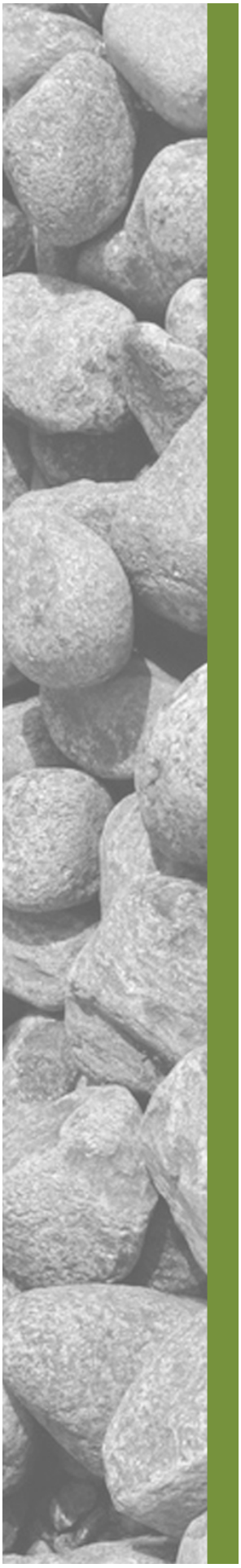
# Appendix A

## Hydrogeological Level Assessment

*Groundwater Science Corp.*



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# Hydrogeologic Assessment
# Proposed Macpherson Pit
# Part Lot 6, Concession 12
# Municipality of Central Elgin
# County of Elgin

**Prepared For:**

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# 1.0 INTRODUCTION

This report presents the results of a hydrogeologic assessment completed for the Talbot Sand and Gravel Limited proposed Macpherson Pit. The proposal is for a Class A Licence for below water extraction at the site. This hydrogeological assessment addresses the requirements of the recently updated *Aggregate resources of Ontario standards: A compilation of the four standards adopted by Ontario Regulation 244/97 under the Aggregate Resources Act* (MNRF, August 2020).

The proposed pit is located within Part Lot 6, Concession 12, Municipality of Central Elgin, County of Elgin, Ontario. The Macpherson Pit is adjacent to, and would be operated as an eastward extension of, the existing Talbot Sand and Gravel Limited licenced below water table pit (Licence # 2134). The existing pit is located at 43317 Truman Line, approximately 3.5 kilometers (km) north of St. Thomas, Ontario.

This assessment and report was completed in support of the application on behalf of the applicant, Talbot Sand and Gravel Limited.

## 1.1 BACKGROUND

The proposed pit location is shown on **Figure 1**. The property has an irregular shape, and consists of agricultural field or vacant land to the east and south of the existing pit, excluding the existing residence area and woodlot at the south east corner of the property.

Surrounding lands are primarily agricultural, with some rural residential use. A portion of the Glanworth Wetland (swamp) Complex (PSW) occurred at the northwest edge of the existing licence. This wetland complex extends to the northwest from the area of the existing licence. An unnamed tributary of Kettle Creek (Upper Kettle Creek catchment) occurs west of the site, draining generally south from the wetland complex.

## 1.2 SCOPE

The Aggregate Resource Act (ARA) Licence proposal for the site includes above and below water extraction.

### 1.2.1 Summary of Provincial Standards

This study utilizes the current ARA related groundwater reporting standards (*Aggregate Resources of Ontario: Technical reports and information standards*, MNRF, August 2020) for a Class A Pit proposing to excavate below the maximum predicted water table.

The standards include the following water table assessment:

> *2.1 Maximum predicted water table report*
>
> *A report must be prepared that details how the maximum predicted water table is identified in metres above sea level, relative to the proposed depth of excavation at the site.*
>
> *The maximum predicted water table shall be determined by monitoring the ground water table at the site for a minimum of one (1) year to account for seasonal variations and influences due to precipitation, unless alternative information already exists (e.g. previous hydrogeological study, existing well*

*data) to support a determination of the maximum predicted water table by a qualified person.*

