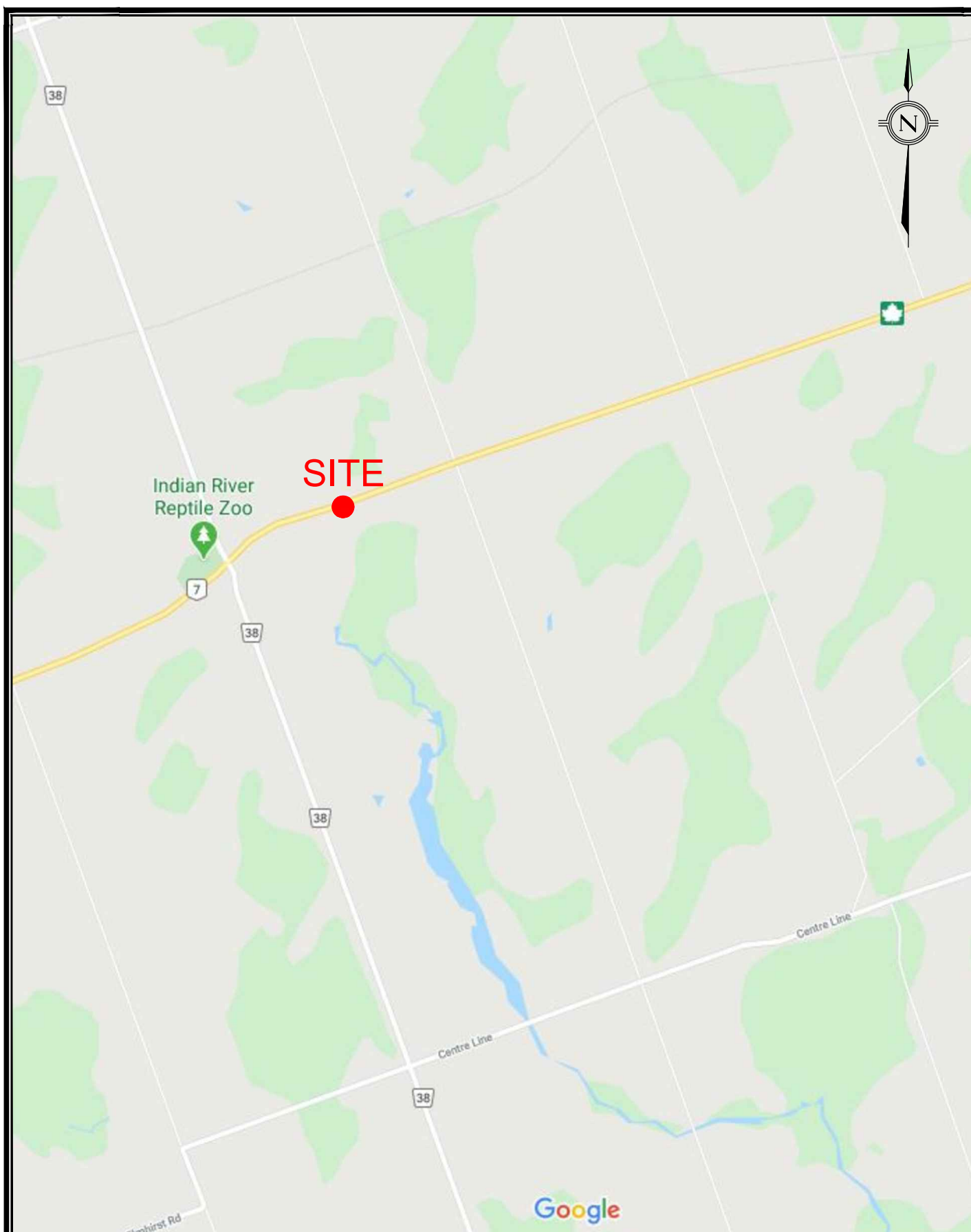
Terraprobe Inc.



FIGURES

Terraprobe Inc.





Terraprobe

903 Barton Street - Unit 22, Stoney Creek, Ontario, L8E 5R7
Tel: (905) 643-7560, Fax: (905) 643-7559

Title:

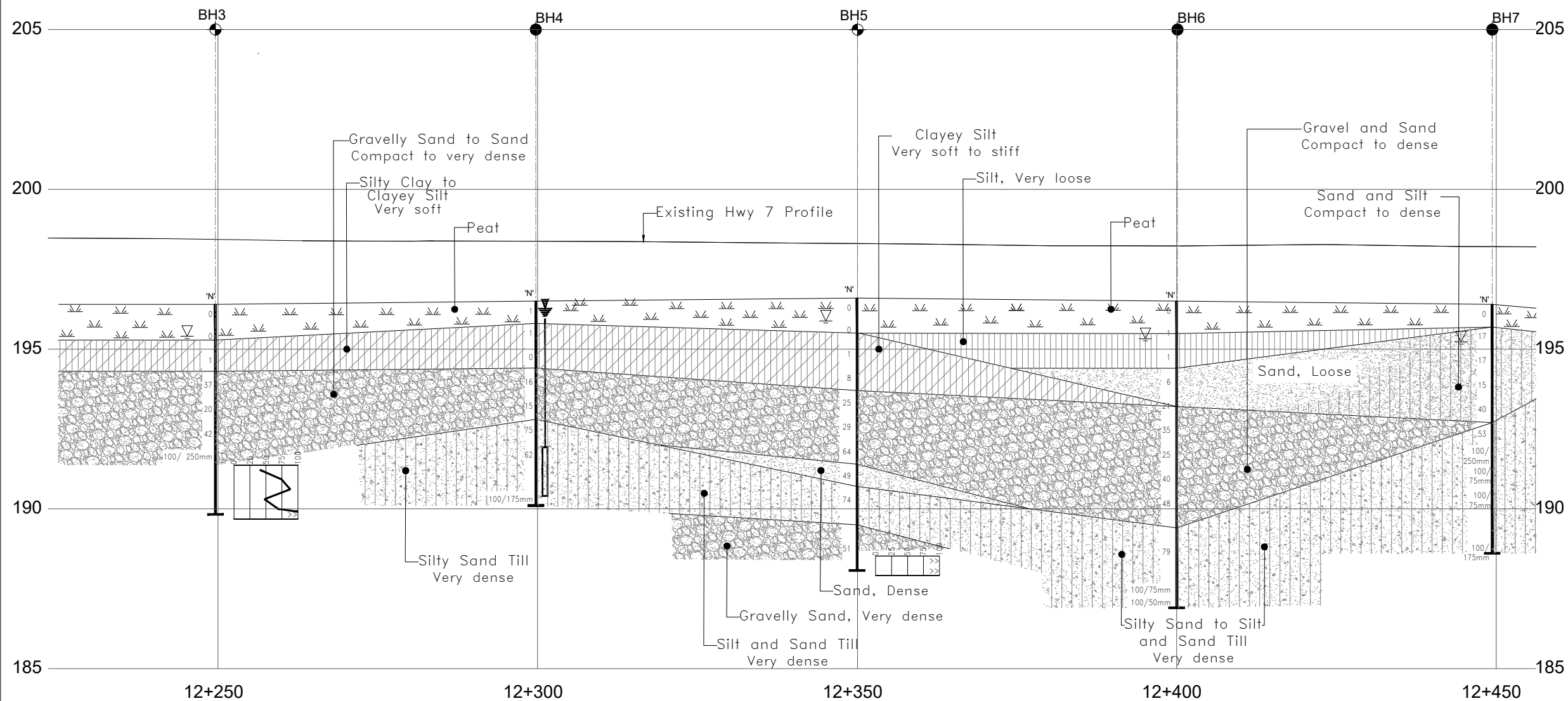
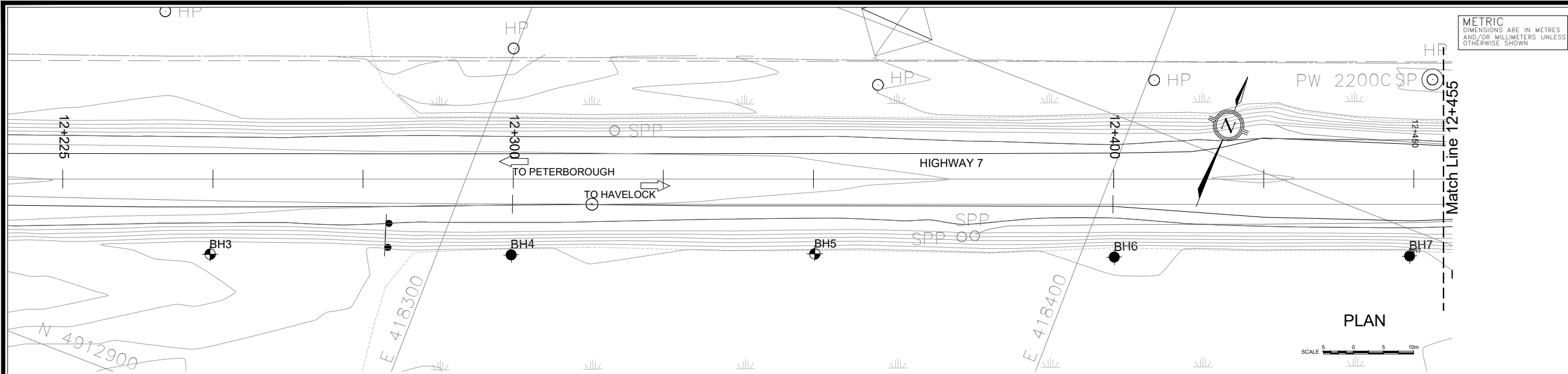
SITE LOCATION PLAN

File No.

1-18-0347-46

FIGURE :

1



GWP No. 4126-10-00
CONT DB 2017-4000

HWY 7
OUSE CREEK
BOREHOLE LOCATIONS AND SOIL STRATA
(PROFILE RIGHT OF CENTRE LINE)

AE **AECOM**

Terraprobe Inc.
Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing
11 Indell Lane - Brampton Ontario L6T 3Y3 (905) 796-2650

LEGEND

- Bore Hole
- Bore Hole And Cone
- Hand Augerhole
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60" Cone, 475 J/blow)
- WL at Time of Investigation
- WL in Piezometer
- Piezometer
- Rock Quality Designation
- Auger Refusal

BH No.	ELEV. (m)	COORDINATES (MTM, ZONE 10)	
		NORTHING (m)	EASTING (m)
1	198.0	4 913 031.1	418 498.3
2	196.7	4 913 028.1	418 471.3
3	196.4	4 912 924.0	418 264.8
4	196.5	4 912 942.0	418 311.6
5	196.6	4 912 960.4	418 358.7
6	196.5	4 912 977.9	418 405.4
7	196.4	4 912 995.8	418 451.3
8	196.7	4 913 020.9	418 514.2
9	196.5	4 913 049.2	418 592.0
10	196.7	4 913 067.9	418 639.1
11	197.2	4 913 086.5	418 685.5
12	197.7	4 913 099.2	418 726.8
13	198.9	4 913 120.5	418 778.2
14	200.1	4 913 138.5	418 825.4
15	198.0	4 913 034.2	418 530.2
13-221	198.1	4 913 030.9	418 500.7
13-222	198.1	4 913 028.8	418 495.9
13-223	198.2	4 913 024.3	418 497.9
13-224	198.1	4 913 016.6	418 478.8
13-225	198.1	4 913 021.4	418 476.5
13-226	198.1	4 913 011.5	418 470.0
13-233	196.9	4 913 009.0	418 481.1
13-235	196.8	4 913 034.9	418 492.5

NOTE

This drawing is for subsurface information only. The proposed structure details/works if shown are for illustration purposes only and may not be consistent with final design configuration as shown elsewhere in the contract documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview.

Information contained in this report and related documents are specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

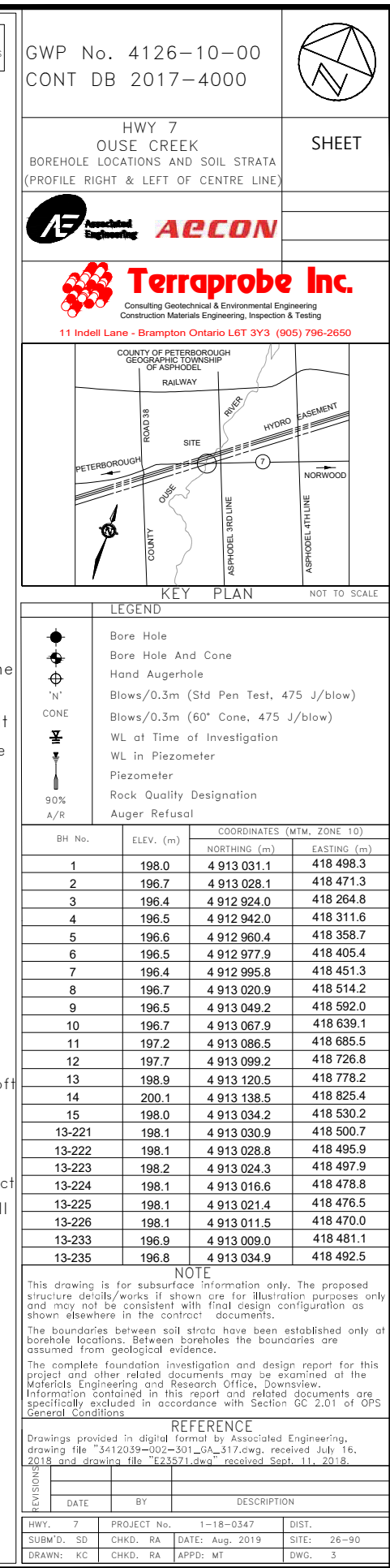
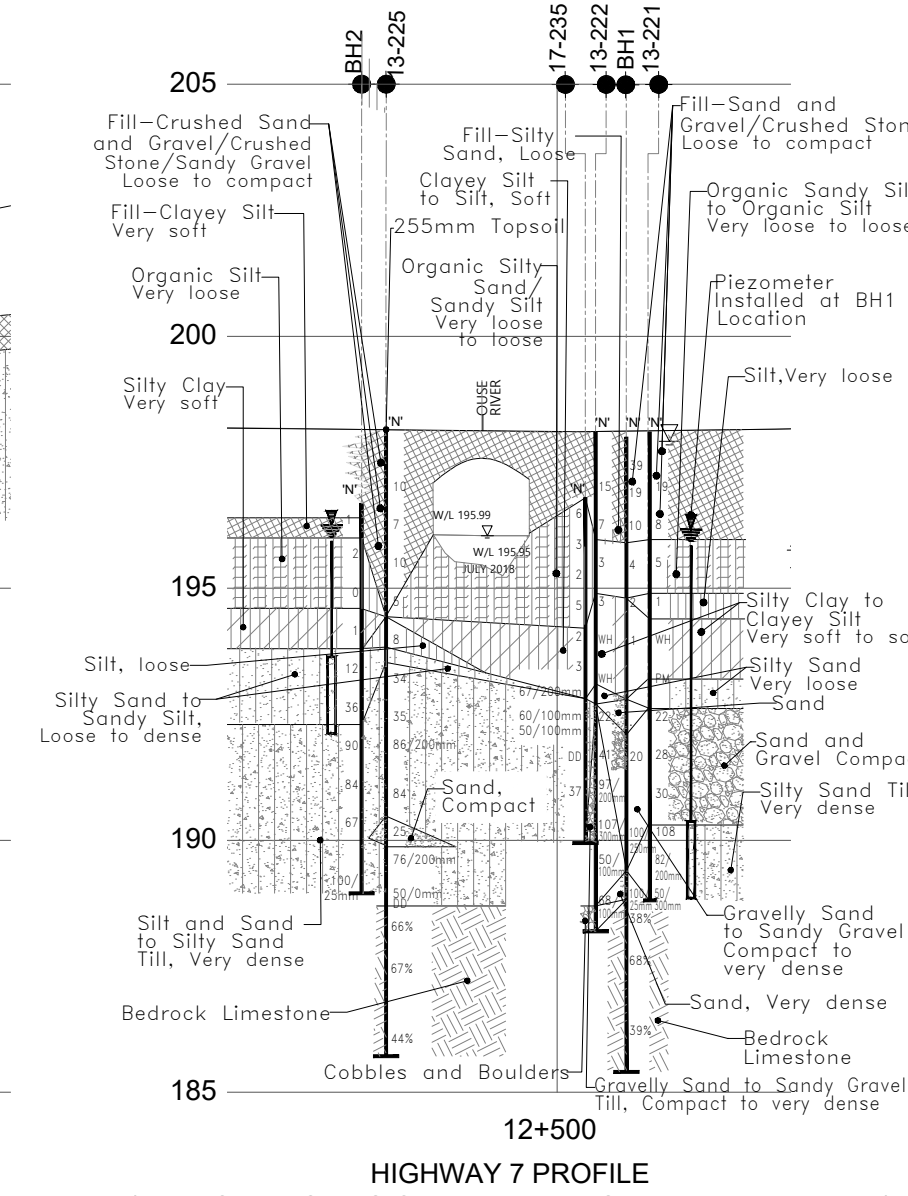
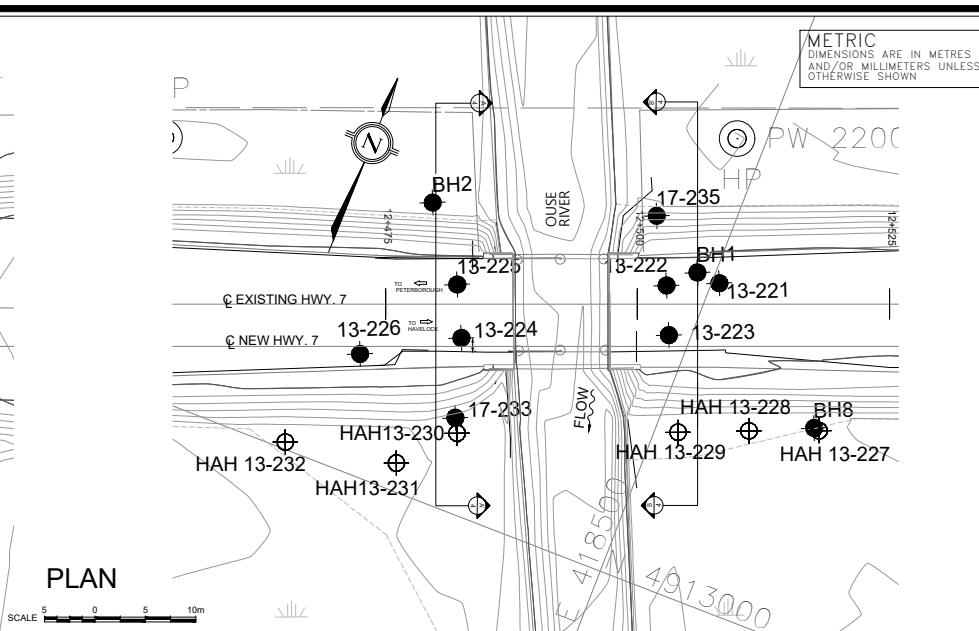
REFERENCE

Drawings provided in digital format by Associated Engineering, drawing file "3412039-002-501_GA_317.dwg, received July 16, 2018 and drawing file "E23571.dwg" received Sept. 11, 2018.

