REPORT

Level 1 and Level 2 Water Report

Proposed Storyland Pit, Horton Township, Ontario

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by R.W. Tomlinson Limited (Tomlinson) to conduct hydrogeological and hydrological studies at the proposed Storyland Pit located at 432 Storyland Road and on Part of Lot 20, Concession 6, Horton Township, Ontario (see Figure 1). The purpose of these studies is to provide supporting documentation for a licence application for a Class 'A' licence for a Pit Below the Groundwater Table, under the *Aggregate Resources Act* (ARA).

1.1 Site Description

The proposed pit is located on the south side of Storyland Road, east of Eady Road and west of Ruttan Road in Horton Township, Ontario (Figure 1). There are no buildings onsite. The site currently consists of active agricultural operations, interspersed with deciduous and mixed forests in the southwest, two tree stands within the central portion of the site and mixed hedgerow. The land uses around the site include rural residential properties, forested areas and patches, meadows and/or agricultural lands. A licensed pit (Sullivan Pit, ARA License #17733), owned by others, is located north and northwest of the site, on the north side of Storyland Road. Beyond the site boundary, the nearest residences are located along Storyland Road, Eady Road and Ruttan Road. The approximate locations of water well records included in the Ministry of the Environment, Conservation and Parks (MECP) Water Well Information System (WWIS) (UTM Reliability Code of 5 or less), within 500 metres of the proposed licensed extraction area are shown on Figure 2. Additional private well locations are shown on Figure 2 based on results of a windshield private well survey or are assumed to be present based on the available satellite imagery.

The ground surface elevation within the site area ranges from approximately 164 to 170 metres above sea level (asl) and is highest along a ridge running north-south along the eastern boundary of the site (see Figure 1). Beyond the eastern boundary of the site the topography declines rapidly towards the Ottawa River located approximately 1.1 kilometers northeast of the site.

Surface water features within the proposed licensed area include an unevaluated wetland (mixed willow deciduous thicket swamp) present in the northwest corner of the site, which includes a small pond and is bordered on the north by Storyland Road and on the west by Eady Road. The topography in the vicinity of the water feature is approximately 166 metres asl. The unevaluated wetland is fed primarily by a watercourse that originates north of Storyland Road via a culvert under the road and, to a lesser degree, by surface runoff from a small portion of the site. Historically the unevaluated wetland discharged via a culvert under Eady Road; however, this culvert is not typically functioning as a result of beaver activity, which has also been observed within the vicinity of the Storyland Road culvert.

1.2 Site Development

The site consists of a 69.5-hectare (ha) area proposed to be licensed under the ARA, of which the proposed extraction area occupies 55.9 ha. The property is owned by the applicant (Tomlinson). Based on the nature of the subsurface materials, the approximate pit base elevation will range between 149 and 152 metres asl (see approximate base elevations on the sequence of operations plan prepared by MHBC dated June 13, 2022 in Appendix A). This will result in a range of extraction depth between 10.5 to 16.5 metres at the site.

The proposed operations plan includes development of the Storyland Pit in five phases. Initially, Phase 1 of the proposed Storyland Pit operations will include a processing plant and product stockpile area located above the water table (refer to Appendix A).

1.3 Study Objectives

It is understood from Tomlinson that extraction operations below the groundwater table will not involve dewatering of the excavation. The final rehabilitation plan includes a permanent pond located within the proposed limit of extraction area (refer to Rehabilitation Plan provided by MHBC dated September 2022 in Appendix A). Based on the groundwater level data collected at the site between May 2021 and August 2022, the predicted elevation of the permanent pond will be between 162 and 163 metres as.Study Objectives

The objective of this study was to fulfill the requirements of a Level 1 and 2 Hydrogeological and Hydrological Assessment for the licensing of a Class 'A', Pit Below the Groundwater Table, under the ARA as well as applicable policies in the Renfrew County Official Plan (Official Plan) (County of Renfrew 2021). The study includes a hydrogeological and hydrological assessment to establish the groundwater conditions and water balance for the site. The results of the hydrogeological and hydrological investigation are used to assess the potential for adverse effects to groundwater users and surface water resources as a result of the proposed extraction below the groundwater table. The qualifications and experience of the report authors are presented in Appendix B.

1.4 County of Renfrew Official Plan

Based on pre-consultation discussions with the County of Renfrew and MHBC, the Level 1 and 2 Water Report should also address general development policies on site servicing (Section 2.2.12) and mineral aggregate policies (Section 7.7.3) of the Official Plan. The proposed site development will not require any servicing, as such, Section 2.2.12 of the Official Plan relating to site servicing would not apply. For Section 7.7.3 of the Official Plan, as required when an amendment to the local zoning by-law is being considered for mineral aggregates, the water table, existing and proposed drainage facilities and setbacks from watercourses have been considered in the Level 1 and 2 Water Report. The site water table and drainage conditions are discussed in Sections 3.1.4 and Section 3.2 of this report, potential impacts to water supply wells and surface water features are presented in Section 5.0, and all setbacks from watercourses will be consistent with the ARA requirements (i.e., minimum 30-metre setback).

2.0 SITE GEOLOGY AND HYDROGEOLOGY

2.1 Surficial Geology

The surficial geology in the vicinity of the site is shown on Figure 3. Published surficial geology mapping indicates the presence of glaciofluvial sediments (i.e., river deposits and delta topset facies) throughout the majority of the site and coarse grained glaciomarine sediments (i.e., sand and gravel, minor silt and clay) along the western and eastern boundaries of the site. There is also an area identified as an organic deposit (i.e., peat, muck, marl; Unit 20 on Figure 3) in the northwestern portion of the site within the vicinity of the surface water feature. The site is also mapped as a sand and gravel deposit in the County of Renfrew Official Plan Schedule "B" – Map 3 Mineral Aggregate and Mining Resource Map (Official Plan 2021). Previous borehole and test pitting programs completed at the site as part of the preliminary aggregate resource assessment (Patterson Group 2016 2017) and hydrogeology study (Golder 2021) confirmed the presence of overburden consisting of sand and gravelly sand deposits and silty sand, as discussed further in Section 3.1.2.

Beyond the site, published surficial geology mapping indicates the presence of glaciofluvial sediments (north and east), coarse-grained deposits (west and south), organic deposit patches (west) and fine grained glaciomarine sediments (east and southeast) surrounding the site (see Figure 3). Surficial Precambrian bedrock is also mapped beyond the north and east extents of the glaciofluvial and fine grained glaciomarine sediments.

2.2 Bedrock Geology

Published bedrock geology mapping indicates the upper bedrock unit in the vicinity of the site consists of Precambrian Bedrock (see Figure 4).

A review of the MECP WWIS indicates that the majority of the bedrock primarily consists of Precambrian granite. Some well records identify limestone/dolomite or sandstone overlaying the granite, although this is not evident in the published mapping. The bedrock surface ranges from 115 to 160 metres asl in vicinity of the site. The local depth to bedrock indicated in the WWIS well records varies from 10 to 52 metres below ground surface (bgs).

2.3 Hydrogeology

2.3.1 Overburden Aquifer

Deposits of coarse and permeable overburden capable of supplying sufficient quantities of groundwater exist locally in the area around the site (see units 7, 11a and 11b on Figure 3). The majority of the area is mapped as glaciofluvial, and coarse-grained sediments comprised of sand and gravel materials. Based on the depth to bedrock noted on the water well records in the MECP WWIS, the overburden in the vicinity of the site ranges between 10 and 52 metres thick (average 29 metres thick). The thickness of overburden present is likely to provide water of sufficient quantity for a water supply.

The overburden aquifer serves as a source of potable groundwater in the area of the proposed pit. The MECP WWIS identifies 6 overburden water supply wells (7156678, 7156685, 7166203, 7166204, 7172666 and 7344207) located within 500 metres of the site boundary based on a UTM Reliability Code of 5 or less (i.e., the well is expected to be within 300 metres or less of the actual well location). Local water supply wells for which information is provided in the MECP WWIS are completed in the overburden, at depths that generally range from 7 to 34 metres bgs and had static water levels generally ranging between 2 and 4 metres bgs at the time of drilling. A blank well record 7389847 is included in the MECP WWIS and plots in the centre of the eastern edge of the site. This location is not considered to be a water supply well, and based on the available drilling date of May 14, 2021, this record is assumed to be representative of the well cluster for the six overburden monitoring wells installed as part of the Golder 2021 investigation.

2.3.2 Bedrock Aquifer

The bedrock is a main source of potable groundwater in the area of the proposed pit. Based on the MECP WWIS, 22 of the 28 water wells located within 500 metres of the site boundary are completed in the bedrock. Of the 22 identified bedrock water wells, a total of 18 were drilled for water supply, and the remaining four were completed as test holes (7156764, 7156765, 7160389 and 7156695). Test hole 7156695 was subsequently abandoned. Based on the MECP WWIS, local water supply wells completed in bedrock generally range in depth from 37 to 104 metres bgs, and had static water levels generally ranging between 2 and 68 metres bgs at the time of drilling.

A review of the MECP WWIS indicates that the majority of the bedrock primarily consists of Precambrian granite. Some well records identify limestone/dolomite or sandstone overlying the granite, although this is not evident in the published mapping. Groundwater flow in the bedrock aquifers is controlled by and occurs along and through fractures (secondary porosity). Groundwater flow in the Precambrian bedrock is attributed to secondary porosity produced by fractures that have developed from tectonic processes (Golder, 2003). The density of fractures in the bedrock tends to decrease with depth (Golder, 2003). Estimates of hydraulic conductivity in fractured igneous and metamorphic rocks ranges from 10^{-8} to 10^{-4} metres per second (Freeze and Cherry, 1979). The actual value of hydraulic conductivity in the region are typically at the low end of the range (Golder, 2003). Generally, the fracture zones in the Precambrian bedrock yield marginal to adequate quantities of water for domestic use (Golder, 2003). The yield of the MECP WWIS bedrock wells within 500 metres of the site range between 15 and 68 litres per minute.

2.3.3 Additional Well Locations

Based on observations made by Golder personnel during the initial site reconnaissance and during a windshield survey completed in August 2022, eight water wells located at the following six properties: 377, 498 and 554 Storyland Road, 2323 (two wells identified) and 2333 Eady Road (two wells identified) and 77 Ruttan Road. Five of the wells were dug wells and three were drilled wells (see locations on Figure 2). Eight additional assumed water supply well locations were identified within 500 metres of the site boundary based on available satellite imagery (refer to locations on Figure 2). The results of the windshield private well survey, to identify additional groundwater users that are not included in the MECP WWIS (i.e., drilled and/or dug wells), are discussed further in Section 3.1.6.

3.0 STUDY METHODS AND RESULTS

3.1 Hydrogeological Investigation

A hydrogeological assessment in support of the application was completed for the site. The hydrogeological assessment involved the following tasks:

- Review of available data/information and site visit
- MECP Water Well Inventory (discussed in Section 2.0)
- Test pit investigation and monitoring well installation program
- Groundwater monitoring program
- Private Water Supply Well Windshield Survey
- Assessment of potential impacts related to the development and rehabilitation of the proposed pit

3.1.1 Borehole Drilling and Monitoring Well Installation

Aggregate resource investigations were carried out by Paterson Group (Paterson) on April 14 (TP1-16 to TP12-16), May 9 through 10, 2016 (BH1-16 to BH4-16) and December 6 to 8, 2016 (BH 1 to BH 8) on the site (Paterson, 2016; 2017). A preliminary field hydrogeological investigation was also completed by Golder between May 7 to 25, 2021 (BH21-01 to BH21-06) (Golder 2021). The objectives of the subsurface investigations were to determine the extent and nature of the aggregate resource in the area and to install monitoring wells for the characterization of hydrogeological conditions at the site. The locations of the test pits, boreholes and boreholes equipped with monitoring wells are shown on Figure 1.

Test pit excavation and boreholes for the 2016 aggregate resource evaluations completed by Paterson were carried out using an excavator and a track-mounted auger. The 2016 field work was monitored by Paterson field staff who located the test pits, observed the excavation operations, logged the test pits, and took custody of the soil samples retrieved. The test pits and/or boreholes were advanced to depths of 2.9 to 15.9 metres bgs. The collected soil samples were submitted to the Paterson laboratory in Ottawa for gradation testing (Paterson 2016; 2017). A monitoring well consisting of a 32-mm diameter PVC screen and riser were installed in boreholes BH 1, BH 3 and BH 4, screened in the sand overburden. The locations of the 2016 test pits and boreholes were identified on-site by Paterson using a handheld GPS.

The boreholes for the 2021 preliminary hydrogeological field investigation completed by Golder were advanced using a track-mounted hollow stem auger drill supplied and operated by Marathon Drilling Company Ltd. of Ottawa, Ontario. All field work was monitored by Golder staff who staked the boreholes in the field in advance of the utility clearances, monitored drilling operations, logged the boreholes and samples, and took custody of the soil samples retrieved. The boreholes were advanced to depths of 3.1 to 15.1 metres bgs. This corresponds to elevations ranging from 151.0 metres asl to 163.1 metres asl. Borehole 21-06 was drilled by rotary drill wash bore below 9.8 mbgs due to running sand in the augers. In each of the boreholes, a monitoring well consisting of a 32-mm diameter PVC screen and riser were installed in boreholes BH21-01 through BH21-06, screened in the sand overburden. The locations and geodetic ground surface elevations of the 2021 boreholes were surveyed by Tomlinson.

Borehole and test pit logs summarizing the subsurface conditions encountered in the test pits and boreholes put down for the site investigations completed by Paterson and Golder are included in Appendix C.

3.1.2 Site Stratigraphy

The test pitting and borehole drilling programs completed at the site as part of the preliminary aggregate resource evaluation and hydrogeological studies indicated that the overburden consists primarily of fine to coarse sand with gravel. In addition, three stratigraphic cross-sections are provided as Figures 5A, 5B and 5C (see Figure 1 for cross-section locations).

Cross-section A-A' (Figure 5A) runs from southwest to northeast across the northern portion of the site. Along most of the section, there is at least between 3.1 and 9.9 metres of sand near ground surface. Gravelly sand was encountered in boreholes BH 2 and BH21-01 located on the northeastern end of the cross-section line. Fine to coarse sand was encountered in all of the boreholes. Layers of fine-to-medium sand were encountered in borehole BH21-02 located in the middle of the cross-section line and borehole BH21-01 located at the northeastern end of the cross-section line. Silty sand was encountered in borehole BH21-01 underlying the fine-to-coarse sand between 9.9 and 11.6 metres depth below ground surface (bottom of hole).

Cross-section B-B' (Figure 5B) runs from approximately southwest to northeast across the central portion of the site. Along the section, the overburden material primarily consists of fine-to-medium, fine-to-coarse or medium-to-coarse sand ranging between at least 4.6 and 6.1 metres thick. The coarsest material is present within the central portion of the site at test pit TP3-16 and borehole BH21-06, where up to 4.4 metres of gravel sand was encountered underlying the silty sand or fine sand materials. Fine sand layers were also encountered at borehole BH21-01 between 0.8 and 1.5 metres and 11.3 and 13.7 metres depth. Silty sand was encountered near the surface along the eastern and central portion of the site and underlying the fine sand unit at borehole BH21-06 from 13.7 to 15.1 metres depth (bottom of hole).

Cross-section C-C' (Figure 5C) runs from south to north across the eastern portion of the site. Along the section line, the overburden material consists of fine-to-medium, fine-to-coarse or medium-to-coarse sand ranging from 4.2 and 11.2 metres thick. Fine sand and silty sand were encountered within the central portion of the site at borehole BH21-06 as previously described in cross-section B-B'.

3.1.3 Hydraulic Conductivity Testing

A total of five well response tests were carried out in the monitoring wells installed in BH21-01, BH21-02, BH21-03, BH21-04 and BH21-05 using the rising/falling head method. The completed well response tests provide an estimate of the horizontal hydraulic conductivity of the overburden materials adjacent to the monitoring well interval. The response testing was performed by displacing water by inserting/removing a plastic slug and monitoring the recovery to the static water level by measuring the depth to the water using a water level tape and/or pressure transducer and datalogger at frequent intervals.

For analysis, the intervals for response testing were defined as the monitoring well screen. This definition of screen length was used to maintain the assumption for horizontal flow to the piezometer screen. The details regarding the locations of the test interval for each monitoring well are provided on the borehole logs in Appendix C. The well response test analyses are provided in Appendix D. The hydraulic conductivity value from each test was calculated using either the Hvorslev (1951or Bouwer and Rice (1976) method.

A summary of the well response testing results from on-site monitoring are provided in the following table:

Table 1: Hydraulic Conductivity Estimates from On-Site Hydraulic Testing

Borehole No.	Estimated Hydraulic Conductivity (metres per second)	Stratigraphy of Screened Interval
21-01	3×10^{-5}	Silty sand, trace clay
21-02	6×10^{-4}	Sand, fine-to-coarse, trace silt
21-03	2×10^{-5}	Sand, fine-to-coarse, trace to some silt
21-04	1×10^{-4}	Sand, fine-to-coarse
21-05	1×10^{-4}	Sand, fine-to-medium

These estimates are relatively consistent with the range of hydraulic conductivity values reported for silty sand to sand (Freeze and Cherry, 1979). The hydraulic conductivity values derived from the single-well pressure response tests completed in the monitoring wells screened within the sand deposit vary from 2×10^{-5} metres per second (m/s) to 6×10^{-4} m/s with a geometric average of 8×10^{-5} m/s. These values indicate a high hydraulic conductivity as expected for the permeable sand materials.

3.1.4 Groundwater Monitoring and Flow Direction

Groundwater monitoring sessions were undertaken between May 25, 2021 and August 3, 2022. Groundwater levels were measured on a monthly basis by Golder (May 2021) and Tomlinson staff (June 2021 to August 2022 and provided to Golder). The top of the piezometer at each monitoring well location was surveyed by Tomlinson to a Geodetic datum in order to allow for calculation of the groundwater elevation based on the measured depth to groundwater and to determine the groundwater level fluctuation in the area that occur within the overburden.

The water level elevations are provided in the following table and plotted against time on Figure 6.

Table 2: Groundwater Elevations

Date	Groundwater Elevations (metres above sea level)								
	BH 1	BH 3	BH 4	BH21-01	BH21-02	BH21-03	BH21-04	BH21-05	BH21-06
25-May-21	162.40	160.50	159.53	159.55	163.79	165.02	164.52	162.83	162.67
21-Jun-21	162.27	160.43	159.42	159.53	163.60	164.73	164.31	162.69	162.53
15-Jul-21	162.37	160.57	159.50	159.62	163.71	164.78	164.28	162.69	162.60
27-Aug-21	162.23	160.40	159.37	159.52	163.42	164.66	164.31	162.55	162.41
23-Sep-21	162.10	160.28	159.27	159.44	163.29	164.38	163.96	162.42	162.24
12-Oct-21	162.15	160.23	159.21	159.38	163.39	164.44	163.97	162.41	162.25
8-Nov-21	162.14	160.22	159.19	159.36	163.40	164.45	163.98	162.39	162.23
14-Dec-21	162.07	160.18	159.22	159.33	163.42	164.39	163.94	162.35	162.17
27-Jan-21	162.01	160.14	[1]	159.22	163.24	164.09	163.93	162.32	162.13
23-Feb-22	162.14	160.19	[1]	159.28	163.49	164.43	164.10	162.46	162.21
30-Mar-22	162.24	160.23	159.21	159.33	163.56	165.27	164.13	162.52	162.35
11-Apr-22	162.33	160.27	159.23	159.36	163.67	165.06	164.36	162.60	162.49
10-May-22	162.86	[2]	159.59	159.67	164.20	165.23	164.65	163.03	163.23
14-Jun-22	162.79	160.81	159.70	159.85	164.40	165.29	164.65	163.06	163.37
11-Jul-22	162.73	160.92	159.86	160.05	164.07	165.06	164.49	163.04	163.07
3-Aug-22	162.46	160.71	159.70	159.95	163.75	164.76	164.25	162.85	162.76

Notes:
1. BH 4 was frozen during the January and February 2022 monitoring sessions, therefore groundwater elevation data is unavailable.
2. BH 3 was blocked during the May 2022 monitoring session, therefore groundwater elevation data is unavailable.

As shown on Figure 6, the pre-development groundwater elevations, which represent background groundwater elevation conditions in the vicinity of the site, ranged from a low of 159.2 metres asl at BH 4 in November 2021 to a high of 165.3 metres asl at BH21-03 in March and June 2022. Groundwater depths range from 0.8 to 2.5 metres bgs along the western boundary (i.e., at BH21-03 and BH21-04) to 5.3 and 9.4 metres bgs along the eastern boundary of the site (i.e., at BH 3, BH 4 and BH21-01). Groundwater elevations in all monitoring wells show seasonal variations, with the highest elevations observed in spring), and the lowest generally observed during the summer and winter months. The June through August 2022 groundwater elevations are likely elevated compared to the same period in 2021 as a result of an increase in precipitation events throughout the monitoring period.

Based on groundwater elevation data collected during the pre-development period, the general groundwater flow direction in the vicinity of the site is influenced by the topography of the site and seasonal water table fluctuations. The direction of groundwater flow in the shallow overburden appears to be to the east/northeast across the site, towards the Ottawa River located off-Site to the east (refer to Figure 7).

Based on the available groundwater elevation data, the maximum predicted water table on the site is 165.3 metres asl on the western edge of the extraction area corner (as measured at BH21-03). Based on the groundwater elevation data measured at BH 4 located on the southeastern side of the site, the water table slopes down moving from west to southeast, and the maximum predicted water table on the east side of the site is approximately 159.9 metres asl.

3.1.5 Predicted Radius of Influence

As discussed in Section 1.2, the proposed Storyland Pit will not be dewatered during operations, but extraction will continue below the groundwater table. Based on the groundwater level data collected at the site between May 2021 and August 2022, the predicted elevation of the pond during operations and after rehabilitation will be between 162 and 163 metres asl. To remain conservative, for the purpose of assessing groundwater drawdown in the vicinity of the site, the lake level was assumed to be 162 metres asl.

Because the surface of the lake within the pit will be flat, there will be minor changes in the pre-development groundwater table in the area adjacent to the sides of the proposed pit. In areas where the existing groundwater table is above the estimated elevation of the lake, drawdown of the groundwater table will be observed during extraction operations and during rehabilitation, whereas in areas where the existing groundwater table is below the estimated elevation of the lake, an increase in the groundwater table would be observed.

The worst-case drawdown will occur along the western side of the pit where the existing groundwater table is the highest. Along the western extraction boundary, the highest measured groundwater elevation is approximately 165.3 metres asl (based on measurements at BH21-03). As such, the worst-case drawdown at the edge of the extraction area is estimated to be 3.3 metres.

The Dupuit-Forchheimer flow equation for an unconfined aquifer (Driscoll, 2003) was used to develop an analytical model to conservatively estimate the radius of influence associated with the flattening of the groundwater table at the site. Table 3 lists the information used during the analytical modelling.

Table 3: Summary of Predicted Radius of Influence Analytical Modeling Input Parameters

Location	Total Depth Below Water Table (m)	Worst-Case Drawdown (m)	Extraction Area (m^2)	Equivalent Radius (m)	Hydraulic Conductivity (m/s)
West End of Extraction Area	13.3	3.3	559,000	422	4×10^{-5}

The total depth information in the above table (13.3 metres) was based on the allowable limit of extraction below the highest measured groundwater table along the western boundary (i.e., the proposed base of the pit of 152.0 metres asl at the western edge subtracted from the highest groundwater level 165.3 metres asl). The worst-case drawdown was calculated as the difference between the highest measured groundwater level on the western side extraction area (i.e., 165.3 metres asl) and the worst-case estimated elevation of the lake after extraction is completed (i.e., 162 metres asl). The hydraulic conductivity used for the analytical modelling was the geometric mean of the values measured at BH21-03 and BH21-04 located along the western boundary (i.e., 4×10^{-5} m/s).

The estimation of the predicted radius of influence for the Dupuit-Forchheimer equation is based upon radial flow geometry. For the purposes of this calculation, the water taking location is assumed to be circular, and an equivalent radius is calculated based on the actual area. As indicated in the above table, the total extraction area is 559,000 square metres, and the equivalent radius for extraction area is 422 metres. The results of the analytical modelling are provided in Appendix E. The estimated radius of influence is equal where the change in predicted inflow as a function of the radius of influence begins to level off on the plot provided in Appendix E. The estimated radius of influence associated with 3.3 metres of drawdown resulting from the flattening of the groundwater table within the extraction area is approximately 30 metres (i.e., no drawdown is predicted beyond 30 metres from the extraction boundary).

The above estimated radius of influence is considered to be conservative because of the assumptions used in completing the analytical modelling (worst-case portion of site for groundwater level drawdown and worst-case estimated lake level), and because the analytical model does not incorporate recharge. It is anticipated that the high infiltration rate (recharge) associated with the exposed sand and gravel deposit at the site would result in an actual predicted radius of influence that is less than the 30 metres estimated using the Dupuit-Forchheimer equation.

As shown on Figure 2, to remain conservative, the worst-case estimated radius of influence has been applied to the western half and central portion of the site. As discussed previously, the maximum groundwater levels measured at the site are contoured on Figure 7. The easterly extent of the predicted radius of influence is cut off at the 162 metres asl contour presented on Figure 7. Because the worst-case lake level is 162 metres asl, there would be no potential for drawdown where the existing worst-case groundwater table is already below 162 metres asl.

The estimated worst-case radius of influence shown on Figure 2 is used to complete the impact assessment for local water supply wells presented in Section 5.1 and the unevaluated wetland feature presented in Section 5.3.

3.1.6 Windshield Private Well Survey

Golder completed a windshield private well survey on May 14, 2021 and August 23, 2022 to identify potential groundwater users that are not included in the MECP WWIS (i.e., drilled and/or dug wells) for the properties located within the 500 metres of the site. The private well survey included a field visual survey to verify the publicly available data for the private water wells located at the residential properties adjacent to the site situated on Eady Road, Storyland Road and Ruttan Road. The windshield survey confirmed the locations of an additional eight water wells located at the following six properties: 377, 498 and 554 Storyland Road, 2323 (two wells identified) and 2333 Eady Road (two wells identified) and 77 Ruttan Road. Five of the wells were dug wells and three were drilled wells. A Table summary of the windshield well survey completed is presented in Table 4.

Table 4: Summary of Windshield Private Well Survey Findings

Address	Observation
377 Storyland Road	Dug well
498 Storyland Road	Dug well
549 Storyland Road	Well assumed to be present based on satellite imagery - presence of private well could not be confirmed during windshield survey
554 Storyland Road	Dug well

Address	Observation
2036 Chapeski Lane	Well assumed to be present based on satellite imagery - presence of private well could not be confirmed during windshield survey
2284 Eady Road	Well assumed to be present based on satellite imagery - presence of private well could not be confirmed during windshield survey
2307 Eady Road	Well assumed to be present based on satellite imagery - presence of private well could not be confirmed during windshield survey
2323 Eady Road	Dug well and drilled well
2333 Eady Road	Dug well and drilled well
2338 Eady Road	Well assumed to be present based on satellite imagery - presence of private well could not be confirmed during windshield survey
58 Ruttan Road	Well assumed to be present based on satellite imagery - presence of private well could not be confirmed during windshield survey
Unknown Ruttan Road	Well assumed to be present based on satellite imagery - presence of private well could not be confirmed during windshield survey
77 Ruttan Road	Drilled well
124 Ruttan Road	Well assumed to be present based on satellite imagery - presence of private well could not be confirmed during windshield survey

3.2 Hydrological Investigation and Water Balance Analysis

A hydrological investigation of existing conditions and a water balance assessment for existing, operational and rehabilitation conditions were completed for the study area. The study area includes the land within the property boundary of the proposed Storyland Pit. The total study area is approximately 69.5 ha.

3.2.1 Surface Water Monitoring

A staff gauge was installed at surface water monitoring location SW-1 by Golder personnel on April 8, 2022 in the unevaluated wetland feature located within the western portion of the site, just west of the limits of the proposed extraction area (refer to Figure 1). A geodetic survey of the staff gauge was completed by Golder personnel on April 12, 2022.

3.2.1.1 Surface Water Levels

The staff gauge was installed to assess the water level within the unevaluated wetland. Surface water levels were measured on a monthly basis by Golder (March 30 through April 8, 2022) and Tomlinson staff (April 11 through August 3, 2022 and provided to Golder) during each of the monthly visits. A hydrograph of the measured surface water level for SW-1 is provided on Figure 6, which also includes the groundwater levels observed during the monitoring period.

Table 5: Summary of Water Levels at SW-1

Period of Record	Surface Water Elevation^1 (metres above sea level)						
	30-Mar-22	8-Apr-22	11-Apr-22	10-May-22	14-Jun-22	11-Jul-22	3-Aug-22
SW-1	Frozen	165.80	165.80	165.75	165.82	165.60	165.37

Note: [1] Top of staff gauge elevation relative to geodetic datum surveyed by Golder on April 12, 2022.

Compared to the water levels seen at the nearby monitoring well installed in borehole BH21-03 located on the eastern edge of the unevaluated wetland, the surface water level is, consistently, at a higher elevation than the groundwater level, which is interpreted to be related to the wetland feature primarily being fed by surface water inputs instead of groundwater.

The available water level data show higher elevations in the spring, followed by a decreasing trend throughout the summer. Surface water elevations will continue to be monitored by Tomlinson on a monthly basis between September 2022 and April 2023 to obtain a minimum year's worth of data. Fall and winter water levels are expected to remain low, marked with high water events likely caused by short melt events, or unavailable due to frozen conditions.

3.2.2 Water Quality Assessment

A water quality sample was collected from the northwest corner of the unevaluated wetland within the site footprint. This water feature is associated with the lowest topography within the site and is connected to the upstream water feature via the culvert underneath Storyland Road situated at the northwestern corner of the site (see Figure 1). One baseline water quality sample was collected by Golder personnel on May 7, 2022 from the unevaluated wetland (SW-1) as seen in Figure 1 and submitted for the analysis of total suspended solids (TSS), oil and grease, total metals including dissolved aluminum, pH, and inorganics.

The results of the sample collected from the unevaluated wetland showed that there were no Provincial Water Quality Objectives (PWQO) exceedances for the analyzed parameters. A table summarizing the water quality results from the May 7, 2022 baseline sampling event, as well as the Certificates of Analyses from the analytical laboratory are included in Appendix F.

3.2.3 Water Balance Methodology

The water balance assessment relied on meteorological data obtained from Environment and Climate Change Canada (ECCC) for the Ottawa International Airport (ID 6106000) Meteorological Station for the period 1939 to 2019. The water balance was based on land use data and existing soil types as identified through the subsurface investigation activities at the site and available mapping. For detailed water balance tables refer to Appendix G.