*An alternative method may be used for sites determining the maximum water table in Precambrian rocks of the Canadian Shield where it is difficult to determine the elevation of the water table. In such cases, the maximum predicted water table may be assumed at an elevation (metres above sea level) that is a minimum of 2.5 metres below the deepest sump or pond on the site, provided a qualified person develops and oversees a drilling and monitoring program to determine if the ground water table would be intercepted at the assumed maximum predicted water table.*

*The number of drill holes and seasonal monitoring frequency shall be determined by a qualified person based on site conditions.*

The standards also include the following site groundwater characterization and impact assessments:

*2.5. Water report*

*Excavation at a pit proposed above the water table may not occur within 1.5 metres above the maximum predicted water table. Excavation at a quarry proposed above the water table may not occur within 2 metres above the maximum predicted water table.*

*Applications proposing to excavate below the maximum predicted water table must complete the following:*

*Water report level 1:*

*Determine the potential for impacts to ground water and surface water resources and their uses (e.g. water wells, ground water aquifers, surface water courses and bodies, springs, discharge areas) and identify if the proposed site is in a Wellhead Protection Area for Quantity (WHPA-Q) set out in an applicable source water protection plan under the Clean Water Act. If so, identify applicable source water protection policies and mitigation measures that will be implemented at the site.*

*Water report level 2:*

*Where the results of Level 1 have identified a potential for impacts from the aggregate site on ground water and/or surface water resources and their uses, an impact assessment is required. The assessment is to determine the significance of the effect and the potential for mitigation.*

*The assessment must address the potential effects of the operation on any ground water and surface water features located within the zone of influence, including but not limited to:*

*a) water wells (includes all types e.g. municipal, private, industrial, commercial, geothermal and agricultural)*

*b) springs (e.g., place where ground water flows out of the ground)*

*c) ground water aquifers;*

*d) surface water courses and bodies (e.g., lakes, rivers, brooks)*

*e) wetlands*

*The assessment must include but not be limited to the following:*

*f) a description of the physical setting including local geology, hydrogeology, and surface water systems;*

*g) proposed water diversion, discharge, storage and drainage facilities;*

*h) water budget (e.g. how water is managed on-site);*

*i) the possible positive or negative impacts that the proposed site may have on the water regime;*

*The Level 2 water report must also contain:*

*j) monitoring plan(s); and*

*k) technical support data in the form of tables, graphs and figures, usually appended to the report.*

The "maximum predicted water table report" provides an assessment of the water table elevation at the site relative to the proposed extraction. The Level 1 report examines the site relative to identified Source Protection Study groundwater quantity protection areas (WHPA-Q) to address quantity protection policies. In addition, the Level 1 report examines the extraction plan relative to the identified water table conditions and provides a general discussion of potential for impact in order to determine the need for a Level 2 report and "scope" the issues to be examined.

The Level 2 report provides a detailed groundwater characterization, examines the type and scale of any potential extraction related impacts, and, based on that assessment identifies any potential for adverse effects on groundwater and surface water resources (and their uses). The need for monitoring and/or mitigation is also assessed. If necessary, the Level 2 report also provides recommendations regarding monitoring and/or mitigation.

The Level 1 and Level 2 hydrogeological reports are typically referenced by the Natural Environment Report (NER), which is also required as part of the ARA application.

### 1.2.2 Impact Assessment Approach

As part of the licensing process for the site some County of Elgin or Municipality of Central Elgin planning applications are also expected.

A Hydrogeological Study (HS) and/or Environmental Impact Study (EIS) related to groundwater and natural environment feature protection can be required as part of the planning application process. The municipal EIS reporting requirements are typically addressed by the NER prepared as part of the ARA application.

This report follows a typical HS and EIS approach, which is identified as follows:

- an outline of the study methodology
- a description of the topographic setting, local surface water drainage and natural environment features (including springs, wetlands, etc.);

- a description of reported local water well locations;
- a description of the geologic and hydrogeologic setting (including aquifers, groundwater/surface water interaction, water budget, etc.);
- a description of the proposed extraction;
- an examination of the potential impact of the proposed extraction (impact assessment);
- an assessment of measures that may be needed to mitigate impacts and ensure environmental feature protection; and,
- conclusions and recommendations.

This study provides the planning related HS, and will be referenced by the associated NER/EIS prepared for the proposed Macpherson pit.