REVISION	DATE	BY	DESCRIPTION

HWY.	PROJECT No.	1-18-0347	DIST.
SUBM'D. SD	CHKD. RA	DATE: Aug. 2019	SITE: 26-90
DRAWN: KC	CHKD. RA	APPD: MT	DWG. 1

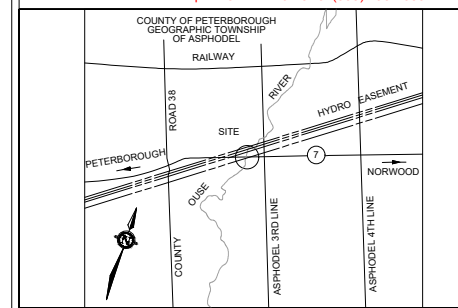
Z:\Project Files\2018\18-0347 - Etk Creek Hwy 28 Peterborough\3 Three Structure Replacements (MTOIA Dwg).
Log\Ouse Creek\Ouse Creek KC\18-0347 Ouse Creek (2019-07-31).dwg, kama



Z:\1-Project Files\2018\1-18-0347 - Eels Creek, Hwy 28, Peterborough\1-Three Structure Replacements (MTO)\A. Dwgs, 180347\005\0use Creek\0use Creek KCV1-18-0347 0use Creek (2019-07-31).dwg, Kamal



SHEET



KEY PLAN NOT TO SCALE

LEGEND	
	Bore Hole
	Bore Hole And Cone
	Hand Augerhole
	Blows/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
	WL at Time of Investigation
	WL in Piezometer
	Piezometer
90°	Rock Quality Designation
A/R	Auger Refusal

BH No.	ELEV. (m)	COORDINATES (MTM, ZONE 10)	
		NORTHING (m)	EASTING (m)
1	198.0	4 913 031.1	418 498.3
2	196.7	4 913 028.1	418 471.3
3	196.4	4 912 924.0	418 264.4
4	196.5	4 912 942.0	418 311.6
5	196.6	4 912 960.4	418 358.7
6	196.5	4 912 977.9	418 405.4
7	196.4	4 912 995.8	418 451.3
8	196.7	4 913 020.9	418 514.2
9	196.5	4 913 049.2	418 592.0
10	196.7	4 913 067.9	418 639.1
11	197.2	4 913 086.5	418 685.5
12	197.7	4 913 099.2	418 726.8
13	198.9	4 913 120.5	418 778.2
14	200.1	4 913 138.5	418 825.4
15	198.0	4 913 034.2	418 530.2
13-221	198.1	4 913 030.9	418 500.7
13-222	198.1	4 913 028.8	418 495.9
13-223	198.2	4 913 024.3	418 497.9
13-224	198.1	4 913 016.6	418 478.8
13-225	198.1	4 913 021.4	418 476.5
13-226	198.1	4 913 011.5	418 470.0
13-233	196.9	4 913 009.0	418 481.1
13-235	196.8	4 913 034.9	418 492.5

NOTE

This drawing is for subsurface information only. The proposed structure details/works if shown are for illustration purposes only and are not to be considered with the final design configuration as shown elsewhere in the contract documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed to vary linearly from given data points.

The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering and Construction Department, Townsville City Council. Information contained in this report and related documents are specifically excluded in accordance with Section GC 2.01 of OP 2.0.

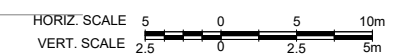
REFERENCE				
Drawings provided in digital format by Associated Engineering, drawing file "5412039-002-301_GA_317.cwg, received July 16, 2018 and drawing file "E25571.dwg received Sept. 11, 2018.				
REVISION	DATE	BY	DESCRIPTION	
HWY.	7	PROJECT No.	1-18-0347	DIST.
SUBM'D.	SD	CHKD. RA	DATE: Aug. 2019	SITE: 26-90
DRAWN:	KC	CHKD. RA	APPD: MT	DWG. 4

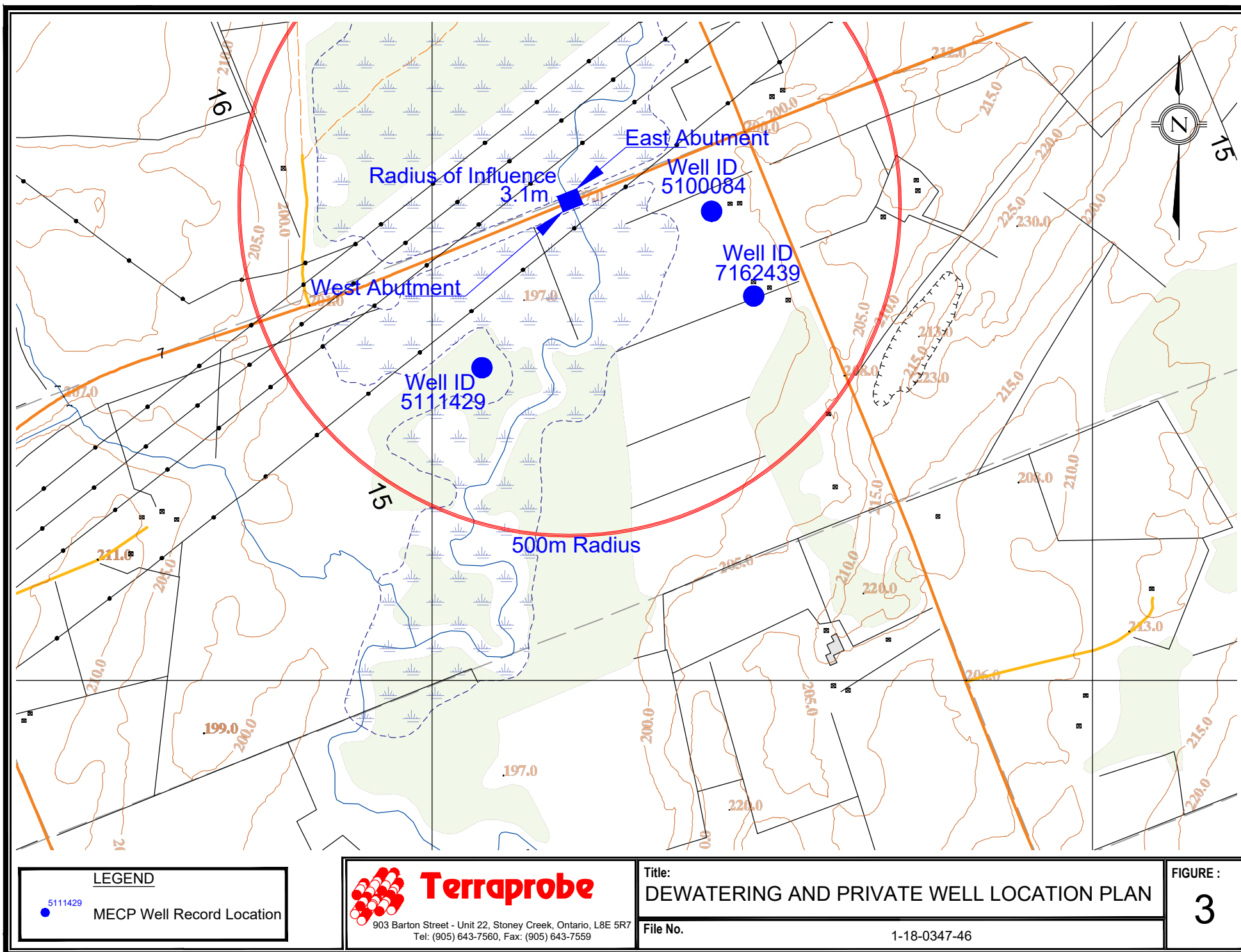


SECTION A-A'



SECTION B-B'

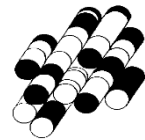




Borehole Logs

APPENDIX A

Terraprobe Inc.



EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_{α}	1	RATE OF SECONDARY CONSOLIDATION
C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	- °	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	- °	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_r	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1.0%	VOID RATIO	e_{min}	1.0%	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1.0%	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1.0%	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_S	%	SHRINKAGE LIMIT	q	m ² /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $(w_L - w_p)$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(w - w_p)/I_p$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $(w_L - w)/I_p$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1.0%	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418498.3 N:4913031.1 ORIGINATED BY NG
DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS, CASING AND WASH BORING, NQ ROCK CORING COMPILED BY SD
DATUM GEODETIC DATE 2018-8-8 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE		20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
198.0	GROUND SURFACE												
197.7	250mm ASPHALTIC CONCRETE												
0.3	FILL, sand and gravel, trace to some silt, loose to dense, brown, moist		1	SS	39								
			2	SS	19								
			3	SS	10								
195.9	ORGANIC SILT, some clay, trace sand, very loose, dark grey, wet		4	SS	4							76	
194.8	CLAYEY SILT, trace sand, trace organics, very soft, grey, wet		5	SS	2								
3.2			6	SS	1								0 8 79 13
192.8	SAND, trace to some silt, trace gravel, trace clay, brown, wet		7	AS			1.6						3 85 10 2
192.1	GRAVELLY SAND to SANDY GRAVEL, trace to some silt, trace clay, compact to very dense, brown, wet		8	SS	20								
5.9			9	SS	100/250mm								54 35 9 2 Sample wet at 7.6m. Resistance to augering from 8.2m to 8.5m.
189.4	SAND, some silt, trace gravel, very dense, brown, wet		10	SS	100/25mm NQ								commence casing washboring
8.6			1	RUN									Run #1 TCR: 81% SCR: 65% RQD: 38% UCS*: 77.5-104.6 MPa
188.8	LIMESTONE BEDROCK Unweathered, grey, interbedded with shale seams, weak to very strong, joints are planar, rough, closed to gapped		2	RUN	NQ								Run #2 TCR: 88% SCR: 86% RQD: 68% UCS*: 12.1-124.3 MPa
9.2			3	RUN	NQ								Run #3 TCR: 91% SCR: 85% RQD: 39% UCS*: 89.4-138.4 MPa
185.4	END OF BOREHOLE												
12.6													

Piezometer installation consists of a 50 mm diameter PVC pipe with a 1.5m slotted screen.
Unable to push Shelby tube below 5.2m, Auger sample collected.
*Uniaxial Compressive Strengths determined from Point Load Strength Index values.

WATER LEVEL READINGS		
Date	Water Depth (m)	Elevation (m)
Aug 23, 2018	2.1	195.9
Sep 5, 2018	1.9	196.1

RECORD OF BOREHOLE No 2

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418471.3 N:4913028.1 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-29 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			20 40 60 80 100											
								SHEAR STRENGTH (kPa)											
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE											
20 40 60 80 100								PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT											
								W _p W W _L											
								WATER CONTENT (%)											
196.7	GROUND SURFACE																		
196.4	255mm TOPSOIL		1	SS	1														
0.3	FILL, clayey silt, trace to some sand, trace gravel, trace to some organics, very soft, grey, wet																		
196.0																			
0.7																			
	ORGANIC SILT, very loose, dark brown to black, wet		2	SS	2														
			3	SS	0*								93						
194.6	SILTY CLAY, trace sand, trace organics, very soft, grey, wet																		
2.1																			
			4	SS	1									42					
193.8	SILTY SAND, some gravel, trace clay, compact to dense, brown, wet																		
2.9																			
				5	SS	12													
			6	SS	36														
192.3	SILT AND SAND, some gravel to gravelly, trace clay, very dense, grey, wet (GLACIAL TILL)																		
4.4																			
				7	SS	90													
				8	SS	84													
			9	SS	67														
189.0			10	SS	100 / 25mm														
7.7																			

END OF BOREHOLE

Borehole was dry and open
completion of drilling.

*Sampler sinking under weight of
hammer and/or rods.

Piezometer installation consists of a
50mm diameter PVC pipe with a 1.5m
slotted screen

Auger refusal at 7.7m below ground
surface, unable to extend the borehole
deeper with hollow stem augers.

Dynamic cone penetration test
(DCPT) performed at 1.7m, 80 blows /
25mm penetration.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Sep 5, 2018	0.7	196.0
Oct 1, 2018	0.6	196.1
Oct 20, 2018	0.5	196.2

METRIC[illegible]

*Sampler sinking under weight of hammer and/or rods.

+³, ×³: Numbers refer to Sensitivity **○^{3%}** STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418311.6 N:4912942.0 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-31 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			20 40 60 80 100							w _p w w _L					
								SHEAR STRENGTH (kPa)								WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
196.5	GROUND SURFACE																			
195.8	PEAT, fibrous, black		1	SS	1		196						265	○	sampler wet at 0.8m					
0.7	SILTY CLAY to CLAYEY SILT, trace sand, very soft, grey, wet		2	SS	1		195									0 7 79 14				
194.4			3	SS	0*															
2.1	GRAVELLY SAND to SAND, some gravel, trace silt, trace clay, compact, grey, wet		4	SS	16		194													
			5	SS	15										19 70 9 2					
192.8	SILTY SAND, trace clay, trace gravel, very dense, grey, wet (GLACIAL TILL)		6	SS	75		193													
3.7			7	SS	62		192								0 76 20 4					
							191													
190.2			8	SS	100/175mm															
190.1																				

Dynamic cone penetration test (DCPT) performed from 6.3m to 6.4m, 185 blows / 100mm penetration.

END OF BOREHOLE

Borehole was dry and open completion of drilling.

*Sampler sinking under weight of hammer and/or rods.

Piezometer installation consists of a 50mm diameter PVC pipe with a 1.5m slotted screen

WATER LEVEL READINGS









Date	Water Depth (m)	Elevation (m)
Oct 1, 2018	0.5	196.0
Oct 20, 2018	0.3	196.2

RECORD OF BOREHOLE No 5

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418358.7 N:4912960.4 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-30 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)						
								20	40	60	80	100		
196.6	GROUND SURFACE													
195.5 1.1	PEAT, fibrous, black		1	SS	0*								99	sampler wet at 1.5m
			2	SS	0*									
193.7 2.9	CLAYEY SILT, some sand, trace gravel, trace to some organics, very soft to stiff, grey, wet		3	SS	1									2 13 71 14
			4	SS	8									
191.4 5.2	GRAVELLY SAND, some silt, trace clay, containing sand seams, compact to very dense, grey, wet		5	SS	25									30 55 12 3 resistance to augering from 4.4m to 4.9m
			6	SS	29									
190.7 5.9	SAND, trace silt, dense, brown, wet		7	SS	64									1 37 50 12
189.5 7.1	SILT AND SAND, some clay, trace gravel, very dense, grey, wet (GLACIAL TILL)		8	SS	49									
188.5 8.1	GRAVELLY SAND, trace to some silt, very dense, grey, wet		9	SS	74									
188.1	Dynamic cone penetration test (DCPT) performed from 8.1m to 8.5m.		10	SS	51									

END OF BOREHOLE

Unstabilized water level measured at 0.8m below ground surface; borehole caved at 3.2m below ground surface upon completion of drilling.

*Sampler sinking under weight of hammer and/or rods.

RECORD OF BOREHOLE No 6

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418405.4 N:4912977.9 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-30 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			20 40 60 80 100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
								SHEAR STRENGTH (kPa)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
W _p W W _L																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
WATER CONTENT (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
196.5	GROUND SURFACE																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
195.5 1.0	PEAT, fibrous, black		1	SS	0*		196																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										

END OF BOREHOLE

Unstabilized water level measured at 1.2m below ground surface; borehole caved at 2.5m below ground surface upon completion of drilling.