Soil types at the site under current conditions were identified from previous borehole and test pitting programs completed at the site as part of the preliminary aggregate resource assessment (Patterson Group 2016, 2017) and hydrogeology study (Golder 2021) as described in Sections 2.1 and 3.1.1. Land use under existing conditions was based on review of digital imagery, site reconnaissance and available documentation (McKinley Environmental Solutions 2021). Land use under operational conditions was based on the ARA Site Plan and assumed the extraction area to remain flooded during operations. The rehabilitated condition was based on the rehabilitation concept plan included in Appendix A (MHBC, 2022) and includes grassed, wetland and nodal planting areas along with a lake and two peninsulas to provide habitat diversity. Operational conditions assume that the setback areas remain unaltered from existing conditions. The land use and soil type data were compiled to estimate the total area of each land use and soil category within the site boundary. Meteorological data and information from this investigation were used with Table 3.1: Hydrologic Cycle Component Values, from the Ministry of the Environment (MOE) *SWM Manual* (MOE 2003), to identify appropriate Water Holding Capacities (WHC) for each land use.

Water balance calculations are based on the following equation, which is described in more detail below:

$$P = S + ET + Surplus$$

Where: P = precipitation
S = change in soil water storage
ET = evapotranspiration
Surplus = Surplus water (available for runoff or infiltration)

Precipitation data obtained from ECCC for the Ottawa International Airport station indicate a mean annual precipitation (P) of 903 millimetres per year (mm/yr).

Short-term or seasonal changes in soil water storage (S) are anticipated to occur on an annual basis as demonstrated by the typically dry conditions in the summer months and the wet conditions in the winter and spring. Long-term changes (e.g., year to year) in soil water storage are considered negligible in this assessment.

Evapotranspiration (ET) refers to water lost to the atmosphere from vegetated surfaces. The term combines evaporation (i.e., water lost from soil or water surfaces) and transpiration (i.e., water lost from plants and trees). Potential evapotranspiration (PET) refers to the loss of water from a vegetated surface to the atmosphere under conditions of an unlimited water supply. The actual rate of ET is typically less than the potential rate under dry conditions (e.g., during the summer months when there is a moisture deficit). The mean annual PET for the study area is approximately 610 mm/yr based on data provided by ECCC.

The mean annual water surplus (Surplus) is the difference between P and the actual ET. The water surplus represents the total amount of water available for either surface runoff (R) or groundwater infiltration (I) on an annual basis. On a monthly basis, surplus water remains after actual evapotranspiration has been removed from the sum of rainfall and snowmelt, and maximum soil or snowpack storage is exceeded. Maximum soil storage is quantified using a water holding capacity (WHC) specific to the soil type and land use. The WHC data obtained from ECCC for Ottawa International Airport station are shown in Table G-1, Appendix G.

Annual surplus values generated from the water balance method may be further divided into annual estimates of runoff and infiltration values. This is done by estimating an infiltration coefficient (based on topography, soil type and land cover) based on literature values, then multiplying the infiltration coefficient by the surplus estimate to produce an approximate value for annual infiltration. The remaining surplus not accounted for in the infiltration is assumed to run off. For this analysis, the infiltration estimates from Table 3.1 of the MOE manual (MOE, 2003) were used to estimate an infiltration coefficient for each land use and soil type.

3.2.4 Catchment Delineation

Under existing conditions, the site is split into two sub-catchments naturally divided by a topographic high which extends north to south across the property. Both sub-catchments ultimately report to the Ottawa River. The total site area is approximately 69.5 ha. Under existing conditions, approximately 14.5 ha (21% of the site) flows west to the unevaluated wetland (hereinafter referred to as the west sub-catchment) and the reminder 55 ha (79% of the site) drains north towards Storyland Road (hereinafter referred to as the east sub-catchment). The east border of the site corresponds with a topographic high and serves as a catchment divide between the east sub-catchment and the lands beyond the site's boundary.

The total drainage areas intercepted by the proposed Storyland Pit were delineated, using the Ontario Flow Assessment Tool (OFAT). The total drainage area of each of the contributing catchments, in which the study area is located, are approximately 10.7 square kilometres (km^2) for the west catchment (1,070 ha) and 3.2 km^2 (320 ha) for the east catchment. The sub-catchments identified in the site (i.e., east sub-catchment and west sub-catchment) represent approximately 1% of the overall west catchment area and 17% of the overall east catchment area. For the purposes of the water balance, because the drainage area of each sub-catchment within the site is small compared to the overall catchment and there is no off-site discharge, the site will be analysed as a whole, instead of per individual catchments.

As a result of the proposed development, the pit footprint (i.e., the extracted area) will have an approximate area of 55.9 ha which overlaps with the two existing drainage areas. The precipitation falling on the pit will be retained within the pond, ultimately infiltrating to recharge the groundwater. No excess runoff is expected to discharge off-site under the operational and rehabilitation scenarios considered in this assessment. Therefore, the runoff to the overall catchments is anticipated to be reduced by the same magnitude as the contributing sub-catchment areas; however, the water intercepted by the pit is expected to continue to flow towards the receiving watersheds by groundwater movement.

3.2.5 Water Balance Scenarios

The following scenarios were considered in this assessment:

- Existing Conditions: Currently, the majority of the site includes cultivated fields, with some portions of mature forest, tree stands and hedgerow and the unevaluated wetland on the west portion of the site.
- Operational Conditions: The full area within the proposed licensed area of extraction is assumed to be below water and therefore considered as a waterbody/pond for water balance calculations as less surplus is generated from waterbodies than from non-inundated land uses. For the purposes of this assessment, it is assumed that the setback allowance area will remain unchanged compared to existing conditions. It is also assumed that the water within the pond will remain on-site as a closed depression.
- Rehabilitated Conditions: The full area within the proposed extraction boundary is assumed to be below water with shallow wetlands located along the shoreline, with grassed areas, reforestation and nodal plant areas surrounding the lake, with no surface flow off-site, and the setback allowance area is assumed to remain unchanged compared to existing conditions. Therefore, there are no material differences, in terms of water balance assessment, between operational and rehabilitated scenarios.

3.2.6 Water Balance Parameters

The maximum soil storage is quantified using a WHC that is based on guidelines provided in Table 3.1 of the MOE *Stormwater Management Planning and Design Manual* (MOE 2003). The WHC represents the practical maximum amount of water that can be stored in the soil void space and is defined as the difference between the water content at the field capacity and wilting point (the practical maximum and minimum soil water content), respectively.

WHCs are specific to the soil type and land use, whereby values typically range from approximately 10 mm for bedrock to 400 mm for mature forest over silt loam. For temperate region watersheds, soil storage is typically relatively stable year-round, remaining at or near field capacity except for the typical mid- to late-summer dry period. As such, the change in soil storage is a minor component in the water budget, particularly at an annual scale. Surplus water is caused after actual ET has been removed (ET demand is met) and the maximum WHC is exceeded (soil-water storage demand is met).

For the open water areas (flooded pit and unevaluated wetland), it was assumed surplus equals the difference between the precipitation and PET. For the purposes of this assessment, we are conservatively assuming a null (i.e., 0%) infiltration factor adopted for the unevaluated wetland given the predominantly organic substrate found at its bottom, recognizing that there is possibly some leakage downwards from the unevaluated wetland to the groundwater system.

Under existing conditions, the majority of the site includes cultivated fields planted with soybeans. A portion of the site includes treed habitat such as forest stands (maple, white pine, mixed forest and hardwood deciduous forest), isolated tree stands along the northern portion of the site, and mixed hedgerow along the southwest edge of the property, parallel to Eady Road. Finally, the site includes the unevaluated wetland area on the northwestern portion of the site. Similar land uses were grouped together for the purposes of completing the water balance assessment.

As seen on Figure 3, the site is primarily composed of glaciofluvial sediments (boulders, sand and gravel, minor silt, clay, clay and glacial till), coarse grained glaciomarine sediments (sand and gravel, minor silt and clay) along the western and eastern boundaries of the site and organic deposit (peat, muck, marl) in the northwestern portion of the site within the vicinity of the surface water feature. Fine sand was used as the soil type for the proposed pit under operational conditions based on existing borehole results as discussed in Section 3.1.2.

Water holding capacities at the site were estimated using the values in Table 3.1 of the MOE manual (MOE, 2003). Areas are summarized by land use, WHC, soil type and infiltration coefficient in Tables 5, 6, and 7 for existing conditions, operational conditions and rehabilitated conditions, respectively.

Table 6: Summary of Catchment Areas, WHCs, Soil Types, and Infiltration Factors – Existing Conditions

Existing Conditions						
Type	**WHC**	**Type of Land Use**	**Soil Type**	**Soil Classification**	**Infiltration Factor**	**Catchment Areas (m^2)**
Dry – Fresh Sugar Maple – White Pine Mixed / Mixed Hedgerow Forest	250 mm	Mature Forest	Fine Sand	A	0.70	131,530
Dry – Fresh Sugar Maple - Hardwood Deciduous Forest / Mixed Hedgerow Forest	300 mm	Mature Forest	Fine Sandy Loam	B	0.65	10,430
Cultivated /Tree Stand	100 mm	Pasture & Shrubs	Fine Sand	A	0.60	434,880

Existing Conditions						
Type	WHC	Type of Land Use	Soil Type	Soil Classification	Infiltration Factor	Catchment Areas (m^2)
Cultivated /Tree Stand	150 mm	Pasture & Shrubs / Tilled	Fine Sandy Loam	B	0.55	56,370
Cultivated /Tree Stand	250 mm	Pasture & Shrubs / Tilled	Clay Loam	C-D	0.40	20,015
Mixed Willow Deciduous Thicket Swamp	Precip. - PET	Wetland	Clay Loam	C-D	0	41,825
Total						**695,050**

Table 7: Summary of Catchment Areas, WHCs, Soil Types, and Infiltration Factors – Operational Conditions

Operational Conditions						
Type	WHC	Type of Land Use	Soil Type	Soil Classification	Infiltration Factor	Catchment Areas (m^2)
Mixed Hedgerow Forest	250 mm	Mature Forest	Fine Sand	A	0.7	10,560
Mixed Hedgerow	300 mm	Mature Forest	Fine Sandy Loam	B	0.65	1,505
Cultivated /Tree Stand	100 mm	Pasture & Shrubs	Fine Sand	A	0.60	41,710
Cultivated /Tree Stand	150 mm	Pasture & Shrubs	Fine Sandy Loam	B	0.55	29,620
Cultivated /Tree Stand	250 mm	Pasture & Shrubs	Clay Loam	C-D	0.4	11,275
Mixed Willow Deciduous Thicket Swamp	Precip. - PET	Wetland	Clay Loam	C-D	0.0	41,825
Below Water Extraction Area	Precip. - PET	Pond	Fine Sand (Saturated)	A	1.0[1]	558,560
Total						**695,050**

Notes:

1) The infiltration factor for the proposed extraction area is 1.0 (i.e., 100% infiltration) as the pit was assumed to be a closed depression with no surface outlet for the purpose of the water balance assessment. Therefore, all available surplus is expected to infiltrate.

Table 8: Summary of Catchment Areas, WHCs, Soil Types, and Infiltration Factors – Rehabilitated Conditions

Rehabilitated Conditions						
Type	WHC	Type of Land Use	Soil Type	Soil Classification	Infiltration Factor	Catchment Areas (m^2)
Mixed Hedgerow Forest	250 mm	Mature Forest	Fine Sand	A	0.7	10,560
Mixed Hedgerow	300 mm	Mature Forest	Fine Sandy Loam	B	0.65	1,505
Cultivated /Tree Stand	100 mm	Pasture & Shrubs	Fine Sand	A	0.6	41,710
Cultivated /Tree Stand	150 mm	Pasture & Shrubs	Fine Sandy Loam	B	0.55	29,620
Cultivated /Tree Stand	250 mm	Pasture & Shrubs	Clay Loam	C-D	0.4	11,275
Mixed Willow Deciduous Thicket Swamp	Precip. - PET.	Wetland	Clay Loam	C-D	0.0	41,825
Rehabilitated Area - Lake	Precip. - PET	Pond	Fine Sand (Saturated)	A	1.0[1]	442,616
Rehabilitated Area - Wetland	Precip. - PET	Wetland	clay loam	C-D	1.0[1]	33,595
Rehabilitated Area - Grassland	150 mm	Pastures & Shrubs	Fine sandy loam	B	1.0[1]	59,307
Rehabilitated Area – Reforestation/Nodal Planting	250 mm	Pastures & Shrubs	Fine sandy loam	C-D	1.0[1]	23,044
Total						**695,050**

Notes:

1) The infiltration factor for the proposed rehabilitated area is 1.0 (i.e., 100% infiltration) as the pit was assumed to be a closed depression with no surface outlet for the purpose of the water balance assessment. Therefore, all available surplus is expected to infiltrate.

For the pit area in the proposed operational and rehabilitated conditions, the active area was assumed as open water with the surplus assumed as the difference between the sum of the inputs (rain and melt) minus the PET. This method does not account for any groundwater flow through the pit; actual groundwater inflows will be additive to the precipitation surplus predicted by this method.

An infiltration coefficient of 1.0 (indicating 100% infiltration with no runoff) was applied to the proposed extraction area in the operational and rehabilitated conditions. This infiltration coefficient was used to acknowledge that with no dewatering or surface water outflow (for water balance assessment purposes only), and assuming the amount of water in the pit does not change on an annual basis, the total annual surplus from the pit area must leave the pit through infiltration.

3.2.7 Water Balance Results

This section presents the water balance results under existing, operational and rehabilitation conditions. A discussion of the potential impacts to surface water features as a result of changes to the water balance during pit development is presented in Section 5.3. Details of the water balance calculations are presented in Table G-2.

3.2.7.1 Existing Conditions

The results from the existing conditions water balance are shown in Table 9.

Table 9: Existing Conditions Water Balance Results

Component	Average Annual Volume - Site Wide	
	mm/yr	m^3/yr
Precipitation (P); (1)	903	627,635
Evapotranspiration (ET); (2)	562	390,670
Total Surplus (S); (3) = (1) - (2) = (4) + (5)	341	236,865
Infiltration (I); (4)	197	136,760
Runoff (R); (5)	144	100,100
Water Balance = (1) - (2) - (3)	0	0

The total average annual surplus for the site area under existing conditions was estimated to be approximately 341 mm or 236,865 m^3 per year (m^3/year) and the estimated infiltration is approximately 197 mm or 136,760 m^3/year. Runoff was calculated as the difference between surplus and infiltration and was estimated to be approximately 144 mm or 100,100 m^3/year.

3.2.7.2 Operational Conditions

The results from the operational conditions water balance are shown in Table 10.

Table 10: Operational Conditions Water Balance Results

Component	Average Annual Volume – Site Wide	
	mm/yr	m^3/yr
Precipitation (P); (1)	903	627,635
Evapotranspiration (ET); (2)	604	419,770
Total Surplus (S); (3) = (1) - (2) = (4) + (5)	299	207,810
Infiltration (I); (4)	262	181,965
Runoff (R); (5)	37	25,845
Water Balance = (1) - (2) - (3)	0	0

The total average annual surplus for the proposed extraction area under operational conditions was estimated to be approximately 299 mm or 207,810 m³/year and the estimated infiltration is approximately 262 mm or 181,965 m³/year. Runoff was calculated as the difference between surplus and infiltration and was estimated to be approximately 37 mm or 25,845 m³/year.

3.2.7.3 Rehabilitated Conditions

The results from the rehabilitated conditions water balance are shown below in Table 11.

Table 11: Rehabilitated Conditions Water Balance Results

Component	Average Annual Volume – Site Wide	
	mm/yr	m³/yr
Precipitation (P); (1)	903	627,635
Evapotranspiration (ET); (2)	600	417,260
Total Surplus (S); (3) = (1) - (2) = (4) + (5)	302	210,235
Infiltration (I); (4)	265	184,390
Runoff (R); (5)	37	25,845
Water Balance = (1) - (2) - (3)	0	0

The total average annual surplus for the proposed extraction area under rehabilitation conditions was estimated to be approximately 302 mm or 210,235 m³/year and the estimated infiltration is approximately 265 mm or 184,390 m³/year. Runoff was calculated as the difference between surplus and infiltration and was estimated to be approximately 37 mm or 25,845 m³/year.

3.2.8 Hydrological Summary

The detailed results of the annual water balance including surplus, infiltration, and runoff for the existing, operational, and rehabilitated conditions are provided in Table G-2 in Appendix G.

Under operational conditions, surplus is anticipated to decrease by approximately 12% from 236,865 to 207,810 m³/year. Based on the proposed operational plan, runoff within the site will be decreased by approximately 74% and infiltration will be increased by approximately 33%. The reduction in runoff is a direct consequence of the changes in land use from cultivated/forest under existing conditions (surplus of 341 mm) to waterbody (surplus of 299 mm) which translates into increased losses to evaporation and increased contribution to the groundwater system resulting from increased infiltration. In addition, the consideration of the site as closed depression with no outlet off-site is the reason for reduced runoff. It is noteworthy that these percent changes (%) are evaluated within the site footprint; however, the effects in the larger overall catchment will be significantly smaller than those presented here as the area subject to changes in land use represent 0.7% of the overall west catchment and 15% of the overall east catchment.

Under rehabilitated conditions, it is assumed the pit will remain flooded with wetlands, grassed areas and reforested and nodal planted areas surrounding the lake. Surplus is anticipated to decrease by approximately 11% from 236,865 to 210,235 m³/year. Based on the proposed rehabilitation plan, runoff within the site will be decreased by approximately 74% and infiltration will be increased by approximately 35%. The reduction in runoff is a direct consequence of the changes in land use and mostly, the consideration of the site as closed depression with no outlet off-site. It is noteworthy that these percent changes (%) are evaluated within the site footprint; however, the effects in the larger overall catchment will be significantly smaller than those presented here as the area subject to changes in land use represent 0.7% of the overall west catchment and 15% of the overall east catchment.

Under existing conditions, the unevaluated wetland, located west of the site, receives some direct runoff from the site. Under operational and rehabilitated conditions, approximately 50% of the total area within the site reporting to the unevaluated wetland, will be subject to changes in land use; however, the unevaluated wetland is fed primarily by upstream surface water features. At the larger scale, the area subject to changes in land use represents only 0.7% of the estimated overall west catchment area that contributes to the unevaluated wetland.

The portion of the site within the east sub-catchment contributes to the overall east catchment and no surface water features are connected to the east sub-catchment within the study area. Under operational and rehabilitated conditions, the area subject to changes in land use represents only 15% of the estimated overall east catchment.

4.0 RECEPTOR IDENTIFICATION

4.1 Water Supply Wells

The MECP WWIS includes records for approximately 24 private water supply wells located within 500 metres of the site based on a UTM Reliability Code of 5 (i.e., the well is located 300 metres or less of the actual location). This excludes four locations that were drilled as test wells. A windshield survey identified an additional eight water wells located at the following six properties: 377, 498 and 554 Storyland Road, 2323 (two wells identified) and 2333 Eady Road (two wells identified) and 77 Ruttan Road. Five of the wells were dug wells and three were drilled wells. This brings the total number of confirmed water supply wells located with 500 metres of the site to 32. The approximate locations of these wells are shown on Figure 2. In addition, a review of a recent aerial photograph indicates that approximately 8 additional wells could be located within 500 metres, but the locations of these wells could not be confirmed during the windshield survey. The locations of the additional potential well locations identify through satellite imagery are shown on Figure 2.

4.2 Surface Water Features

In the study area, there is only one small watercourse that passes through mixed wetland located northwest of the licenced boundary and drains to the unevaluated wetland through a culvert underneath Storyland Road. As a result of the proposed operation and rehabilitation of the Storyland Pit, the small watercourse and unevaluated wetland will remain undisturbed, along with the majority of the of surface water catchment area reporting to them. The small watercourse and unevaluated wetland are part of the west catchment and the proposed changes in land use affect only 0.7% of the total estimated area.

5.0 ASSESSMENT OF POTENTIAL IMPACTS OF PROPOSED PIT

Based on the nature of the subsurface materials, the approximate pit base elevation will range between 149 and 152 metres asl (see approximate base elevations on the sequence of operations plan prepared by MHBC dated June 13, 2022 in Appendix A). Based on the groundwater level data collected at the site between May 2021 and August 2022, the predicted elevation of the permanent pond will be between 162 and 163 metres asl.

5.1 Potential Impact to Groundwater Users

Approximately 32 private well users have been confirmed within the 500 metres of the proposed boundary area to be licensed, of which 24 are listed in the MECP WWIS as water supply wells (with a UTM Reliability Code of 5 or less). A review of the completion details available for the 24 water supply wells listed in the MECP WWIS provided the following information:

Table 12: MECP WWIS Water Supply Well Information

Well Type	Well ID	Depth of Well (m)	Bottom Well Elevation (masl)	Depth to Bedrock (m)	Depth(s) to Water Found (m)	Water Found Elevation(s) (masl)	Depth to Static Water Level (m)	Static Water Level Elevation (masl)	Available Drawdown[1] (m)
Overburden	7156678[2]	7.2	161.7	-	6.4	162.5	3.1	165.8	3.3
	7156685[2]	7.2	159.9	-	6.4	160.7	3.6	163.6	2.8
	7166203[2]	7.2	160.0	-	6.4	160.7	1.9	165.3	4.5
	7166204[3]	18.3	148.9	-	10.7	156.5	2.2	165.0	8.5
	7172666[3]	18.9	149.3	-	10.7	157.6	3.8	164.5	6.7
	7344207[3]	33.5	-	-	33.5	-	3.3	-	30.2
Bedrock	5503723	38.1	132.2	24.7	27.7, 36.3	134.0, 142.6	19.8	150.5	7.9
	5512795	51.8	115.1	27.1	32.6, 44.8	122.2, 134.4	18.0	149.0	14.6
	5514809	103.6	53.2	23.5	48.5, 100.3	56.6, 108.4	67.7	89.2	32.6
	5516604	37.0	129.7	24.0	34.0	132.7	1.8	164.9	32.2
	7051959	43.4	123.8	30.4	40.3	126.9	2.4	164.8	37.9
	7133111	36.6	131.6	30.0	34.1, 35.1	133.1, 134.0	2.4	165.7	31.7
	7151036	60.6	109.2	30.3	37.9, 56.1	113.7, 131.9	19.0	150.8	18.9
	7153080	65.8	101.2	43.1	62.8	104.2	3.2	163.8	59.6
	7168388	39.6	127.7	37.5	39.3	128.0	3.2	164.1	36.1
	7172863	73.2	95.3	32.2	61.0	107.5	4.3	164.2	56.7
	7185518	56.4	111.9	24.3	31.0, 42.4, 53.1	115.2, 125.9, 137.3	24.9	143.5	6.1
	7203271	55.8	107.4	29.6	53.3	109.8	15.0	148.1	38.3
	7219456	61.0	108.9	19.4	38.7, 44.8	125.0, 131.1	11.9	157.9	26.8

Well Type	Well ID	Depth of Well (m)	Bottom Well Elevation (masl)	Depth to Bedrock (m)	Depth(s) to Water Found (m)	Water Found Elevation(s) (masl)	Depth to Static Water Level (m)	Static Water Level Elevation (masl)	Available Drawdown[1] (m)
	7248852	38.5	132.2	26.4	36.4	134.3	23.2	147.5	13.2
	7274873	52.7	113.2	18.6	51.2	114.7	19.1	146.8	32.1
	7288279	61.0	94.9	21.5	29.3, 60.2	95.7, 126.6	8.1	147.8	21.1
	7301096	94.5	75.7	10.4	36.6, 91.1	79.1, 133.7	18.8	151.4	17.7
	7387708	64.0	-	28.0	44.2, 61.0	-	2.8	-	41.4

Notes:
m = metres, masl = metres above sea level, - = information unavailable in MECP WWIS well record
1. Available drawdown estimated as the difference between the static water level and depth of water found.
2. Dug well
3. Drilled overburden well (rotary or air percussion)

Table 13: Summary of MECP WWIS Water Supply Wells

Well Type	Parameter	Range in Values in MECP WWIS Wells
Overburden	Number of Water Supply Wells	6
	Bottom of Well (Depth)	7.2 to 33.5 metres
	Bottom of Well (Elevation)	148.9 to 161.7 metres asl
	Uppermost Water-Bearing Zone (Depth)	6.4 to 33.5 metres
	Uppermost Water-Bearing Zone (Elevation)	156.5 to 162.5 metres asl
Bedrock	Number of Water Supply Wells	18
	Bottom of Well (Depth)	36.6 to 103.6 metres
	Bottom of Well (Elevation)	53.2 to 132.2 metres asl
	Uppermost Water-Bearing Zone (Depth)	27.7 to 100.3 metres
	Uppermost Water-Bearing Zone (Elevation)	56.6 to 142.6 metres asl

As previously discussed in Section 3.1.6, an additional eight water supply wells were identified within 500 metres of the proposed boundary as part of the windshield private well survey completed by Golder. The windshield well survey identified five unlisted dug wells completed in the overburden and three drilled wells. Eight additional wells may also be present in the vicinity of the site at the eight assumed locations shown on Figure 2 (identified through a review of satellite imagery) that could not be confirmed during the windshield private well survey completed by Golder.

Given that the aggregate extraction below the groundwater table will occur without dewatering, there will be minimal lowering of the groundwater table in the overburden and no drawdown in the underlying bedrock. As such, there is no potential for the proposed extraction activities to cause drawdown of the groundwater table such that it interferes with local water supply wells completed within the bedrock.

As the material is extracted from below the groundwater table, there would be a localized and temporary depression of the groundwater level as the aggregate material is extracted but this would rapidly recover given the permeable nature of the subsurface materials. Over the long-term, there will be a flattening of the groundwater table at the site as a result of extraction activities. The worst-case estimated radius of influence associated with the flattening of the groundwater table is shown on Figure 2. The estimated radius of influence is 30 metres (i.e., no drawdown is predicted beyond 30 metres). As shown on Figure 2, there are no water supply wells located within the estimated radius of influence. As such, impacts to water supply wells, completed in the overburden or the bedrock as a result of the proposed development of the Storyland Pit are not predicted.

Because there are several wells located in close proximity to the estimated radius of influence (i.e., 498 and 554 Storyland Road and 2333 and 2338 Eady Road), a long-term groundwater level monitoring program is proposed in Section 7.0.

5.2 Potential Impacts to Groundwater Flow Directions and Water Balance

In general, extraction of aggregate material from below the established water table has the potential for interference with local groundwater flow directions in the vicinity of a site. However, given that no dewatering is proposed during the extraction below the water table and because the radius of influence associated with the development of the site is small (see estimated radius of influence on Figure 2), significant impacts to groundwater flow directions in the vicinity of the site are not predicted.

5.3 Potential Impact to Existing Surface Water Features

As discussed above, the existing water features lay outside the limits of extraction of the proposed Storyland Pit. The unevaluated wetland is located approximately 30 metres from the proposed limit of extraction and outside of the estimated radius of influence associated with the flattening of the water table at the site. As a result, impacts to the unevaluated wetland as a result of lowering of the water table are not predicted.

Under existing conditions, the unevaluated wetland, located west of the site, receives some direct runoff from the site (approximately 14.5 ha or 21% of the site). Under operational and rehabilitated conditions, approximately 7.3 ha (i.e., 50% of the total area within the site reporting to the unevaluated wetland) will be subject to changes in land use; however, the unevaluated wetland is fed primarily by upstream surface water features to which is connected via the culvert crossing Storyland Road (see Figure 1). At the larger scale, the area subject to changes in land use (7.3 ha) represents only 0.7% of the overall west catchment area estimated, using OFAT, at 1,070 ha.

The portion of the site within the east sub-catchment (approximately 55 ha or 79% of the site) contributes to the overall east catchment which has an estimated total area, based on OFAT, of 320 ha. Under operational and rehabilitated conditions, approximately 48.3 ha (i.e., 88% of the total area within the site reporting to the east catchment) will be subject to changes in land use. At the larger scale, the area subject to changes in land use (48.3 ha) represents only 15% of the overall east catchment area estimated, using OFAT, at 320 ha.

The Storyland Pit excavation will convert approximately 55.9 ha to a closed depression without a perennial surface outlet to the environment. The water balance assessment in Section 3.2.8 that there is an overall reduction in water available given the estimated reduction of 13% in surplus as a direct consequence of increased evaporation from the waterbody. Rehabilitated conditions are expected to have a similar decrease in surplus compared to existing conditions. Although the pit area will no longer be directing a substantial amount of runoff to the corresponding east and west catchments, the water surplus collecting in the pit will also infiltrate in volumes approximately 33% larger than under existing conditions and continue reporting to the environment as shallow groundwater flow.

Operation of the proposed pit area is also not predicted to contribute to flooding in the receiving environment. The presence of the pit lake is expected to result in a minor overall reduction of peak flows relative to existing conditions during operations and rehabilitated conditions as no off-site surface discharges from the pit lake will occur.

Overall, the surface water impacts associated with the proposed pit that are discussed in this report are expected to be minor based on the information available at this time and the results of this assessment.

Changes to land uses in contributing catchments are on the order of 0.7% (west catchment) and 15% (east catchment) and overall surplus and runoff are expected to be reduced; however, infiltration will be increased under operational and rehabilitated conditions.

5.4 Source Water Protection

The proposed Storyland Pit falls outside of a local conservation authority and there is no source water protection plan established for the region. Therefore, there are no impacts to groundwater quality or quantity related to Wellhead Protection Areas as a result of the proposed development of the Storyland Pit.

6.0 COMPLAINTS RESPONSE PROGRAM

Based on the results of the groundwater modelling and the review of local water supply wells, it is concluded that water well interference complaints attributable to the development of the Storyland Pit are unlikely. Water well interference complaints will be responded to in light of the collected monitoring data and under the *Complaints Response Program* described below.

A comprehensive complaints response program has been developed for the purpose of responding to well interference complaints from local water supply well users. Each complaint will be dealt with on a case-by-case basis.

When a complaint is received by Tomlinson, the Complaints Response Program detailed below shall be initiated. As soon as can be arranged, a representative of Tomlinson and/or their agent will visit the site to make an initial assessment of the complaint. This will include a well/system inspection (where accessible) by a licensed pump maintenance contractor to determine the groundwater level, pump depth setting and condition of the well system. The available groundwater level data from the existing on-site monitoring well network will be reviewed by a licensed professional hydrogeologist/engineer to develop an estimate of the potential groundwater level drawdown at the potentially affected well that is the subject of the complaint response. The information obtained by the contractor from the well/well system inspection and the review of the available groundwater level data will be used by the professional hydrogeologist/engineer to prepare an opinion on the likelihood that the well interference complaint is related to pit operation.