# 2.0 METHODOLOGY

This assessment included a background information review to characterize the site setting, detailed site-specific fieldwork to characterize local conditions and the use of specific analysis methods for the water budget and impact assessment.

Standard hydrogeologic field and analysis methods are used for this study. The specific methodologies used for each step of the characterization and analysis are outlined in the respective Sections of this report.

## 2.1 INFORMATION REVIEW

As part of this study the following information sources were used:

1) Harrington McAvan Ltd.; *Talbot Sand And Gravel Limited Macpherson Pit Site Plans.*
2) Terrastory Environmental Consulting Inc. (Terrastory); April 2022: *Natural Environment Report, Aggregate Resources Act Application, Macpherson Pit, Municipality of Central Elgin.*
3) Atkinson Davies Inc.; September 16, 1994: *Report on Geotechnical Investigation to Assess Commercial Aggregate Supply, Donald Ferguson Estate, North Half of Lot 6, Concession 12, Township of Yarmouth.*
4) Kettle Creek Conservation Authority (KCCA): *Kettle Creek Watershed 2018 Report Card*.
5) Lake Erie Region Source Protection Committee; May 15, 2014 (amended January 25, 2022); *Kettle Creek Source Protection Area Approved Assessment Report.*
6) Lake Erie Source Protection Region; online *Policy Mapping Tool*, available at: https://maps.grandriver.ca/swp-policymapping/.
7) Ministry of the Environment Conservation and Parks (MECP) water well records.
8) MECP Source Protection Information Atlas, available at: https://www.ontario.ca/page/source-protection.
9) Ministry of Agriculture, Food and Rural Affairs; *AgMaps* application, available at: http://www.omafra.gov.on.ca/english/landuse/gis/portal.htm.
10) Ontario Geological Survey OGSEarth published geological mapping (KML files viewed on Google Earth); available online at: http://www.mndm.gov.on.ca/en/mines-and-minerals/applications/ogsearth
11) Ontario Base Map (OBM) 1:10,000 series topographic mapping.

Additional general references used are noted in the text of this report.

# 3.0 BACKGROUND REVIEW

The local site setting is shown in **Figure 2**. We note that extraction at the existing licenced pit has created a large depression, and some limited below water extraction has occurred. The proposed extraction would extend east and south of the existing pit.

## 3.1 SITE TOPOGRAPHY AND DRAINAGE

Please refer to the Site Plan for specific topographic information at the property. Local topography is shown on **Figure 3**. Topographic information provided below is based on the Site Plan elevations.

The proposed new extraction area, consisting of agricultural field, is gently sloped from an elevation of approximately 258 metres above sea level (mASL) at Truman Line to approximately 252 mASL near the southwest corner of the site. A disturbed portion of the proposed licence along the edge of the existing pit includes some berm features (raised above the surrounding landscape) and slopes that extend into the extracted area.

The lowest portion of the existing pit floor is approximately 242.7 mASL. The extraction has created an enclosed drainage area that captures and infiltrates runoff. Based on the existing topography, most runoff that may be generated within the proposed new extraction area would move generally south, entering the southwest woodlot or adjacent farm fields. However, as discussed later in this report, actual runoff volumes at the site are expected to be limited due to soils, slope and farming practices.

There are no surface water courses or drainage features within the proposed licence.

An unnamed drainage channel occurs approximately 120 m west of the proposed licence. This feature appears to be channelized or partly constructed and used as an agricultural drain in this area. Information available through the OMAFRA AgMaps application indicates agricultural fields in the area of the site are systematically drained and likely outlet to the unnamed channel. The closest reach of this channel is at approximately 246.5 mASL. This feature is discussed further in **Section 3.2** of this report.

The site is located within the Upper Kettle Creek catchment (KCCA). However, the main channel of Kettle Creek is over 2 km southeast of the site.

## 3.2 NATURAL ENVIRONMENT FEATURES

There are no groundwater related natural environment features reported within the proposed licence.

The edge of the Glanworth Wetland (swamp) Complex (PSW) occurs just within 120 m of the site (**Figure 3**). The wetland also extends further to the northwest. Based on a review of the Site Plan topographic information the wetland floor closest to the site (south of Truman Line) varies from approximately 249.9 to 253 mASL. The wetland edge 120 m from the site is described as a deciduous swamp (Terrastory).