*Sampler sinking under weight of hammer and/or rods.

Auger refusal at 9.6m below ground surface, unable to extend the borehole deeper with hollow stem augers.

RECORD OF BOREHOLE No 7

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418451.3 N:4912995.8 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-30 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)							WATER CONTENT (%)		
								20 40 60 80 100							w _p w w _L		
								○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE x LAB VANE							WATER CONTENT (%)		
196.4	GROUND SURFACE																
195.7	PEAT, fibrous, black		1	SS	0*		196										
0.7	SAND AND SILT, trace clay, trace gravel, compact to dense, grey, wet		2	SS	17		195							sampler wet at 0.8m			
			3	SS	17		194										
			4	SS	15		193										
			5	SS	40		192										
192.7	SANDY SILT to SILT AND SAND, trace clay, trace gravel, very dense, grey, wet (GLACIAL TILL)		6	SS	53		191							4 35 55 6			
3.7			7	SS	100/ 250mm		190							resistance to augering from 4.7m to 7.2m			
			8	SS	100 / 75mm		189										
			9	SS	100 / 75mm												
188.6			10	SS	100/ 75mm												
7.8																	

END OF BOREHOLE

Unstabilized water level measured at 1.2m below ground surface; borehole caved at 3.1m below ground surface upon completion of drilling.

*Sampler sinking under weight of hammer and/or rods.

Auger refusal at 7.8m below ground surface, unable to extend the borehole deeper with hollow stem augers.

RECORD OF BOREHOLE No 8

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418514.2 N:4913020.9 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-28 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			20 40 60 80 100																
								SHEAR STRENGTH (kPa)																
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE																
								20 40 60 80 100					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT											
													W _p W W _L											
													WATER CONTENT (%)											
196.7	GROUND SURFACE																							
	PEAT, fibrous, black		1	SS	0*																			
196.0	SAND AND SILT, trace clay, trace organics, very loose, grey, wet		2	SS	4										sampler wet at 0.8m									
195.3																								
194.6	SILT, trace to some clay, trace sand, trace organics, loose, grey, wet		3	SS	5									42	0 6 84 10									
193.0	SILTY CLAY, trace sand, very soft to firm, grey, wet		4	SS	5																			
			5	SS	1										0 4 76 20									
191.2	SAND AND GRAVEL, trace silt, trace clay, containing sand seams, compact to very dense, grey, wet		6	SS	18										44 48 7 1									
																resistance to augering from 4.6m to 7.5m								
			7	SS	100/ 225mm																			
189.2	SILTY SAND, gravelly, trace clay, very dense, grey, wet (GLACIAL TILL)		8	SS	100/ 275mm										25 43 25 7									
187.5	END OF BOREHOLE		9	SS	100/ 25mm																			

WATER LEVEL READINGS

END OF BOREHOLE

Piezometer installation consists of a 50mm diameter PVC pipe with a 1.5m slotted screen.

*Sampler sinking under weight of hammer and/or rods.

Auger refusal at 7.5m below ground surface, unable to extend the borehole deeper with hollow stem augers.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 1, 2018	0.7	196.0
Oct 20, 2018	0.4	196.3

RECORD OF BOREHOLE No 9

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418592.0 N:4913049.2 ORIGINATED BY NG
DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
DATUM GEODETIC DATE 2018-8-28 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)					WATER CONTENT (%)					
								20 40 60 80 100					w _p w w _L					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
196.5	GROUND SURFACE																	
195.8	PEAT, fibrous, black		1	SS	0*		196								99	sampler wet at 0.8m		
0.7	SAND AND SILT, trace clay, trace to some organics, very loose, grey, wet		2	SS	4		195											
195.1	SILTY CLAY to CLAYEY SILT, trace sand, very soft to firm, grey, wet		3	SS	0*		194										0 5 77 18	
1.4			4	SS	1												0 3 75 22	
			5	SS	5													
			6	SS	26													
192.8	SAND AND GRAVEL, trace to some silt, trace clay, containing sand seams, compact to dense, grey, wet		7	SS	43		192											5 84 8 3
3.7			8	SS	32													resistance to augering from 5.2m to 6.7m 40 45 12 3
190.6	SILTY SAND, some gravel, trace clay, very dense, grey, moist (GLACIAL TILL)		9	SS	100 / 150mm		191											
5.9			10	SS	100 / 75mm	190												
			11	SS	70 / 25mm	189												
187.6							188											
8.9																		

RECORD OF BOREHOLE No 10

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418639.1 N:4913067.9 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-28 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE					SHEAR STRENGTH (kPa)													
										20 40 60 80 100													
										20 40 60 80 100													
					+ FIELD VANE X LAB VANE					WATER CONTENT (%)													
					W _p W W _L																		
					10 20 30																		
196.7	GROUND SURFACE																						
196.0	PEAT, fibrous, black		1	SS	1																		
0.7	SANDY SILT, some clay, some organics, very loose to loose, grey to 2.1m, brown below, wet		2	SS	5																		
			3	SS	7																		
			4	SS	4																		
			5	SS	29																		
194.0	SILT AND SAND, some gravel, trace clay, compact to very dense, grey, wet (GLACIAL TILL)		6	SS	100/ 200mm																		
2.7			7	SS	100/ 175mm																		
			8	SS	100/ 25mm																		
191.4	END OF BOREHOLE																						
5.3																							

</

END OF BOREHOLE

Borehole was dry and open completion of drilling.

Piezometer installation consists of a 50mm diameter PVC pipe with a 1.5m slotted screen

Auger refusal at 5.3m below ground surface, unable to extend the borehole deeper with hollow stem augers.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 1, 2018	0.6	196.1
Oct 20, 2018	0.4	196.3

RECORD OF BOREHOLE No 11

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418685.5 N:4913086.5 ORIGINATED BY NG
DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
DATUM GEODETIC DATE 2018-8-27 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)					WATER CONTENT (%)						
								20 40 60 80 100					w _p w w _L						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)						
197.2	GROUND SURFACE																GR SA SI CL		
197.0	205mm TOPSOIL		1	SS	1		197												
0.2	CLAYEY SILT, trace sand, trace to some organics, very soft, brown, moist																		
196.5	SILTY SAND to SILT AND SAND, trace clay, loose to compact, brown, wet		2	SS	11		196										sampler wet at 0.8m		
0.7																	0 37 58 5		
			3	SS	6														
							195												
			4	SS	27												0 56 36 8		
194.5	SILTY SAND, some gravel to gravelly, trace clay, very dense, grey, wet (GLACIAL TILL)																		
2.7			5	SS	100/ 250mm		194												
			6	SS	100/ 150mm														
			7	SS	100/ 150mm		193												
																	resistance to augering from 4.7m to 5.5m		
							192												
191.1																			
6.1			8	SS	100 / 25mm														
END OF BOREROLE																			

END OF BOREHOLE

Unstabilized water level measured at 3.7m below ground surface; borehole caved at 4.6m below ground surface upon completion of drilling.

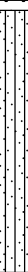


Auger refusal at 6.1m below ground surface, unable to extend the borehole deeper with hollow stem augers.

RECORD OF BOREHOLE No 12

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418726.8 N:4913099.2 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-24 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)											
								20 40 60 80 100											
								O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE											
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L WATER CONTENT (%)												
197.7	GROUND SURFACE						20	40	60	80	100	10	20	30	GR SA SI CL				
195.0	90mm TOPSOIL SILT AND SAND, trace clay, very loose to compact, brown, wet		1	SS	4		197									sampler wet at 0.8m 0 44 52 4			
			2	SS	6														
			3	SS	13														
			4	SS	18														
2.7	SILTY SAND, some gravel to gravelly, trace clay, dense to very dense, grey, moist (GLACIAL TILL)		5	SS	46			195										27 38 27 8	
			6	SS	100/ 175mm														
			7	SS	100/ 50mm														
			8	SS	100/ 50mm														
192.8	END OF BOREHOLE					194										resistance to augering from 4.6m to 4.9m			
4.9						193													

Unstabilized water level measured at 1.3m below ground surface; borehole caved at 3.7m below ground surface upon completion of drilling.

Dynamic cone penetration test (DCPT) performed at 4.9m, 100 blows / 12mm penetration.

RECORD OF BOREHOLE No 13

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418778.2 N:4913120.5 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-23 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)								
								20 40 60 80 100								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE								
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w _p w w _L WATER CONTENT (%)									
198.9	GROUND SURFACE															
198.2 0.7	85mm TOPSOIL		1	SS	4		198								0 23 71 6	
	SAND AND GRAVEL, some organics, trace silt, very loose, brown, wet		2	SS	10											
	SANDY SILT, trace clay, trace gravel, loose to compact, brown, wet		3	SS	26											
			4	SS	19											
196.0 2.9	SILT AND SAND, some gravel, some clay, very dense, brown to 3.4m, grey below, wet (GLACIAL TILL)	5	SS	62												resistance to augering at 3.0m 15 37 37 11
		6	SS	100/ 200mm												
		7	SS	100/ 275mm												
193.2 5.7	END OF BOREHOLE		8	SS	100/ 25mm									resistance to augering at 5.6m		

END OF BOREHOLE

Unstabilized water level measured at 1.1m below ground surface; borehole caved at 1.9m below ground surface upon completion of drilling.

Auger refusal at 3.5m below ground surface, borehole relocated 1.0m south and drilled to 3.8m without SPT testing.

Auger refusal at 5.7m below ground surface, unable to extend the borehole deeper with hollow stem augers.

resistance to augering at 5.6m

RECORD OF BOREHOLE No 14

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418825.4 N:4913138.5 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-27 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT 'N' VALUE			SHEAR STRENGTH (kPa)					WATER CONTENT (%)				
								20	40	60	80	100	20	40			60
200.1	GROUND SURFACE																
199.9	165mm TOPSOIL		1	SS	16											GR SA SI CL	
0.2	FILL, gravelly sand, trace silt, compact, brown, dry																
199.4																	
0.7	SILTY SAND, some gravel to gravelly, trace to some clay, compact to very dense, brown to 1.8m, grey below, moist to wet (GLACIAL TILL)		2	SS	19												
			3	SS	100/ 100mm												
			4	SS	100/ 100mm												
			5	SS	100/ 100mm												
			6	SS	100/ 75mm												
196.3																	
3.8																	

24 47 23 6
resistance to
augering from
0.9m to 3.7m
sampler wet at
1.5m

END OF BOREHOLE

Borehole was dry and open
completion of drilling.

Piezometer installation consists of a
50mm diameter PVC pipe with a 1.5m
slotted screen

Auger refusal at 3.8m below ground
surface, unable to extend the borehole
deeper with hollow stem augers.

WATER LEVEL READINGS

Date	Water Depth (m)	Elevation (m)
Oct 1, 2018	2.4	197.7
Oct 20, 2018	2.1	198.0

24 47 23 6
resistance to
augering from
0.9m to 3.7m
sampler wet at
1.5m

RECORD OF BOREHOLE No 15

1 of 1

METRIC

G.W.P. 4127-10-01 LOCATION Coords: E:418530.2 N:4913034.2 ORIGINATED BY NG
 DIST HWY 7 BOREHOLE TYPE HOLLOW STEM AUGERS COMPILED BY SD
 DATUM GEODETIC DATE 2018-8-29 CHECKED BY RA

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 (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	SPT N' VALUE			SHEAR STRENGTH (kPa)									
								20	40	60	80	100					
198.0	GROUND SURFACE																
197.3	FILL, sand, some gravel, some silt, trace clay, compact, brown, dry		1	SS	23												18 62 16 4
0.7	FILL, clayey silt, and sand, trace gravel, soft to firm, grey, moist		2	SS	7												6 41 36 17
196.2	PEAT, fibrous, black with grey clayey silt and silty sand layers		3	SS	2												
1.8			4	SS	2												
194.8	SILTY CLAY, trace sand, very soft, grey, wet		5	SS	1												
3.2			6	SS	0*												sampler wet at 3.8m
			7	SS	0*												0 3 69 28
192.8	SAND AND GRAVEL, trace silt, trace clay, compact to dense, brown, wet		8	SS	16												
5.2			9	SS	31												
190.9	SILTY SAND, trace clay, trace to some gravel, very dense, grey, moist (GLACIAL TILL)		10	SS	100 / 75mm												41 51 6 2
7.1			11	SS	100 / 25mm												resistance to augering from 6.4m to 9.4m
188.4			12	SS	100 / 25mm												
9.6																	

END OF BOREHOLE

Unstabilized water level measured at 2.3m below ground surface; borehole caved at 3.7m below ground surface upon completion of drilling.

*Sampler sinking under weight of hammer and/or rods.

Auger refusal at 9.6m below ground surface, unable to extend the borehole deeper with hollow stem augers.

LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures, and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open-ended, driven or pushed tube samplers
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample
DT	Dual tube sample
DD	Diamond drilling

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split spoon sampler for a distance of 300 mm (12 in.).

Dynamic Cone Penetration Resistance (DCPT); N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive an uncased 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Cone Penetration Test (CPT):

An electronic cone penetrometer with a 60° conical tip and a projected end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm Or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils C_u or S_u

Consistency	kPa	Psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	Over 200	Over 4,000

IV. SOIL TESTS

w	Water content
w_p or PL	Plastic limited
w_l or LL	Liquid limit
C	Consolidation (oedometer) test
CHEM	Chemical analysis (refer to text)
CID	Consolidated isotropically drained triaxial test ¹
CIU	Consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	Relative density
DS	Direct shear test
Gs	Specific gravity
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	Organic content test
SO ₄	Concentration of water-soluble sulphates
UC	Unconfined compression test
UU	Unconsolidated undrained triaxial test
V	Field vane test (LV-laboratory vane test)
γ	Unit weight

Note: ¹ Tests which are anisotropically consolidated prior shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
$\log_{10} x$ or $\log x$	logarithm of x to base 10
g	acceleration due to gravity
t	time
FOS	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma'$
ϵ	linear strain
ϵ_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial vertical effective overburden stress
$\sigma_1 \sigma_2 \sigma_3$	principal stresses (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3) / 3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) formerly (G_s)
e	void ratio
n	porosity
S	degree of saturation
*	Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity Index $= (w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_c	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (overconsolidated range)
C_s	swelling index
C_α	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	overconsolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p or τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u or s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3) / 2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3) / 2$
q	$(\sigma_1 - \sigma_3) / 2$ or $(\sigma'_1 - \sigma'_3) / 2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: ¹ $\tau = c' + \sigma' \tan \phi'$

² shear strength $= (\text{compressive strength}) / 2$

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

PROJECT		12-1121-0099-1220		RECORD OF BOREHOLE No 13-222		SHEET 1 OF 2		METRIC						
G.W.P.		4127-10-01		LOCATION		N 4913028.8 ; E 418495.9		ORIGINATED BY		HEC				
DIST		Eastern HWY 7		BOREHOLE TYPE		Power Auger 200 mm Diam. (Hollow Stem)		COMPILED BY		JM				
DATUM		Geodetic		DATE		May 1, 2013		CHECKED BY		SAT				
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	25 50 75		
198.1	GROUND SURFACE						198							
0.0	ASPHALTIC CONCRETE													
197.9														
0.3	Crushed stone, trace to some silt (FILL) Compact Grey Moist		1	SS	15		197							
196.6														
1.5	Silty sand, trace gravel (FILL) Loose Dark grey Moist to wet		2	SS	7									
196.0							196							
2.1	Sandy Organic SILT Soft Dark brown Wet		3	SS	3									
195.4														
2.7	Organic SILT Soft Dark brown Wet						195							
194.9														
3.2	CLAYEY SILT, trace sand Soft Grey Wet		4	SS	3									
			5	SS	WH		194							
193.2														
5.0	Silty SAND Very loose Brown Wet		6	SS	WH		193							
192.7														
5.4	Gravelly SAND to Sandy GRAVEL, trace silt and clay, contains cobbles and boulders (TILL) Compact to very dense Brown Wet		7	SS	22		192							
			8	SS	41									
			9	SS	97/0.2		191							
			10	SS	107/0.3									
			11	SS	50/0.1		190							
188.8														
9.3	COBBLES and BOULDERS or possible weathered BEDROCK		12	SS	68/0.1		189							
188.2														

Continued Next Page

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

GTA-MTO 001 N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IM\GINT\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM



+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE


N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IMAGING\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM

PROJECT		12-1121-0099-1220		RECORD OF BOREHOLE No 13-223				SHEET 1 OF 3		METRIC									
G.W.P.		4127-10-01		LOCATION		N 4913024.3 ; E 418497.9				ORIGINATED BY		HEC							
DIST		Eastern HWY 7		BOREHOLE TYPE		Power Auger 200 mm Diam. (Hollow Stem), Rotary Drill NQ Core				COMPILED BY		JM							
DATUM		Geodetic		DATE		May 7, 2013				CHECKED BY		SAT							
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 (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED											
							20	40	60	80	100	25	50	75	GR	SA	SI	CL	
198.2	GROUND SURFACE																		
0.0	Crushed stone (FILL) Grey																		
0.3	Sand and gravel (FILL) Brown																		
	Sandy silt, some clay (FILL) Loose Grey Moist		1	SS	8												2	31	52 15
197.0																			
1.2	Crushed stone (FILL) Loose Grey Moist																		
196.7																			
1.5	Sandy silt, some clay and gravel (FILL) Very loose to loose Brown Wet		2	SS	4														
195.9																			
195.7	Organic SILT Soft Dark brown Wet		3	SS	2												0	25	65 10
195.3	Organic SILT, some sand and clay Soft Grey Wet																		
	Sandy Organic SILT, trace to some shells and roots Soft Brown to grey-brown Wet		4	SS	WH														
194.4																			
3.8	SILTY CLAY, contains organic matter Soft Grey Wet		5	SS	WH														
193.9																			
4.3	CLAYEY SILT, trace sand Soft Grey to brown Wet		6	SS	WH												0	3	72 25
192.9																			
5.3	SAND, some gravel Compact Brown Wet		7	SS	17														
192.3																			
5.9	Gravelly SAND, some silt, trace clay, contains cobbles and boulders (TILL) Very dense Brown to grey Wet		8	SS	48												41	44	12 3
			9	SS	90														
190.9																			
7.3	SAND, trace silt and gravel, contains cobbles and boulders Very dense Brown Wet		10	SS	76												5	87	7 1
189.8																			
8.4	Silty SAND, some gravel, trace clay, contains cobbles and boulders (TILL) Very dense Grey Wet		11	SS	88/0.2														
			12	RC	DD														
189.0			1	RC	REC 100%													RQD = 32%	
9.2			2	RC	REC 100%													RQD = 78%	

Continued Next Page

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

GT-AMT0 001 N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IMG\INT\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM

PROJECT <u>12-1121-0099-1220</u>		RECORD OF BOREHOLE No 13-223				SHEET 2 OF 3		METRIC																
G.W.P. <u>4127-10-01</u>		LOCATION <u>N 4913024.3 ;E 418497.9</u>				ORIGINATED BY <u>HEC</u>																		
DIST <u>Eastern</u> HWY <u>7</u>		BOREHOLE TYPE <u>Power Auger 200 mm Diam. (Hollow Stem), Rotary Drill NQ Core</u>				COMPILED BY <u>JM</u>																		
DATUM <u>Geodetic</u>		DATE <u>May 7, 2013</u>				CHECKED BY <u>SAT</u>																		
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			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					WATER CONTENT (%)											
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> W_p W W_L </div>												
185.9	Limestone (BEDROCK)		2	RC	REC 100%	188																		
	Bedrock cored from depths of 9.2 m to 12.3 m		3	RC	REC 100%	187													RQD = 86%					
	For bedrock coring details refer to Record of Drillhole 13-223		4	RC	REC 100%	186													RQD = 75%					
12.3	END OF BOREHOLE																							

GTA-MTO 001 N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IMAGING\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM

PROJECT: 12-1121-0099-1220

RECORD OF DRILLHOLE: 13-223

SHEET 3 OF 3

LOCATION: N 4913024.3 ; E 418497.9

DRILLING DATE: May 7, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 75

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
							RECOVERY		R.Q.D. %	FRACT. INDEX PER	DISCONTINUITY DATA	HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
							TOTAL CORE %	SOLID CORE %																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
							TYPE AND SURFACE DESCRIPTION							Jr	Ja	W1	W2	W3	W4	W5		W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
							000000	000000						000000	000000	000000	000000	000000	000000	000000		000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000	000000

DEPTH SCALE

1 : 50



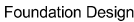
LOGGED: HEC

CHECKED: SAT

GTA-RCK 031 N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IMG\INT\1211210099.GPJ GAL-MISS.GDT 5/25/17 JM

GSTA-MTO 001 N:ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IM\GINT\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE



N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IMAGING\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

PROJECT: 12-1121-0099-1220

RECORD OF DRILLHOLE: 13-224

SHEET 3 OF 3

LOCATION: N 4913016.6 ; E 418478.8

DRILLING DATE: May 6, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 75

DRILLING CONTRACTOR: Marathon Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
						FLUSH RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec	WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr		Js	W1	W2	W3	W4		W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
9	Rotary Drill NQ Core	Continued from Record of Borehole 13-224		189.18																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	</

DEPTH SCALE

1 : 50



LOGGED: HEC

CHECKED: SAT

GTA-RCK 031 N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IMG\INT\1211210099.GPJ GAL-MISS.GDT 5/25/17 JM

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE



+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

SHEET 3 OF 3

DATUM: Geodetic

DRILLING CONTRACTOR: Marathon Drilling

[illegible]

DEPTH SCALE

1 : 50



LOGGED: HEC

CHECKED: SAT

PROJECT <u>12-1121-0099-1220</u>		RECORD OF BOREHOLE No 13-226		SHEET 1 OF 1		METRIC	
G.W.P. <u>4127-10-01</u>		LOCATION <u>N 4913011.5 ;E 418470.0</u>		ORIGINATED BY <u>HEC</u>			
DIST <u>Eastern</u> HWY <u>7</u>		BOREHOLE TYPE <u>Power Auger 200 mm Diam. (Hollow Stem)</u>		COMPILED BY <u>JM</u>			
DATUM <u>Geodetic</u>		DATE <u>May 3, 2013</u>		CHECKED BY <u>SAT</u>			

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT 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 (%)			
							20	40	60	80	100	W _p	W	W _L		
198.1	GROUND SURFACE															
0.0	ASPHALTIC CONCRETE															
0.1	Sand and gravel, trace silt and clay (FILL) Compact to loose Brown Moist to wet															
			1	SS	12											
			2	SS	9											
196.0	Sand and gravel, trace to some organics (FILL) Compact Grey Wet															
2.1																
			3	SS	20											
195.2	Silty SAND, some gravel, trace clay, contains cobbles and boulders (TILL) Loose to very dense Grey Wet															
2.9			4	SS	7											
			5	SS	22											
			6	SS	70											
			7	SS	50/0.1											
			8	SS	55/0.1											
			9	SS	50/0.1											
190.4	END OF BOREHOLE		10	SS	32/0.1											
7.7																
NOTES: 1. Water level in well screen at a depth of 1.4 m below ground surface (Elev. 196.7 m), measured on June 3, 2013.																

GTA-MTO 001 N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IMG\INT\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM

GSTA-MTO 001 N:ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IM\GINT\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

PROJECT		RECORD OF BOREHOLE No 17-233				SHEET 2 OF 2		METRIC									
G.W.P. 4127-10-01		LOCATION N 4913009.0 ; E 418481.1				ORIGINATED BY KM											
DIST Eastern HWY 7		BOREHOLE TYPE Wash Boring/BQ Casing, Rotary Drill/BTW Core, Portable				COMPILED BY JLL											
DATUM Geodetic		DATE January 3, 4, 5 and 6, 2017				CHECKED BY SAT											
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									
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					25 50 75 WATER CONTENT (%)					
186.5	END OF BOREHOLE		4	RC	REC 100%												
10.4	NOTES: 1. Water level in well screen at a depth of 0.1 m below ground surface (Elev. 196.8 m), measured on January 12, 2017.																

GTA-MTO 001 N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IM\GINT\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM

PROJECT: 12-1121-0099-1221

RECORD OF DRILLHOLE: 17-233

SHEET 2 OF 2

LOCATION: N 4913009.0 ; E 418481.1

DRILLING DATE: January 3, 4, 5 and 6, 2017

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Drill

DRILLING CONTRACTOR: M3 / Grenville

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	NOTE: For abbreviations, symbols and descriptions refer to LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY														FEATURES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
				ELEV. DEPTH (m)	RUN No.	FLUSH RETURN	RECOVERY		R.Q.D. %	FRACT. INDEX PER	DIP w.r.t. CORE AXIS °	DISCONTINUITY DATA		HYDRAULIC CONDUCTIVITY K, cm/sec		WEATH- ERING INDEX																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
							TOTAL CORE %	SOLID CORE %				TYPE AND SURFACE DESCRIPTION	Jr	Ja	10 ⁻⁶	10 ⁻³	W1		W2	W3	W4	W5	W6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
		Continued from Record of Borehole 17-233		188.77																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						</

DEPTH SCALE

1 : 50




LOGGED: KM

CHECKED: SAT

GTA-RCK 031 N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IMG\INT\1211210099.GPJ GAL-MISS.GDT 5/25/17 JM

PROJECT 12-1121-0099-1221		RECORD OF BOREHOLE No 17-235		SHEET 1 OF 1		METRIC	
G.W.P. 4127-10-01		LOCATION N 4913034.9 ; E 418492.5		ORIGINATED BY KM			
DIST Eastern HWY 7		BOREHOLE TYPE Wash Boring/BQ Casing, Portable		COMPILED BY JJL			
DATUM Geodetic		DATE January 7, 2017		CHECKED BY SAT			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					W _p	W	W _L			
							20	40	60	80	100							
196.8 0.0	GROUND SURFACE Sandy Organic SILT to Silty Organic SAND Soft to firm Black Wet		1	SS	6													
			2	SS	3													
			3	SS	2													
			4	SS	5													
194.2 2.6	CLAYEY SILT to SILT, some clay, trace sand Soft Brown to grey-brown Wet		5	SS	2													
			6	SS	3													
			7	SS	67/0.2													
			8	SS	60/0.1													
			9	SS	50/0.1													
192.8 4.0	Silty SAND, some gravel to Sandy GRAVEL, trace silt, contains cobbles and boulders (TILL) Dense to very dense Grey Wet		10	RC	DD													
			11	SS	37													
189.9 6.9	END OF BOREHOLE																	

GTA-MTO 001 N:\ACTIVE\2012\1121 - GEOTECHNICAL\12-1121-0099 MRC 22 STRUCTURES EASTERN REGION\SPATIAL IMGINT\1211210099.GPJ GAL-GTA.GDT 5/25/17 JM

TABLE A1
RECORD OF HAND AUGERHOLES

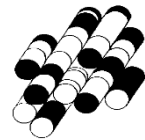
<u>Hand Augerhole Number</u>	<u>Depth (metres)</u>	<u>Description</u>
13-227	0.00 – 0.15	Water
	0.15 – 0.75	Fibrous organic material, brown, wet
	0.75 – 1.00	Silty sand, fine-grained, compact, brown, moist to wet
	1.00	End of Hand Augerhole
13-228	0.00 – 0.19	Water
	0.19 – 0.70	Fibrous organic material, brown, wet
	0.70 – 1.00	Silty sand, fine-grained, compact, brown, moist to wet
	1.00	End of Hand Augerhole
13-229	0.00 – 0.35	Sandy topsoil, contains organic matter, brown
	0.35 – 0.95	Silty sand, fine-grained, compact, brown, moist to wet
	0.95 – 1.20	Silty sand, fine-grained, compact, grey, moist to wet
	1.20	End of Hand Augerhole
13-230	0.00 – 0.45	Fibrous organic material, brown, wet
	0.45 – 1.15	Sand with gravel, trace clay, coarse-grained, compact, brown, wet
	1.15	End of Hand Augerhole
13-231	0.00 – 0.10	Water
	0.10 – 0.88	Fibrous organic material, brown, wet
	0.88 – 1.35	Silty sand and gravel, trace clay, compact, brown, wet
	1.35	End of Hand Augerhole
13-232	0.00 – 0.09	Water
	0.09 – 0.14	Silty sand and gravel, compact, brown, wet
	0.14 – 0.44	Fibrous organic material, brown, wet
	0.44 – 1.10	Silty sand and gravel, trace clay, contains trace to some organic matter, brown, wet
	1.10 – 1.40	Silty sand, fine-grained, compact, grey, moist to wet
	1.40	End of Hand Augerhole

n:\active\2012\1121 - geotechnical\12-1121-0099 mrc 22 structures eastern region\foundations\6 - reports\package 2\26-90 ouse river\final\attachments\appendix a\12-1121-0099-1220 record of augerholes.docx

MECP Well Records

APPENDIX B

Terraprobe Inc.



Address of Well Location (Street Number/Name) 2220 3rd Line		Township Asphodel	Lot 15	Concession 2
County/District/Municipality Pthco / Asphodel		City/Town/Village	Province Ontario	Postal Code
UTM Coordinates NAD 83	Zone 17	Easting 733347	Northing 7914680	Municipal Plan and Sublot Number 4581808
				Other

Overburden and Bedrock Materials/Abandonment Sealing Record (see instructions on the back of this form)

[illegible]

Angular Space		
Depth Set at (in/ft)	Type of Sealer Used (Material and Type)	Volume Placed (in/ft ³)
From 3' To 7'	Blue Clay Sealer	15 m ³

Method of Construction		Well Use		
<input type="checkbox"/> Cable Tool	<input type="checkbox"/> Drilled	<input type="checkbox"/> Public	<input type="checkbox"/> Commercial	<input type="checkbox"/> Not used
<input type="checkbox"/> Rotary (Conventional)	<input type="checkbox"/> Jetting	<input checked="" type="checkbox"/> Domestic	<input type="checkbox"/> Municipal	<input type="checkbox"/> Dewatering
<input type="checkbox"/> Rotary (Reverse)	<input type="checkbox"/> Driving	<input type="checkbox"/> Livestock	<input type="checkbox"/> Test Hole	<input type="checkbox"/> Monitoring
<input type="checkbox"/> Boring	<input checked="" type="checkbox"/> Digging	<input type="checkbox"/> Irrigation	<input type="checkbox"/> Cooling & Air Conditioning	
<input type="checkbox"/> Air percussion		<input type="checkbox"/> Industrial		
<input type="checkbox"/> Other, specify _____		<input type="checkbox"/> Other, specify _____		

Construction Record - Casing				Status of Well	
Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Well Thickness (cm/in)	Depth (m/ft)		<input checked="" type="checkbox"/> Water Supply <input type="checkbox"/> Replacement Well <input type="checkbox"/> Test Hole <input type="checkbox"/> Recharge Well <input type="checkbox"/> Dewatering Well <input type="checkbox"/> Observation and/or Monitoring Hole <input type="checkbox"/> Alteration (Construction) <input type="checkbox"/> Abandoned
			From	To	
36"	Plastic	4"	0	16'	

Construction Record - Screen				
Outside Diameter (mm)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (mm)	
			From	To

☐ Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, specify _____
☐ Other, specify _____

Water Details			Hole Diameter		
Water found at Depth	Kind of Water: <input checked="" type="checkbox"/> Fresh <input type="checkbox"/> Untested		Depth (mft)		Diameter (cm/in)
10' <input type="checkbox"/> Gas <input type="checkbox"/> Other, specify			From	To	
Water found at Depth	Kind of Water: <input type="checkbox"/> Fresh <input type="checkbox"/> Untested		0'	16'	15'
(mft) <input type="checkbox"/> Gas <input type="checkbox"/> Other, specify					
Water found at Depth	Kind of Water: <input type="checkbox"/> Fresh <input type="checkbox"/> Untested				
(mft) <input type="checkbox"/> Gas <input type="checkbox"/> Other, specify					

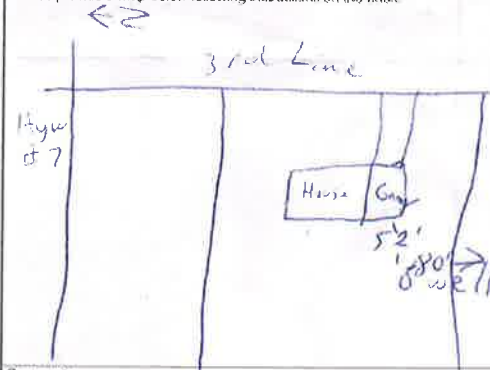
Well Contractor and Well Technician Information			
Business Name of Well Contractor		Well Contractor's Licence No.	
Leahy Excavations Inc.		65913	
Business Address (Street Number/Name)		Municipality	
2187 Keene Road		Otonabee	
Province	Postal Code	Business E-mail Address	
Ont.	K9T6K9	leahyexcavation@nexicominc.com	
Bus. Telephone No. (inc. area code)		Name of Well Technician (Last Name, First Name)	
7057424765		Leahy, Paul	
Well Technician's Licence No.	Signature of Technician and/or Contractor		Date Submitted
T1992	[Signature]		20110414

Results of Well Yield Testing

After test of well yield, water was:		Draw Down		Recovery	
<input type="checkbox"/> Clear and sand free <input type="checkbox"/> Other, specify _____		Time (min)	Water Level (mft)	Time (min)	Water Level (mft)
If pumping discontinued, give reason:		Static Level			
		1	80"	1	120"
Pump intake set at (mft)		2	82"	2	119"
Pumping rate (l/min / GPM)		3	84"	3	119"
20 l/min Duration of pumping 1 hrs + _____ min		4	85"	4	118"
Final water level end of pumping (mft)		5	87"	5	118"
120		10	96"	10	116"
If flowing give rate (l/min / GPM)		15	102"	15	111"
Recommended pump depth (mft)		20	108"	20	105"
Recommended pump rate (l/min / GPM)		25	111"	25	101"
		30	115"	30	95"
Well production (l/min / GPM)		40	117"	40	892"
Disinfected?		50	119"	50	88"
<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		60	120"	60	85"

Map of Well Location

Please provide a map below following instructions on the back



Comments

Well owner's information package delivered <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	Date Package Delivered 2011 MM/DD	Ministry Use Only Audit No. Z 88157 APR 29 2011
	Date Work Completed 2011 MM/DD	