If it is concluded that the well interference complaint is most likely attributable to site activities and the water supply is at risk, then a temporary supply will immediately be arranged, and a water supply restoration program will be implemented. The decision as to whether to proceed with the water supply restoration program will be based on a review of groundwater level information by the professional hydrogeologist/engineer and well construction and performance information from the licensed pump maintenance contractor as noted above.

The water supply restoration program consists of the following measures which are applicable for local water supply wells where the operation of the water supply wells may have been compromised by pit operation or based on the analysis of all monitoring data, are assessed to likely be compromised in the near future:

- Well System Rehabilitation – The well system could be rehabilitated by replacement or lowering of pumps, pump lines flushing, well deepening, etc. to improve performance. Where water is unavailable in the shallow bedrock and a well in deeper bedrock is being considered, a water sample(s) would be taken from the existing well for chemical, physical and bacteriological analyses prior to deepening the well to provide a basis of comparison. If the groundwater in the deeper bedrock is found to be of acceptable quality by the homeowner, either directly from the well or with treatment, it will be developed as the domestic supply. Any modifications to a well would be conducted in accordance with *Ontario Regulation 903*.
- Well Replacement or Additional Well(s) – The well could be replaced or augmented with a new well(s) that could be located further from the pit excavation. The feasibility of well replacement would be based on a test drilling program that could include more than one test well. Where water is unavailable in the shallow bedrock/overburden and a well in deeper bedrock (compared to the original water supply well) is being considered, a water sample(s) would be taken from the existing well for chemical, physical and bacteriological analyses to provide a basis of comparison. If the groundwater in the deeper bedrock is found to be of acceptable quality by the homeowner, either directly from the well or with treatment, it will be developed as the domestic supply. Construction of a new well(s) would be conducted in accordance with *Ontario Regulation 903*.
- Water Treatment Considerations – Appropriate water treatment will be incorporated into any restored water supply as discussed above.

Tomlinson would be responsible for all costs associated with the water supply restoration program. It is important to note that water supply restoration activities undertaken to address an adverse effect would be done so in consultation with the affected property owner in order to ensure a mutually agreeable solution is implemented.

7.0 MONITORING PROGRAM

A site-specific water level monitoring program has been developed to measure and evaluate the actual effects on potential receptors associated with long-term development of the proposed Storyland Pit, and to allow for a comparison of the actual effects measured during the monitoring program and those predicted as part of the impact assessment provided in Section 5.0.

7.1 Proposed Groundwater Level Monitoring Program

The proposed groundwater level monitoring program would include existing on-site monitoring wells. Table 14 includes a description of the monitoring locations proposed for inclusion in the groundwater level monitoring program, as well as the rationale for inclusion. The locations of the proposed monitoring wells are shown on Figure 2.

Table 14: Proposed Groundwater Monitoring Locations

Location	Rationale for Inclusion
BH21-01	Long-term monitoring location to assess changes in groundwater levels in the overburden between the site and private wells located to the east of the site.
BH21-02	Long-term monitoring location to assess changes in groundwater levels in the overburden between the site and private wells located to the north of the site.

Location	Rationale for Inclusion
BH21-03	Long-term monitoring location to assess changes in groundwater levels in the overburden between the site and private wells located to the northwest of the site.
BH21-04	Long-term monitoring location to assess changes in groundwater levels in the overburden between the site and private wells located to the southwest of the site.
BH 1	Long-term monitoring location to assess changes in groundwater levels in the overburden between the site and private wells located to the north of the site.

7.2 Proposed Surface Water Monitoring Program

The proposed surface water level monitoring program would include the existing on-site staff gauge SW-1. The collection of water levels at this location will allow for long-term monitoring of the water level within the unevaluated wetland located in the northwest portion of the site.

7.3 Monitoring Frequency

Water levels at the identified monitoring well and staff gauge locations would be measured manually on a quarterly basis. A datalogger will be installed at SW-1 to record water level measurements at least once per day.

8.0 SUMMARY AND CONCLUSIONS

A Level 1 and 2 Water Report was completed for the proposed Tomlinson Storyland Pit located at 432 Storyland Road and on Part of Lot 20, Concession 6, Horton Township, Ontario. Based on the results of the investigation, the following summary and conclusions are presented:

- The local overburden deposits on the property consist primarily of sand and gravel materials that range between 10 and 52 metres thick (average 29 metres thick).
- The majority of the bedrock primarily consists of Precambrian granite. The local depth to bedrock indicated in the WWIS well records varies from 37 to 104 metres.
- Three field investigations were carried out at the site by Paterson in 2016 and 2017 and Golder in 2021, which included the drilling of 18 boreholes and the excavation of 12 test pits. A single monitoring well was installed in nine boreholes (BH 1, BH 3, BH 4 and BH21-01 through BH21-06), and water levels were measured on a monthly basis from May 2021 to August 2022.
- Surface water monitoring station SW-1 was established in the unevaluated wetland feature located within the western portion of the site, just west of the limits of the proposed extraction area. Water levels were measured on a monthly basis during ice-free conditions between April and August 2022.
- Groundwater depths range from 0.8 to 2.5 metres bgs along the western boundary (i.e., at BH21-3 and BH21-4) to 5.3 and 9.4 metres bgs along the eastern boundary of the site (i.e., at BH 3, BH 4 and BH21-01). Groundwater elevations in all monitoring wells show seasonal variations, with the highest elevations observed in spring), and the lowest generally observed during the summer and winter months.
- Based on groundwater elevation data collected during the pre-development period, the general groundwater flow direction in the vicinity of the site is influenced by the topography of the site and seasonal water table fluctuations. The direction of groundwater flow in the shallow overburden appears to be to the east/northeast

across the site, towards the Ottawa River located off-Site to the east. Based on the available groundwater elevation data, the maximum predicted water table on the site is 165.3 metres asl on the western edge of the extraction area corner (as measured at BH21-03). Based on the groundwater elevation data measured at BH 4 located on the southeastern side of the site, the water table slopes down moving from west to southeast, and the maximum predicted water table on the east side of the site is approximately 159.9 metres asl.

- Over the long-term, there will be a flattening of the groundwater table at the site as a result of extraction activities. There are no water supply wells located within the worst-case estimated radius of influence associated with the flattening of the groundwater table at the site. As such, impacts to water supply wells, completed in the overburden or the bedrock as a result of the proposed development of the Storyland Pit are not predicted.
- The predicted surface water impacts associated with the proposed pit are marginal. Changes to land uses in contributing catchments are on the order of 0.7% (west catchment) and 15% (east catchment) and overall surplus and runoff are expected to be reduced however infiltration will be increased under operational and rehabilitated conditions. Operation of the proposed pit area is also not expected to contribute to flooding problems in the receiving environment, as water will not be typically discharged from the pit, and in fact, operating the pit is expected lead to a minor overall reduction in peak flows.
- The proposed water level monitoring program will permit the collection of long-term groundwater and surface water level data as the Storyland Pit develops. These data will show the actual changes in water levels within the monitoring wells completed around the extraction area as the pit expands laterally and vertically. In the unlikely event that complaints are received regarding interference to water wells in the vicinity of the site, the complaints response plan would be implemented.
- Based on the findings of this assessment, no adverse effects to groundwater and surface water resources and their uses are anticipated as a result of the operation and rehabilitation of the proposed Storyland Pit.

9.0 RECOMMENDATIONS

Based on the results of the hydrogeological and hydrological assessments for the Storyland Pit, the following recommendations are provided for inclusion on the site plans:

- The following water level monitoring program shall be implemented by the Licensee.
  - Quarterly water levels shall be collected from BH21-01, BH21-02, BH21-03, BH21-04, BH 1 and SW-1. A datalogger will be installed at SW-1 to record water level measurements at least once per day.
- In the event of a well interference complaint, the Licensee shall implement the Complaints Response Program outlined in Section 6.0 of this report.

10.0 LIMITATIONS AND USE OF REPORT

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11.0 CLOSURE

We trust this report meets your current needs. If you have any questions regarding this report, please contact the undersigned.

Signature Page

Golder Associates Ltd.

Dale Holtze

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https://golderassociates.sharepoint.com/sites/136741/project files/6 deliverables/phase 3000/water rpt/20412072-r-rev0_water rpt_10nov22.docx

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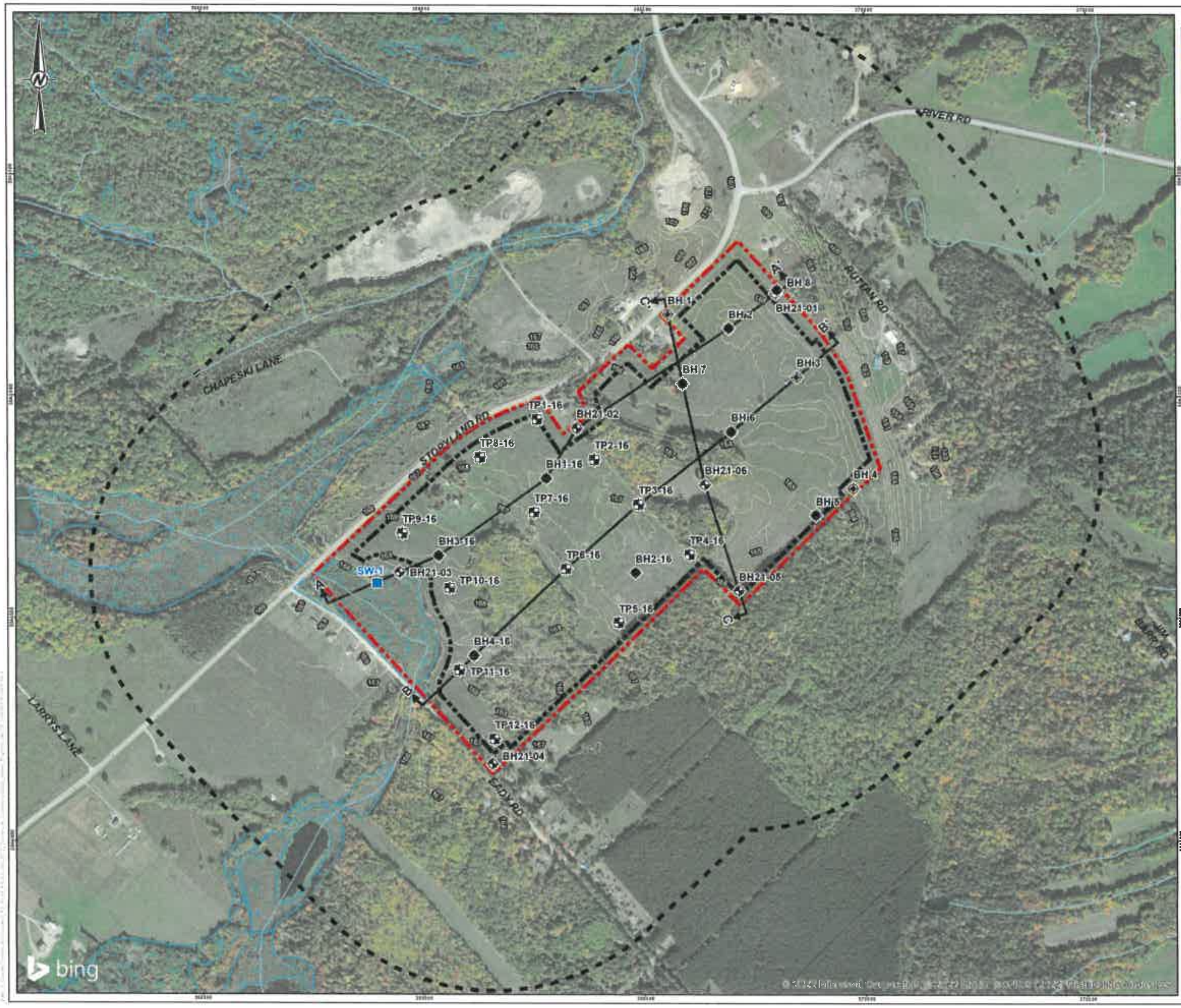
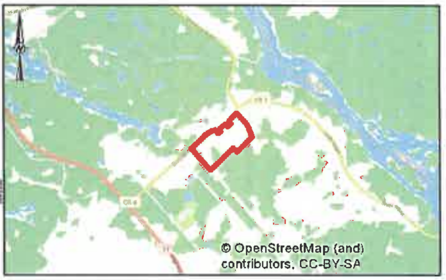


KEY MAP



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SCALE 1:100,000

LEGEND

⊕	APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION, CURRENT INVESTIGATION
⊕	APPROXIMATE BOREHOLE LOCATION WITH MONITORING WELL LOCATION, PREVIOUS INVESTIGATION
●	APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION
▣	APPROXIMATE TEST PIT LOCATION, PREVIOUS INVESTIGATION
🟦	SURFACE WATER MONITORING LOCATION
	TOPOGRAPHIC CONTOUR, metres
—	WATERCOURSE
↔	CROSS-SECTION LOCATION
▭	UNEVALUATED WETLAND
🟥	PROPOSED LICENSED BOUNDARY (69.5 ha)
⬛	PROPOSED LIMIT OF EXTRACTION (55.6 ha)
╍	500 m BUFFER

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)
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3. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

0 85 170 340
1:8,500 METRES

CLIENT
R.W. TOMLINSON LIMITED

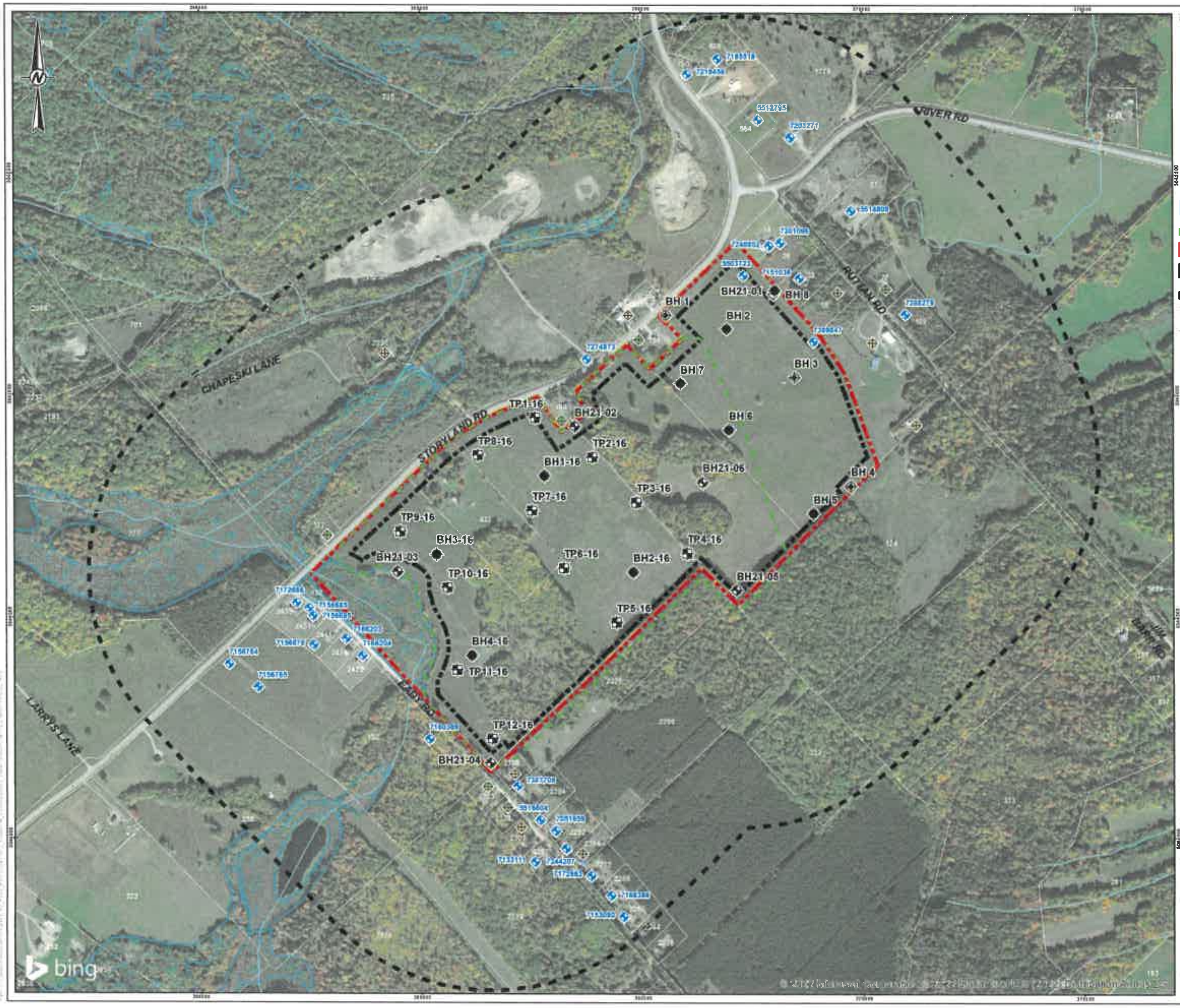
PROJECT
STORYLAND ROAD PIT PROPERTY, 432 STORYLAND ROAD AND PART OF LOT 20, CONCESSION 6, HORTON TOWNSHIP, ON

TITLE
SITE PLAN

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-08-26
DESIGNED	—
PREPARED	JEM
REVIEWED	DH
APPROVED	JPAO

PROJECT NO.	CONTROL	REV.	FIGURE
20412072	0003	0	1



LEGEND

- 🔷 APPROXIMATE MECP WWIS WATER WELL LOCATION
- ⊕ APPROXIMATE LOCATION OF OBSERVED ADDITIONAL WATER WELL
- ⊕ ASSUMED WATER WELL LOCATION BASED ON SATELLITE IMAGERY
- ◆ APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION, CURRENT INVESTIGATION
- ⊕ APPROXIMATE BOREHOLE LOCATION WITH MONITORING WELL LOCATION, PREVIOUS INVESTIGATION
- ● APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION
- ▨ APPROXIMATE TEST PIT LOCATION, PREVIOUS INVESTIGATION
- — WATERCOURSE
- ▨ UNEVALUATED WETLAND
- ▭ PREDICTED GROUNDWATER LEVEL DRAWDOWN RADIUS OF INFLUENCE
- 🟥 PROPOSED LICENSED BOUNDARY (69.5 ha)
- ▭ PROPOSED LIMIT OF EXTRACTION (55.8 ha)
- ▭ 500 m BUFFER

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0 85 170 340
1:8,500 METRES

CLIENT
R.W. TOMLINSON LIMITED

PROJECT
STORYLAND ROAD PIT PROPERTY, 432 STORYLAND ROAD AND PART OF LOT 20, CONCESSION 6, HORTON TOWNSHIP, ON

TITLE
WATER SUPPLY WELLS

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-09-16
DESIGNED	—
PREPARED	JEM
REVIEWED	DH
APPROVED	JPAD

PROJECT NO.	CONTROL	REV.	FIGURE
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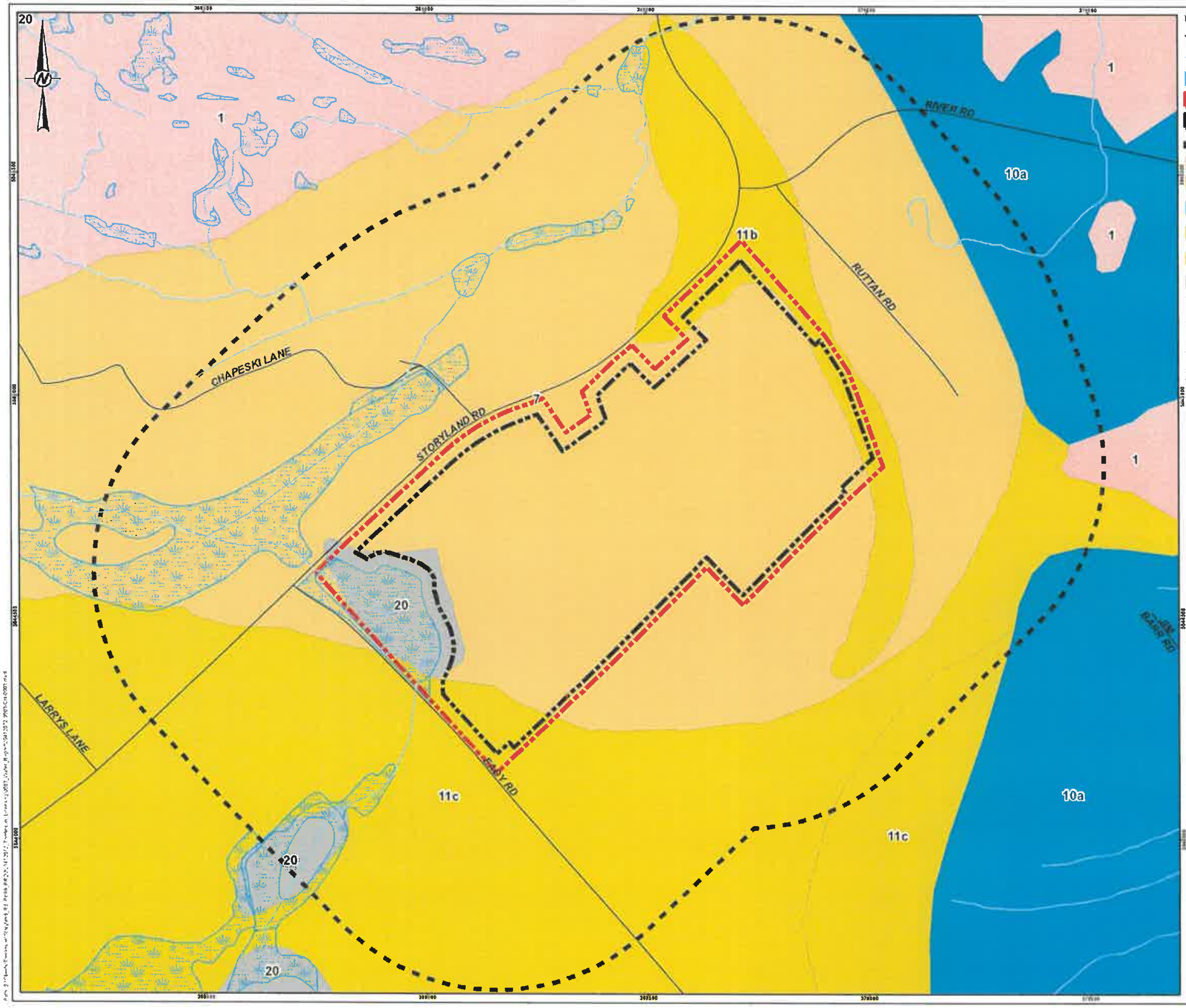

LEGEND

— ROADWAY

— WATERCOURSE

▨ UNEVALUATED WETLAND

▭ PROPOSED LICENSED BOUNDARY (69.5 ha)

▭ PROPOSED LIMIT OF EXTRACTION (55.6 ha)

▭ 500 m BUFFER

■ 1. PRECAMBRIAN BEDROCK

■ 7. GLACIOFLUVIAL DEPOSITS: RIVER DEPOSITS AND DELTA TOPSET FACIES

■ 10a. FINE-TEXTURED GLACIOMARINE DEPOSITS: SILT AND CLAY, MINOR SAND AND GRAVEL; MASSIVE TO WELL LAMINATED

■ 11b. COARSE-TEXTURED GLACIOMARINE DEPOSITS: SAND, GRAVEL, MINOR SILT AND CLAY; LITTORAL DEPOSITS

■ 11c. COARSE-TEXTURED GLACIOMARINE DEPOSITS: SAND, GRAVEL, MINOR SILT AND CLAY; FORESHORE AND BASINAL DEPOSITS

■ 20. ORGANIC DEPOSITS: PEAT, MUCK, MARL

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

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2. ONTARIO GEOLOGICAL SURVEY 2010. SURFICIAL GEOLOGY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE–DATA 128-REV
3. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

0 85 170 340

1:8,500 METRES

CLIENT
R.W. TOMLINSON LIMITED

PROJECT
STORYLAND ROAD PIT PROPERTY, 432 STORYLAND ROAD AND PART OF LOT 20, CONCESSION 6, HORTON TOWNSHIP, ON

TITLE
SURFICIAL GEOLOGY

CONSULTANT

WSP GOLDER

YYYY-MM-DD	2022-08-26
DESIGNED	---
PREPARED	JEM
REVIEWED	DH
APPROVED	JPAO

PROJECT NO.	CONTROL	REV.	FIGURE
20412072	0003	0	3

LEGEND

- ROADWAY
- WATERCOURSE
- UNEVALUATED WETLAND
- PROPOSED LICENSED BOUNDARY (69.5 ha)
- PROPOSED LIMIT OF EXTRACTION (55.6 ha)
- 500 m BUFFER
- FAULT
- 🟥 1: PRECAMBRIAN

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2020
2. ARMSTRONG, D.K. AND DODGE, J.E.P. 2007. PALEOZOIC GEOLOGY OF SOUTHERN ONTARIO; ONTARIO GEOLOGICAL SURVEY, MISCELLANEOUS RELEASE–DATA 219
3. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

0 85 170 340
1:8,500 METRES

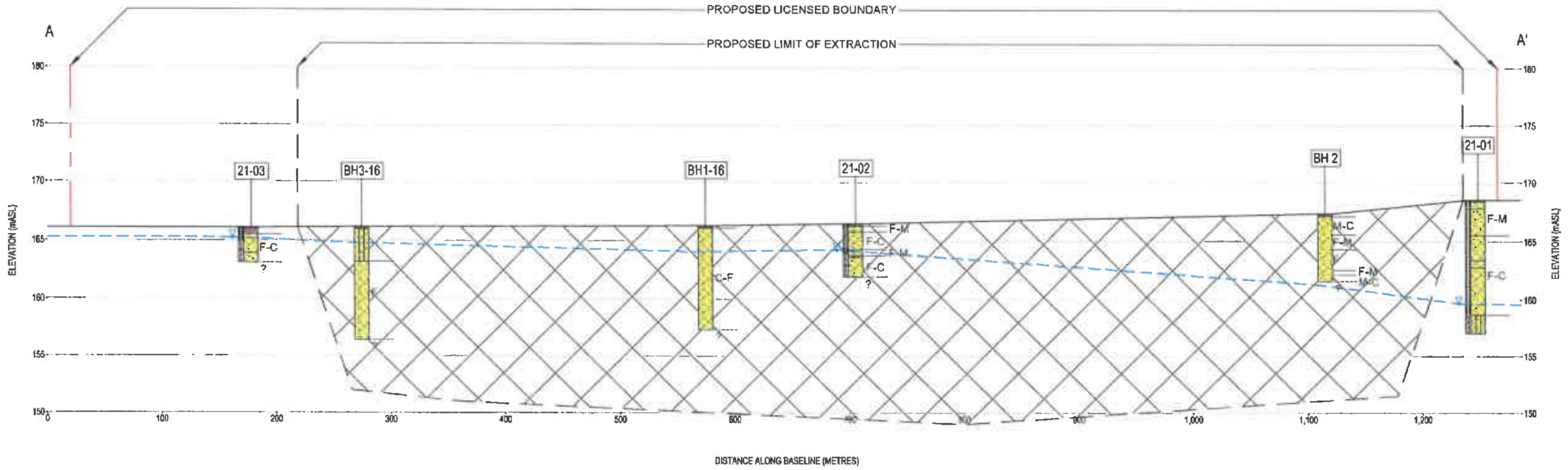
CLIENT
R.W. TOMLINSON LIMITED

PROJECT
STORYLAND ROAD PIT PROPERTY, 432 STORYLAND ROAD AND PART OF LOT 20, CONCESSION 6, HORTON TOWNSHIP, ON

TITLE
BEDROCK GEOLOGY

CONSULTANT	YYYY-MM-DD	2022-08-25
WSP GOLDER	DESIGNED	—
	PREPARED	JEM
	REVIEWED	DH
	APPROVED	JPAO

PROJECT NO.	CONTROL	REV.	FIGURE
20412072	0003	0	4



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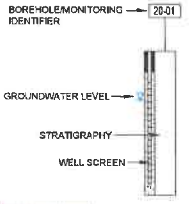


- - - - -	INTERPRETED POSITION OF GROUNDWATER TABLE (MAY 10, 2022)
F	FINE SAND
F-M	FINE TO MEDIUM SAND
M-F	MEDIUM TO FINE SAND
M	MEDIUM SAND
M-C	MEDIUM TO COARSE SAND
C-M	COARSE TO MEDIUM SAND
C-F	COARSE TO FINE
C	COARSE SAND
?	BOTTOM OF RESOURCE UNKNOWN
▨	TOPSOIL
▨	SAND
▨	SILTY SAND

0 10 20
1:400 VERTICAL METRES

0 100 200
1:4,000 HORIZONTAL METRES

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE
2. FOR DETAILED STRATIGRAPHY SEE RECORD OF BOREHOLE LOGS
3. FOR CROSS-SECTION LOCATION SEE FIGURE 1

CLIENT
R.W. TOMLINSON LIMITED

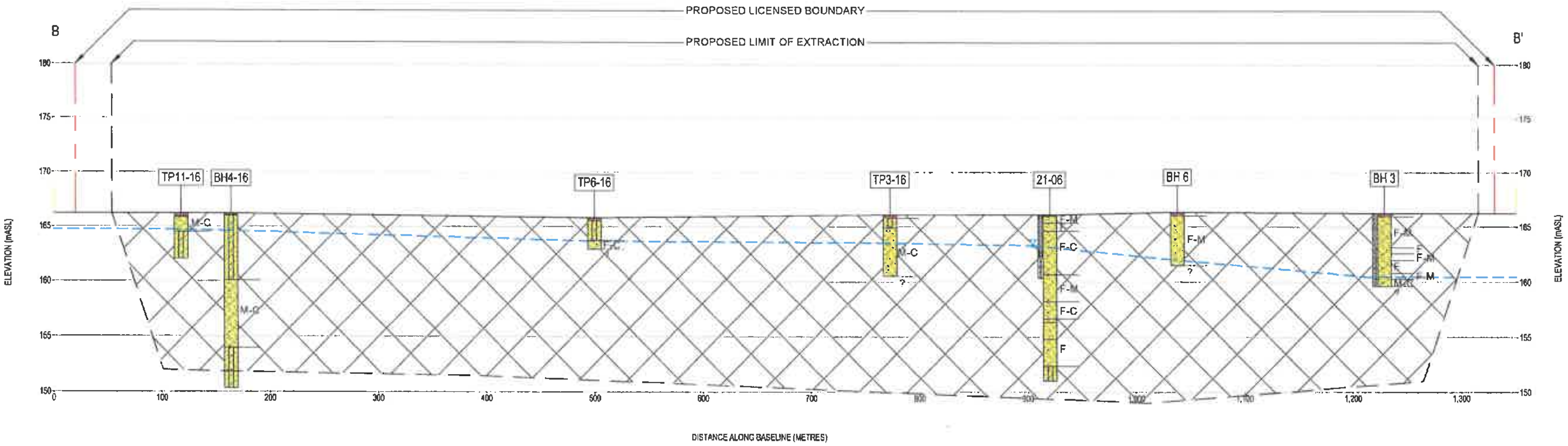
PROJECT
STORYLAND ROAD PIT PROPERTY, 432 STORYLAND ROAD AND PART OF LOT 20, CONCESSION 6, HORTON TOWNSHIP, ON