The unnamed drainage channel (west of the site, within 120 m) flows generally south from wetland areas located northwest of the site. Based on available topographic mapping, the channel elevation is approximately 250 to 250.5 mASL at Truman Line. One branch of the channel is mapped as draining two ponds and the wetland area (elevation approximately 250 to 250 mASL) immediately north of Truman Line and

northwest of the existing pit. A second branch of the channel is mapped as draining the wetland area south of Truman Line and adjacent to the existing pit. Near the site the channel appears to be an agricultural drain. The channel becomes more naturalized south of Ferguson Line, and joins Kettle Creek approx. 2.6 km south of site. No fish habitat was identified on-site or within 120 m of the site (Terrastory).

There are no other groundwater related natural environment features (springs, surface water courses or bodies, wetlands, etc) on-site or within 120 m of the site.

## 3.3 PRIVATE WATER WELLS AND LOCAL GROUNDWATER USE

MECP well records with reported locations in the general area of the site were examined as an initial assessment of local water supply. The reported water well locations, based on the well records, are shown on **Figure A1** and summarized in **Table A1** in **Appendix A**.

A total of 6 well records are reported within the study review area, which extends more than 500 m from the site within Lots 5 to 7, Concession 12 and 13. As part of the field assessment for this study a private water well survey was also completed, the results are summarized in **Section 4.5** of this report.

All 6 of the well records within the review area represent drilled overburden wells, completed generally at depth in sand or sand/gravel. All of the wells are reportedly used for domestic and occasionally stock (or crop spraying) purposes.

Three of the wells are completed in unconfined sands, drilled to depths between 11.6 and 24.1 m below ground surface (BGS). Reported static level in the unconfined wells varied from 8.5 to 14.9 mBGS. Three of the wells are completed in confined units (i.e. overlain by substantial clayey layers), drilled to depths between 14.9 and 29.6 mBGS. Reported confined well static level varied from 7.6 to 16.2 mBGS.

A brief review of deep wells in the wider area (>1km) indicated that shale bedrock was encountered at one well (WWR# 2003049) at a depth of 73.5 mBGS. The deeper wells report that the overburden sequence generally consists of layered (alternating) sand deposits and sand/clay deposits, extending to bedrock.

The well record information at and near the site generally confirms the geologic setting discussed in **Sections 3.4** and **3.5**, consisting of surficial sand and gravel, overlying an deep sequence of layered sand and clayey units that extend to bedrock.

## 3.4 QUATERNARY GEOLOGY

According to published Physiographic mapping, the proposed Macpherson Pit is located within an intermorainal till plain.

Surficial Geology mapping indicates the existing and proposed pits are located within a localized coarse-textured glaciolacustrine littoral and deltaic deposits of sand, gravel, minor silt and clay. The mapped deposit extends onto surrounding neighbouring properties, however is not shown to extend into the southeast corner of the site. The glaciolacustine deposits are set within a clay to silt textured till unit. Organic deposits of

peat, muck and marl are mapped within the wetland complex, and recent alluvium is mapped along the unnamed drainage channel.

Based on the setting, the till unit is expected to underlie the glaciofluvial, organic soils and alluvial deposits.

## 3.5 BEDROCK GEOLOGY

The underlying bedrock at the site is mapped as the Dundee Formation, consisting of limestone and minor dolostone and described as locally cherty.

## 3.6 PREVIOUS ASSESSMENTS

Thirteen boreholes (BH1 to BH13) were drilled within the proposed licence area in August and September 1994 as part of an aggregate resource assessment completed by Atkinson Davies Inc. The borehole locations are shown on **Figure 4**. The borehole logs are included in **Appendix B**. The drilling results are discussed in **Section 5** of this report.

## 3.7 SOURCE PROTECTION CONSIDERATIONS

Relevant Source Protection mapping was reviewed. The proposed Macpherson Pit is not within any identified Well Head Protection Area (WHPA) or Intake Protection Zone (IPZ). In addition, no WHPA-Q zone has been identified in this area. Source Protection considerations are also summarized in **Section 8**.