WATER WELL RECORD

1. PRINT ONLY IN SPACES PROVIDED

2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

11

5111492

MUNICIPAL

COM

COUNTY OR DISTRICT	TOWNSHIP BOROUGH CITY TOWN VILLAGE	CON. BLOCK FRACT. SURVEY ETC.	LOT
Peterborough	Asphodel	Con 2	15
2-3 Indian River		DATE COMPLETED	48-13
DAY	MO	TR	
16	8	83	

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

[illegible]

31

32

41 WATER RECORD				51 CASING & OPEN HOLE RECORD				61 PLUGGING & SEALING RECORD					
WATER FOUND AT - FEET		KIND OF WATER		INSIDE DIA. INCHES		MATERIAL		3" WALL THICKNESS INCHES		DEPTH - FEET		SCREEN	
										FROM		TO	
10-12		1 FRESH 3 SULPHUR 2 SALTY 4 MINERAL		10-11		1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE		10-11		10-11		10-11	
13-18		1 FRESH 3 SULPHUR 2 SALTY 4 MINERAL		13-18		1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE		13-18		13-18		13-18	
20-23		1 FRESH 3 SULPHUR 2 SALTY 4 MINERAL		20-23		1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE		20-23		20-23		20-23	
25-28		1 FRESH 3 SULPHUR 2 SALTY 4 MINERAL		25-28		1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE		25-28		25-28		25-28	
30-33		1 FRESH 3 SULPHUR 2 SALTY 4 MINERAL		30-33		1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE		30-33		30-33		30-33	

PUMPING TEST	71	PUMPING TEST METHOD		1C	PUMPING RATE		11-14	DURATION OF PUMPING	
		1 <input type="checkbox"/> PUMP 2 <input checked="" type="checkbox"/> TAILER			4		GPM	1	15-18 HOURS 17-18 MINS
		STATIC LEVEL		WATER LEVEL END OF PUMPING		23		PUMPING 1 <input checked="" type="checkbox"/> RECOVERY	
		15-20		22-24		15 MINUTES		30 MINUTES	
		21		61		58		58	
		FEET		FEET		FEET		FEET	
		IF FLOWING, GIVE RATE		30-41		PUMP INTAKE SET AT		WATER AT END OF TEST	
		RECOMMENDED PUMP TYPE		RECOMMENDED PUMP SETTING		40-45		RECOMMENDED PUMPING RATE	
	1 <input type="checkbox"/> SHALLOW 2 <input checked="" type="checkbox"/> DEEP		64		FEET		4		
	90-93								

FINAL STATUS OF WELL	52	1 <input checked="" type="checkbox"/> WATER SUPPLY 2 <input type="checkbox"/> OBSERVATION WELL 3 <input type="checkbox"/> TEST HOLE 4 <input type="checkbox"/> RECHARGE WELL	5 <input type="checkbox"/> ABANDONED, INSUFFICIENT SUPPLY 6 <input type="checkbox"/> ABANDONED, POOR QUALITY 7 <input type="checkbox"/> UNFINISHED
	53-54	1 <input type="checkbox"/> DOMESTIC 2 <input type="checkbox"/> STOCK 3 <input type="checkbox"/> IRRIGATION 4 <input type="checkbox"/> INDUSTRIAL <input type="checkbox"/> OTHER	5 <input type="checkbox"/> COMMERCIAL 6 <input type="checkbox"/> MUNICIPAL 7 <input type="checkbox"/> PUBLIC SUPPLY 8 <input type="checkbox"/> COOLING OR AIR CONDITIONING <input type="checkbox"/> NOT USED
METHOD OF DRILLING	57	1 <input checked="" type="checkbox"/> CABLE TOOL <input checked="" type="checkbox"/> ROTARY (CONVENTIONAL) <input type="checkbox"/> ROTARY (REVERSE) <input type="checkbox"/> ROTARY (AIR) <input type="checkbox"/> AIR PERCUSSION	6 <input type="checkbox"/> BORING 7 <input type="checkbox"/> DIAMOND 8 <input type="checkbox"/> JETTING 9 <input type="checkbox"/> DRIVING

1170

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE INDICATE NORTH BY ARROW

Hwy. tower

No 7 Hwy.

3rd Line

Petebough

1/2 mile of Hwy

Now

Dusg River

Well

DRILLER'S REMARKS

CONTRACTOR	NAME OF WELL CONTRACTOR		LICENCE NUMBER	
	O'Connor Well Drill		4008	
	ADDRESS			
	Bramona Ont Bx 102			
	NAME OF DRILLER OR BORE		LICENCE NUMBER	
	John O'Connor			
	SIGNATURE OF CONTRACTOR		SUBMISSION DATE	
	John O'Connor		DAY 19 MO 8/ YR 8	

OFFICE USE ONLY	DATA SOURCE	18 CONTRACTOR	19-24 DATE RECEIVED	25-28	29-32	33-36	37-40
	DATE OF INSPECTION		INSPECTOR				
	REMARKS						



Map: Well records

This map allows you to search and view well record information from reported wells in Ontario.

Full dataset is available in the [Open Data catalogue](#).

[Go Back to Map](#)

Well ID

Well ID Number: 5100084

Well Audit Number:

Well Tag Number:

This table contains information from the original well record and any subsequent updates.

Well Location

Address of Well Location	
Township	ASPHODEL TOWNSHIP
Lot	015
Concession	CON 03
County/District/Municipality	PETERBOROUGH
City/Town/Village	
Province	ON
Postal Code	n/a
UTM Coordinates	

NAD83 — Zone 17

Easting: 733421.10

Northing: 4914765.00

Municipal Plan and Sublot Number

Other

Overburden and Bedrock Materials Interval

General Colour	Most Common Material	Other Materials	General Description	Depth From	Depth To
	CLAY	GRVL		0 ft	7 ft
GREY	LMSN			7 ft	17 ft

Annular Space/Abandonment Sealing Record

Depth From	Depth To	Type of Sealant Used (Material and Type)	Volume Placed
---------------	-------------	---------------------------------------------	------------------

Method of Construction & Well Use**Method of Construction Well Use**

Cable Tool

Public

Status of Well

Water Supply

Construction Record - Casing

Open Hole or material

Inside Diameter		Depth From	Depth To
5 inch	STEEL		10 ft
5 inch	OPEN HOLE		17 ft

Construction Record - Screen

Outside Diameter	Material	Depth From	Depth To
---------------------	----------	---------------	-------------

Well Contractor and Well Technician Information

Well Contractor's Licence Number: 1343

Results of Well Yield Testing

After test of well yield, water was	CLEAR
If pumping discontinued, give reason	
Pump intake set at	
Pumping Rate	3 GPM
Duration of Pumping	0 h:30 m
Final water level	17 ft
If flowing give rate	
Recommended pump depth	
Recommended pump rate	
Well Production	PUMP
Disinfected?	

Draw Down & Recovery

Draw Down Time (min)	Draw Down Water level	Recovery Time (min)	Recovery Water level
SWL	11 ft		
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
45		45	
50		50	
60		60	

Water Details

Water Found at Depth	Kind
17 ft	Fresh

Hole Diameter

Depth From	Depth To	Diameter
---------------	-------------	----------

Audit Number:

Date Well Completed: September 22, 1953

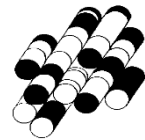
Date Well Record Received by MOE: March 29, 1954

Updated: January 24, 2020

Dewatering Analysis

APPENDIX C

Terraprobe Inc.



Ouse River Bridge Replacement - Highway 7

Job No. 1-18-0347-46

Bridge Abutments (East & West) - Construction Dewatering

Excavation Area (m2)	Excavation Depth (mbgl)	Excavation Perimeter (m)	Water Level (mbgl)	Excavation Depth (m below water table)	Vertical Area Below Water Table (m2)	K (m/s)
62.05	4.28	41.3	1.4	2.88	119	1E-07

Darcy - flow into excavation

	Q (m^3/s)	A (m^2)	i	k (m/s)	Q (m^3/hr)	Q (L/hr)	Q (gal/min)	Q (L/day)	Factor of Safety = 1.5 Q (L/day)	Total Q (L/day)
Horizontal	1.55E-05	119	1	1E-07	0.0557	56	0.25	1336	2,004	
Vertical	8.07E-06	62	1	1E-07	0.0290	29	0.13	697	1,045	8,800
Rainfall (30 mm storm event) 2,900 L/day										

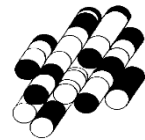
Radius of Influence - Sichardt's equation

R (m)	drawdown (m)	K (m/s)
3.1	2.88	1.30E-07

Engineering Drawings

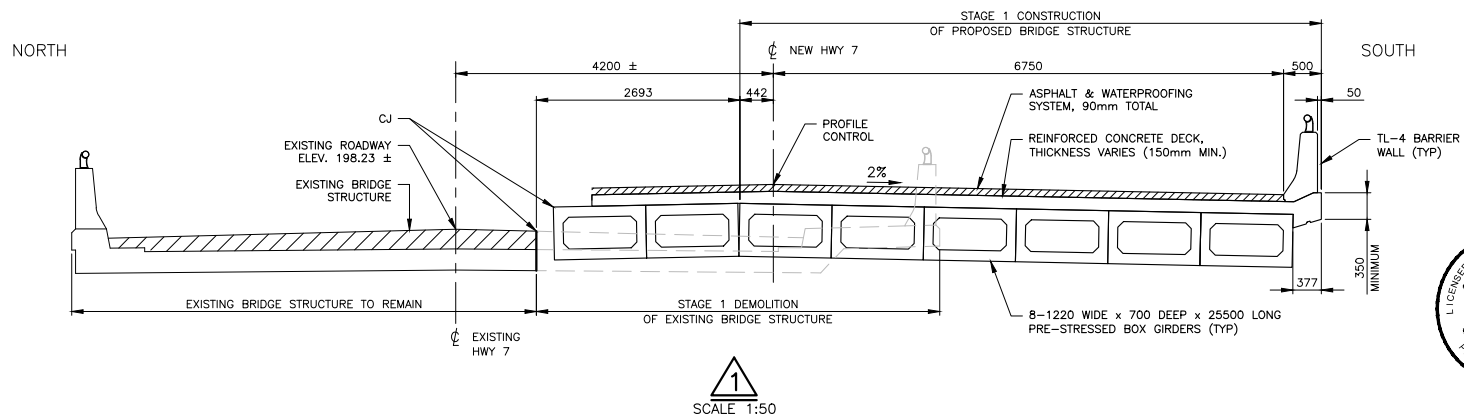
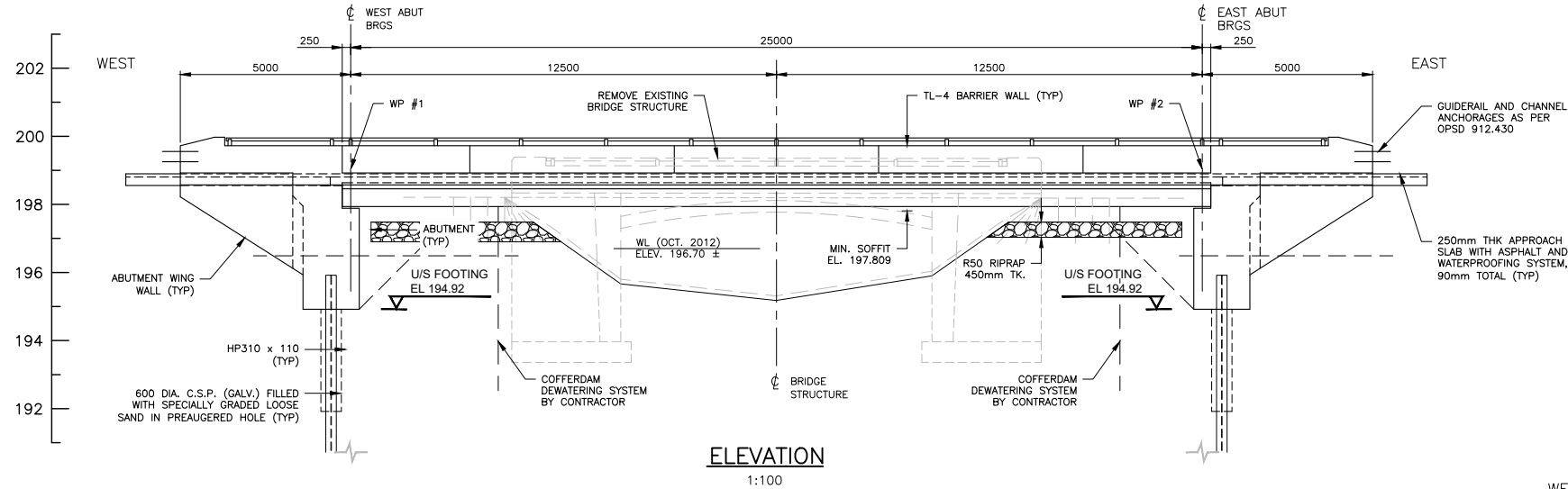
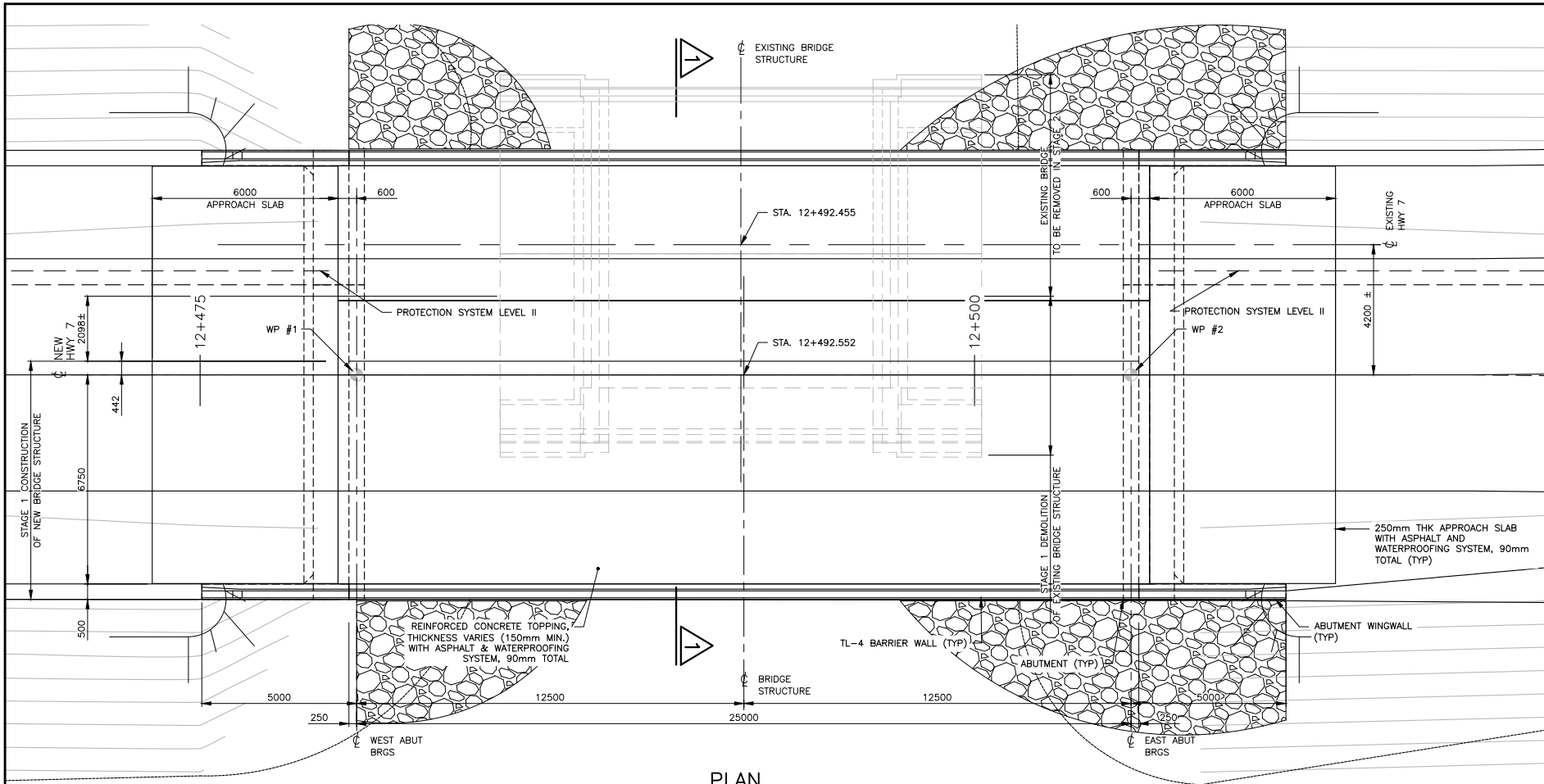
APPENDIX D

Terraprobe Inc.