TITLE
GEOLOGICAL CROSS-SECTION A-A'

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-05-26
DESIGNED	—
PREPARED	JEM
REVIEWED	DH
APPROVED	JPAO

PROJECT NO.	CONTROL	REV.	FIGURE
20412072	0003	0	5A



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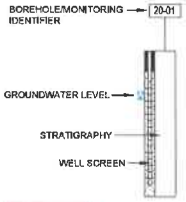


— — —	INTERPRETED POSITION OF GROUNDWATER TABLE (MAY 10, 2022)
F	FINE SAND
F-M	FINE TO MEDIUM SAND
M-F	MEDIUM TO FINE SAND
M	MEDIUM SAND
M-C	MEDIUM TO COARSE SAND
C-M	COARSE TO MEDIUM SAND
C-F	COARSE TO FINE SAND
C	COARSE SAND
?	BOTTOM OF RESOURCE UNKNOWN

🟪	TOPSOIL
🟨	SAND
▥	SILTY SAND

0 10 20
1:400 VERTICAL METRES

0 100 200
1:4,000 HORIZONTAL METRES

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE
2. FOR DETAILED STRATIGRAPHY SEE RECORD OF BOREHOLE LOGS
3. FOR CROSS-SECTION LOCATION SEE FIGURE 1

CLIENT
R.W. TOMLINSON LIMITED

PROJECT
STORYLAND ROAD PIT PROPERTY, 432 STORYLAND ROAD AND PART OF LOT 20, CONCESSION 6, HORTON TOWNSHIP, ON

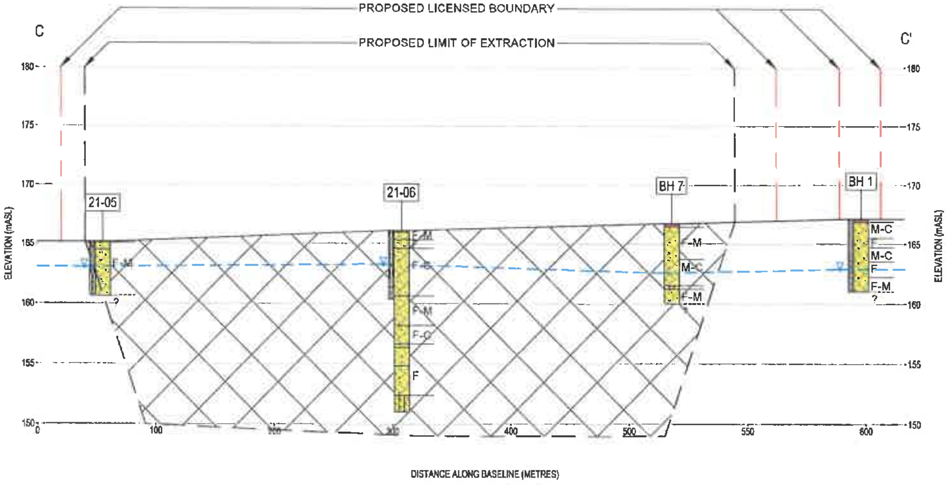
TITLE
GEOLOGICAL CROSS-SECTION B-B'

CONSULTANT

WSP GOLDER

YYYY-MM-DD	2022-05-26
DESIGNED	—
PREPARED	JEM
REVIEWED	DH
APPROVED	JPAO

PROJECT NO.	CONTROL	REV.	FIGURE
20412072	0003	0	5B



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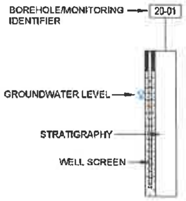
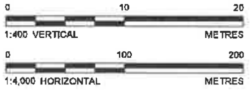


▨	TOPSOIL
▨	SAND
▨	SILTY SAND
— — —	INTERPRETED POSITION OF GROUNDWATER TABLE (MAY 10, 2022)
F	FINE SAND
F-M	FINE TO MEDIUM SAND
M-F	MEDIUM TO FINE SAND
M	MEDIUM SAND
M-C	MEDIUM TO COARSE SAND
C-M	COARSE TO MEDIUM SAND
C-F	COARSE TO FINE SAND
C	COARSE SAND
?	BOTTOM OF RESOURCE UNKNOWN

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE
2. FOR DETAILED STRATIGRAPHY SEE RECORD OF BOREHOLE LOGS
3. FOR CROSS-SECTION LOCATION SEE FIGURE 1



CLIENT
R.W. TOMLINSON LIMITED

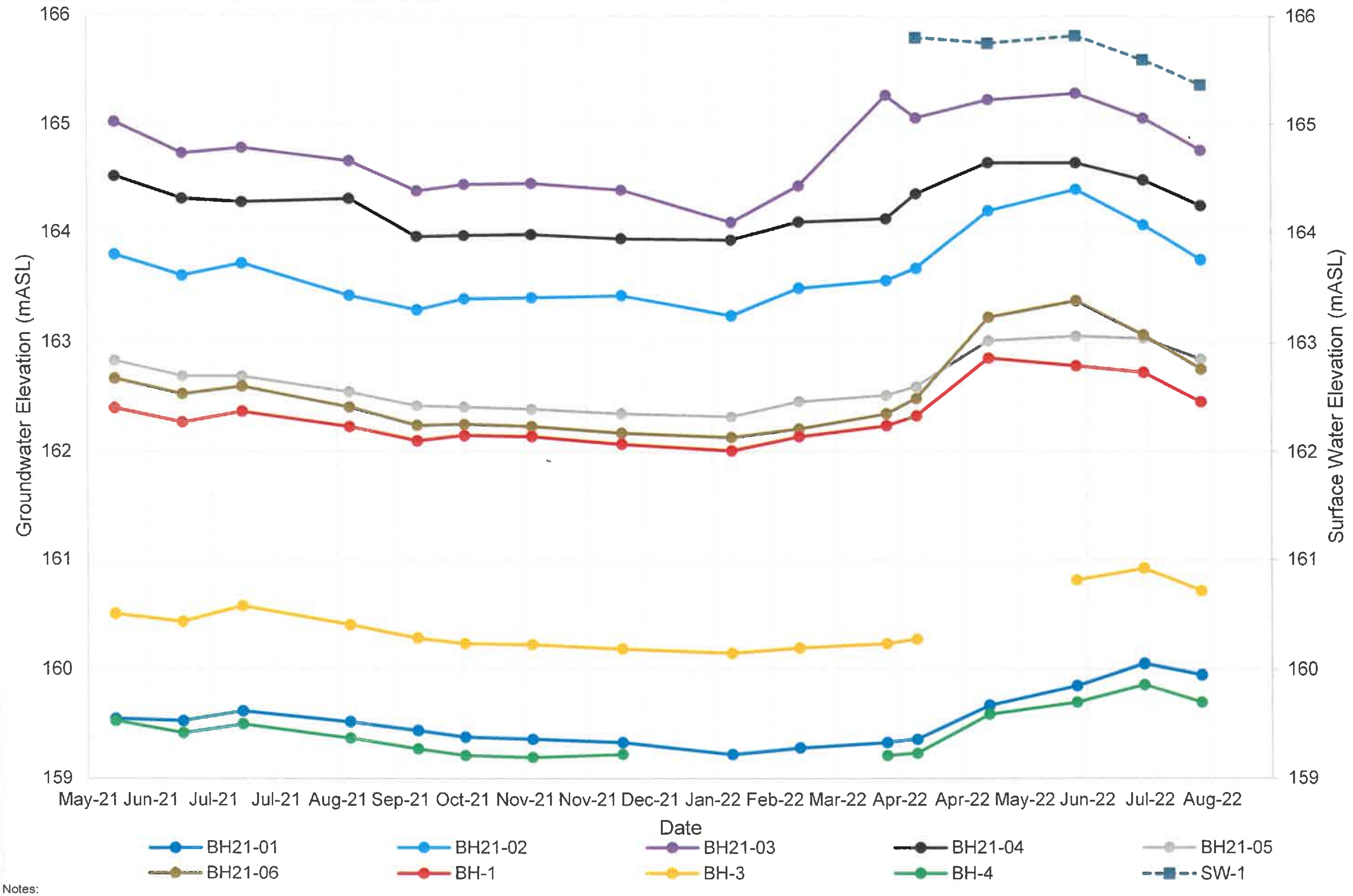
PROJECT
STORYLAND ROAD PIT PROPERTY, 432 STORYLAND ROAD AND PART OF LOT 20, CONCESSION 6, HORTON TOWNSHIP, ON

TITLE
GEOLOGICAL CROSS-SECTION C-C'

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-05-26
DESIGNED	—
PREPARED	JEM
REVIEWED	OH
APPROVED	JPAO

PROJECT NO.	CONTROL	REV.	FIGURE
20412072	0003	0	5C



Notes:

1) mASL = metres above sea level
2) Monitoring well BH-4 was frozen during the January and February 2022 monitoring sessions.
3) Monitoring well BH 3 was blocked during the May 2022 monitoring session.
4) Staff gauge installed in the unevaluated wetland feature on April 8, 2022 at surface water monitoring location SW-1. The unevaluated wetland feature was frozen on March 30, 2022.

CLIENT
R.W. TOMLINSON LIMITED

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-08-23
PREPARED	DH
DESIGN	DH
REVIEW	JPAO
APPROVED	JPAO

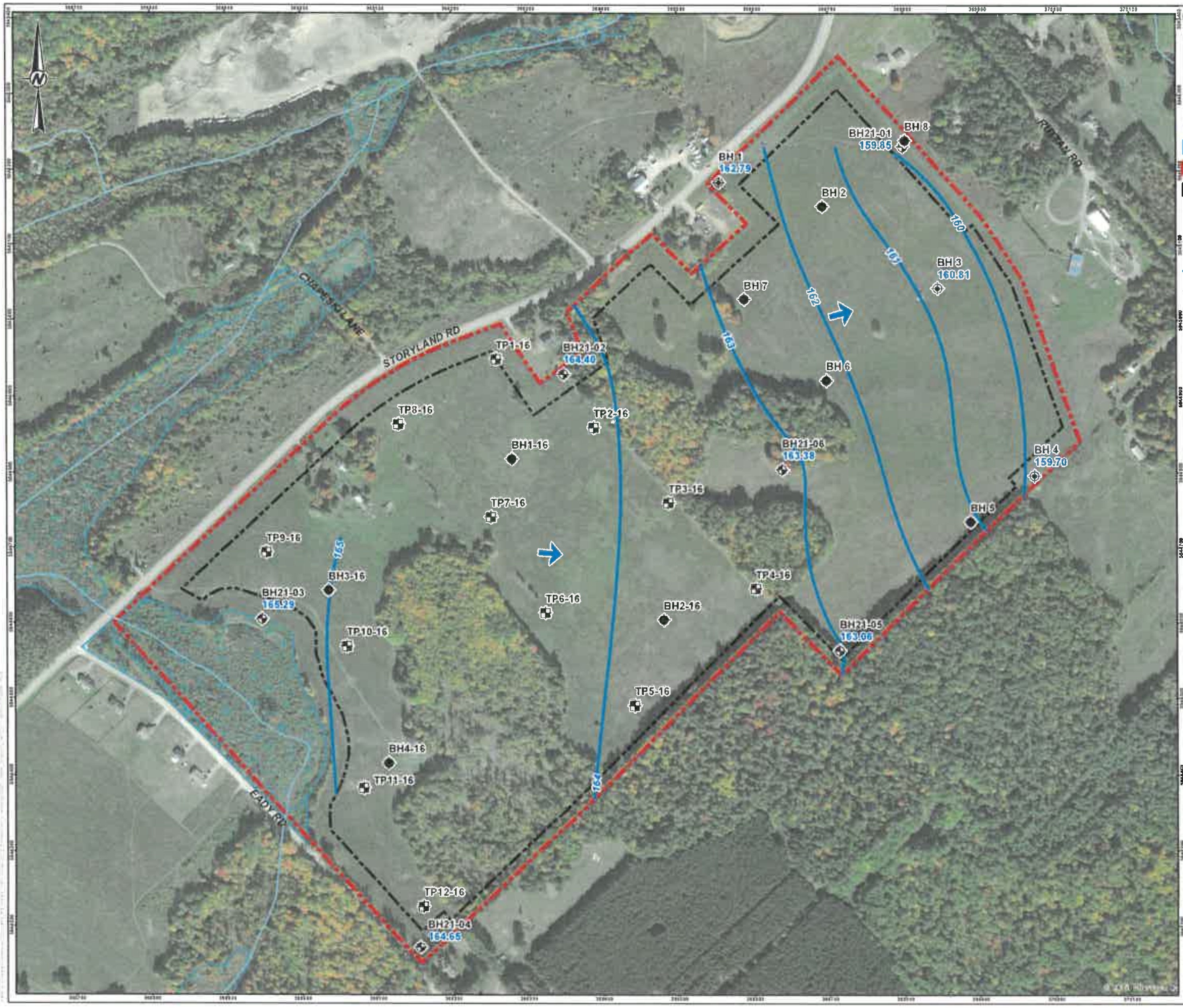
PROJECT
STORYLAND ROAD PIT PROPERTY, 432 STORYLAND ROAD AND PART OF LOT 20, CONCESSION 6, HORTON TOWNSHIP, ONTARIO

TITLE
GROUNDWATER ELEVATIONS AT THE ON-SITE MONITORING WELLS AND THE UNEVALUATED WETLAND FEATURE, MAY 2021 TO AUGUST 2022

PROJECT No.
20412072

Rev.

FIGURE 6



LEGEND

- ⊕ APPROXIMATE BOREHOLE WITH MONITORING WELL LOCATION, CURRENT INVESTIGATION
- ⊕ APPROXIMATE BOREHOLE LOCATION WITH MONITORING WELL LOCATION, PREVIOUS INVESTIGATION
- ◆ APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION
- ▣ APPROXIMATE TEST PIT LOCATION, PREVIOUS INVESTIGATION
- — WATERCOURSE
- ▨ UNEVALUATED WETLAND
- 🟥 PROPOSED LICENSED BOUNDARY (69.5 ha)
- ▭ PROPOSED LIMIT OF EXTRACTION (55.8 ha)
- 99.99 GROUNDWATER ELEVATION, mASL (JUNE 14, 2022)
- ← INTERPRETED SHALLOW GROUNDWATER FLOW DIRECTION IN THE GRANULAR LAYER (JUNE 14, 2022)
- — GROUNDWATER ELEVATION CONTOUR, mASL (JUNE 14, 2022)

NOTE(S)
1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)
1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2020
2. BING IMAGERY SUPPLIED BY ESRI AND MICROSOFT © 2020 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS
3. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

0 50 100 200
1:5,000 METRES

CLIENT
R.W. TOMLINSON LIMITED

PROJECT
STORYLAND ROAD PIT PROPERTY, 432 STORYLAND ROAD AND PART OF LOT 20, CONCESSION 6, HORTON TOWNSHIP, ON

TITLE
GROUNDWATER ELEVATIONS AND INTERPRETED GROUNDWATER FLOW DIRECTION (JUNE 2022)

CONSULTANT
WSP GOLDER

YYYY-MM-DD	2022-09-16
DESIGNED	—
PREPARED	JEM
REVIEWED	DH
APPROVED	JPAO

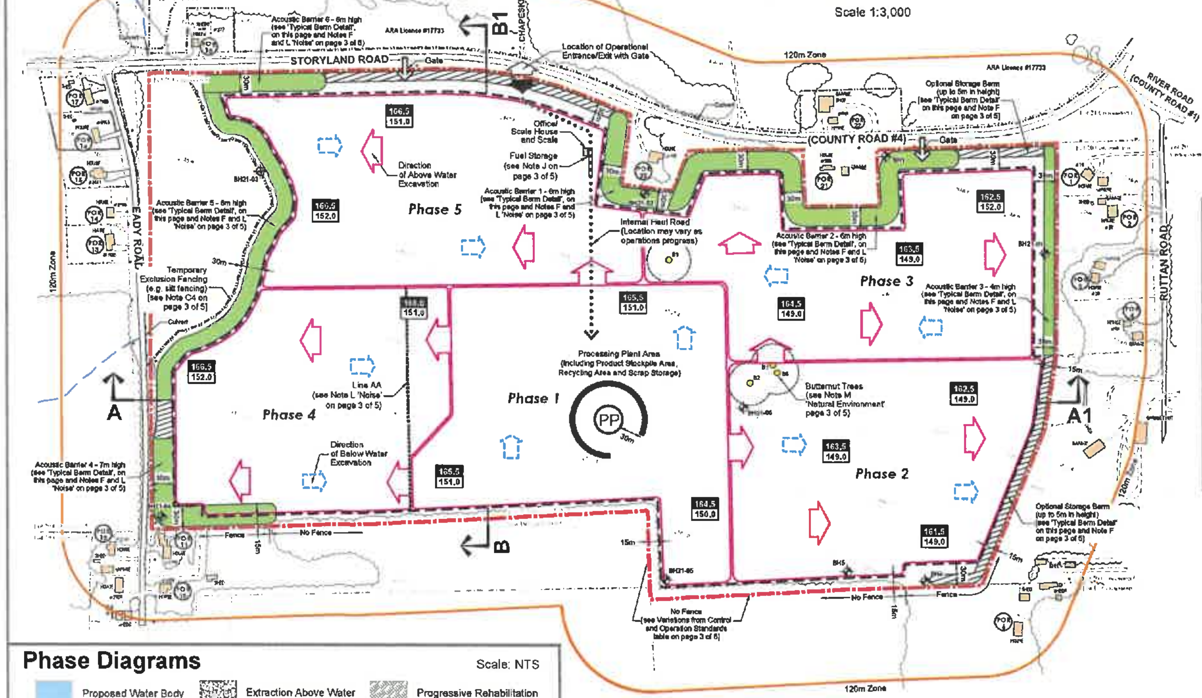
PROJECT NO.	CONTROL	REV.	FIGURE
20412072	0003	0	7

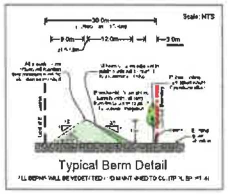
APPENDIX A

Rehabilitation Plan and Site Operations Sequencing provided by MHBC

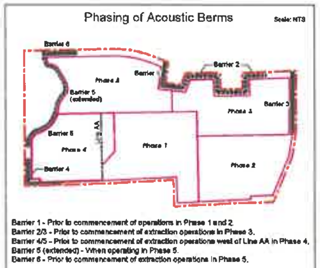
Sequence of Operations

Scale 1:3,000





Typical Berm Detail



Phasing of Acoustic Berms

Scale: NTS

Barrier 1 - Prior to commencement of operations in Phase 1 and 2.
Barrier 2/3 - Prior to commencement of extraction operations in Phase 3.
Barrier 4/5 - Prior to commencement of extraction operations west of Line AA in Phase 4.
Barrier 5 (extended) - When operating in Phase 5.
Barrier 6 - Prior to commencement of extraction operations in Phase 5.

Source: Acoustic Assessment for the Proposed Storyland Pit Township of Horton, County of Renfrew, Ontario" November 2022 (Source: Freefield Ltd.)

Phase Diagrams

Scale: NTS

- 🟦 Proposed Water Body
- ▨ Stripping
- ▨ Extraction Above Water
- ▨ Extraction Below Water
- ▨ Progressive Rehabilitation
- ▨ Final Rehabilitation

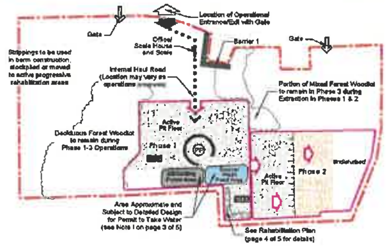


Diagram 1 (Phase 1 & 2 Above Water)

1. Site preparation in Phase 1 to include: confirm that there is existing fencing on the licensed boundary; install 1.2m marker posts on south portion of licensed boundary where the is no fencing; removal of vegetation where applicable; initial stripping of overburden/topsoil and constructing berms as shown; and establishing operational entrance/exit.
2. Build office/scale house and scale as required on-site.
3. Establish fuel storage and equipment parking/highway truck parking areas on-site.
4. Begin Phase 1 and 2 above water extraction in the direction as shown.
5. Construct processing plant. Source/settling ponds may be created during Phase 1 extraction in the approximate areas as shown.
6. Initiate progressive rehabilitation of above water side slopes in Phase 1 as shown.
7. Establish scrap area in the vicinity of the processing plant.
8. Commence site preparation in Phase 3.

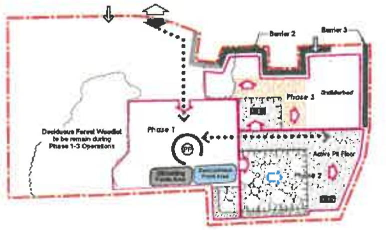


Diagram 2
(Phase 2 Below Water / Phase 3 Above Water)

1. Site preparation in Phase 3 to include: removal of vegetation where applicable; initial stripping of overburden/topsoil and constructing berms as shown;
2. Begin Phase 3 above water extraction in the direction as shown.
3. Extraction below water to occur in the eastern portion of Phase 1 and western portion of Phase 2, in an easterly direction.
4. Continue rehabilitation activities of above water side slopes in Phase 2.
5. Commence site preparation in Phase 4.

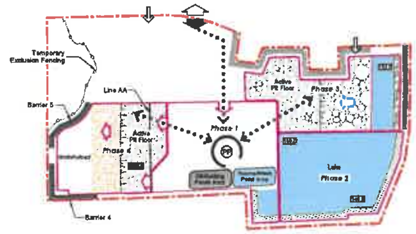


Diagram 3
(Phase 3 Below Water / Phase 4 Above Water)

1. Site preparation in Phase 4 to include: removal of vegetation where applicable, initial stripping of overburden/topsoil, constructing berms and installation of temporary exclusion fencing (e.g. silt fencing) as shown;
2. Begin Phase 4 above water extraction in the direction as shown.
3. Continue below water extraction in Phase 3.
4. Finalize side slope rehabilitation in Phase 2.
5. Commence site preparation in Phase 5.

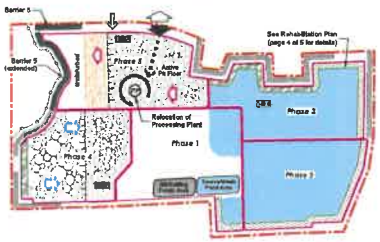


Diagram 4
(Phase 4 Below Water / Phase 5 Above Water)

1. Site preparation in Phase 5 to include: removal of vegetation where applicable; initial stripping of overburden/topsoil and constructing berms as shown;
2. Begin Phase 5 above water extraction in the direction as shown.
3. Commence Phase 4 below water extraction and continue below water extraction in Phase 1.
4. Continue progressive rehabilitation in Phase 3 and begin progressive rehabilitation in Phase 4.
5. Processing Plant to be moved to Phase 5 once material above water table has been mined and sufficient operational area is available.

Not Shown on Phase Diagrams

1. The processing plant will remain on site until the encroachment of below water extraction in Phase 5 requires the removal of the plant.
2. Remove any equipment, scrap, haul roads and buildings on site.
3. Finalize rehabilitation of site (see Rehabilitation Plan on page 4 of 5 for details).

Legal Description

PART OF LOT 20 CONCESSION 6
(geographic township of Horton)
TOWNSHIP OF HORTON
COUNTY OF RENFREW

Legend

- Boundary of Area to be Licensed
- Existing Fence — PAGE WIRE FENCE UNLESS OTHERWISE NOTED
- Existing Spot Elevation — METRES ABOVE SEA LEVEL
- Private Laneway
- ⇩ Farm/Field Access
- Existing Vegetation
- Drainage Feature
- Unevaluated Wetland — ONTARIO GEOHUB OPEN DATA
- Monitoring Well Locations — GOLDER 2021
- Category 3 Butternut Trees — FROM McKINLEY ENVIRONMENTAL (2022)
- A1 Cross Sections — SEE PAGE 4 OF 4 FOR EXISTING AND REHABILITATED CROSS SECTIONS
- Limit of Excavation — ALL SETBACKS ARE DRAWN TO SCALE AND SHOW LABELLED DISTANCES
- Existing Licensed Boundary — ARA LICENCE #17733
- General Direction of Above Water Excavation (SEE NOTES ON THIS PAGE)
- Operational Access — MAINTAINED BY A GATE WHICH WILL BE CLOSED WHEN PIT IS NOT IN OPERATION
- Direction of Below Water Excavation — SEE NOTES ON THIS PAGE/PAGE 3 OF 5
- 🟩 Acoustic Berm — SEE "TYPICAL BERM DETAIL" AND NOTES ON THIS PAGE/PAGE 3 OF 5
- ▨ Optional Storage Berm — SEE "TYPICAL BERM DETAIL" AND NOTES ON THIS PAGE/PAGE 3 OF 5
- 165.5 / 151.0 Elevation — ABOVE WATER DEPTH OF EXTRACTION / MAXIMUM DEPTH OF BELOW WATER EXTRACTION/PIT FLOOR
- Internal Haul Road — LOCATION TO VARY AS OPERATIONS PROGRESS
- Receptor Locations — WITHIN 120m OF THE SITE

Site Plan Amendments

No.	Date	Description	By

MHBC
PLANNING
URBAN DESIGN
& LANDSCAPE
ARCHITECTURE

MNRF Approval Stamp

Stamp

Applicant

TOMLINSON
R. W. Tomlinson Limited
100 CitiGate Drive, Ottawa Ontario, K2J 6K7
Tel: (613) 822-1867 Fax: (613) 822-6844

Rob Pierce
R.W. Tomlinson Limited
Vice President Planning and Development

Project

Storyland Pit

ARA Licence Reference No.

Pre-approval review:

For Submittal to MNRF - November 2022

Plan Scale: See Plan

SCALE
50 0 50 100
METRES

Plot Scale 1:3 [1mm = 3 units] MODEL

Drawn By D.G.S.

Checked By N.D.

File No. 9137W

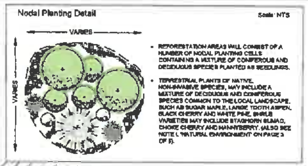
File Name

OPERATIONAL PLAN

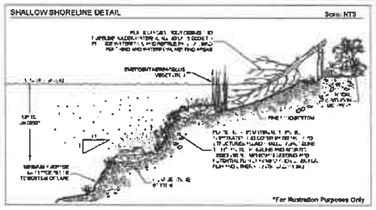
Drawing No.

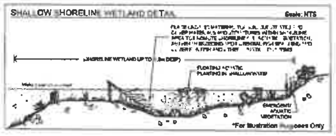
2 OF 5

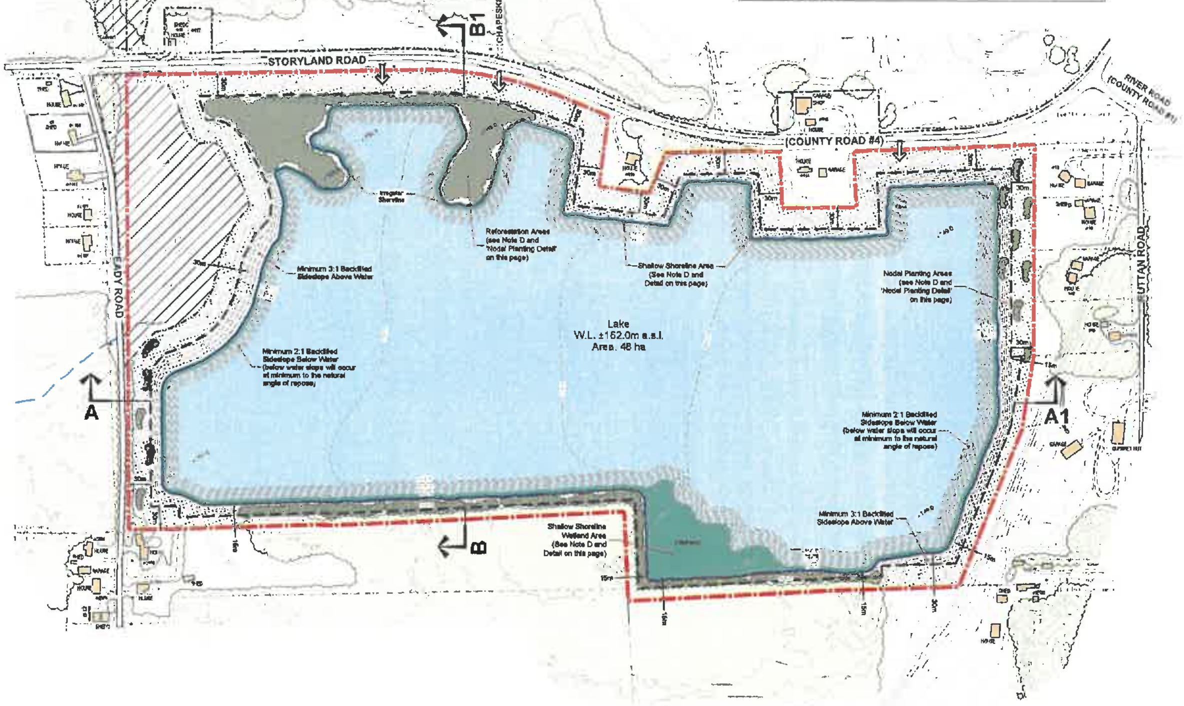
K:\9137W Renfrew Twp Horton\A\Operplan 2of5 November2022.dwg



- REFORESTATION AREAS WILL CONSIST OF A NUMBER OF NODAL PLANTING CELLS CONTAINING A MIXTURE OF CONIFEROUS AND DECIDUOUS SPECIES PLANTED AS SEEDLINGS.
- TERRESTRIAL PLANTS OF NATIVE, NON-INVASIVE SPECIES, MAY INCLUDE A MIXTURE OF DECIDUOUS AND CONIFEROUS SPECIES COMMON TO THE LOCAL LANDSCAPE, SUCH AS SUGAR MAPLE, LARGE TOOTH ASPEN, BLACK CHERRY AND WHITE PINE. SHRUB VARIETIES MAY INCLUDE STAGHORN SUMAC, CHOKE CHERRY AND NANNYBERRY. (ALSO SEE NOTE I. 'NATURAL ENVIRONMENT' ON PAGE 3 OF 5).