# 4.0 FIELD WORK

The on-site fieldwork completed for this assessment included site inspections; drilling and installing water table monitoring wells; installation of a drive-point piezometer; monitor elevation survey; hydraulic response testing; water level monitoring; and, a door to door private well survey.

## 4.1 MONITOR INSTALLATION AND SURVEY

As part of this study 6 boreholes were drilled in January 2021, one borehole was drilled in February 2022 and one additional borehole was drilled in May 2022. At 5 of the boreholes (BH1-21 to BH3-21, BH4-22 and BH5-22) soil sampling (only) occurred, these holes were then backfilled with bentonite. At the remaining 3 boreholes water table monitors (MW1 to MW3) were installed after soil sampling. The January 2021 and February 2022 drilling and monitoring well installations were completed by Aardvark Drilling Corp. The May 2022 drilling was completed by Marathon Underground Constructors Corporation. Monitoring construction includes nominal 2 inch (5.1 cm) diameter PVC wells with 10 ft (3 m) long well screens. Each well is equipped with a locking protective casing at surface.

In order to measure water table and surface water elevations within the existing pit, a drive-point piezometer (DP1) was installed at one of the extraction ponds in January 2021. The drive-point piezometer was installed by hand and consists of 0.3 m long nominal 3 cm (1.25 inch) diameter stainless steel manufactured screen (drive-point) and galvanized pipe riser.

The drilling and monitoring locations are shown on **Figure 4**. Borehole logs are included in **Appendix B**.

All of the monitoring locations were developed by pumping (using a Waterra® inertial pump) and until the discharge water was relatively clear and a consistent water level response was noted.

The monitoring locations were surveyed relative to a reported reference (spot) elevation of 257.59 mASL at the driveway near the existing residence as shown on the Site Plan. The surveyed elevations are summarized in **Table 1**.

| Monitor | Elevations (mASL) | | | |
|---|---|---|---|---|
| | Ground Surface | Top of Casing or Reference Point | Top of Well Screen | Bottom of Well |
| MW1 | 253.61 | 254.61 | 243.3 | 240.2 |
| MW2 | 253.69 | 254.60 | 242.6 | 239.6 |
| MW3 | 257.53 | 258.46 | 243.3 | 240.3 |
| DP1 | - | 242.77 | 241.0 | 240.7 |

**Table 1: Installation Details**

## 4.2 WATER LEVEL MONITORING

Routine monthly water level monitoring began in January 2021 and is ongoing. Water level measurements for the site are summarized in table and hydrograph format in **Appendix C**. Measurements were obtained by Groundwater Science Corp. as depth to water below top of well casing using a Heron Instruments® electronic water level tape and recorded in the field. Measurements are currently ongoing.

The seasonal water table has fluctuated by approximately 0.6 to 0.7 m since monitoring began, from low levels in September 2021 to high levels in May 2022. The observed seasonal water level fluctuation is considered within the typical range for this type of deposit in Southern Ontario.

The measured water table "high" to date occurred in May 2022, and ranged from 242.1 to 242.2 mASL across the site. The water table "low" occurred in September 2021, and ranged from 241.4 to 241.5 mASL.

The water table at the site has a very low slope, with and observed water level difference from MW1 to MW3 of only 2 to 14 cm over the 1 year monitoring period to date. We note that water levels at DP1 may be affected by surface water accumulation in the pit pond and infiltration on the pit floor.

## 4.4 RESPONSE TESTING

After the on-site monitors were developed, response tests were completed to estimate the hydraulic conductivity (K) of the sand unit. The tests were completed on January 21, 2021 as repeated rising head (slug) tests using dataloggers set to a 1 second sampling frequency and a slug of known volume. Tests were completed at MW2 and MW3. Tests were attempted at MW1 however the water level response was too rapid to obtain representative measurements.