DRAWING NAME: P:\20185256\00_Three_Structures\Working_Dwg\300_Structural\02-0USE\5256-02-s-301_GA_1.dwg
CREATED: 2019/11/21
MODIFIED: 2019/12/04 9:48:23 AM

MINISTRY OF TRANSPORTATION, ONTARIO



DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

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

GENERAL NOTES:

- CLASS OF CONCRETE
PRECAST BOX GIRDER UNITS 75 MPa
REMAINDER UNLESS OTHERWISE NOTED 30 MPa
- CLEAR COVER TO REINFORCING STEEL
FOOTING 100 ±25
DECK TOPPING 70 ±20
REMAINDER UNLESS OTHERWISE NOTED 70 ±20
- REINFORCING STEEL
REINFORCING STEEL SHALL BE GRADE 400W, UNLESS OTHERWISE NOTED.
- CONSTRUCTION NOTES
THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND ELEVATIONS OF THE EXISTING STRUCTURE AND ALL DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE ENGINEER BEFORE PROCEEDING WITH THE WORK.

UNLESS OTHERWISE SHOWN, TENSION LAP SPLICES FOR REINFORCING STEEL BARS SHALL BE CLASS B.

BAR HOOKS SHALL HAVE STANDARD HOOK DIMENSIONS USING MINIMUM BEND DIAMETERS, WHILE STIRRUPS AND TIES SHALL HAVE MINIMUM HOOK DIMENSIONS. ALL HOOKS SHALL BE IN ACCORDANCE WITH THE STRUCTURAL STANDARDS DRAWING SS12-1, UNLESS OTHERWISE INDICATED.

FOR STAGING AND MAINTENANCE OF TRAFFIC, SEE GRADING DRAWINGS AND SPECIFICATIONS.

THE CONTRACTOR IS RESPONSIBLE FOR THE COMPLETE DESIGN, EXTENT AND INSTALLATION OF ALL TEMPORARY STRUCTURES, PROTECTION SYSTEMS, CONSTRUCTION PLATFORMS AND DEBRIS CONTAINMENT SYSTEMS, ETC.

THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ANY PERMITS REQUIRED TO CONSTRUCT THE TMB AND THE NEW BRIDGE STRUCTURE FROM THE REGULATORY AUTHORITIES.

BACKFILL SHALL NOT BE PLACED AGAINST ANY CONCRETE COMPONENTS UNTIL CONCRETE HAS REACHED 70% OF ITS DESIGNED STRENGTH.

ALL ELEVATIONS ARE TO GEODETIC DATUM.

HAZARDOUS MATERIALS ARE PRESENT IN THE FOLLOWING:
1. ARSENIC IN THE GUIDE RAIL WOOD POST.

THE CONTRACTOR IS RESPONSIBLE FOR TEMPORARY FLOW PASSAGE DESIGN AND SHALL DESIGN ALL COFFERDAMS, DEBRIS CONTAINMENT SYSTEMS, FALSEWORK, ETC. TO SUIT.

- DESIGN NOTES
THE STRUCTURE SHALL BE DESIGNED TO THE FOLLOWING CRITERIA:
197.74m MINIMUM SOFFIT ELEVATION
15.3m MINIMUM CLEAR SPAN
1.6m MINIMUM FROST COVER

COMPOSITE ACTION IS REQUIRED BETWEEN REINFORCED TOPPING AND GIRDERS.

POSITIVE, SHEAR CONNECTION REQUIRED BETWEEN GIRDERS.

CONT 2017-4000
WP 4128-10-01

OUSE RIVER BRIDGE
SITE NO. 26X-0090/B0
GENERAL ARRANGEMENT



SHEET
23



NOTES:

- THIS DRAWING SHALL BE READ IN CONJUNCTION WITH DRAWINGS 2-17.

WP COORDINATES				
WP	STATION ALONG HWY 7	T.O. ROADWAY ELEVATION	COORDINATE	
			NORTHING	EASTING
1	12+480.052	198.970	4913014.903	4184767.04
2	12+505.552	198.970	4913023.923	4185000.20

LIST OF DRAWINGS

- GENERAL ARRANGEMENT I
- GENERAL ARRANGEMENT II
- STRUCTURAL STAGING SECTIONS
- PILE LAYOUT
- ABUTMENT DETAILS
- ABUTMENT REINFORCING DETAILS
- WINGWALL DETAILS
- WINGWALL REINFORCING DETAILS
- BEARING DETAILS
- GIRDER DETAILS I
- GIRDER DETAILS II
- DECK LAYOUT
- DECK REINFORCING
- TL-4 BARRIER DETAILS
- CONCRETE END WALL FOR BOX BEAM RAILING (STAINLESS STEEL REBAR)
- 6000 mm APPROACH SLAB
- TEMPORARY BRIDGE DETAILS

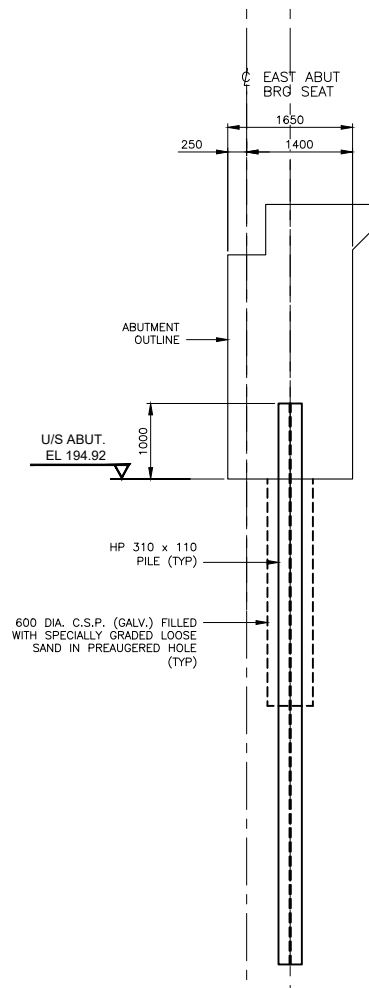
LIST OF ABBREVIATIONS:

ABUT.	DENOTES ABUTMENT
B.F.	DENOTES BACK FACE
BRG.	DENOTES BEARING
CJ	DENOTES CONTROL JOINT
C.S.P.	DENOTES CORRUGATED STEEL PIPE
E	DENOTES EAST
F.F.	DENOTES FRONT FACE
GALV.	DENOTES GALVANIZED
MIN.	DENOTES MINIMUM
T.O.	DENOTES TOP OF
TYP	DENOTES TYPICAL
U/S	DENOTES UNDERSIDE
W	DENOTES WEST

APPLICABLE STANDARD DRAWINGS:

OPSD 3101.150	WALLS ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENTS
OPSD 3102.100	WALL ABUTMENT BACKFILL DRAIN
OPSD 3370.100	DECK WATERPROOFING HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD DETAILS.
OPSD 3370.101	DECK WATERPROOFING HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2 mm WIDE AND CONSTRUCTION JOINTS.
OPSD 3419.100	BARRIERS AND RAILING STEEL GUIDERAIL CHANNEL ANCHORAGE.
OPSD 3941.200	FIGURES IN CONCRETE, SITE NUMBER AND LAYOUT.

REVISIONS		DATE	BY	DESCRIPTION
DESIGN	MT	CHK	CC	CODE
DRAWN	TK	CHK	PK	SITE
				LOAD CL-625-ONT
				DATE
				MAY/2019
				DWG
				1



2
SCALE 1:50

SHEET
30



1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER APPLICABLE CONTRACT DRAWINGS.
2. STEEL H-PILES SHALL BE HP 31x110 FITTED WITH TITUS STANDARD 'H' BEARING POINTS OR APPROVED EQUAL.
3. PILE SPACINGS ARE MEASURED AT THE UNDERSIDE OF ABUTMENT.
4. PILE LENGTHS SHOWN ARE THE THEORETICAL LENGTHS BELOW CUT-OFF.
5. PILE SPLICES SHALL BE IN ACCORDANCE WITH OPSD 3000.150
6. PILES TO BE DRIVEN IN ACCORDANCE WITH SS 103-11 USING AN ULTIMATE GEOTECHNICAL RESISTANCE OF 2000kN PER PILE. THE FINAL PILE TIP ELEVATIONS WILL BE DETERMINED ON SITE AFTER THE ULTIMATE PILE RESISTANCE IS ACHIEVED AND ACCEPTED BY THE CONTRACT ADMINISTRATOR.
7. THE PILES SHALL BE DRIVEN TO ABOUT 2.5m ABOVE THE RECOMMENDED PILE TIP ELEVATION AND THEN THE DRIVING BE MONITORED BY EMPLOYING THE HILEY DYNAMIC FORMULA AS PER SS 103-11.

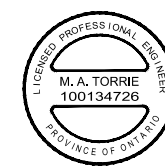
FACTORED AXIAL RESISTANCE AT ULS: 2000 kN/PILE

PILE DATA						
LOCATION		BATTER	No. REQ'D	PILE CUT-OFF ELEVATION (m)	ESTIMATED PILE TIP ELEVATION (m)	ESTIMATED LENGTH (m)
WEST ABUTMENT	STAGE 1	1:10	1	195.42	188.50	6.96
		—	7	195.42	188.50	6.92
	STAGE 2	1:10	1	195.42	188.50	6.96
		—	2	195.42	188.50	6.92
EAST ABUTMENT	STAGE 1	1:10	1	195.42	188.50	6.96
		—	7	195.42	188.50	6.92
	STAGE 2	1:10	1	195.42	188.50	6.96
		—	2	195.42	188.50	6.92

LIST OF PILES		
LOCATION	PILE No.	BATTER
WEST ABUT.	1W & 11W	1:10
	2W TO 10W	—
NOTE: SAME FOR EAST ABUTMENT		

ABUT.	DENOTES	ABUTMENT
B.F.	DENOTES	BACK FACE
B.R.G.	DENOTES	BEARING
CJ.	DENOTES	CONTROL JOINT
C.S.P.	DENOTES	CORRUGATED STEEL PIPE
E	DENOTES	EAST
F.F.	DENOTES	FRONT FACE
GALV.	DENOTES	GALVANIZED
I.F.	DENOTES	INSIDE FACE
MIN.	DENOTES	MINIMUM
O.F.	DENOTES	OUTSIDE FACE
T.O.	DENOTES	TOP OF
TYP.	DENOTES	TYPICAL
U/S	DENOTES	UNDERSIDE
W	DENOTES	WEST


OPSD 3000.150 FOUNDATION PILES - STEEL H-PILE
SPICE



DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

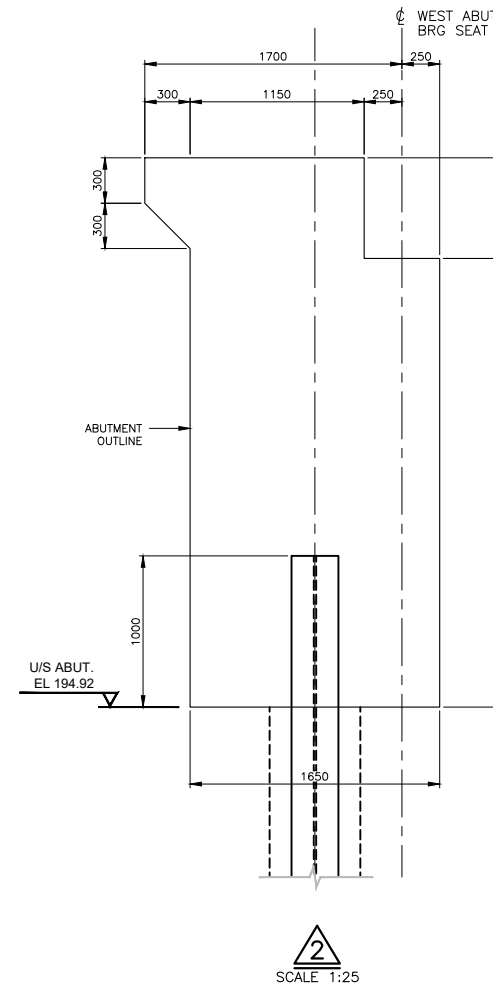
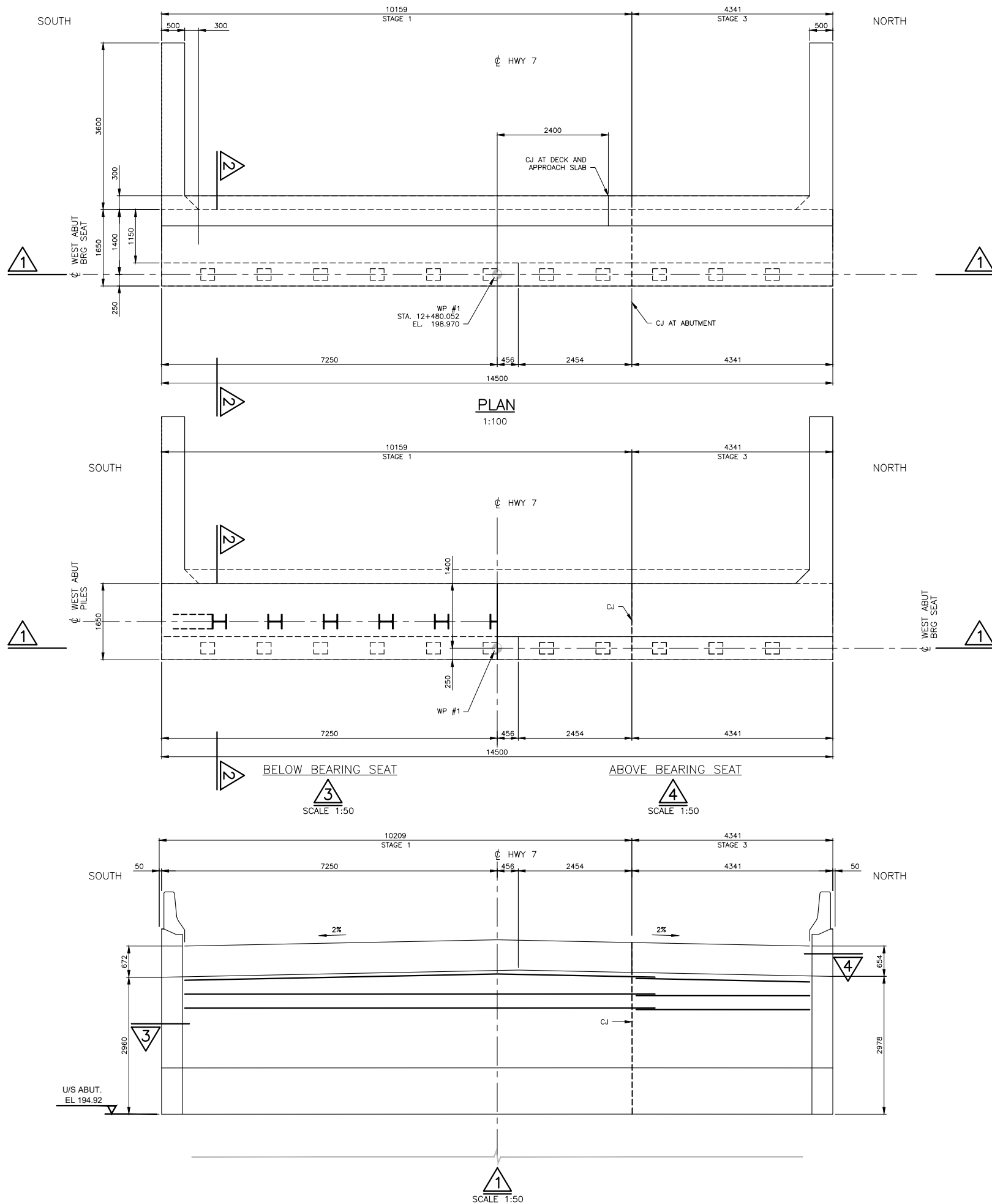
[illegible]

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

CONT 2017-4000 WP 4128-10-01	
OUSE RIVER BRIDGE SITE NO. 26-090 ABUTMENT	SHEET 31



- NOTES:
- THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER APPLICABLE CONTRACT DRAWINGS.
 - WEST ABUTMENT SHOWN, EAST ABUTMENT MIRRORED.