A. General
1. Area Calculations: Licence Area: 69.5 hectares (172 acres)
   Limit of Excavation: 55.9 hectares (138 acres)
2. The rehabilitated landform of this site will include: lake, shallow shoreline and shallow shoreline wetland areas, reforestation, various side slope treatments and nodal tree and shrub planting areas.

B. Phasing
1. The proposed Storyland Pit will be rehabilitated on a progressive basis, corresponding to the operational progression of the pit excavation, to form a lake at final rehabilitation.
2. As the pit is excavated to its maximum, or any other/lesser terminal limits, both horizontally and vertically on a lift-by-lift basis, progressive rehabilitation will follow provided the subject area is of an appropriate area to undergo rehabilitation (See Note G on page 3 of 5 for details).
3. The excavation perimeter will be fully side sloped at a maximum 2:1 (from original ground to floor) at a portion of the north, the entire west and the entire south side slope areas. Sloping will occur as the limits of the pit excavation are reached. See Rehabilitation Plan drawing and Note D on this page.
4. Side slopes will be vegetated where located above the final water level of the pit lake and will include nodal tree and shrub plantings in suitable locations in order to introduce a diversity of native vegetation types and species that are anticipated to spread around the rehabilitated side slopes (see Note D and 'Nodal Planting Detail' on this page).

C. Slopes and Grading
1. Topsoil and overburden will be used in the progressive rehabilitation of the side slope areas. Overburden and/or imported material will be used to backfill pit faces to create the topography of the side slopes (i.e. 3:1 slope). Above water side slope areas that will be vegetated will be covered with a minimum 15 cm of topsoil/organic matter prior to planting.
2. Importation of fill/excess soil:
   a. Excess soil, as defined in Ontario Regulation 244/97 may be imported to this site to facilitate the following rehabilitation:
      i. Establish final grades as described on the site plan
      ii. Top dressing to establish vegetation
   c. The quality of excess soil imported to the site for final placement must be equivalent to or more stringent than the applicable excess soil quality standards as determined in accordance with Ontario Regulation 244/97 as amended from time to time and must be consistent with the site conditions and the end use identified in the approved rehabilitation plan.
   d. Where a qualified person is retained or required to be retained in accordance with Ontario Regulation 244/97, the quality, storage, and final placement of excess soils shall be done according to the advice of the qualified person.
   e. Excess soil imported to facilitate rehabilitation as described on this site plan shall be undertaken in accordance with Ontario Regulation 244/97 under the Aggregate Resources Act, as amended from time to time.

D. Proposed Vegetation and Rehabilitated Features
1. All planting and seeding will consist of native species. All ground covers on side slopes will be established as part of the phased stripping operations that proceed extraction and will be maintained and replaced as soon as possible if the vegetative cover fails to establish itself to control erosion.

2. *Shallow Shoreline Area Habitat Creation*

   Shallow shoreline areas will be created around the perimeter of the lake. Shallow shoreline habitats shall be created up to 2 m deep and shall include habitat features such as boulders, submerged logs, etc. Organic material and topsoil shall be added to the shoreline areas to promote shoreline vegetation, and the placement of basking logs along the shoreline is recommended to create turtle basking areas, waterfowl nesting areas and bird perching sites (see "Shallow Shoreline Detail" on this page). Shoreline and Aquatic plantings will coincide with the final stages of site rehabilitation. Species suitable for aquatic plantings are listed in the species planting list on this page.

3. *Shallow Shoreline Wetland Habitat*

   Wetland areas will be created along the shoreline in the southeast part of the lake. These areas will be backfilled to the desired elevations and plants shall be established by broadcast seeding an Ontario Native Wetland/Riparian Restoration Seed Mix.

4. *Terrestrial Habitat Creation on sideslope and in setback areas*

   Side slope areas above the water table will be covered with a minimum 15 cm of topsoil/organic matter and planted/seeded. Any undisturbed setback areas will also be planted in nodal plantings and seeded with Ontario Native Grassland Seed Mix.

5. *Reforestation and Nodal Plantings*

   Terrestrial nodal plantings on the side slope and within the setback areas and reforestation areas shall include a mixture of coniferous and deciduous tree and shrub species to promote species diversity and provide a variety of species to compensate for any substrate deficiencies (see nodal planting detail on this page). Recommended species are outlined in the species planting list. The establishment of nodal planting areas will occur progressively and follow the sequence of excavation and side slope/setback grading and seeding. Nodal planting areas are conceptually shown on the drawing

6. *Rehabilitated Landform*

   The proposed rehabilitation includes an opportunity to enhance the biological diversity of the local landscape by providing features that will attract migratory waterfowl and terrestrial and aquatic habitat features that will be of value to locally resident wildlife. Rehabilitation of this site involves the creation of 48 ha of lake and terrestrial landform comprised of above water overburden side slopes and setback areas. Some of the rehabilitated area will be rehabilitated to forest cover through nodal tree and shrub plantings as shown conceptually on this plan. The final landform will be in accordance with the drawing as shown on this page.

E. Drainage
1. Final surface drainage will follow the rehabilitated contours as shown and be directed towards the post-extraction lake and existing wetland.

F. Final Rehabilitation
1. No buildings or structures associated with aggregate operations will remain on site
2. The water level of the proposed lake (±162m a.s.l.) and the post- extraction ground water table, are as shown on pages 1, 4 and 5 of 5 as per hydrogeological/ hydrological assessment.

Species Planting List - Recommended Species		
Nodal Plantings/Reforestation	Wetland/Shoreline Areas	Above Shoreline Area
Sugar Maple	Ontario Native Wetland/ Riparian Restoration Seed Mix	Ontario Native Grassland Seed Mix
Large Tooth Aspen		
White Pine		
Basswood		
Black Cherry		
Ironwood		
Red Oak		
White Birch		
Staghorn Sumac		
Choke Cherry		
Nannyberry		
Red Elderberry		

Legal Description

PART OF LOT 20 CONCESSION 6
(geographic township of Horton)
TOWNSHIP OF HORTON
COUNTY OF RENFREW

Legend

- Boundary of Area to be Licensed
- Contour with Elevation — METRES ABOVE SEA LEVEL
- Existing Fence — PAGE WIRE FENCE UNLESS OTHERWISE NOTED
- Building/Structure — LOCATION AND USE FOR BUILDINGS ON-SITE AND WITHIN 120m ARE SHOWN ON THIS PAGE.
- Public Road (Paved)
- Public Road (Gravel)
- Private Laneway
- ⇩ Field Access
- Existing Vegetation
- Drainage Feature
- Unevaluated Wetland
- A1 Cross Sections — SEE PAGE 5 OF 5 FOR EXISTING AND REHABILITATED CROSS SECTIONS
- Limit of Excavation — ALL SETBACKS ARE DRAWN TO SCALE AND SHOW LABELLED DISTANCES
- Existing Licensed Boundary — ARA LICENCE #17733
- Proposed Contour — METRES ABOVE SEA LEVEL (m A.S.L.)
- Proposed Elevation — REHABILITATED ELEVATION
- Nodal Planting Areas — LOCATION APPROXIMATE
- Post Extraction Lake
- Shallow Shoreline Area (SEE DETAIL ON THIS PAGE)
- Grassland Area (SEE NOTE D ON THIS PAGE)

Site Plan Amendments

No.	Date	Description	By

PLANNING
URBAN DESIGN
& LANDSCAPE
ARCHITECTURE
MHBC

MNRF Approval Stamp

Stamp

north

Applicant

TOMLINSON

R. W. Tomlinson Limited
100 CitiGate Drive, Ottawa Ontario, K2J 6K7
Tel: (613) 822-1867 Fax: (613) 822-6844

Rob Pierce
R.W. Tomlinson Limited
Vice President Planning and Development

Project: Storyland Pit

ARA Licence Reference No.

Pre-approval review:

For Submittal to MNRF - November 2022

Plan Scale 1:3,000 (Arch D)

SCALE
50 0 50 100
METRES

Plot Scale: 1:3 [1mm = 3 units] MODEL

Drawn By: D.G.S.

Checked By: N.D.

File No.: 9137W

File Name: REHABILITATION PLAN

Drawing No.: 4 OF 5

K:\9137W Renfrew Twp Horton\A\Rehaplan 4of5 November2022.dwg

APPENDIX B

Qualifications and Experience of the Authors

Education

M.Sc. Civil Engineering: Hydrogeology
Queen's University
Kingston, Ontario, 2001

B.Sc. Environmental Science: Earth Sciences Stream, Honours
Brock University
St. Catharines, Ontario
1998

Certifications

Registered Professional Geoscientist Ontario

Golder Associates Ltd. – Ottawa

Senior Hydrogeologist

Jaime Oxtobee has over 20 years of broad experience in the field of physical hydrogeology that includes hydrogeological impact assessments in support of the licensing of pits and quarries under the *Aggregate Resources Act*, water supply development and regional scale groundwater studies.

Employment History

Golder Associates Ltd. – Ottawa

Associate and Senior Hydrogeologist (2001 to Present)

Jaime is responsible for project management, technical analysis and reporting for a variety of hydrogeological and environmental projects. Jaime is also often responsible for senior technical review of hydrogeological investigations.

Projects have included groundwater resources studies; hydrogeological investigation programs in support of licensing/permitting pits and quarries and in support of Permit to Take Water applications for local construction dewatering projects, ready-mix concrete plants, golf courses and quarries; communal water supply investigations; wellhead protection studies; contaminated site investigations; and, providing senior review for landfill, pit and quarry monitoring reports.

Queen's University – Kingston, Ontario

Teaching Assistant (2000 to 2001)

Teaching assistant for university courses relating to groundwater flow and contaminant transport in porous media and fractured rock environments.

Phase IV Bedrock Remediation Program – Smithville, Ontario

Project Manager (1999)

Coordinated and conducted a groundwater/surface water interaction study downgradient from the PCB-contaminated site in Smithville, Ontario. The study involved detailed numerical modelling, as well as an extensive field program including stream surveys, stream gauging, construction and installation of mini-piezometers, seepage meters and weirs, fracture mapping, groundwater and surface water sampling.

SELECTED PROJECT EXPERIENCE – AGGREGATE INDUSTRY

Hydrogeological and Hydrological Assessments for Quarry Licensing
Township of Drummond-North Elmsley, Ontario, Canada

Golder carried out the necessary hydrogeological, hydrological ecological and archaeological studies to support an application under the *Aggregate Resource Act* for licensing the extension of an existing quarry. The application was for two new below water quarries on either side of an existing below water quarry. Jaime led the hydrogeological and hydrological assessment component of the project, and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development and execution of the hydrogeology field program, development of the site conceptual model and completion of the hydrogeological impact assessment/reporting. Jamie also provided input to the integration of the findings from the multiple disciplines.

Hydrogeological Assessments for Pit Licensing
Township of Lanark, Ontario, Canada

Golder carried out the necessary hydrogeological, ecological and archaeological studies to support an application under the *Aggregate Resource Act* for licensing a new pit above the water table. Jaime led the hydrogeological assessment component of the project and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development and execution of the hydrogeology field program and preparing the required reporting.

Hydrogeological and Hydrological Assessments for Quarry Licensing
Ramara, Ontario, Canada

Golder carried out the necessary hydrogeological, hydrological and archaeological studies to support an application under the *Aggregate Resource Act* for licensing the extension of an existing quarry. The application was for one new below water quarry adjacent to an existing below water quarry. Jaime led the hydrogeological and hydrological assessment component of the project. Jaime was responsible for development and execution of the hydrogeology field program, development of the site conceptual model and completion of the hydrogeological impact assessment/reporting.

Hydrogeological Assessments for Pit Licensing
Township of Leeds and Thousand Islands, Ontario, Canada

Golder carried out the necessary hydrogeological studies to support an application under the *Aggregate Resource Act* for licensing a new pit below the water table. Jaime led the hydrogeological assessment component of the project. Jaime was responsible for the development and execution of the hydrogeology field program and completing the hydrogeological impact assessment/reporting.

Hydrogeological Assessment for Quarry Permitting
Township of Bomby

Golder carried out the necessary hydrogeological, ecological and archaeological studies to support an application under the *Aggregate Resource Act* for permitting a new quarry. The application was for a below water quarry located on Crown Land. Jaime led the hydrogeological assessment component of the project and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development and execution of the hydrogeology field program, development of the site conceptual model and completion of the hydrogeological impact assessment/reporting. Jamie also provided input to the integration of the findings from the multiple disciplines.

Hydrogeological Assessment for Pit Permitting
District of Kenora,
Ontario, Canada

Golder carried out the necessary hydrogeological, ecological and archaeological studies to support an application under the *Aggregate Resource Act* for permitting a new pit. The application was for a below water pit located on Crown Land. Jaime provided input to the hydrogeological assessment component of the project and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development of the site conceptual model in the vicinity of the pit and completion of the hydrogeological impact assessment/reporting. Jamie also provided input to the integration of the findings from the multiple disciplines.

Hydrogeological Assessment for Quarry Permitting
District of Kenora,
Ontario, Canada

Golder carried out the necessary hydrogeological, ecological and archaeological studies to support an application under the *Aggregate Resource Act* for permitting a new quarry. The application was for a below water quarry located on Crown Land. Jaime provided input to the hydrogeological assessment component of the project and was responsible for coordinating the multi-disciplinary team. Jaime was responsible for the development of the site conceptual model in the vicinity of the quarry and completion of the hydrogeological impact assessment/reporting. Jamie also provided input to the integration of the findings from the multiple disciplines.

Hydrogeological and Hydrological Assessment for Quarry Licensing
City of Kawartha Lakes,
Ontario, Canada

Golder carried out the necessary hydrogeological, hydrological and ecological studies to support an application under the *Aggregate Resource Act* for licensing a new quarry. The application was for a below water quarry located adjacent to a provincially significant wetland. Jaime provided input to the hydrogeological assessment component of the project, which included the installation of over 80 monitoring intervals and the completing of three pumping tests. Jaime was involved in data analysis and the completion of the impact assessment and reporting for the hydrogeology assessment.

TRAINING

Beyond Data: Conceptual Site Models in Environmental Site Assessments
Golder U, 2011

Health and Safety Modules 1, 2, 3 and 4
Golder U, various years

Critical Thinking in Aquifer Test Interpretation
Golder U, 2011

HydroBench (Proprietary Aquifer Test Interpretation Software)
Golder U, 2011

Project Management
Golder U, 2007

Short course: Environmental Isotopes in Groundwater Resource and Contaminant Hydrogeology
2007

Short course: Hydrogeology of Fractured Rock – Characterization, Monitoring, Assessment and Remediation
2002

OSHA 40 Hour Hazardous Waste Site Worker Training
2002

PROFESSIONAL AFFILIATIONS

Member, Association of Professional Geoscientist of Ontario Member,

Ottawa Geotechnical Group

PUBLICATIONS

Conference Proceedings	West, A.L., K.A. Marentette and J.P.A. Oxtobee. 2009. *Quantifying Cumulative Effects of Multiple Rock Quarries on Aquifers*. 2009 Joint Assembly, May. Toronto, Canada.
	Novakowski, K.S., P.A. Lapcivic, J.P.A. Oxtobee and L. Zanini. 2000. *Groundwater Flow in the Lockport Formation Underlying the Smithville Ontario Area*. 1st IAH-CNC and CGS Groundwater Specialty Conference, October. Montreal, Canada.
	Oxtobee, J.P.A. and K.S. Novakowski. 2001. *A Study of groundwater/Surface Water Interaction in a Fractured Bedrock Environment*. Fractured Rock 2001 Conference, March. Toronto, Canada.
Journal Articles	Oxtobee, J.P.A. and K.S. Novakowski. Groundwater/Surface Water Interaction in a Fractured Rock Aquifer. *Journal of Ground Water*, 41(5) (2003), 667-681.
	Oxtobee, J.P.A. and K.S. Novakowski. A Field Investigation of Groundwater/Surface Water Interaction in a Fractured Bedrock Environment. *Journal of Hydrology*, 269 (2002), 169-193.
Other	Oxtobee, J.P.A., 1998. Environmental Assessment of Grapeview, Francis and Richardson's Creeks, St. Catharines, Ontario. B.Sc. Thesis, Brock University, Earth Sciences Department pp.119.

Education

Master of Science Earth Sciences, Hydrogeology, University of Waterloo, Waterloo, ON, 2011

Bachelor of Science Honours Environmental Sciences, University of Waterloo, Waterloo, ON, 2007

Diploma in Environmental Assessment, University of Waterloo, Waterloo, ON, 2007

Professional Affiliations

Registered Professional Geoscientist, Association of Professional Geoscientists of Ontario and Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists

Golder Associates Ltd. – Ottawa

Hydrogeologist

Dale Holtze has over 12 years of consulting experience in the field of physical hydrogeology that includes hydrogeological impact assessments in support of water supply and construction dewatering projects, environmental compliance monitoring related to mining, landfills, aggregate sites and hydrogeological investigations related to the licensing of pits and quarries under the Aggregate Resources Act.

Employment History

Golder Associates Ltd. (Golder, member of WSP) – Ottawa, ON

Hydrogeologist (2010 to Present)

Dale is responsible for project management, field investigations, technical analysis and reporting for a variety of hydrogeological and environmental projects.

Projects have included hydrogeological investigation programs in support of licensing/permitting pits below the water table, Permit to Take Water applications for local construction dewatering projects and water supply studies, hydrogeological and environmental compliance monitoring investigations and reporting for various mining, landfill, pits and quarries.

University of Waterloo – Waterloo, ON

Contaminant Hydrogeology M.Sc. Graduate Student (2007 to 2010)

Watters Environmental Group Inc. – Concord, Ontario

Environmental Consultant Co-op Student (May 2006 to Aug 2006)

Supported senior staff in preparation of Phase 1 and 2 Environmental Site Assessment investigations and reporting.

Aqua Terre Solutions Inc. – Toronto, Ontario

Environmental Field Technician Co-op Student (Sep 2005 to Dec 2005)

Conducted groundwater monitoring and soil sampling programs and supervised contractors during remediation programs for Phase 2 and/or 3 Environmental Site Assessments.

Stantec Consulting Ltd. – Guelph, Ontario

Soil Toxicologist Co-op Student (Jan 2004 to Sep 2004)

Performed regulatory terrestrial toxicity testing of invertebrate and plants.

Stantec Consulting Ltd. – Aberfoyle, Ontario

Aquatic Toxicologist Co-op Student (May 2003 to Sep 2003)

Performed regulatory aquatic toxicity testing of Daphnia Magna and Fat Head Minnows for various industrial effluents and maintained organism cultures.

SELECTED PROJECT EXPERIENCE – AGGREGATE INDUSTRY

Hydrogeological Assessment for Pit Licensing
Kemptville, Ontario, Canada

Golder carried out the necessary hydrogeological, hydrological, ecological and archeological studies to support an application under the Aggregate Resource Act for licensing a new pit below the water table. Dale was responsible for the execution of the hydrogeology field program and prepared the required reporting with support from senior staff.

Hydrogeological and Hydrological Assessment for Quarry Licensing Goulbourn Township, Ontario, Canada	Golder carried out the necessary hydrogeological, hydrogeological and ecological studies to support an application under the Aggregate Resources Act and the Planning Act for a site plan license for a new quarry. Dale coordinated field staff and/or conducted the hydrogeological field investigation which involved borehole drilling, groundwater level monitoring and an aquifer testing program, data analysis and technical reporting to address regulatory agency comments. The data was used to develop a detailed conceptual and numerical groundwater flow mode. The model results were used to demonstrate potential impacts to local environment and proposed mitigative measures.
Environmental Compliance Monitoring Programs Ottawa, Canada	Golder carried out environmental compliance monitoring programs for various aggregate and municipal clients. Dale managed groundwater and surface water monitoring programs; conducted field work, technical data review and analysis, and preparation of comprehensive annual environmental compliance monitoring reports for various landfill and quarry sites.
Proposed New Waste Disposal Site Ottawa, Ontario, Canada	Managed groundwater and surface water monitoring programs; conducted field work, technical data review and analysis, and preparation of comprehensive baseline environmental report in support of Class Environmental Assessment for a proposed new waste disposal site.
MTO Highway 401 and Boundary Road Tire Derived Aggregate Bridge Embankments Cornwall, Ontario, Canada	Managed hydrogeological and environmental investigation for the construction of tire derived aggregate bridge embankments located at Boundary Road and Highway in Cornwall, Ontario. The project involved groundwater and surface water monitoring during pre-construction, construction and post-construction. Provided hydrogeological input to assess potential impacts related to the leaching of TDA fill materials on surface water features and groundwater receptors during construction and post-construction.
Town of Carleton Place Pumping Station and Sanitary Sewer Collection System Expansion Carleton Place, ON, Canada	Project manager and conducted hydrogeological investigation for the construction of a sewage pumping station and related sewer and forcemain lines as part of the expansion of the sanitary sewer collection system in Carleton Place, Ontario. Provided hydrogeological input to design and construction, conducted a pumping test and prepared a Permit to Take Water application with supporting documentation. Analytical and numerical groundwater modelling was carried out to evaluate rates of water taking and impacts to nearby structures founded in sensitive clay deposits.
Township of North Dundas Water Supply Expansion Class EA ON, Canada	Task hydrogeologist for Class Environmental Assessment Water Supply Expansion for the Township of North Dundas. Conducted desktop hydrogeological study, aquifer pumping test program of proposed new municipal well, support of groundwater modeling of wellhead protection area study and reporting.
Combined Sewage Storage Tunnel Ottawa, Ontario	Project included geotechnical and hydrogeological investigations for a new 6 km combined sewer storage tunnel system in Ottawa. A field investigation and reporting program was completed through the downtown core to support the preliminary and detail design team. Assisted with the implementation of the hydrogeological field program, carried out the packer test data analysis, compiled and interpreted data and completed pumping tests which were challenging due to the location on the streets of downtown Ottawa. Results of the hydrogeological assessment were included in a report used as a supporting document for a Permit to Take Water application for construction dewatering for the project. Supervised contractors during drilling and hydrogeological testing.

APPENDIX C

Record of Test Pits and Borehole Logs

APPENDIX C-I

Paterson Investivation Test Pit and Borehole Logs (2016, 2017)

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated - having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.

Fissured - having cracks, and hence a blocky structure.

Varved - composed of regular alternating layers of silt and clay.

Stratified - composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.

Well-Graded - Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).

Uniformly-Graded - Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	**ROCK QUALITY**
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC% - Natural moisture content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic limit, % (water content above which soil behaves plastically)
PI - Plasticity index, % (difference between LL and PL)

Dxx - Grain size which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu - Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay
(more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

p'_o - Present effective overburden pressure at sample depth
p'_c - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below p'_c)
Cc - Compression index (in effect at pressures above p'_c)

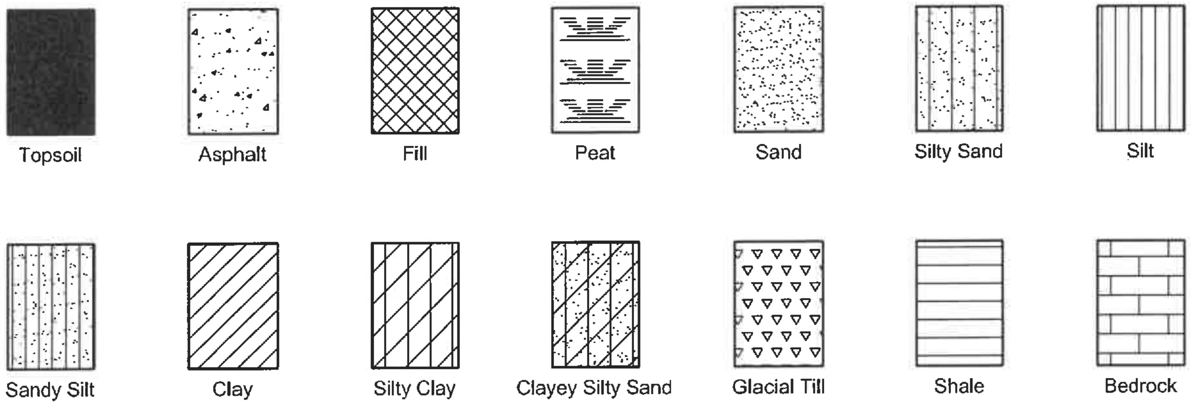
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

k - Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

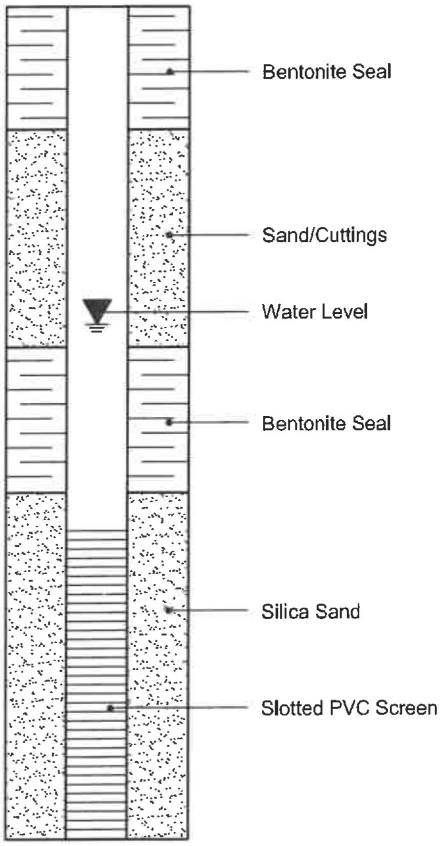
SYMBOLS AND TERMS (continued)

STRATA PLOT

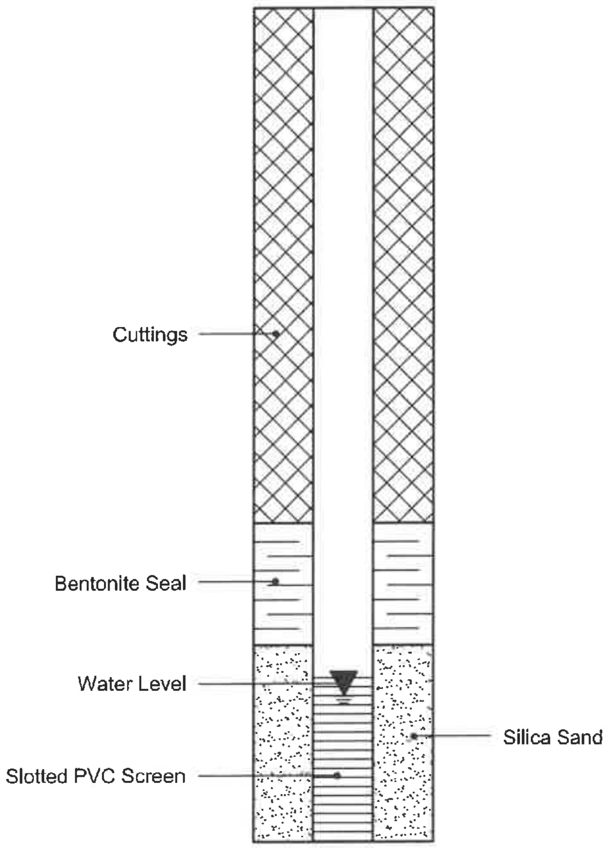


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE 10 May 2016

FILE NO. PG3802

HOLE NO. BH 1-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0		
TOPSOIL 0.20		AU	1					
		SS	2	67	12	1		
Compact to dense, brown **FINE SAND** with gravel and cobbles		SS	3	67	41	2		▽
- roots to 0.9m depth		SS	4	58	45			
3.66		SS	5	25	19	3		
		SS	6	83	11	4		
Compact to dense, brown **FINE SAND,** trace gravel		SS	7	75	54	5		
		SS	8	83	24	6		
- compact and grey-brown by 5.3m depth		SS	9	83	21			
7.60		SS	10	88	17	7		
Dense, grey-brown fine to medium **SAND**		SS	11	100	30	8		
8.99		SS	12	100	32			
End of Borehole (GWL @ 2.0m depth based on field observations)								

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE 10 May 2016

FILE NO. PG3802

HOLE NO. BH 2-16

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)
GROUND SURFACE						0
TOPSOIL	0.18	AU	1			
Loose to compact, brown **SILTY SAND,** trace gravel		SS	2	92	8	1
	2.13	SS	3	79	12	2
Very dense to compact, brown fine to coarse **SAND** with gravel and cobbles		SS	4	25	50+	
		SS	5	54	35	3
		SS	6	62	26	4
		SS	7	38	40	5
	6.10	SS	8	38	29	6
Very dense to compact, brown medium to coarse **SAND,** trace gravel and cobbles		SS	9	75	30	
		SS	10	38	61	7
		SS	11	83	48	8
		SS	12	88	52	9
	9.75	SS	13	42	13	

End of Borehole

(GWL @ 3.0m depth based on field observations)

ELEV. (m)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %
20 40 60 80

Piezometer Construction

▽ (at approx. 3 m)

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE 9 May 2016

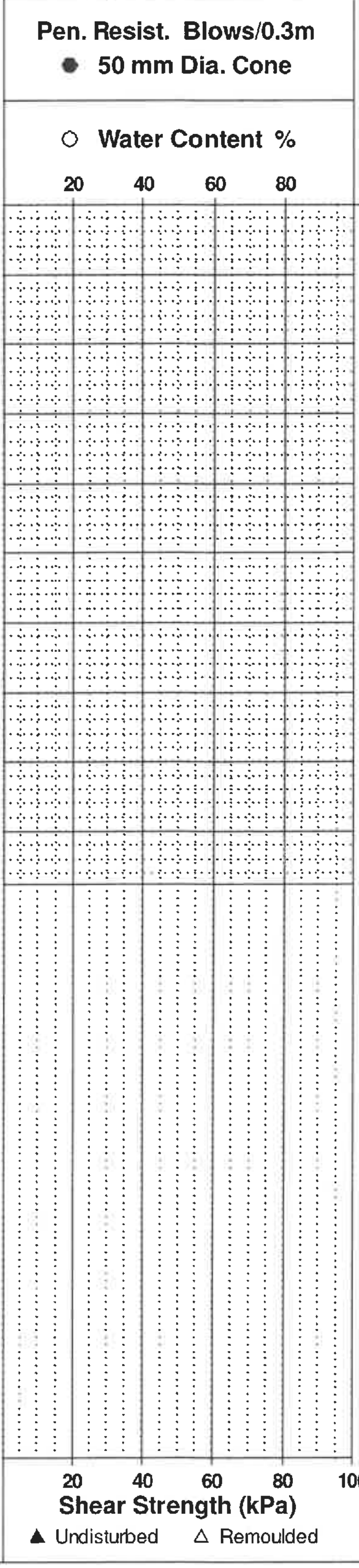
FILE NO. **PG3802**

HOLE NO. **BH 3-16**

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE					0		
TOPSOIL 0.20	AU	1					
Loose to dense, brown **SILTY SAND** with gravel, cobbles and roots	SS	2	54	8	1		
	SS	3	12	8	2		
3.00	SS	4	46	33			
Very loose to compact, brown **FINE SAND**	SS	5	17	4	3		∇
	SS	6	38	2	4		
- dense by 4.5m depth	SS	7	54	39	5		
	SS	8	58	43	6		
6.70	SS	9	50	42			
Dense to compact, grey medium to coarse **SAND**	SS	10	46	40	7		
	SS	11	58	27	8		
	SS	12	54	33	9		
9.75	SS	13	50	23			