The response data was analyzed according to the Bouwer and Rice method using the AQTESOLV computer analysis program. The total saturated aquifer thickness was assumed to be 11 m for the analysis. The test analysis plots are included in **Appendix D**. The response test analysis is summarized in **Table 2**.

| Monitor | Estimated Hydraulic Conductivity (m/s) | |
|---|---|---|
| | Rising Head Test #1 | Rising Head Test #2 |
| MW2 | $6.67 \times 10^{-5}$ | $8.03 \times 10^{-5}$ |
| MW3 | $8.83 \times 10^{-5}$ | $9.85 \times 10^{-5}$ |

**Table 2: Response Test Results**

The response test geometric mean K value is calculated to be $8.26 \times 10^{-5}$ m/s. Given the rapid response at MW1, the sand and gravel unit can be considered to have a bulk hydraulic conductivity value on the order of $1 \times 10^{-4}$ m/s.

## 4.5 PRIVATE WELL SURVEY

In order to augment the MECP database a private water well survey was completed within approximately 500 m of the site on February 4, 2022. The survey area is shown in **Figure A2** (**Appendix A**). Emergency (911) locate numbers, as available, are shown for each property.

As part of the survey each residence was visited and an information and response package was delivered. The package included a response form and stamped return envelope, in addition to telephone and email contact information. A copy of the survey letter and response form is included in **Appendix A**.

A total of 6 residences were surveyed. A total of 2 survey responses were received, as summarized in **Table A2** (**Appendix A**). The survey confirmed the location of 3 wells (corresponding to available well records), however did not add any additional information that was not available through the well record review.

# 5.0 HYDROGEOLOGIC SETTING

The hydrogeologic setting of the site is discussed in context of the known regional setting, information review undertaken for this site, and, monitoring and assessment completed as part of this study.

The existing pit is excavated into the sand/gravel deposit at the site. The operator reports that clayey material was encountered along the west edge of the pit, and can occur at surface (overlying the sand/gravel). Sand was encountered from surface to depth at 1994 borehole locations BH2, BH3, BH4, BH6, BH7, BH8, BH11 and BH13, in addition to 2021 boreholes MW2 and MW3 and 2021 borehole BH5 (on the existing pit floor). A relatively thin layer of clayey material at or near surface, underlain by sand that extended to depth was encountered at 1994 boreholes BH1, BH9, BH10 and BH12, in addition to 2021 borehole MW1. A relatively thin layer of sandy material, overlain by clayey materials at surface and underlain by silt/clay till to depth, was encountered at 2021 boreholes BH1-21 and BH2-21. No sand or gravel was encountered at 1994 borehole BH5 and 2021 borehole BH3-21.

This variability is also reported within the water well records in the area of the site, both laterally and vertically. The sand deposit appears to extend to depth, and is interlayered with silt/clayey deposits.

Based on the reported geologic setting and site specific drilling results the site represents a localized sand and gravel deposit that appears to be inter-fingered with the surrounding clay/silt till deposit and have an irregular outline. Based on the 2022 drilling results at BH5 the sand deposit is very deep, extending to at least 36.6 m below the existing pit floor (down to an elevation below 207.4 mASL). A possible increase in silt content is noted at depth at this location (within the mud rotary cuttings below about 30 m depth).

In order to illustrate the conditions in this area of the site 2 schematic cross-section were developed based on site topographic mapping, water well record database, borehole logs and water level monitoring results. The cross-section locations are shown on **Figure 5**. The sections are provided as **Figure 6 and Figure 7**.

Cross-section A (**Figure 6**) runs west to east through the site. The section illustrates the local topography and surface water features relative to the existing (and proposed) extraction. The interpreted (inter-fingered) transition from the sand/gravel deposit to the surrounding till is shown schematically. Based on the elevations of the wetland and drainage channel features west of the site, relative to the existing extraction, these features must be underlain by the till unit. This is consistent with the reported occurrence of clayey material along the west extraction face.

The water table within the sand/gravel unit is approximately 7+ m lower than the wetland and drainage channel system. Therefore the surface water features are “perched” relative to the existing and proposed extraction. Within the section the proposed pit would consist of an eastward extension of the approved above and below water extraction.

Cross-section B (**Figure 7**) runs south to north through the site. Again, the interpreted (inter-fingered) transition from the sand/gravel deposit to the surrounding till is shown schematically. Within the section the proposed pit would consist of a southward extension of the approved above and below water extraction.