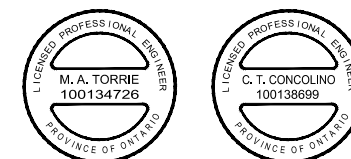


LIST OF ABBREVIATIONS:

ABUT.	DENOTES	ABUTMENT
B.F.	DENOTES	BACK FACE
BRG.	DENOTES	BEARING
CJ	DENOTES	CONTROL JOINT
C.S.P.	DENOTES	CORRUGATED STEEL PIPE
E.	DENOTES	EAST
F.F.	DENOTES	FRONT FACE
GALV.	DENOTES	GALVANIZED
I.F.	DENOTES	INSIDE FACE
MIN.	DENOTES	MINIMUM
O.F.	DENOTES	OUTSIDE FACE
T.O.	DENOTES	TOP OF
TYP	DENOTES	TYPICAL
U/S	DENOTES	UNDERSIDE
W	DENOTES	WEST

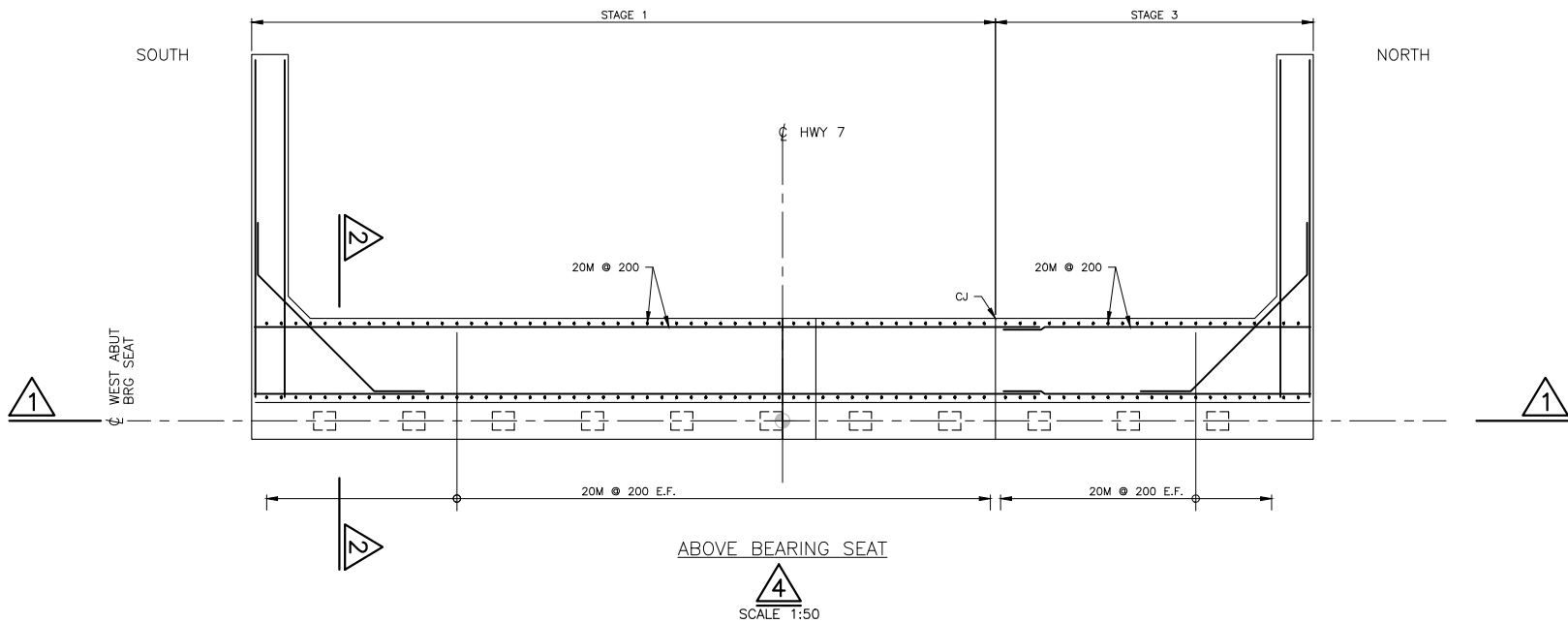
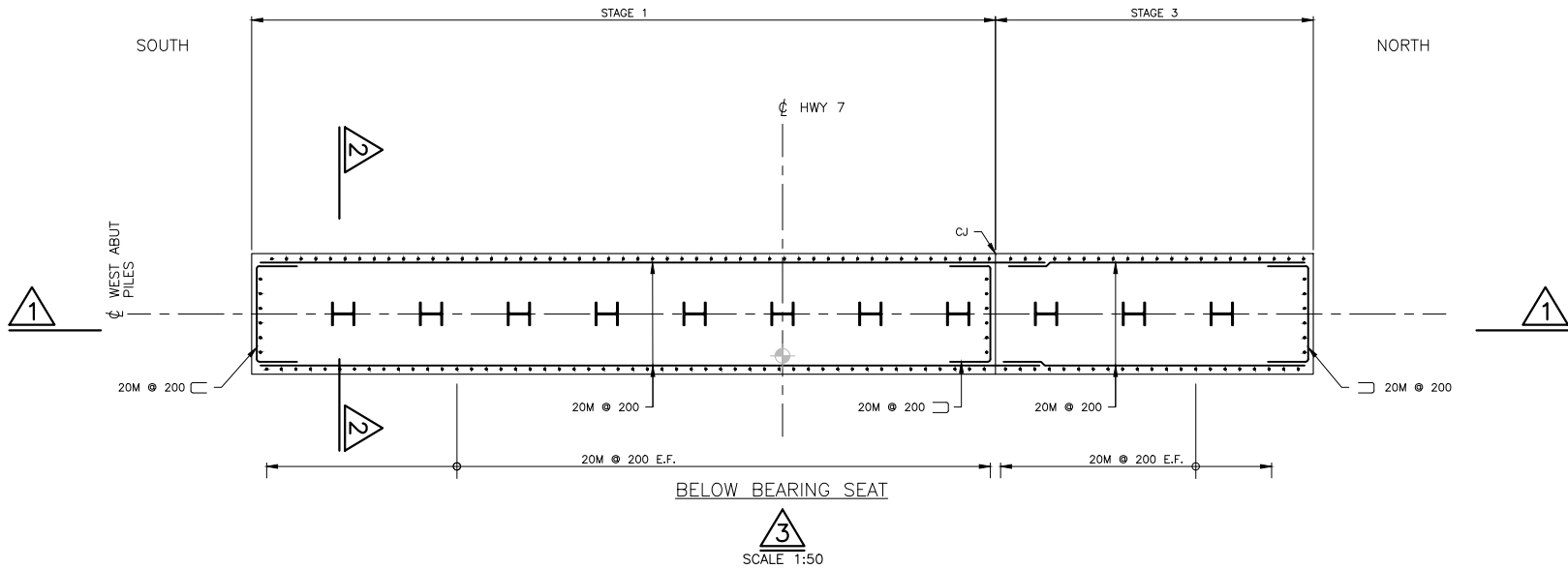
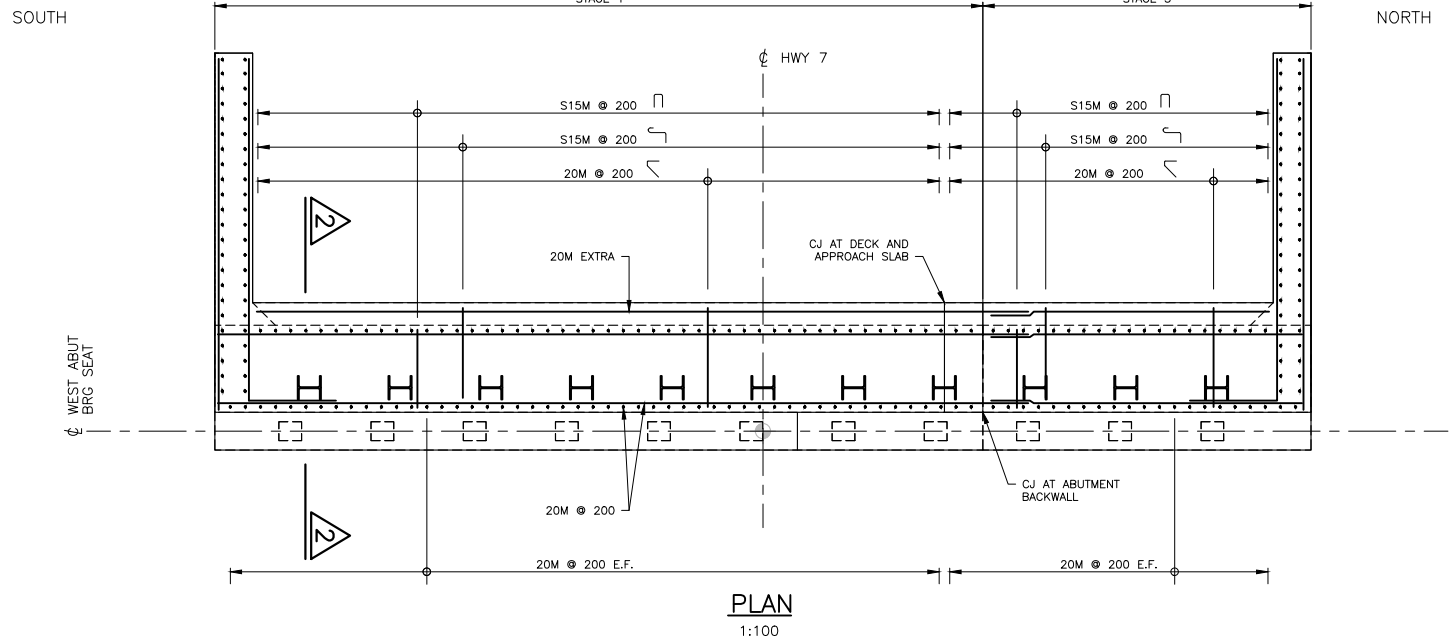
APPLICABLE STANDARD DRAWINGS:

OPSD 3950.100	JOINTS CONCRETE EXPANSION AND CONSTRUCTION ON STRUCTURE
---------------	---------------------------------------------------------



DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

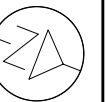
REVISIONS		DATE	BY	DESCRIPTION
DESIGN	MT	CHK	CC	CODE
DRAWN	TK	CHK	PK	SITE



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

CONT 2017-4000
WP 4128-10-01

OUSE RIVER BRIDGE
SITE NO. 26-090
ABUTMENT REINFORCEMENT

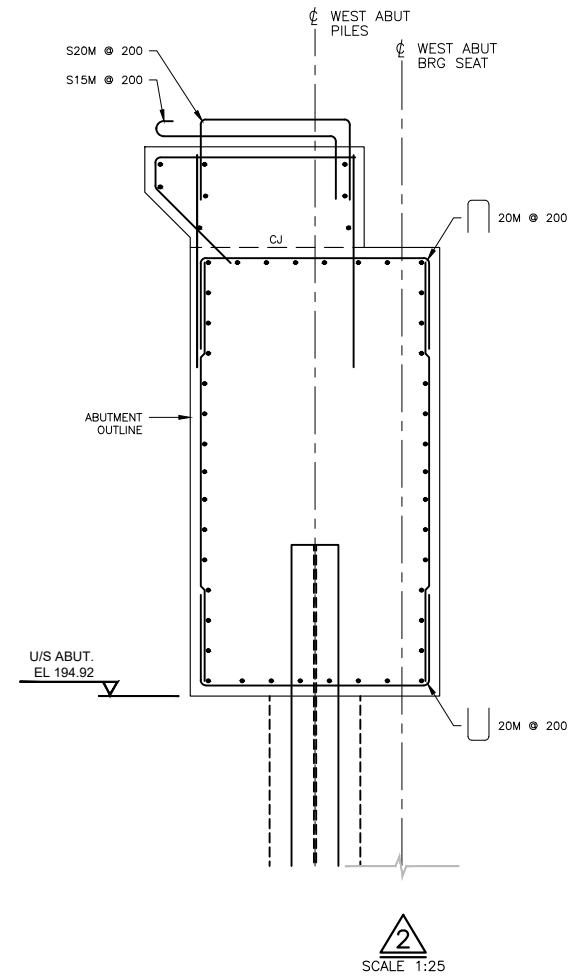


SHEET
32



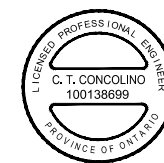
NOTES:

- THIS DRAWING SHALL BE READ IN CONJUNCTION WITH ALL OTHER APPLICABLE CONTRACT DRAWINGS.
- WEST ABUTMENT SHOWN, EAST ABUTMENT MIRRORED.



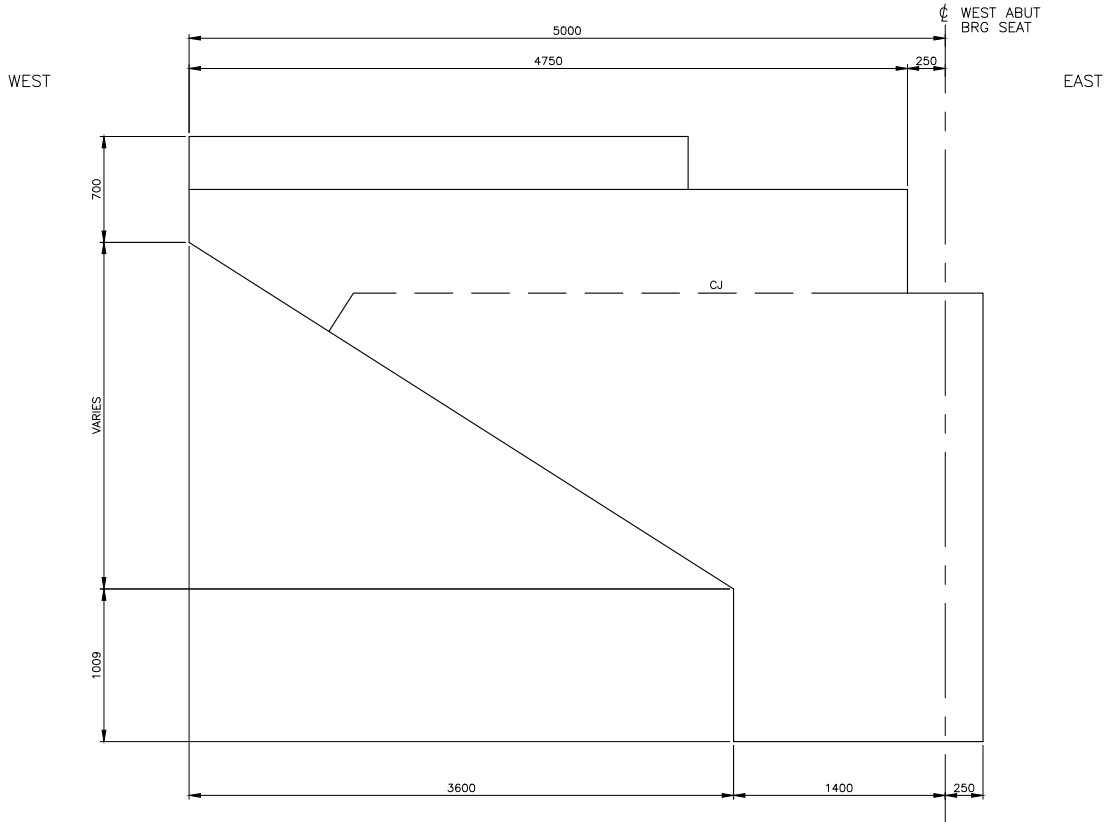
LIST OF ABBREVIATIONS:

ABUT.	DENOTES ABUTMENT
B.F.	DENOTES BACK FACE
BRG.	DENOTES BEARING
CJ	DENOTES CONTROL JOINT
C.S.P.	DENOTES CORRUGATED STEEL PIPE
E.	DENOTES EAST
F.F.	DENOTES FRONT FACE
GALV.	DENOTES GALVANIZED
I.F.	DENOTES INSIDE FACE
MIN.	DENOTES MINIMUM
O.F.	DENOTES OUTSIDE FACE
T.O.	DENOTES TOP OF
TYP	DENOTES TYPICAL
U/S	DENOTES UNDERSIDE
W	DENOTES WEST

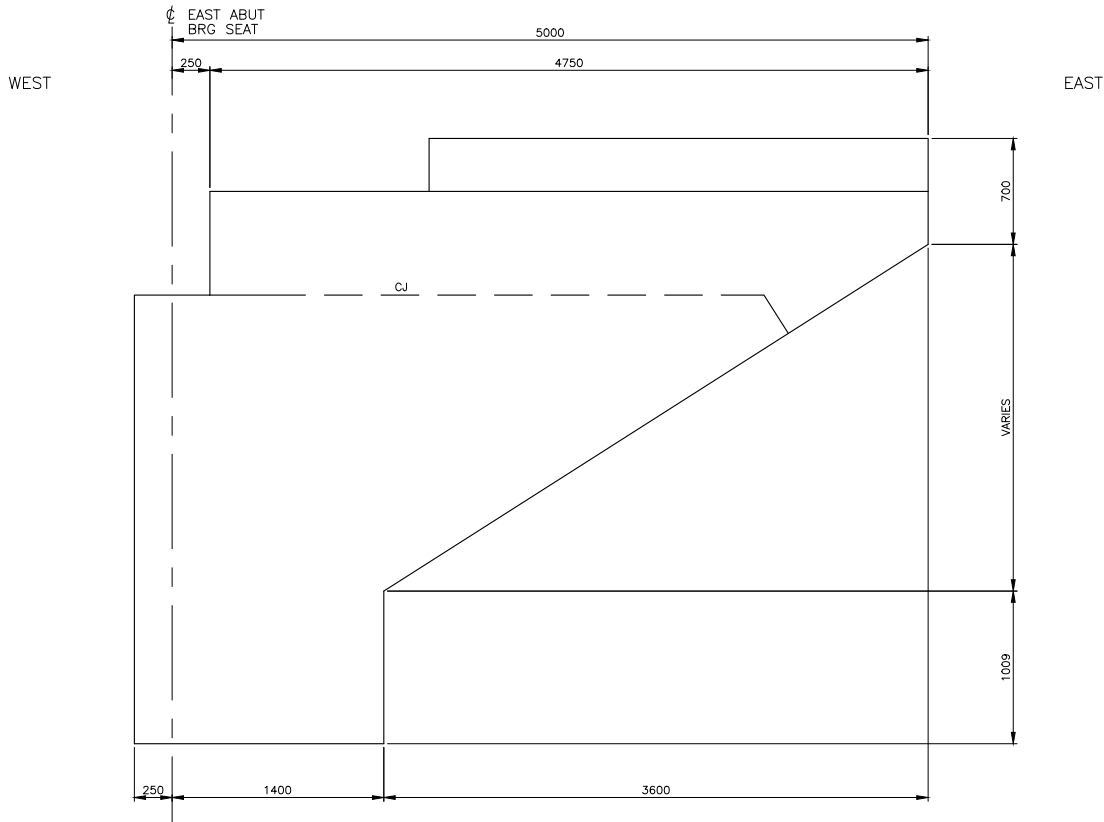


DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS		DATE	BY	DESCRIPTION
DESIGN	MT	CHK	CC	CODE CHBDC-14
DRAWN	TK	CHK	PK	SITE 26X-090
				LOAD CL-625-ONT
				DATE MAY/2019
				DWG 6



WEST WINGWALL ELEVATION
1:25



EAST WINGWALL ELEVATION
1:25

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

CONT 2017-4000
WP 4128-10-01

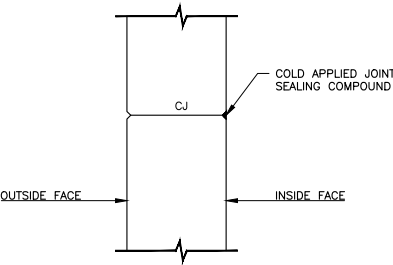
OUSE RIVER BRIDGE
SITE NO. 26-090
WINGWALL

SHEET
33

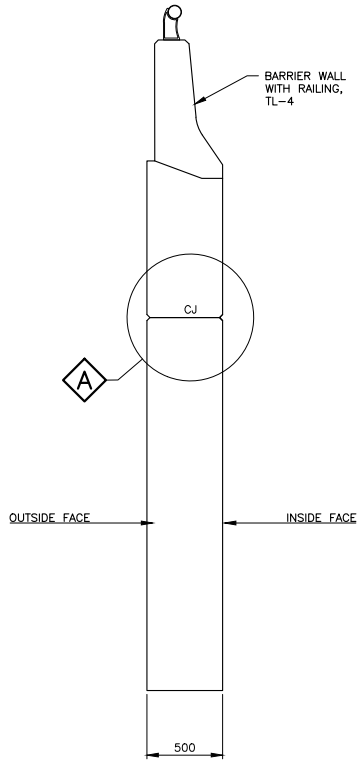


NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER APPLICABLE CONTRACT DRAWINGS.
2. WEST ABUTMENT SHOWN, EAST ABUTMENT MIRRORED.