End of Borehole

(GWL @ 3.0m depth based on field observations)



patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE 9 May 2016

FILE NO. PG3802

HOLE NO. BH 4-16

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.18	AU	1		
Loose, brown **SILTY SAND** with gravel and roots 1.50	SS	2	42	5
Loose, brown **SILTY SAND,** trace cobbles	SS	3	58	9
	SS	4	50	12
	SS	5	46	8
	SS	6	0	4
	SS	7	46	3
6.10	SS	8	50	3
Loose, grey medium to coarse **SAND**	SS	9	58	8
	SS	10	50	4
	SS	11	42	3
	SS	12	62	8
	SS	13	17	7
12.20	SS	14	38	10
Compact, grey **SILTY SAND**	SS	15	46	13
	SS	16	50	12
15.85	SS	17	67	14
End of Borehole (GWL @ 1.8m depth based on field observations)				

DEPTH (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

ELEV. (m)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %
20 40 60 80

Piezometer Construction
▽ (at approx. 1.8 m)

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY Hydraulic Shovel

DATE 14 April 2016

FILE NO. PG3802

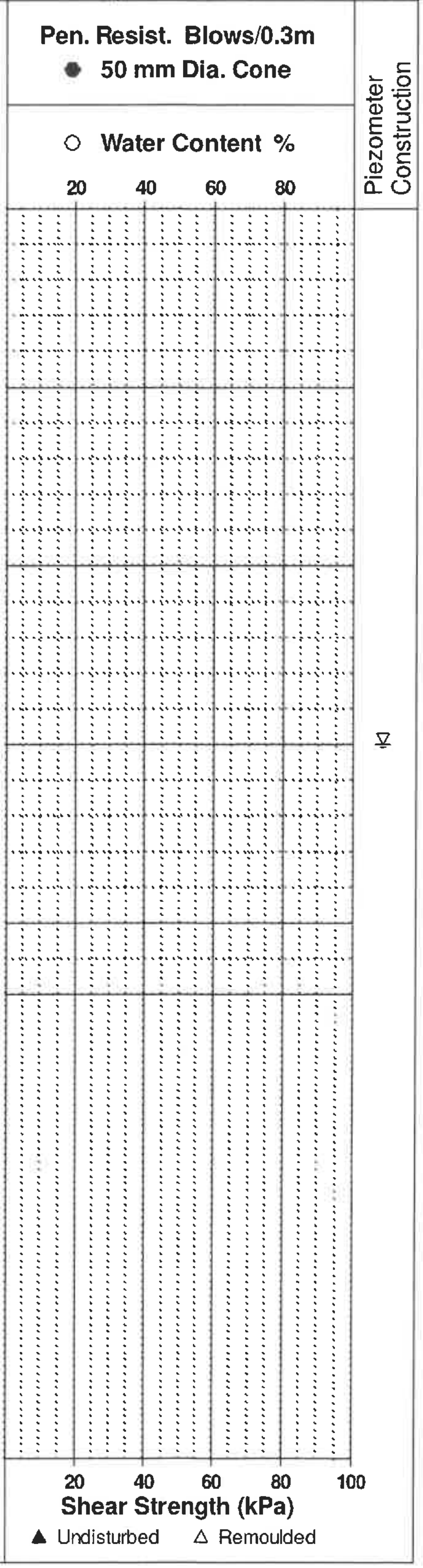
HOLE NO. TP 1-16

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	
TOPSOIL (to 0.30)						
Loose to compact, brown **SILTY SAND** with gravel and cobbles - root system to 1.1m depth - dry to moist (0.30 to 3.00)	G	1			1	
	G	2			2	
Loose, grey-brown medium to coarse **SAND** with gravel and cobbles (3.00 to 4.40)	G	3			3 4	

End of Test Pit

TP terminated in loose glacial till due to unstable excavation sidewalls

(GWL @ 3.0m depth based on field observations)



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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY Hydraulic Shovel

DATE 14 April 2016

FILE NO. PG3802

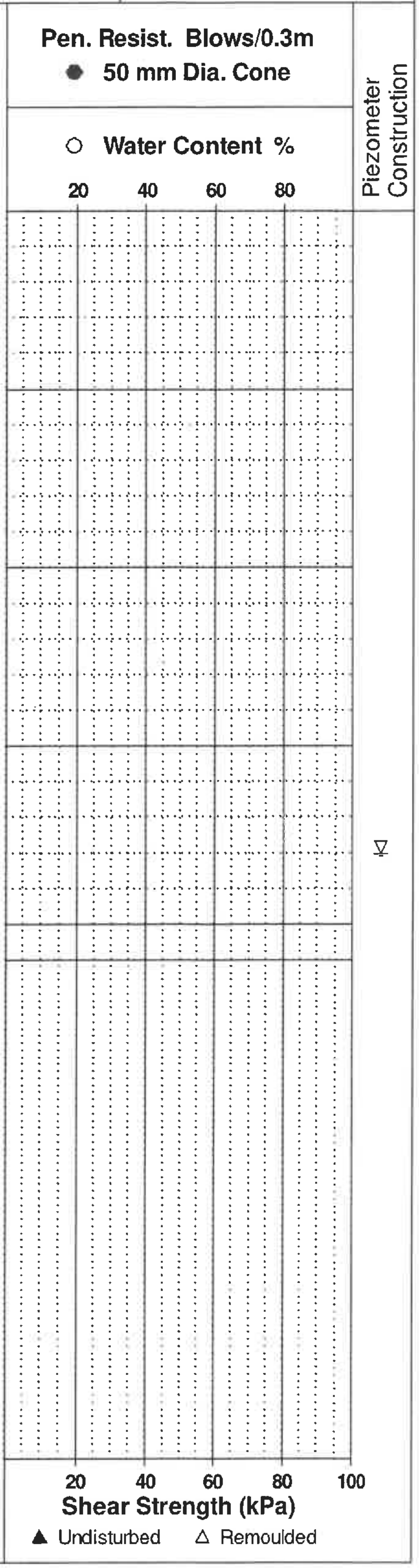
HOLE NO. TP 2-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	
TOPSOIL 0.30							
Loose to compact, brown **SILTY SAND** with gravel and cobbles - root system to 1.2m depth - dry to moist 1.30		G	1			1	
Loose, grey-brown medium to coarse **SAND** with gravel and cobbles - minor gravel and cobbles by 3.1m depth - moist to wet 4.20		G G	2 3			2 3 4	

End of Test Pit

TP terminated in loose glacial till due to unstable excavation sidewalls

(GWL @ 3.6m depth based on field observations)



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Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY Hydraulic Shovel

DATE 14 April 2016

FILE NO. PG3802

HOLE NO. TP 3-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0			
TOPSOIL 0.30									
Loose to compact, brown **SILTY FINE SAND** with some gravel and cobbles - root system to 1.1m depth - dry to moist 1.20		G	1			1			
Loose, grey-brown medium to coarse **SAND** with gravel and cobbles - minor cobbles and boulders from 2.2m to 3.7m depth - moist to wet 5.60		G	2			2			
		G	3			3			∇
						4			
						5			
End of Test Pit TP terminated in loose glacial till due to unstable excavation sidewalls (GWL @ 4.2m depth based on field observations)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY Hydraulic Shovel

DATE 14 April 2016

FILE NO. PG3802

HOLE NO. TP 4-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	
TOPSOIL 0.40							
						1	
Loose to compact, brown **SILTY SAND** - root system to 1.0m depth - dry		G	1				
						2	
						3	
3.70							
Loose, grey-brown medium to coarse **SAND,** trace gravel and cobbles - wet 4.00		G	2			4	

End of Test Pit

TP terminated in loose sand due to unstable excavation sidewalls

(GWL @ 3.7m depth based on field observations)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

▽

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY Hydraulic Shovel

DATE 14 April 2016

FILE NO. PG3802

HOLE NO. TP 5-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0			
TOPSOIL 0.35									
Loose to compact, brown **SILTY SAND** - root system to 1.2m depth - dry 1.90		G	1			1			
Loose, grey-brown **SAND,** trace gravel and cobbles - moist to wet 3.70		G	2			2 3			∇
End of Test Pit TP terminated in loose sand due to unstable excavation sidewalls (GWL @ 2.4m depth based on field observations)									

Water Content % scale: 20 40 60 80

Shear Strength (kPa) scale: 20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY Hydraulic Shovel

DATE 14 April 2016

FILE NO. PG3802

HOLE NO. TP 6-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0			
TOPSOIL 0.25									
Loose, brown **SILTY SAND,** trace gravel and cobbles - root system to 0.9m depth - dry to moist						1			
		G	1						
2.10						2			
Loose, grey-brown coarse **SAND**, minor gravel and cobbles - moist to wet		G	2						▽
2.90									
End of Test Pit TP terminated in loose glacial till due to unstable excavation sidewalls (GWL @ 2.5m depth based on field observations)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

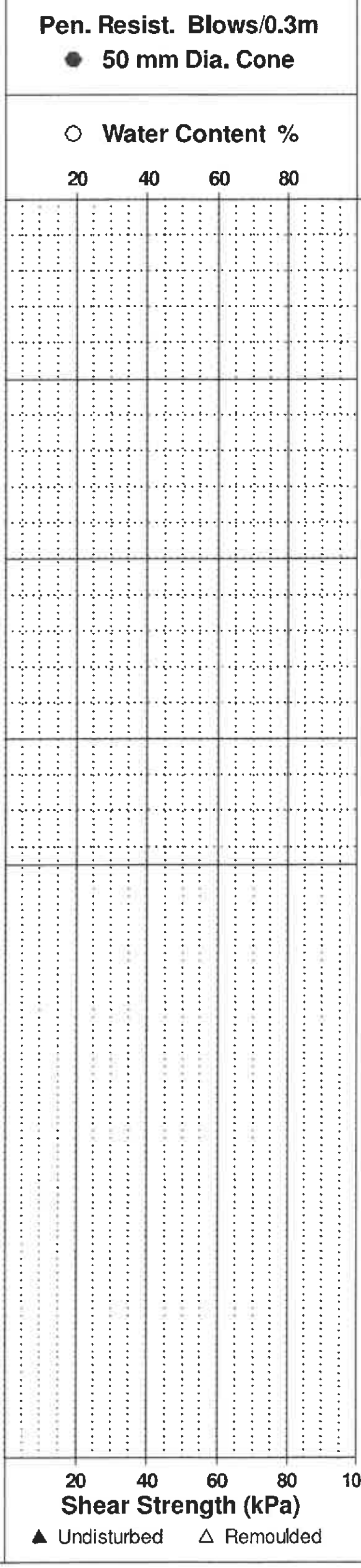
BORINGS BY Hydraulic Shovel

DATE 14 April 2016

FILE NO. PG3802

HOLE NO. TP 7-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0		
TOPSOIL 0.30								
Loose to compact, brown **SILTY SAND** - root system to 1.1m depth - dry to moist 1.60		G	1			1		
Loose, grey-brown medium to coarse **SAND,** trace gravel and cobbles - moist to wet 3.70		G	2			2 3		∇
End of Test Pit TP terminated in loose sand due to unstable excavation sidewalls (GWL @ 2.4m depth based on field observations)								



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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

FILE NO. PG3802

HOLE NO. TP 8-16

DATUM

REMARKS

BORINGS BY Hydraulic Shovel

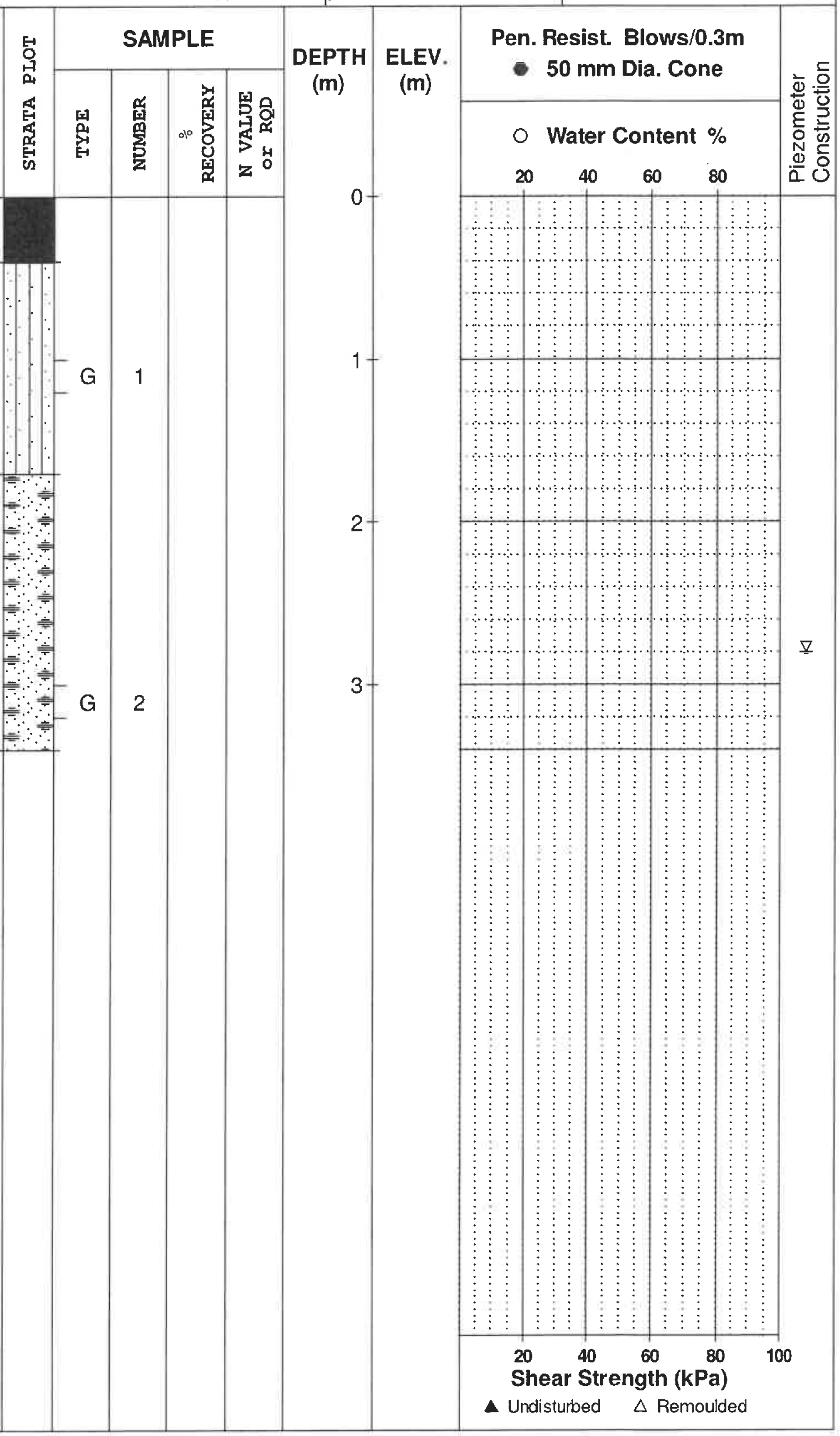
DATE 14 April 2016

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	
TOPSOIL (to 0.40)						
Loose to compact, brown **SILTY SAND,** trace gravel and cobbles - root system to 0.7m depth - dry to moist (to 1.70)	G	1			1	
Loose, grey-brown medium to coarse **SAND** with gravel and cobbles - moist to wet (to 3.40)	G	2			2 3	

End of Test Pit

TP terminated in loose glacial till due to unstable excavation sidewalls

(GWL @ 2.8m depth based on field observations)



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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Storyland Road
Horton Township, Ontario

DATUM

REMARKS

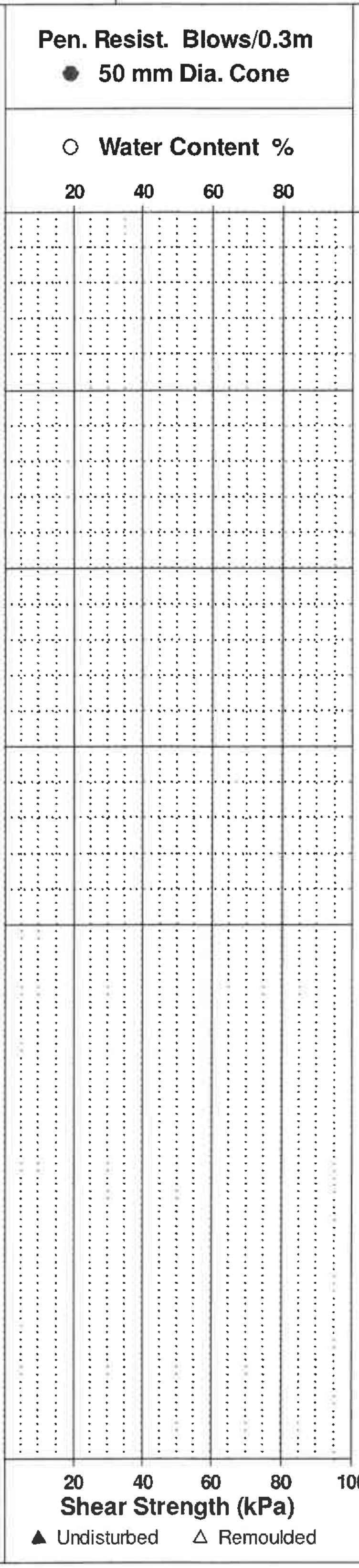
BORINGS BY Hydraulic Shovel

DATE 14 April 2016

FILE NO. PG3802

HOLE NO. TP 9-16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0		
TOPSOIL 0.30								
Loose to compact, brown **SILTY SAND** with gravel and cobbles - root system to 1.1m depth - dry to moist 1.30		G	1			1		
Loose to compact, grey-brown medium to coarse **SAND** with gravel and cobbles - dry to moist 4.00		G	2			2		
		G	3			3		▽
End of Test Pit TP terminated in loose glacial till due to unstable excavation sidewalls (GWL @ 3.2m depth based on field observations)						4		



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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Part of Lot 20, Concession 6
Horton Township, Ontario

DATUM

REMARKS

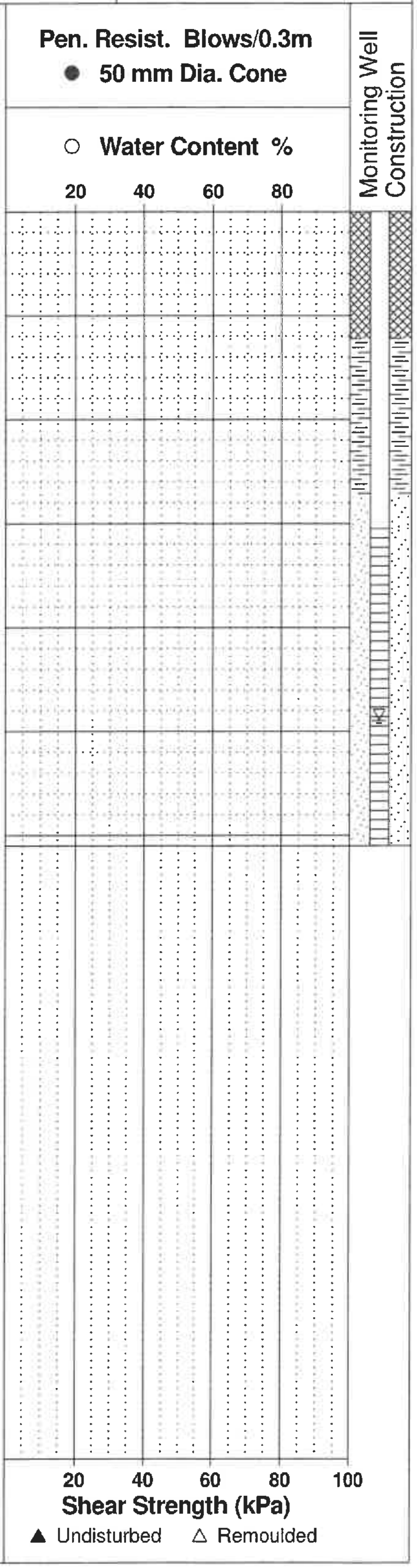
BORINGS BY CME 55 Power Auger

DATE December 6, 2016

FILE NO. PG4018

HOLE NO. BH 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	
TOPSOIL 0.25		AU	1				
Loose, brown medium to coarse **SAND** with gravel, silt and cobbles		SS	2	42	5	1	
1.60		SS	3	46	5		
Loose to dense, brown **FINE SAND** 2.40		SS	4	17	33	2	
Dense, brown medium to coarse **SAND** with gravel and cobbles		SS	5	33	38	3	
3.66		SS	6	58	64		
Dense, brown **FINE SAND** with silty clay seam		SS	7	75	33	4	
4.90		SS	8	83	38		
Very dense, brown fine to medium **SAND,** trace gravel		SS	9	67	60	5	
6.10		SS	10	92	66	6	
End of Borehole (GWL @ 4.9m depth based on field observations)							



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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Part of Lot 20, Concession 6
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE December 6, 2016

FILE NO. PG4018

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Monitoring Well Construction
GROUND SURFACE						0			
TOPSOIL 0.25		AU	1						
Compact, brown medium to coarse **SAND** with gravel, silt and cobbles		SS	2	58	13	1			
		SS	3	42	11				
1.83									
Dense to very dense, brown fine to medium **SAND,** trace gravel		SS	4	75	46	2			
		SS	5	90	50+				
3.10						3			
Very dense, brown **FINE SAND**		SS	6	100	50+				
		SS	7	88	50+	4			
		SS	8	88	50+				
4.90									∇
Very dense, brown fine to medium **SAND** 5.30		SS	9	94	50+	5			
Very dense, brown medium to coarse **SAND,** trace gravel 5.84		SS	10	100	50+				
End of Borehole (GWL @ 4.9m depth based on field observations)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Part of Lot 20, Concession 6
Horton Township, Ontario

FILE NO. PG4018

HOLE NO. BH 3

DATUM

REMARKS

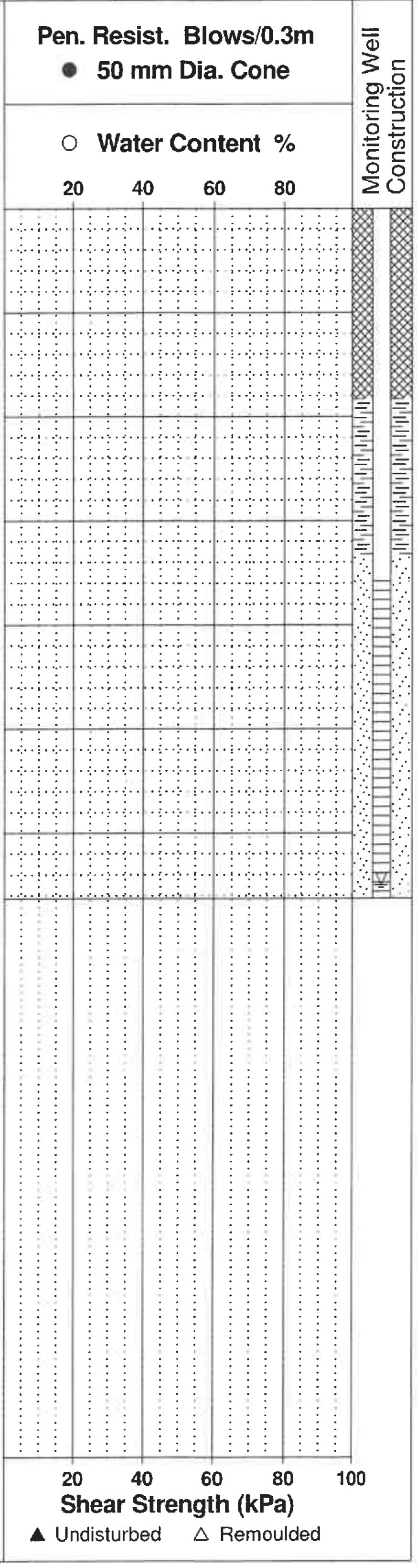
BORINGS BY CME 55 Power Auger

DATE December 7, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	
TOPSOIL 0.30		AU	1				
Loose to dense, brown fine to medium **SAND,** trace to some gravel and cobbles 3.05		SS	2	50	7	1	
		SS	3	50	5		
		SS	4	17	22	2	
		SS	5	75	44		
Very dense, brown **FINE SAND** 3.70		SS	6	83	57	3	
Dense, brown fine to medium **SAND** 4.30		SS	7	83	39	4	
Dense to very dense, brown **FINE SAND,** trace silt and clay 5.50		SS	8	83	33		
		SS	9	100	50+	5	
Very dense, brown fine to medium **SAND** 6.10		SS	10	100	50+	6	
Very dense, brown medium to coarse **SAND,** trace gravel 6.63		SS	11	76	50+		

End of Borehole

(GWL @ 6.5m depth based on field observations)



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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Part of Lot 20, Concession 6
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

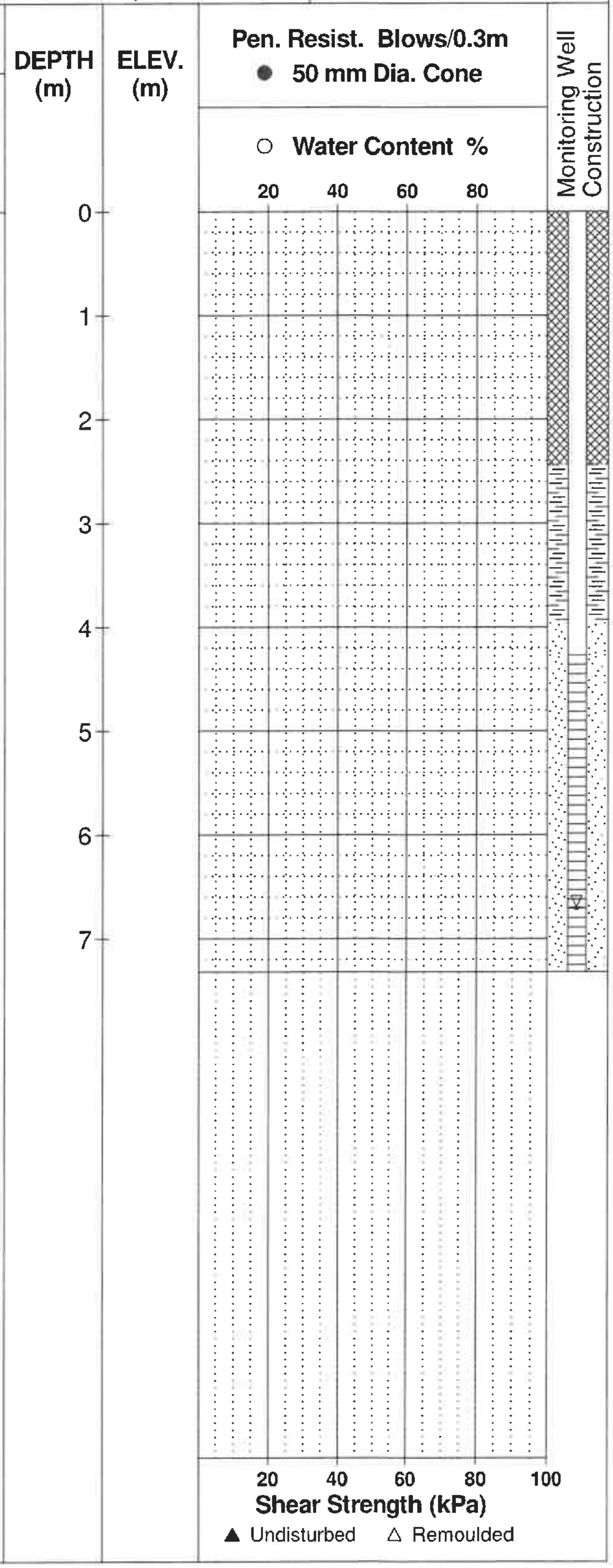
DATE December 7, 2016

FILE NO. PG4018

HOLE NO. BH 4

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
TOPSOIL	0.23
Loose, brown **FINE SAND** with silt	1.14
Loose, brown fine to medium **SAND**	1.80
Compact to dense, brown medium to coarse **SAND,** trace to some gravel and cobbles	4.00
Dense to very dense, brown **FINE SAND**	4.90
Very desen to dense, brown fine to medium **SAND,** trace gravel	6.70
Dense, brown medium to coarse **SAND**	7.32
End of Borehole (GWL @ 6.7m depth based on field observations)	

SAMPLE			
TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	75	5
SS	3	67	6
SS	4	67	14
SS	5	58	16
SS	6	4	41
SS	7	75	35
SS	8	83	69
SS	9	100	50+
SS	10	83	51
SS	11	75	45
SS	12	75	41



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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Part of Lot 20, Concession 6
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE December 7, 2016

FILE NO. **PG4018**

HOLE NO. **BH 5**

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.28	AU	1		
Loose, brown medium to coarse **SAND,** some gravel and cobbles 1.40	SS	2	42	8
Loose, brown **FINE SAND,** some gravel and cobbles 1.80	SS	3	67	9
Compact to dense, brown medium to coarse **SAND** with gravel, some cobbles 4.40	SS	4	67	23
	SS	5	75	21
	SS	6	62	34
	SS	7	75	34
Very dense, brown fine to medium **SAND,** trace gravel 6.10	SS	8		50+
	SS	9	100	50+
	SS	10	87	50+
Very dense, brown medium to coarse **SAND** 6.71	SS	11	100	53

End of Borehole

(GWL @ 4.9m depth based on field observations)

DEPTH (m): 0, 1, 2, 3, 4, 5, 6

ELEV. (m)

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**
20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Monitoring Well Construction
▽

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Part of Lot 20, Concession 6
Horton Township, Ontario

FILE NO. PG4018

HOLE NO. BH 6

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE December 8, 2016

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % (20, 40, 60, 80)	Monitoring Well Construction
GROUND SURFACE						0			
TOPSOIL 0.30		AU	1						
Loose to compact, brown fine to medium **SAND**		SS	2	67	7	1			
		SS	3	67	10				
		SS	4	75	15	2			∇
		SS	5	67	6	3			
		SS	6	75	11				
- very loose by 3.7m depth		SS	7	67	2	4			
4.88		SS	8	67	2				
End of Borehole (GWL @ 2.1m depth based on field observations)									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Part of Lot 20, Concession 6
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE December 8, 2016

FILE NO. PG4018

HOLE NO. BH 7

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20, 40, 60, 80)	Monitoring Well Construction
GROUND SURFACE						0			
TOPSOIL 0.28		AU	1						
Loose, brown fine to medium **SAND**		SS	2	58	8	1			
		SS	3	67	8				
		SS	4	67	9	2			
3.00		SS	5	58	4				
Loose to comapct, brown medium to coarse **SAND,** trace gravel		SS	6	67	6	3			▽
		SS	7	58	20	4			
5.20		SS	8	58	12				
Compact, brown **SILTY FINE SAND** 5.50		SS	9	58	11	5			
Loose, brown fine to medium **SAND**		SS	10	50	7	6			
6.71		SS	11	67	7				
End of Borehole (GWL @ 3.7m depth based on field observations)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Aggregate Resource Assessment
Part of Lot 20, Concession 6
Horton Township, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE December 8, 2016

FILE NO. PG4018

HOLE NO. BH 8

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	
TOPSOIL	0.28	AU	1				
Loose, brown fine to medium **SAND,** trace gravel and cobbles		SS	2	62	9	1	
	1.80	SS	3	67	12		
Dense to compact, brown **FINE SAND,** some gravel		SS	4	83	34	2	
		SS	5	67	13	3	
	3.70	SS	6	17	12		
Compact, brown medium to coarse **SAND** with gravel, silt and cobbles		SS	7	54	14	4	
		SS	8	75	23		
		SS	9	79	24	5	
	5.90	SS	10	67	76	6	
Very dense, brown **FINE SAND**		SS	11	67	76		
		SS	12	79	50	7	
	7.75	SS	13	96	74		
Very dense, brown **SANDY SILT,** trace clay	7.80					8	
Very dense, brown **FINE SAND** with silty clay seam	8.50	SS	14	67	73		
		SS	15	100	50+		
Very dense, brown fine to medium **SAND**		SS	16	100	50+	9	
	9.75						
Very dense, brown medium to coarse **SAND,** trace gravel		SS	17	48	50+	10	
	10.44	SS	18	0	50+		
End of Borehole (GWL @ 8.5m depth based on field observations)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Monitoring Well Construction

APPENDIX C-II

Golder Investigation Borehole Logs (2021)

PROJECT: 20412072

RECORD OF BOREHOLE: 21-01

SHEET 1 OF 2

LOCATION: N 5045231.6 ;E 369798.9

BORING DATE: May 13, 2021

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger 200 mm Diam. (Hollow Stem)

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ├──○W──┤ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
GROUND SURFACE	168.59			
TOPSOIL - (SM) SILTY SAND, trace gravel; dark brown, contains organics; non-cohesive, moist, loose	0.00			
(SP) SAND, fine to medium, trace coarse, trace silt; orange brown; non-cohesive, moist, loose	0.13	1	SS	5
(SP) SAND, fine to medium, trace coarse; light brown; non-cohesive, moist, loose to compact	167.90 0.69	2	SS	9
		3	SS	19
		4	SS	18
(SW) gravelly SAND, fine to coarse; brown, contains cobbles; non-cohesive, moist, compact to dense	165.54 3.05	5	SS	48
		6	SS	51
		7	SS	28
(SW) SAND, fine to coarse, some gravel; brown; non-cohesive, moist, dense	163.41 5.18	8	SS	33
(SP) SAND, fine to medium, trace coarse, trace silt; light brown; non-cohesive, moist to wet, dense	162.80 5.79	9	SS	63
		10	SS	148
		11	SS	100
		12	SS	81
		13	SS	92
	158.68 9.91	14	SS	36

PIEZOMETER OR STANDPIPE INSTALLATION:
- Bentonite Seal
- Bentonite and Cuttings
- ▽
- Bentonite Seal
- Silica Sand

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: JS
CHECKED: DH

PROJECT: 20412072

RECORD OF BOREHOLE: 21-01

SHEET 2 OF 2

LOCATION: N 5045231.6 ;E 369798.9

BORING DATE: May 13, 2021

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ├──○W──┤ Wl 20 40 60 80

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		— CONTINUED FROM PREVIOUS PAGE —						
10	Power Auger 200 mm Diam. (Hollow Stem)	(SP/SM) SILTY SAND, fine, trace clay; brown; non-cohesive, wet, dense		14	SS	36		
11				15	SS	85		51 mm Diam. PVC #10 Slot Screen
			157.01 11.58					
		End of Borehole						WL in Screen at Elev. 159.55 m on May 25, 2021
12								
13								
14								
15								
16								
17								
18								
19								
20								

MIS-BHS 001 20412072.GPJ GAL-MIS.GDT 21-9-29 JEM

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: JS

CHECKED: DH

PROJECT: 20412072

RECORD OF BOREHOLE: 21-02

SHEET 1 OF 1

LOCATION: N 5044930.0 ;E 369348.0

BORING DATE: May 14, 2021

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

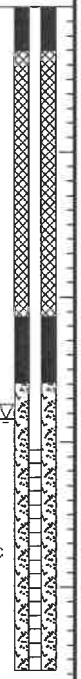
SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	166.51				
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SP) SAND, fine to medium, some silt; dark brown, contains organics; non-cohesive, moist, loose	0.00				Bentonite Seal
		(SP) SAND, fine to medium, some to trace silt; orange brown; non-cohesive, moist, loose	166.31 0.20	1	SS	3	
		(SW) gravelly SAND, fine to coarse, trace silt; brown, contains cobbles; non-cohesive, moist, loose to compact	165.82 0.69				
1				2	SS	11	Bentonite and Cuttings
2				3	SS	35	
		(SP) SAND, fine to medium; brown; non-cohesive, moist to wet, compact	164.30 2.21	4	SS	30	Bentonite Seal
		(SM) SILTY SAND, fine; brown; non-cohesive, wet, compact	163.77 2.74				Silica Sand
3		(SW) SAND, fine to coarse, trace silt; brown; non-cohesive, wet, compact	2.90	5	SS	24	
4				6	SS	42	51 mm Diam. PVC #10 Slot Screen
		End of Borehole	161.94 4.57				WL in Screen at Elev. 163.79 m on May 25, 2021
5							
6							
7							
8							
9							
10							



MIS-BHS 001 20412072.GPJ GAL-MIS.GDT 21-9-29 JEM

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: JS

CHECKED: DH

PROJECT: 20412072

LOCATION: N 5044605.3 ;E 368946.6

SAMPLER HAMMER, 64kg; DROP, 760mm

RECORD OF BOREHOLE: 21-03

BORING DATE: May 14, 2021

SHEET 1 OF 1

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

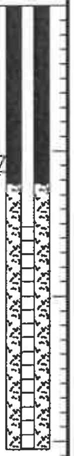
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	166.13					
0	Power Auger 200 mm Diam. (Hollow Stem)	(PT) PEAT, fiberous	0.00					
		TOPSOIL - (SP) SAND, fine to medium, some silt; dark brown, contains organics; non-cohesive, moist, loose	0.10	1	SS	5		Bentonite Seal
		(SW) SAND, fine to coarse, some gravel and silt; brown; non-cohesive, wet, compact	165.52 0.61	2	SS	27		
1								Silica Sand
				3	SS	10		
2		(SW) SAND, fine to coarse, trace silt; dark brown, contains organic odour; non-cohesive, wet, loose	163.92 2.21	4	SS	2		51 mm Diam. PVC #10 Slot Screen
3		End of Borehole	163.08 3.05					WL in Screen at Elev. 165.02 m on May 25, 2021
4								
5								
6								
7								
8								
9								
10								

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80



DEPTH SCALE

1 : 50

GOLDER MEMBER OF WSP

LOGGED: JS

CHECKED: DH

PROJECT: 20412072

RECORD OF BOREHOLE: 21-04

SHEET 1 OF 1

LOCATION: N 5044171.5 ;E 369156.3

BORING DATE: May 14, 2021

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

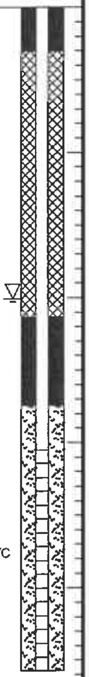
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m
		GROUND SURFACE	166.43 0.00			
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SP) SAND, fine to medium, some silt; dark brown; non-cohesive, moist, loose	166.23 0.20	1	SS	2
		(SP) SAND, fine to medium, trace coarse; brown; non-cohesive, moist, loose	165.82 0.61			
1		(SW) SAND, fine to coarse, trace gravel and silt; brown; non-cohesive, moist, loose	164.91 1.52	2	SS	6
2		(SP) SAND, fine to medium, trace coarse; light brown; non-cohesive, wet	163.74 2.69	3 4	SS SS	19 64
3 4		(SW) SAND, fine to coarse; brown; non-cohesive, wet, dense	161.86 4.57	5 6	SS SS	14 26
5 6 7 8 9 10		End of Borehole				

PIEZOMETER OR STANDPIPE INSTALLATION



Bentonite Seal

Bentonite and Cuttings

Bentonite Seal

Silica Sand

51 mm Diam. PVC #10 Slot Screen

WL in Screen at Elev. 164.52 m on May 25, 2021

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: JS

CHECKED: DH

PROJECT: 20412072

RECORD OF BOREHOLE: 21-05

SHEET 1 OF 1

LOCATION: N 5044563.5 ;E 369713.9

BORING DATE: May 13, 2021

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

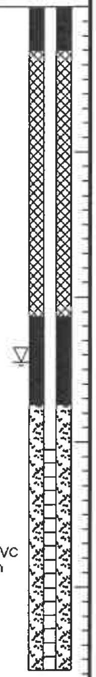
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m
		GROUND SURFACE	165.19			
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SW) SAND, some silt; dark brown, contains organics; non-cohesive, moist, loose	0.00			
		(SP) SAND, fine to medium, trace silt; orange brown; non-cohesive, moist, loose	0.10	1	SS	2
		(SP) SAND, fine to medium; brown; non-cohesive, moist to wet, loose	164.50 0.69			
1				2	SS	5
2				3	SS	9
				4	SS	7
3				5	SS	20
4				6	SS	15
		End of Borehole	160.62 4.57			
5						
6						
7						
8						
9						
10						

PIEZOMETER OR STANDPIPE INSTALLATION



Bentonite Seal

Bentonite and Cuttings

Bentonite Seal

Silica Sand

51 mm Diam. PVC #10 Slot Screen

WL in Screen at Elev. 162.83 m on May 25, 2021

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: JS
CHECKED: DH

PROJECT: 20412072

RECORD OF BOREHOLE: 21-06

SHEET 1 OF 2

LOCATION: N 5044804.4 ;E 369638.0

BORING DATE: May 12, 2021

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES: 0–10

BORING METHOD: Power Auger, 200 mm Diam. (Hollow Stem)

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	166.13				
TOPSOIL - (SP) SAND, fine to medium, trace silt; dark brown, contains organics; non-cohesive, moist, loose	0.00				Bentonite Seal
(SP) SAND, fine to medium; orange brown, mottled; non-cohesive, moist, loose	0.13	1	SS	10	
(SP) SAND, fine, trace gravel; light brown; non-cohesive, moist, loose	165.37 0.76	2	SS	15	
(SW) gravelly SAND, fine to coarse, trace silt; brown, contains cobbles and boulders; non-cohesive, moist to wet, compact	164.61 1.52	3	SS	62	
		4	SS	100	Bentonite and Cuttings
		5	SS	37	
		6	SS	25	
					∇ Bentonite Seal
		7	SS	13	Silica Sand
		8	SS	46	
		9	SS	74	51 mm Diam. PVC #10 Slot Screen
(SP) SAND, fine, some medium, some silt, some to trace gravel; brown; non-cohesive, wet, dense	160.64 5.49	10	SS	>100	
		11	SS	>50	WL in Screen at Elev. 162.67 m on May 25, 2021
		12	SS	100	
		13	SS	63	
(SW) SAND, fine to coarse, trace gravel and silt; brown to grey; non-cohesive, wet, dense	158.21 7.92	14	SS	82	
		15	SS	64	
(SP) SAND, fine, some medium, trace coarse, trace silt; grey; non-cohesive, wet, loose	156.68 9.45	16	SS	17	
	156.38 9.75	17	SS	12	

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

GOLDER
MEMBER OF WSP

LOGGED: JS
CHECKED: DH

PROJECT: 20412072

RECORD OF BOREHOLE: 21-06

SHEET 2 OF 2

LOCATION: N 5044804.4 ;E 369638.0

BORING DATE: May 12, 2021

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		— CONTINUED FROM PREVIOUS PAGE —									
10	Wash Bore NW Casing	(SM) SAND, fine, some medium, some silt; grey; non-cohesive, wet, compact			17	SS	12				
11					18	SS	15				
				154.85							
		(SP) SAND, fine, trace to some silt; grey; non-cohesive, wet, compact to very dense		11.28	19	SS	26				
12					20	SS	15				
13					21	SS	54				
				152.41							
		SILTY SAND, fine; grey; non-cohesive, wet, compact to very dense		13.72							
14					22	SS	40				
					23	SS	71				
15				151.04							
				15.09							
16											
17											
18											
19											
20											

MIS-BHS 001 20412072.GPJ GAL-MIS.GDT 21-9-29 JEM

DEPTH SCALE

1 : 50

GOLDER

MEMBER OF WSP

LOGGED: JS

CHECKED: DH

APPENDIX D

Well Response Test Analyses

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST 21-01

INTERVAL (metres below ground surface)

Top of Interval = 10.06
Bottom of Interval = 11.58

$$K = \frac{r_c^2}{2L_e} ln\left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e}\right)^2}\right]\left[\frac{ln\left(\frac{h_1}{h_2}\right)}{(t_2 - t_1)}\right]$$

where K = (m/sec)

where:

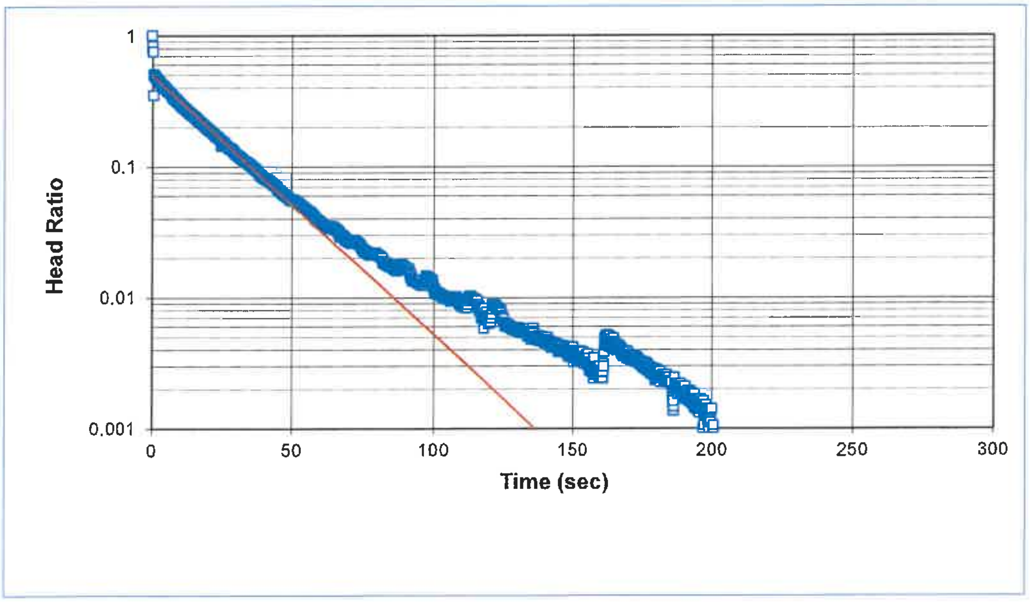
r_c = casing radius (metres)
R_e = filter pack radius (metres)
L_e = length of screened interval (metres)
t = time (seconds)
h_t = head at time t (metres)

INPUT PARAMETERS

r_c =	2.5E-02
R_e =	1.0E-01
L_e =	1.5
t_1 =	0
t_2 =	50
h_1/h_0 =	0.50
h_2/h_0 =	0.05

RESULTS

K=	3E-05	m/sec
K=	3E-03	cm/sec



Project Name: Tomlinson/Storyland Road Pit/Horton Twp
Project No.: 20412072
Test Date: 25-May-21

Analysis By: DH
Checked By: JPAO
Analysis Date: 27-May-21

WSP GOLDER

BOUWER AND RICE SLUG TEST ANALYSIS
RISING HEAD TEST 21-02

INTERVAL (metres below ground surface)

Top of Interval =	**3.05**
Bottom of Interval =	**4.57**

$$K = \frac{r_c^2 ln\left(\frac{R_e}{r_w}\right)}{2L_e}\frac{1}{t}ln\frac{y_0}{y_t}$$ where K=m/sec

where:

r_c = casing radius (metres);

R_e = effective radius (metres);

L_e = length of screened interval (metres);

r_w = radial distance to undisturbed aquifer (metres)

y_0 = initial drawdown (metres)

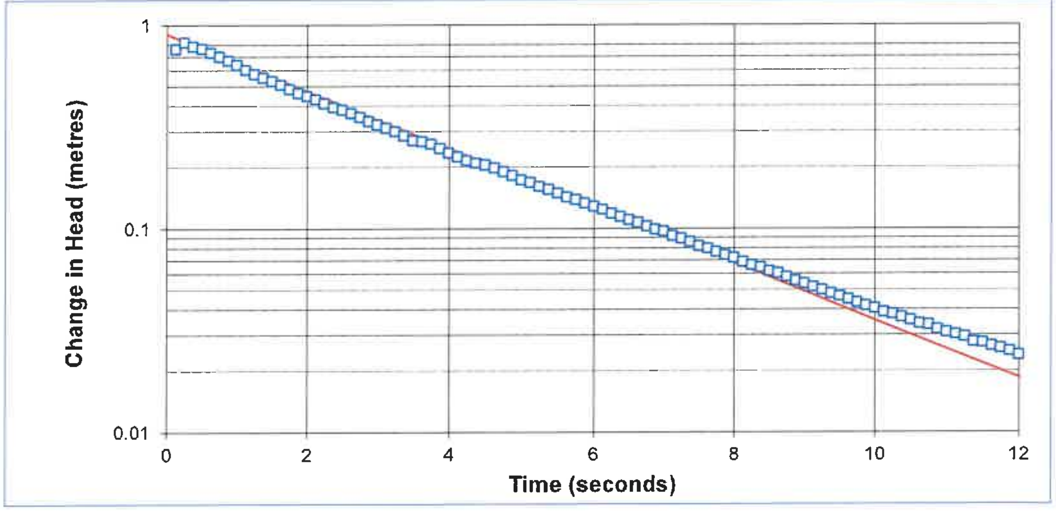
y_t = drawdown (metres) at time t (seconds)

INPUT PARAMETERS

r_c =	0.06
r_w =	0.10
L_e =	1.52
$ln(R_e/r_w)$	1.65
y_0 =	0.90
y_t =	0.01
t =	15

RESULTS

K=	6E-04	m/sec
K=	6E-02	cm/sec



Project Name: Tomlinson/Storyland Road Pit/Horton Twp
Project No.: 20412072
Test Date: 05-25-21

Analysis By: DH
Checked By: JPAO
Analysis Date: 2021-05-27

HVORSLEV SLUG TEST ANALYSIS
FALLING HEAD TEST 21-03

INTERVAL (metres below ground surface)

Top of Interval =	**1.52**
Bottom of Interval =	**3.05**

$$K = \frac{r_c^2}{2L_e} ln\left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e}\right)^2}\right]\left[\frac{ln\left(\frac{h_1}{h_2}\right)}{(t_2 - t_1)}\right]$$

where K = (m/sec)

where:

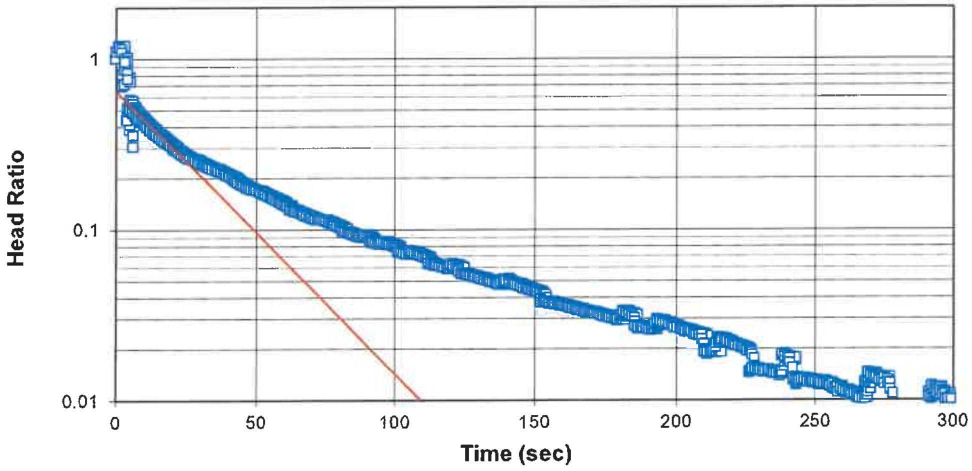
r_c = casing radius (metres)
R_e = filter pack radius (metres)
L_e = length of screened interval (metres)
t = time (seconds)
h_t = head at time t (metres)

INPUT PARAMETERS

r_c =	2.5E-02
R_e =	1.0E-01
L_e =	1.5
t_1 =	0
t_2 =	25
h_1/h_0 =	0.65
h_2/h_0 =	0.25

RESULTS

K=	2E-05	m/sec
K=	2E-03	cm/sec



Project Name: Tomlinson/Storyland Road Pit/Horton Twp
Project No.: 20412072
Test Date: 25-May-21

Analysis By: DH
Checked By: JPAO
Analysis Date: 27-May-21

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST 21-04

INTERVAL (metres below ground surface)

Top of Interval = 3.05
Bottom of Interval = 4.57

$$K = \frac{r_c^2}{2L_e} ln\left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e}\right)^2}\right]\left[\frac{ln\left(\frac{h_1}{h_2}\right)}{(t_2 - t_1)}\right]$$

where K = (m/sec)

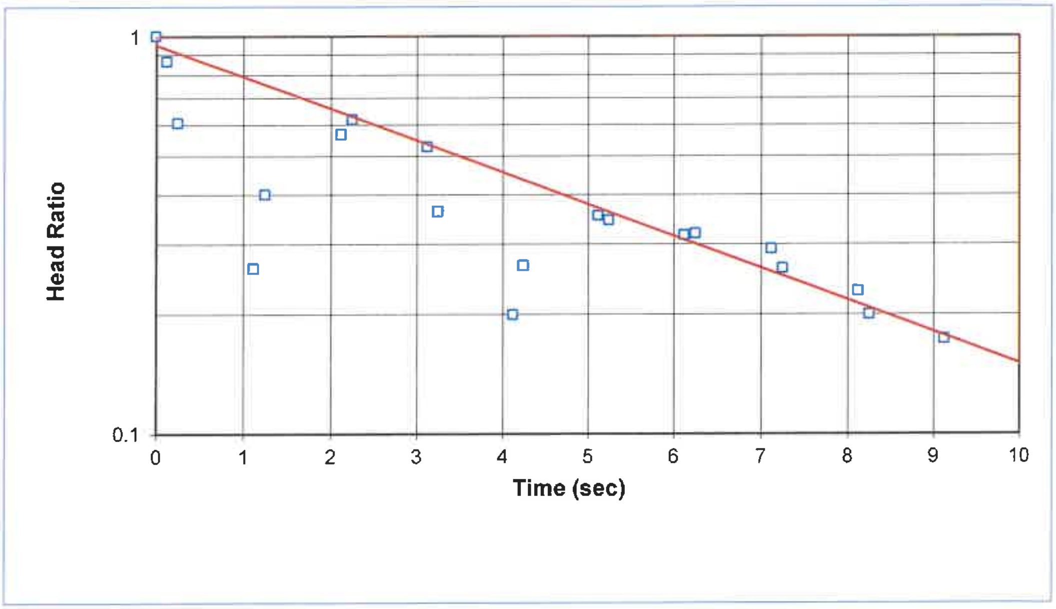
where:
r_c = casing radius (metres)
R_e = filter pack radius (metres)
L_e = length of screened interval (metres)
t = time (seconds)
h_t = head at time t (metres)

INPUT PARAMETERS

r_c = 2.5E-02
R_e = 1.0E-01
L_e = 1.5
t_1 = 0
t_2 = 10
h_1/h_0 = 0.95
h_2/h_0 = 0.15

RESULTS

K=	**1E-04**	**m/sec**
K=	**1E-02**	**cm/sec**



Project Name: Tomlinson/Storyland Road Pit/Horton Twp
Project No.: 20412072
Test Date: 25-May-21

Analysis By: DH
Checked By: JPAO
Analysis Date: 27-May-21

Golder Associates Ltd.

https://golderassociates.sharepoint.com/sites/136741/Project Files/5 Technical Work/Phase 1000/Phase 1030 Water Levels & K-testing/K analysis/
21-04 RHT2

HVORSLEV SLUG TEST ANALYSIS
RISING HEAD TEST 21-05

INTERVAL (metres below ground surface)

Top of Interval = 3.05
Bottom of Interval = 4.57

$$K = \frac{r_c^2}{2L_e} ln\left[\frac{L_e}{2R_e} + \sqrt{1 + \left(\frac{L_e}{2R_e}\right)^2}\right]\left[\frac{ln\left(\frac{h_1}{h_2}\right)}{(t_2 - t_1)}\right]$$

where K = (m/sec)

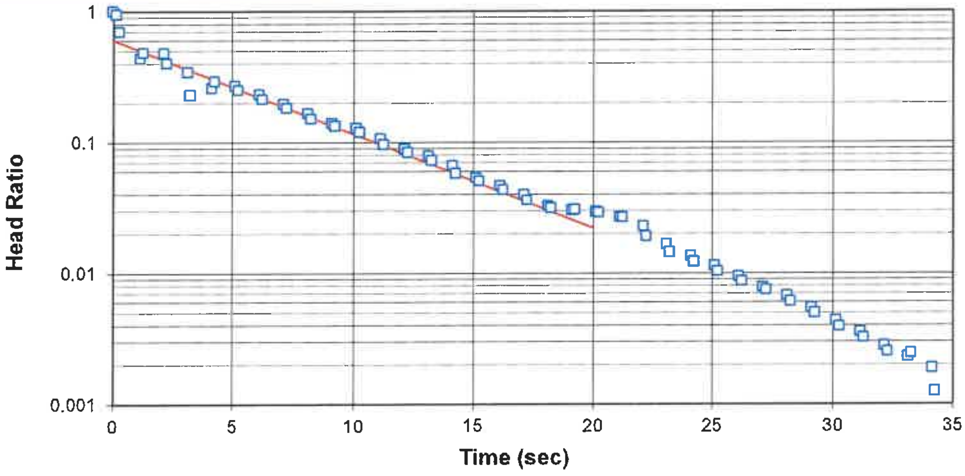
where:
r_c = casing radius (metres)
R_e = filter pack radius (metres)
L_e = length of screened interval (metres)
t = time (seconds)
h_t = head at time t (metres)

INPUT PARAMETERS

r_c =	2.5E-02
R_e =	1.0E-01
L_e =	1.5
t_1 =	0
t_2 =	20
h_1/h_0 =	0.60
h_2/h_0 =	0.02

RESULTS

K=	1E-04	m/sec
K=	1E-02	cm/sec



Project Name: Tomlinson/Storyland Road Pit/Horton Twp
Project No.: 20412072
Test Date: 25-May-21

Analysis By: DH
Checked By: JPAO
Analysis Date: 27-May-21

APPENDIX E

Analytical Modeling Results

Inflow to Circular Excavation
Dupuit-Forchheimer Equation:

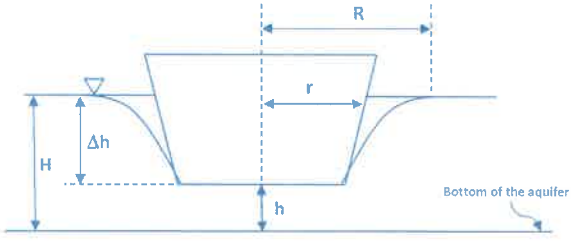
$$Q = \left(\frac{\pi K(H^2 - h^2)}{\ln\left(\frac{R}{r}\right)}\right)$$

K (m/s) 4E-05
H (m) 13.3
h (m) 10.0
r (m) 422.0

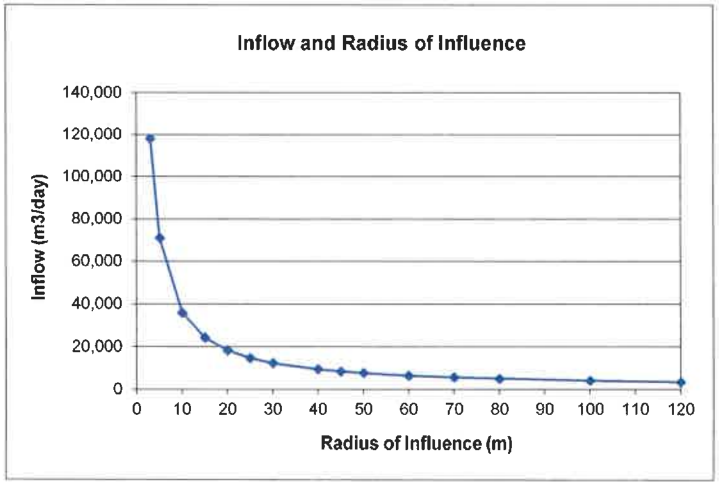
r - radius of pit
R - radius of influence