A
N.T.S.



1
SCALE 1:25



DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

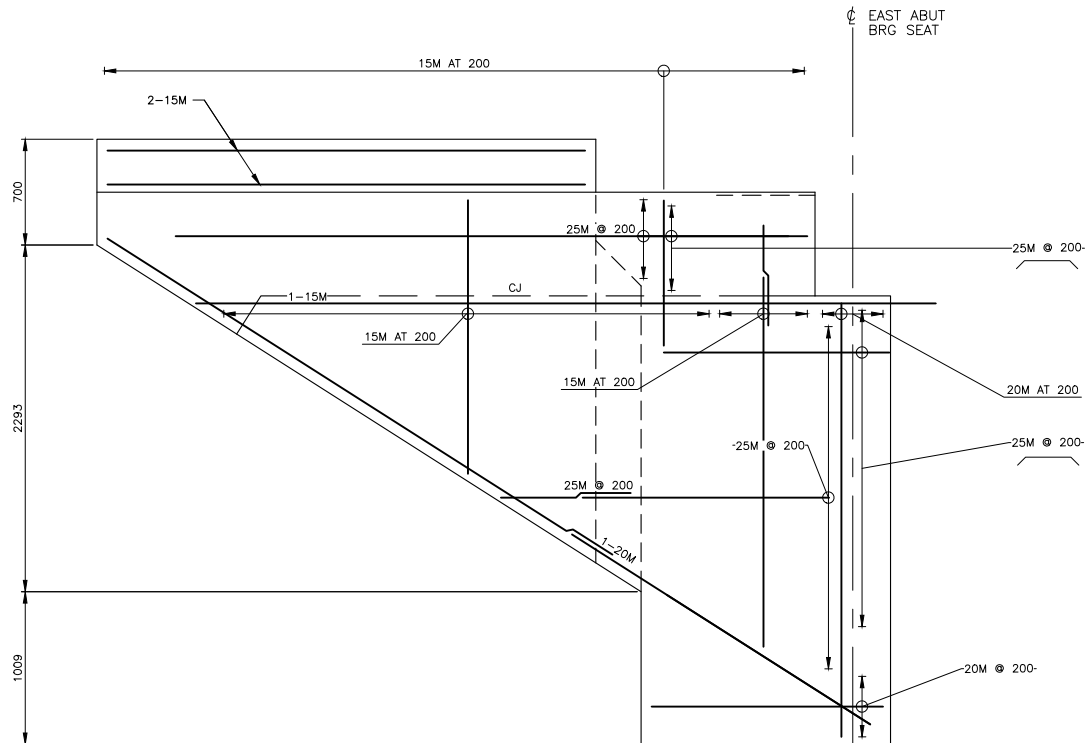
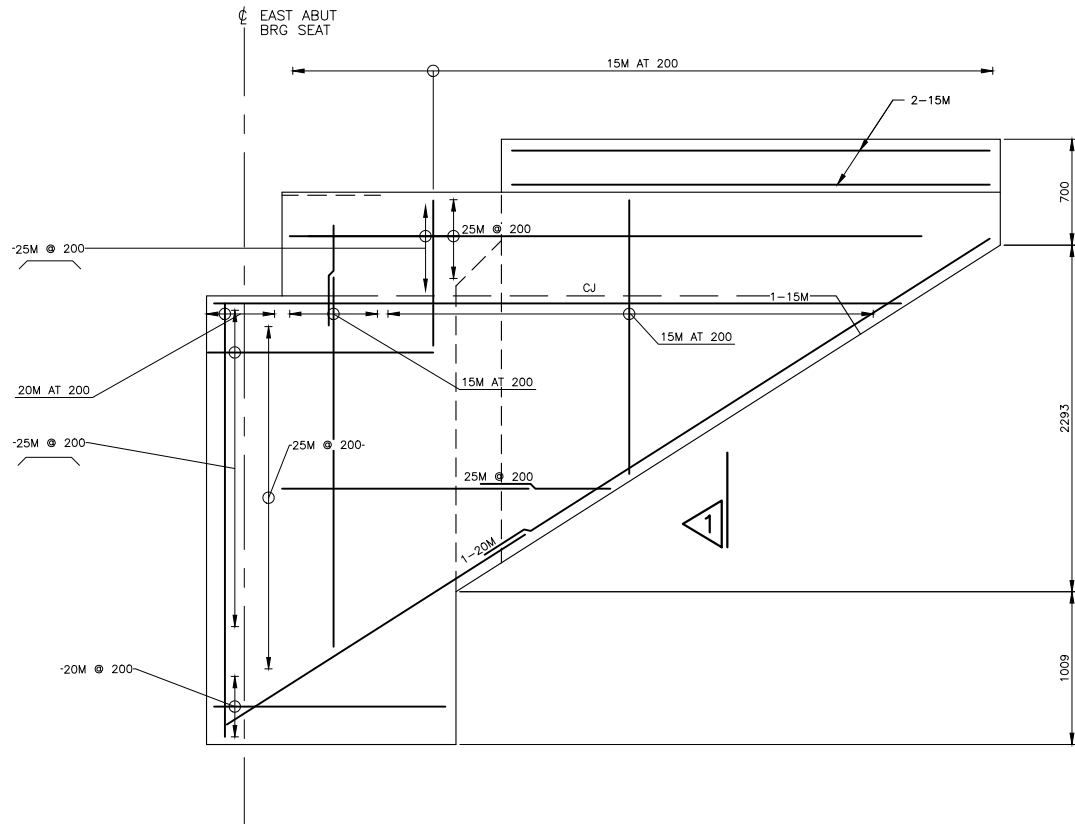
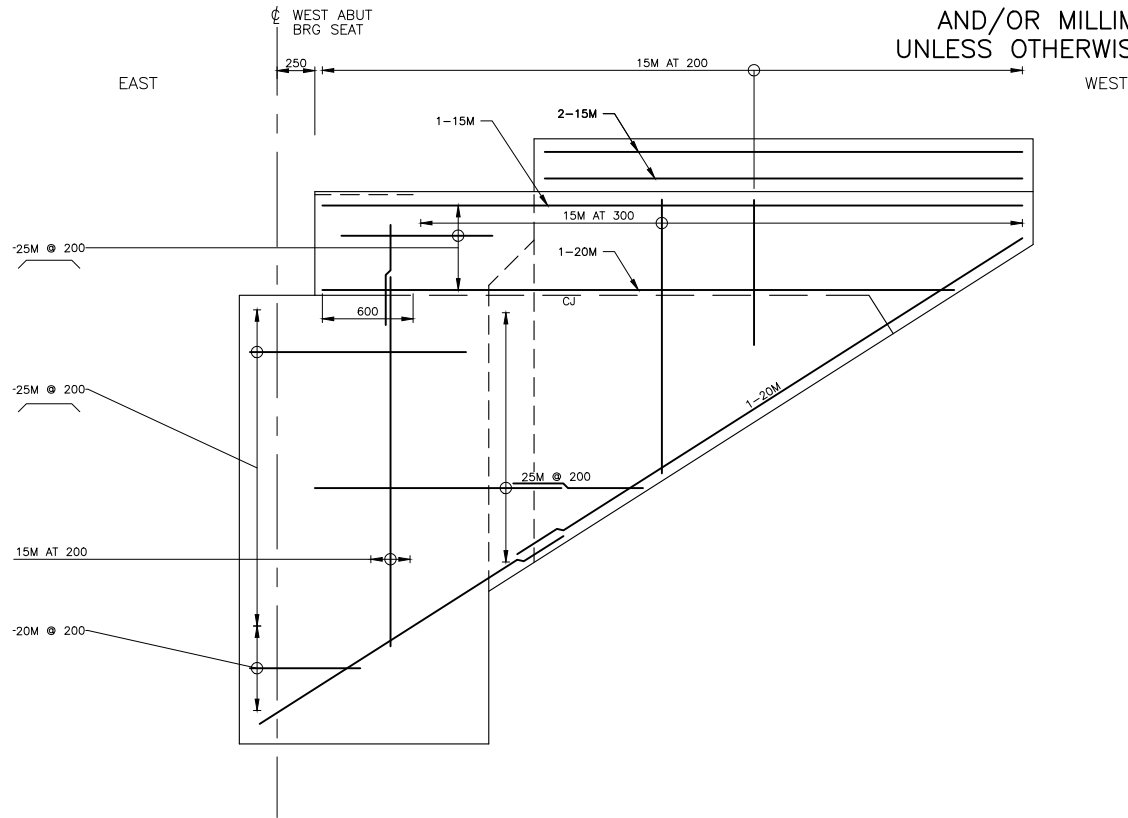
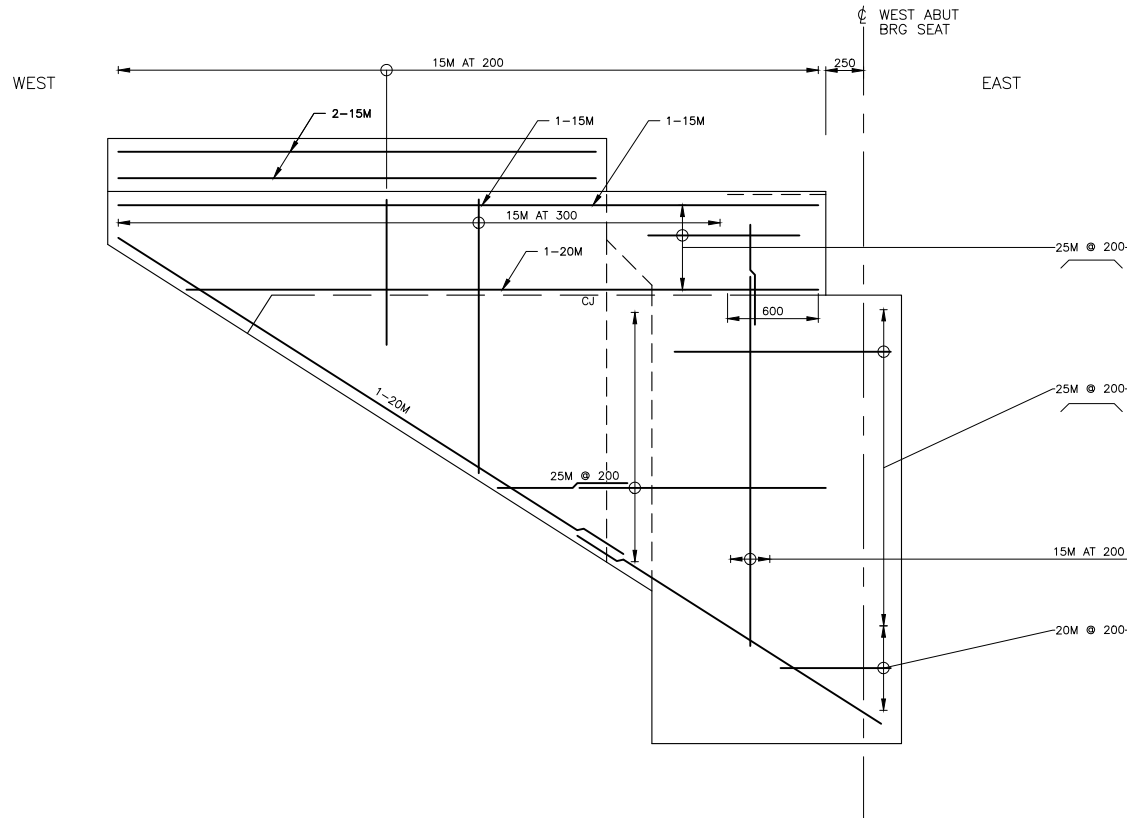
LIST OF ABBREVIATIONS:

- ABUT. DENOTES ABUTMENT
B.F. DENOTES BACK FACE
BRG. DENOTES BEARING
CJ DENOTES CONTROL JOINT
C.S.P. DENOTES CORRUGATED STEEL PIPE
E. DENOTES EAST
F.F. DENOTES FRONT FACE
GALV. DENOTES GALVANIZED
I.F. DENOTES INSIDE FACE
MIN. DENOTES MINIMUM
O.F. DENOTES OUTSIDE FACE
T.O. DENOTES TOP OF
TYP DENOTES TYPICAL
U/S DENOTES UNDERSIDE
W DENOTES WEST

APPLICABLE STANDARD DRAWINGS:

OPSD 3950.100 JOINTS CONCRETE EXPANSION AND
CONSTRUCTION ON STRUCTURE

REVISIONS		DATE	BY	DESCRIPTION
DESIGN	MT	CHK	CC	CODE CHBDC-14
DRAWN	TK	CHK	PK	SITE 26X-090
				LOAD CL-625-ONT
				DATE MAY/2019
				DWG 7



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

CONT 2017-4000
WP 4128-10-01

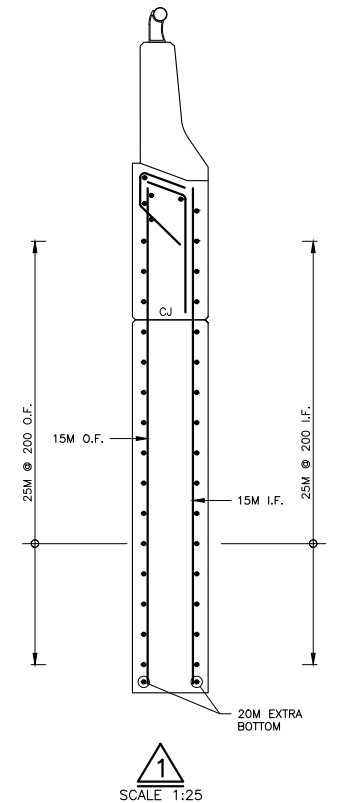
OUSE RIVER BRIDGE
SITE NO. 26-090
WINGWALL REINFORCEMENT

SHEET
34



NOTES:

1. THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER APPLICABLE CONTRACT DRAWINGS.
2. WEST ABUTMENT SHOWN, EAST ABUTMENT MIRRORED.
3. REINFORCING BARS TO BE CONTINUOUS THROUGH CONSTRUCTION JOINT.



LIST OF ABBREVIATIONS:

ABUT. DENOTES ABUTMENT
B.F. DENOTES BACK FACE
BRG. DENOTES BEARING
CJ DENOTES CONTROL JOINT
C.S.P. DENOTES CORRUGATED STEEL PIPE
E. DENOTES EAST
F.F. DENOTES FRONT FACE
GALV. DENOTES GALVANIZED
I.F. DENOTES INSIDE FACE
MIN. DENOTES MINIMUM
O.F. DENOTES OUTSIDE FACE
T.O. DENOTES TOP OF
TYP DENOTES TYPICAL
U/S DENOTES UNDERSIDE
W DENOTES WEST

APPLICABLE STANDARD DRAWINGS:

OPSD 3950.100 JOINTS CONCRETE EXPANSION AND
CONSTRUCTION ON STRUCTURE



DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS		DATE	BY	DESCRIPTION
DESIGN	MT	CHK	CC	CODE CHBDC-14
DRAWN	TK	CHK	PK	SITE 26X-090
				LOAD CL-625-ONT DATE MAY/2019
				DWG 8