Q (m^3/s)	R	Rad of Inf. from edge	m^3/day
1.4E+00	425.0	3.0	117,848
8.2E-01	427.0	5.0	70,876
4.1E-01	432.0	10.0	35,645
2.8E-01	437.0	15.0	23,901
2.1E-01	442.0	20.0	18,029
1.7E-01	447.0	25.0	14,505
1.4E-01	452.0	30.0	12,156
1.1E-01	462.0	40.0	9,218
9.5E-02	467.0	45.0	8,239
8.6E-02	472.0	50.0	7,456
7.3E-02	482.0	60.0	6,280
6.3E-02	492.0	70.0	5,440
5.6E-02	502.0	80.0	4,809
4.5E-02	522.0	100.0	3,926
3.9E-02	542.0	120.0	3,336

predicted radius of influence



CROSS SECTON



Notes
L - litres
m - metres
K - hydraulic conductivity
m/s - metres per second

Prepared by:JPAO
Checked by:KAM

APPENDIX F

Water Quality Results

Parameter	Unit	PWQO (1)	SW-1 07-May-22
General Chemistry			
Alkalinity (Total as CaCO3)	ug/l	(2)	95000
Ammonia, unionized (Field)	ug/l	20	<20
Ammonia Nitrogen	ug/l	--	61
Chloride	ug/l	--	2900
Conductivity (Field)	uS/cm	--	198
Dissolved Organic Carbon	ug/l	--	7600
Hardness, Calcium Carbonate	ug/l	--	91000
Nitrate as N	ug/l	--	<0.10
Nitrite as N	ug/l	--	<0.010
Nitrogen, Total Kjeldahl	ug/l	--	18000
pH (Field)	-	6.5 - 8.5	7.47
Phosphorus	ug/l	(3)	18
Sulphate	ug/l	--	<1000
Temperature (Field)	deg c	(4)	10.8
Total Dissolved Solids	ug/l	--	70000
Total Suspended Solids	ug/l	--	<10000
Turbidity	NTU	(5)	0.7
Metals			
Aluminum, dissolved	ug/l	-- (9)	5
Barium	ug/l	--	38
Boron	ug/l	200 (10)	<10
Calcium	ug/l	--	34000
Chromium	ug/l	-- (12)	<5.0
Cobalt	ug/l	0.9	<0.50
Copper	ug/l	5	<0.90
Iron	ug/l	300	<100
Magnesium	ug/l	--	5600
Manganese	ug/l	--	9.2
Molybdenum	ug/l	40	<0.50
Nickel	ug/l	25	<1.0
Potassium	ug/l	--	920
Silicon	ug/l	--	550
Sodium	ug/l	--	2700
Strontium	ug/l	--	61
Thallium	ug/l	--	<0.050
Vanadium	ug/l	6	<0.50
Zinc	ug/l	30 (11)	<5.0
Petroleum Hydrocarbons			
Oil & Grease - Animal/Vegetable	ug/l	--	1000
Oil & Grease - Mineral/Synthetic	ug/l	--	1000
Oil & Grease, Total Rec	ug/l	-- (14)	<500

Footnotes:

	Tables should be read in conjunction with the accompanying document.
<	Indicates parameter not detected above laboratory method detection limit.
>	Indicates parameter detected above equipment analytical range.
--	Chemical not analyzed or criteria not defined.
Value	Parameter is greater than PWQO
(1)	Provincial Water Quality Objectives (July 1994, reprinted February 1999)
(2)	Alkalinity should not be decreased by more than 25% of the natural concentration.
(3)	Current scientific evidence is insufficient to develop a firm Objective at this time. Accordingly, the following phosphorus concentrations should be considered as general guidelines which should be supplemented by site-specific studies: To avoid nuisance concentrations of algae in lakes, average total phosphorus concentrations for the ice-free period should not exceed 20 ug/L; A high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 10 ug/L or less. This should apply to all lakes naturally below this value; Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 30 ug/L.
(4)	(1) General: The natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed. (2) Waste Heat Discharge: (a) Ambient Temperature Changes: The temperature at the edge of a mixing zone shall not exceed the natural ambient water temperature at a representative control location by more than 10°C (18°F). However, in special circumstances, local conditions may require a significantly lower temperature difference than 10°C (18°F). Potential dischargers are to apply to the MOEE for guidance as to the allowable temperature rise for each thermal discharge. This ministry will also specify the nature of the mixing zone and the procedure for the establishment of a representative control location for temperature recording on a case-by-case basis. (b) Discharge Temperature Permitted: The maximum temperature of the receiving body of water, at any point in the thermal plume outside a mixing zone, shall not exceed 30°C (86°F) or the temperature of a representative control location plus 10°C (18°F) or the allowed temperature difference, which ever is the lesser temperature. These maximum temperatures are to be measured on a mean daily basis from continuous records. (c) Taking and Discharging of Cooling Water: Users of cooling water shall meet both the Objectives for temperature outlined above and the "Procedures for the Taking and Discharge of Cooling Water" as outlined in the MOEE publication Deriving Receiving-Water Based, Point-Source Effluent Requirements for Ontario Waters(1994).
(5)	Suspended matter should not be added to surface water in concentrations that will change the natural Secchi disc reading by more than 10 percent.
(9)	At pH 4.5 to 5.5 the Interim PWQO is 15 µg/L based on inorganic monomeric aluminum measure in clay-free samples; At pH > 5.5 to 6.5, no condition should be permitted which would increase the acid soluble inorganic aluminum concentration in clay-free samples to more than 10% above natural background concentrations for waters representative of that geological area of the Province that are unaffected by man-made inputs. At pH > 6.5 to 9.0, the Interim PWQO is 75 µg/L based on total aluminum measured in clay-free samples. If natural background aluminum concentrations in water bodies unaffected by man-made inputs are greater than the numerical Interim PWQO (above), no condition is permitted that would increase the aluminum concentration in clay-free samples by more than 10% of the natural background level. Note: pH values of < 6.5 and > 8.5 are outside the range considered acceptable by the PWQO for pH. See the Scientific Criteria Document for Development of Provincial Water Quality Objectives and Guidelines - Aluminum for a discussion of analytical procedures.
(10)	See Section 1.2.3. of PWQO. This Interim PWQO was set for emergency purposes based on the best information readily available. Employ due caution when applying this value.
(11)	An Interim PWQO also exists for this parameter. See Section 1.10 of the PWQO - Where both a PWQO and an Interim PWQO exist.
(12)	PWQO values exist for Cr(III) and Cr(VI)
(13)	If alkalinity as CaCO3 < 20 mg/L, PWQO = 5 µg/L; if alkalinity as CaCO3 from 20 to 40 mg/L, PWQO = 10 µg/L; if alkalinity as CaCO3 from 40 to 80 mg/L, PWQO = 20 µg/L; if alkalinity as CaCO3 > 80 mg/L, PWQO = 25 ug/L. An Interim PWQO also exists for this parameter. See Section 1.10 of the PWQO - Where both a PWQO and an Interim PWQO exist.
(14)	Oil or petrochemicals should not be present in concentrations that can be detected as a visible film,sheen,or discolouration or the surface; or can be detected by odour;or can cause tainting of edible aquatic organisms; or can form deposits on shorelines.

Your Project #: 20412072A
Site Location: STORYLAND
Your C.O.C. #: 877797-01-01

Attention: Dale Holtze
Golder Associates Ltd
1931 Robertson Rd
Ottawa, ON
CANADA K2H 5B7

Report Date: 2022/05/17
Report #: R7127994
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2C4904
Received: 2022/05/09, 14:13

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Dissolved Aluminum (0.2 u, clay free) (1)	1	N/A	2022/05/12	CAM SOP-00447	EPA 6020B m
Alkalinity (1)	1	N/A	2022/05/12	CAM SOP-00448	SM 23 2320 B m
Chloride by Automated Colourimetry (1)	1	N/A	2022/05/11	CAM SOP-00463	SM 23 4500-Cl E m
Dissolved Organic Carbon (DOC) (1, 2)	1	N/A	2022/05/12	CAM SOP-00446	SM 23 5310 B m
Hardness (calculated as CaCO3) (1)	1	N/A	2022/05/12	CAM SOP 00102/00408/00447	SM 2340 B
Total Metals Analysis by ICPMS (1)	1	N/A	2022/05/13	CAM SOP-00447	EPA 6020B m
Total Ammonia-N (1)	1	N/A	2022/05/14	CAM SOP-00441	USGS I-2522-90 m
Nitrate & Nitrite as Nitrogen in Water (1, 3)	1	N/A	2022/05/11	CAM SOP-00440	SM 23 4500-NO3I/NO2B
Animal and Vegetable Oil and Grease (1)	1	N/A	2022/05/16	CAM SOP-00326	EPA1664B m,SM5520B m
Total Oil and Grease (1)	1	2022/05/15	2022/05/16	CAM SOP-00326	EPA1664B m,SM5520B m
Sulphate by Automated Colourimetry (1)	1	N/A	2022/05/12	CAM SOP-00464	EPA 375.4 m
Total Dissolved Solids (1)	1	2022/05/12	2022/05/13	CAM SOP-00428	SM 23 2540C m
Total Kjeldahl Nitrogen in Water (1)	1	2022/05/12	2022/05/13	CAM SOP-00938	OMOE E3516 m
Total Phosphorus (Colourimetric) (1)	1	2022/05/13	2022/05/13	CAM SOP-00407	SM 23 4500 P B H m
Mineral/Synthetic O & G (TPH Heavy Oil) (1, 4)	1	2022/05/15	2022/05/16	CAM SOP-00326	EPA1664B m,SM5520F m
Total Suspended Solids (1)	1	2022/05/12	2022/05/13	CAM SOP-00428	SM 23 2540D m
Turbidity (1)	1	N/A	2022/05/10	CAM SOP-00417	SM 23 2130 B m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCC, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Your Project #: 20412072A
Site Location: STORYLAND
Your C.O.C. #: 877797-01-01

Attention: Dale Holtze

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CANADA K2H 5B7

Report Date: 2022/05/17
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Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2C4904
Received: 2022/05/09, 14:13

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Bureau Veritas Mississauga, 6740 Campobello Rd , Mississauga, ON, L5N 2L8
(2) Dissolved Organic Carbon (DOC) present in the sample should be considered as non-purgeable DOC.
(3) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.
(4) Note: TPH (Heavy Oil) is equivalent to Mineral / Synthetic Oil & Grease

Encryption Key Katherine Szozda

Katherine Szozda
Project Manager
17 May 2022 10:09:47

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Katherine Szozda, Project Manager
Email: Katherine.Szozda@bureauveritas.com
Phone# (613)274-0573 Ext:7063633
==
Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports.
For Service Group specific validation please refer to the Validation Signature Page.

OIL & GREASE - A/V/M/T (WATER)

Bureau Veritas ID		SOQ009		
Sampling Date		2022/05/07 12:00		
COC Number		877797-01-01		
	UNITS	**SW-1**	**RDL**	**QC Batch**
Calculated Parameters				
Total Animal/Vegetable Oil and Grease	mg/L	1.0	0.50	7986012
Petroleum Hydrocarbons				
Total Oil & Grease	mg/L	1.0	0.50	7996427
Total Oil & Grease Mineral/Synthetic	mg/L	<0.50	0.50	7996433

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

RESULTS OF ANALYSES OF WATER

Bureau Veritas ID		SOQ009			SOQ009		
Sampling Date		2022/05/07 12:00			2022/05/07 12:00		
COC Number		877797-01-01			877797-01-01		
	UNITS	**SW-1**	**RDL**	**QC Batch**	**SW-1 Lab-Dup**	**RDL**	**QC Batch**
Calculated Parameters							
Hardness (CaCO3)	mg/L	91	1.0	7986011			
Inorganics							
Total Ammonia-N	mg/L	0.061	0.050	7992562	<0.050	0.050	7992562
Total Dissolved Solids	mg/L	70	10	7991889	60	10	7991889
Total Kjeldahl Nitrogen (TKN)	mg/L	1.8	0.10	7992056			
Dissolved Organic Carbon	mg/L	7.6	0.40	7989418			
Total Phosphorus	mg/L	0.018	0.004	7993765			
Total Suspended Solids	mg/L	<10	10	7991827			
Dissolved Sulphate (SO4)	mg/L	<1.0	1.0	7987638			
Turbidity	NTU	0.7	0.1	7986847			
Alkalinity (Total as CaCO3)	mg/L	95	1.0	7987517			
Dissolved Chloride (Cl-)	mg/L	2.9	1.0	7987637			
Nitrite (N)	mg/L	<0.010	0.010	7987644			
Nitrate (N)	mg/L	<0.10	0.10	7987644			
Nitrate + Nitrite (N)	mg/L	<0.10	0.10	7987644			

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Bureau Veritas ID		SOQ009			SOQ009		
Sampling Date		2022/05/07 12:00			2022/05/07 12:00		
COC Number		877797-01-01			877797-01-01		
	UNITS	**SW-1**	**RDL**	**QC Batch**	**SW-1 Lab-Dup**	**RDL**	**QC Batch**
Metals							
Dissolved (0.2u) Aluminum (Al)	ug/L	5	5	7988893	<5	5	7988893
Total Barium (Ba)	ug/L	38	2.0	7993743			
Total Boron (B)	ug/L	<10	10	7993743			
Total Calcium (Ca)	ug/L	34000	200	7993743			
Total Chromium (Cr)	ug/L	<5.0	5.0	7993743			
Total Cobalt (Co)	ug/L	<0.50	0.50	7993743			
Total Copper (Cu)	ug/L	<0.90	0.90	7993743			
Total Iron (Fe)	ug/L	<100	100	7993743			
Total Magnesium (Mg)	ug/L	5600	50	7993743			
Total Manganese (Mn)	ug/L	9.2	2.0	7993743			
Total Molybdenum (Mo)	ug/L	<0.50	0.50	7993743			
Total Nickel (Ni)	ug/L	<1.0	1.0	7993743			
Total Potassium (K)	ug/L	920	200	7993743			
Total Silicon (Si)	ug/L	550	50	7993743			
Total Sodium (Na)	ug/L	2700	100	7993743			
Total Strontium (Sr)	ug/L	61	1.0	7993743			
Total Thallium (Tl)	ug/L	<0.050	0.050	7993743			
Total Vanadium (V)	ug/L	<0.50	0.50	7993743			
Total Zinc (Zn)	ug/L	<5.0	5.0	7993743			

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

TEST SUMMARY

Bureau Veritas ID: SOQ009
Sample ID: SW-1
Matrix: Water

Collected: 2022/05/07
Shipped:
Received: 2022/05/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	7988893	N/A	2022/05/12	Nan Raykha
Alkalinity	AT	7987517	N/A	2022/05/12	Yogesh Patel
Chloride by Automated Colourimetry	KONE	7987637	N/A	2022/05/11	Alina Dobreanu
Dissolved Organic Carbon (DOC)	TOCV/NDIR	7989418	N/A	2022/05/12	Anna-Kay Gooden
Hardness (calculated as CaCO3)		7986011	N/A	2022/05/12	Automated Statchk
Total Metals Analysis by ICPMS	ICP/MS	7993743	N/A	2022/05/13	Prempal Bhatti
Total Ammonia-N	LACH/NH4	7992562	N/A	2022/05/14	Amanpreet Sappal
Nitrate & Nitrite as Nitrogen in Water	LACH	7987644	N/A	2022/05/11	Samuel Law
Animal and Vegetable Oil and Grease	BAL	7986012	N/A	2022/05/16	Automated Statchk
Total Oil and Grease	BAL	7996427	2022/05/15	2022/05/16	Mitul Patel
Sulphate by Automated Colourimetry	KONE	7987638	N/A	2022/05/12	Chandra Nandlal
Total Dissolved Solids	BAL	7991889	2022/05/12	2022/05/13	Kristen Chan
Total Kjeldahl Nitrogen in Water	SKAL	7992056	2022/05/12	2022/05/13	Massarat Jan
Total Phosphorus (Colourimetric)	LACH/P	7993765	2022/05/13	2022/05/13	Shivani Shivani
Mineral/Synthetic O & G (TPH Heavy Oil)	BAL	7996433	2022/05/15	2022/05/16	Mitul Patel
Total Suspended Solids	BAL	7991827	2022/05/12	2022/05/13	Shaneil Hall
Turbidity	AT	7986847	N/A	2022/05/10	Roya Fathitil

Bureau Veritas ID: SOQ009 Dup
Sample ID: SW-1
Matrix: Water

Collected: 2022/05/07
Shipped:
Received: 2022/05/09

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Dissolved Aluminum (0.2 u, clay free)	ICP/MS	7988893	N/A	2022/05/12	Nan Raykha
Total Ammonia-N	LACH/NH4	7992562	N/A	2022/05/14	Amanpreet Sappal
Total Dissolved Solids	BAL	7991889	2022/05/12	2022/05/13	Kristen Chan

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	1.3°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
7986847	Turbidity	2022/05/10			94	85 - 115	<0.1	NTU	4.0	20		
7987517	Alkalinity (Total as CaCO3)	2022/05/12			93	85 - 115	<1.0	mg/L	0.15	20		
7987637	Dissolved Chloride (Cl-)	2022/05/11	NC	80 - 120	105	80 - 120	<1.0	mg/L	0.24	20		
7987638	Dissolved Sulphate (SO4)	2022/05/12	NC	75 - 125	105	80 - 120	<1.0	mg/L	0.16	20		
7987644	Nitrate (N)	2022/05/11	99	80 - 120	98	80 - 120	<0.10	mg/L	0.91	20		
7987644	Nitrite (N)	2022/05/11	101	80 - 120	106	80 - 120	<0.010	mg/L	NC	20		
7988893	Dissolved (0.2u) Aluminum (Al)	2022/05/12	97	80 - 120	99	80 - 120	<5	ug/L	1.5	20		
7989418	Dissolved Organic Carbon	2022/05/12	98	80 - 120	96	80 - 120	<0.40	mg/L	1.2	20		
7991827	Total Suspended Solids	2022/05/13					<10	mg/L	NC	25	95	85 - 115
7991889	Total Dissolved Solids	2022/05/13					<10	mg/L	15	25	97	90 - 110
7992056	Total Kjeldahl Nitrogen (TKN)	2022/05/13	87	80 - 120	101	80 - 120	<0.10	mg/L	NC (1)	20	98	80 - 120
7992562	Total Ammonia-N	2022/05/14	94	75 - 125	98	80 - 120	<0.050	mg/L	19	20		
7993743	Total Barium (Ba)	2022/05/13	97	80 - 120	95	80 - 120	<2.0	ug/L	4.7	20		
7993743	Total Boron (B)	2022/05/13	95	80 - 120	90	80 - 120	<10	ug/L	2.8	20		
7993743	Total Calcium (Ca)	2022/05/13	NC	80 - 120	96	80 - 120	<200	ug/L	0.040	20		
7993743	Total Chromium (Cr)	2022/05/13	96	80 - 120	94	80 - 120	<5.0	ug/L	NC	20		
7993743	Total Cobalt (Co)	2022/05/13	98	80 - 120	96	80 - 120	<0.50	ug/L	NC	20		
7993743	Total Copper (Cu)	2022/05/13	96	80 - 120	93	80 - 120	<0.90	ug/L	NC	20		
7993743	Total Iron (Fe)	2022/05/13	101	80 - 120	99	80 - 120	<100	ug/L	3.7	20		
7993743	Total Magnesium (Mg)	2022/05/13	100	80 - 120	99	80 - 120	<50	ug/L	1.4	20		
7993743	Total Manganese (Mn)	2022/05/13	100	80 - 120	98	80 - 120	<2.0	ug/L	1.5	20		
7993743	Total Molybdenum (Mo)	2022/05/13	101	80 - 120	96	80 - 120	<0.50	ug/L	0.83	20		
7993743	Total Nickel (Ni)	2022/05/13	99	80 - 120	96	80 - 120	<1.0	ug/L	3.5	20		
7993743	Total Potassium (K)	2022/05/13	101	80 - 120	97	80 - 120	<200	ug/L	1.4	20		
7993743	Total Silicon (Si)	2022/05/13	99	80 - 120	94	80 - 120	<50	ug/L	0.22	20		
7993743	Total Sodium (Na)	2022/05/13	NC	80 - 120	98	80 - 120	<100	ug/L	1.4	20		
7993743	Total Strontium (Sr)	2022/05/13	103	80 - 120	98	80 - 120	<1.0	ug/L	0.15	20		
7993743	Total Thallium (Tl)	2022/05/13	99	80 - 120	97	80 - 120	<0.050	ug/L	NC	20		
7993743	Total Vanadium (V)	2022/05/13	101	80 - 120	96	80 - 120	<0.50	ug/L	NC	20		
7993743	Total Zinc (Zn)	2022/05/13	101	80 - 120	102	80 - 120	<5.0	ug/L	NC	20		
7993765	Total Phosphorus	2022/05/13	136 (2)	80 - 120	101	80 - 120	<0.004	mg/L	12	20	93	80 - 120
7996427	Total Oil & Grease	2022/05/16			99	85 - 115	<0.50	mg/L	0.76	25		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
7996433	Total Oil & Grease Mineral/Synthetic	2022/05/16			96	85 - 115	<0.50	mg/L	1.0	25		

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

(1) Due to a high concentration of NOx, the sample required dilution. The detection limit was adjusted accordingly.

(2) Recovery or RPD for this parameter is outside·control limits. The overall quality control for this analysis meets acceptability criteria.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Cristina Carriere

Cristina Carriere, Senior Scientific Specialist

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Bureau Veritas
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Page 1 of 1

09-May-22 14:13
Katherine Szozda
C2C4904
ENV-803
C#877797-01-01

ly:
Bottle Order #:
877797
Project Manager:
Katherine Szozda

INVOICE TO:

Company Name: #14090 Golder Associates Ltd
Attention: Central Accounting
Address: 1931 Robertson Rd
Ottawa ON K2H 5B7
Tel: (613) 592-9600 Fax: (613) 592-9601
Email: gld.CanadaAccountsPayableInvoices@wsp.com

REPORT TO:

Company Name:
Attention: Dale Holtze
Address:
Tel: Fax:
Email: Dale_Holtze@golder.com

PROJECT INFORMATION:

Quotation #: C22487
P.O. #:
Project: 20412072A
Project Name: Stapyland
Site #:
Sampled By: C Albert

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ For RSC
☐ Table ____

Other Regulations
☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ____
☒ PWQO ☐ Reg 406 Table ____
☐ Other ____

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)?

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	gen chem / metals	oil & grease									# of Bottles	Comments
1		S4-1	May 7/22 10pm	12pm	SW	No	X	X									7	
2																		
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details

Job Specific Rush TAT (if applies to entire submission)
Date Required: ____ Time Required: ____ ☐
Rush Confirmation Number: ____ (call lab for #)

RECEIVED IN OTTAWA

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
C Albert	May 7/22	12pm	Angelica Santiago	22/05/09	14:13	
C Albert	May 9/22	10am	VI TRINH	2022/05/	0810	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	0,3,1 ice	Present		
		Intact		/

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVNA.COM/RESOURCES/CHAIN-OF-CUSTODY-FORMS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

White: Bureau Veritas Yellow: Client

4/4

APPENDIX G

Water Balance

Table G-1
Meteorological Data

WATER HOLDING CAPACITY...100 MM

Ottawa IntlAWATERBUDGETMEANSFORTHEPERIOD1939-2019DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...100 MM HEAT INDEX... 36.68
LONG... 75.67 LOWER ZONE.............. 60 MM A............ 1.079

DATE		TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31	1	-10.7	62	11	14	0	0	0	24	84	98	295
28	2	-9	56	11	16	1	1	0	26	113	98	350
31	3	-2.9	65	31	77	5	5	0	101	70	100	416
30	4	5.7	73	68	75	31	31	0	112	0	100	490
31	5	13.1	76	76	0	80	80	0	14	0	81	566
30	6	18.3	85	85	0	116	112	-4	5	0	49	651
31	7	20.9	88	88	0	136	114	-22	3	0	20	739
31	8	19.6	84	84	0	118	87	-31	1	0	16	823
30	9	14.8	82	82	0	75	65	-10	3	0	30	905
31	10	8.3	77	77	0	37	36	-1	9	0	63	77
30	11	1.2	76	59	8	10	10	0	31	9	89	154
31	12	-6.9	79	26	14	1	1	0	32	48	97	233
AVE		6	904	698	204	610	542	-68	361			

WATER HOLDING CAPACITY...150 MM

Ottawa IntlAWATERBUDGETMEANSFORTHEPERIOD1939-2019DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...150 MM HEAT INDEX... 36.68
LONG... 75.67 LOWER ZONE.............. 90 MM A............ 1.079

DATE		TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31	1	-10.7	62	11	14	0	0	0	21	84	142	295
28	2	-9	56	11	16	1	1	0	24	113	144	350
31	3	-2.9	65	31	77	5	5	0	98	70	149	416
30	4	5.7	73	68	75	31	31	0	111	0	150	490
31	5	13.1	76	76	0	80	80	0	14	0	131	566
30	6	18.3	85	85	0	116	116	0	5	0	96	651
31	7	20.9	88	88	0	136	127	-9	3	0	54	739
31	8	19.6	84	84	0	118	98	-20	1	0	39	823
30	9	14.8	82	82	0	75	67	-8	2	0	52	905
31	10	8.3	77	77	0	37	36	-1	7	0	86	77
30	11	1.2	76	59	8	10	10	0	20	9	123	154
31	12	-6.9	79	26	14	1	1	0	24	48	139	233
AVE		6	904	698	204	610	572	-38	330			

WATER HOLDING CAPACITY...250 MM

Ottawa IntlAWATERBUDGETMEANSFORTHEPERIOD1939-2019DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...250 MM HEAT INDEX... 36.68
LONG... 75.67 LOWER ZONE.............. 150 MM A........... 1.079

DATE		TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31	1	-10.7	62	11	14	0	0	0	17	84	230	295
28	2	-9	56	11	16	1	1	0	21	113	235	350
31	3	-2.9	65	31	77	5	5	0	91	70	247	416
30	4	5.7	73	68	75	31	31	0	109	0	250	490
31	5	13.1	76	76	0	80	80	0	14	0	231	566
30	6	18.3	85	85	0	116	116	0	5	0	196	651
31	7	20.9	88	88	0	136	135	-1	3	0	146	739
31	8	19.6	84	84	0	118	111	-7	1	0	118	823
30	9	14.8	82	82	0	75	72	-4	2	0	127	905
31	10	8.3	77	77	0	37	37	0	6	0	161	77
30	11	1.2	76	59	8	10	10	0	16	9	202	154
31	12	-6.9	79	26	14	1	1	0	18	48	224	233
AVE		6	904	698	204	610	599	-12	303			

WATER HOLDING CAPACITY...300 MM

Ottawa IntlAWATERBUDGETMEANSFORTHEPERIOD1939-2019DC20492

LAT.... 45.32 WATER HOLDING CAPACITY...300 MM HEAT INDEX... 36.68
LONG... 75.67 LOWER ZONE.............. 180 MM A........... 1.079

DATE		TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31	1	-10.7	62	11	14	0	0	0	16	84	276	295
28	2	-9	56	11	16	1	1	0	20	113	282	350
31	3	-2.9	65	31	77	5	5	0	89	70	296	416
30	4	5.7	73	68	75	31	31	0	108	0	300	490
31	5	13.1	76	76	0	80	80	0	14	0	281	566
30	6	18.3	85	85	0	116	116	0	5	0	246	651
31	7	20.9	88	88	0	136	136	0	3	0	195	739
31	8	19.6	84	84	0	118	114	-4	1	0	164	823
30	9	14.8	82	82	0	75	73	-3	2	0	171	905
31	10	8.3	77	77	0	37	37	0	6	0	205	77
30	11	1.2	76	59	8	10	10	0	16	9	247	154
31	12	-6.9	79	26	14	1	1	0	17	48	269	233
AVE		6	904	698	204	610	604	-7	297			

Prepared by: MLE
Checked by: KMM

Table G-2
Water Balance Summary

Existing Conditions - Estimated Annual Average Water Balance

Land Use	Area	Precipitation		ET		Surplus		Infiltration		Runoff	
	(m^2)	(mm/a)	Volume (m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)
Dry – Fresh Sugar Maple – White Pine Mixed / Mixed Hedgerow Forest	131,534	903	118775	600	78920	303	39854.71	212	27898.3	90.9	11956.41
Dry – Fresh Sugar Maple - Hardwood Deciduous Forest / Mixed Hedgerow	10,427	903	9415	604	6300	297	3096.74	193	2012.88	104	1083.86
Cultivated /Tree Stand	434,882	903	392700	542	235710	361	156992.4	217	94195.44	144	62796.96
Cultivated /Tree Stand	56,370	903	50900	572	32,240	330	18602.14	182	10231.18	149	8370.96
Cultivated /Tree Stand	20,015	903	18075	599	11990	303	6064.57	121	2425.83	181.8	3638.74
Mixed Willow Deciduous Thicket Swamp	41,826	903	37770	610	25510	293	12254.91	0	0	293	12254.91
TOTAL	695,053	903	627,635	562	390,670	341	236,865	197	136,760	144	100,100

Operational Conditions - Estimated Average Annual Water Balance

Land use	Area	Precipitation		Evapotranspiration		Surplus		Infiltration		Runoff	
	(m^2)	(mm/a)	Volume (m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)
Dry – Fresh Sugar Maple – White Pine Mixed / Mixed Hedgerow Forest	10,558	903	9,535	600	6,330	303	3,199	212	2,239	91	960
Dry – Fresh Sugar Maple - Hardwood Deciduous Forest / Mixed Hedgerow	1,505	903	1,360	604	910	297	447	193	291	104	157
Cultivated /Tree Stand	41,712	903	37,665	542	22,610	361	15,058	217	9,035	144	6,023
Cultivated /Tree Stand	29,617	903	26,745	572	16,940	330	9,774	182	5,376	149	4,398
Cultivated /Tree Stand	11,275	903	10,180	599	6,750	303	3,416	121	1,366	182	2,050
Mixed Willow Deciduous Thicket Swamp	41,826	903	37,770	610	25,510	293	12,255	0	0	293	12,255
Below Water Extraction Area	558,561	903	504,380	610	340,720	293	163,658	293	163,658	0	0
TOTAL	695,053	903	627,635	604	419,770	299	207,810	262	181,965	37	25,845

Rehabilitated Conditions - Estimated Average Annual Water Balance

Land use	Area	Precipitation		Evapotranspiration		Surplus		Infiltration		Runoff	
	(m^2)	(mm/a)	Volume (m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)	(mm/a)	(m^3/a)
Dry – Fresh Sugar Maple – White Pine Mixed / Mixed Hedgerow Forest	10,558	903	9,535	600	6,330	303	3,199	212	2,239	91	960
Dry – Fresh Sugar Maple - Hardwood Deciduous Forest / Mixed Hedgerow	1,505	903	1,360	604	910	297	447	193	291	104	157
Cultivated /Tree Stand	41,712	903	37,665	542	22,610	361	15,058	217	9,035	144	6,023
Cultivated /Tree Stand	29,617	903	26,745	572	16,940	330	9,774	182	5,376	149	4,398
Cultivated /Tree Stand	11,275	903	10,180	599	6,750	303	3,416	121	1,366	182	2,050
Mixed Willow Deciduous Thicket Swamp	41,826	903	37,770	610	25,510	293	12,255	0	0	293	12,255
Rehabilitated Lake	442,616	903	399,680	610	270,000	293	129,686	293	129,686	0	0
Rehabilitated Wetland	33,595	903	30,335	610	20,490	293	9,843	293	9,843	0	0
Rehabilitated Grassland	59,307	903	53,555	572	33,920	330	19,571	330	19,571	0	0
Rehabilitated Reforestation/Nodal planting	23,044	903	20,810	599	13,800	303	6,982	303	6,982	0	0
TOTAL	695,053	903	627,635	600	417,260	302	210,235	265	184,390	37	25,845

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