The sand and gravel forms a local unconfined aquifer where saturated. We would expect the water table to be higher within the surrounding till unit (further from the site). Within the sand and gravel unit the water table is relatively flat, potentially constrained by the surrounding till deposit.

The primary groundwater function of the proposed extraction area is recharge. This recharge supports groundwater conditions and flow in the surrounding area. A very slight south/southwestward water table slope is identified. Overall groundwater flow (direction and volume) may be limited, both laterally and vertically, by the variable and layered nature of the overburden in this area.

Water level monitoring at the Macpherson Pit site began in January 2021 and has continued to the present (last measurement in May 2022). To date a water table minimum was observed in September 2021 (as expected), and the highest water levels were observed in May 2022. Water levels in spring 2021 did not reach an expected "maximum" for that period. This was likely due to a lack of spring snowmelt and precipitation related recharge.

To illustrate climate conditions over the monitoring period we compared the Environment Canada reported 2020 and 2021 monthly precipitation at the London CS weather station to reported Climate Normals for that station. The comparison is provided in tabular and graphical format in **Appendix C**. As indicated, there was an extended dry period from October 2020 to May 2021, which would have resulted in reduced groundwater recharge. Spring 2021 was unusually dry (lack of snowmelt and precipitation recharge), therefore the water table was likely lower than normal over the start of the monitoring period.

High water table conditions at the site, based on the May 2022 observations, are provided in **Figure 8**. Additional discussion regarding water levels at the site is provided in **Section 7.0**.

# 6.0 PROPOSED EXTRACTION

The following general description of the proposed Macpherson Pit extraction is provided as a framework for the impact analysis. For specific details regarding existing site conditions or the extraction plan please refer to the Site Plan(s).

The existing licenced area is approximately 10.3 hectares (ha) in size, within which below water table extraction is currently approved. The approved rehabilitation plan would result in a final pond of approximately 3.2 ha. The approved below water extraction depth is to an elevation of approximately 234 mASL. The original pond level was predicted to be 240.3 mASL, which would result in a pond approximately 6.3 m deep. The gravel is known to extend to that depth (at least), as indicated by the 2022 drilling results (see Section A and Section B).

The proposed licenced area is approximately 23.4 ha, consisting of the farm fields east and south of the existing pit. The proposed new extraction area is 20 ha. The proposed Rehabilitation Plan and pond outline are shown within the application Site Plan(s), please refer to those plans for additional specific details.

The proposed extraction would extend below the water table to expand the currently approved permanent pond (within the existing pit). The pond would be extracted to a depth of 229 mASL. Based on the seasonal average predicted pond elevation (241.9 mASL – see **Section 7.0**), the final pond depth would be approximately 12.9 m.

The proposed final pond is shown on **Figure 9**. The total proposed new additional pond/wetland area at the site is approximately 12.1 ha. The proposal also includes some new below water extraction within the existing licence (along the common boundary). The combined below water extraction (existing licence and new proposed licence) would result in a final total pond area of approximately 19.3 ha.

This assessment examines the impact of the total proposed new below water extraction (within both existing and new proposed licence areas).

Gravel would be extracted from below water using an excavator or dragline, piled at the extraction pond edge and allowed to drain. There is no dewatering proposed as part of the below water extraction.

Post extraction drainage within the rehabilitated area would be maintained on-site, directed toward the proposed pond. This water would be retained (and infiltrated) on-site. There are no other proposed water use, diversion, storage or drainage facilities on-site.

The existing spills response program will remain in place at the site.

# 7.0 MAXIMUM PREDICTED WATER TABLE REPORT

The proposed extraction would occur within unconsolidated surficial sand and gravel deposits. Therefore the following definitions are used:

> *"ground water table" means*
>
> *a) for unconsolidated surficial deposits, the ground water table is the surface of an unconfined water-bearing zone at which the fluid pressure in the unconsolidated medium is atmospheric. Generally, the ground water table is the top of the saturated zone.*
>
> *"maximum predicted water table" means the maximum ground water elevation (metres above sea level) predicted by a qualified person who has considered conditions at the site and mean annual precipitation levels.*

The water table at the site was measured and determined by the installation of 3 water table wells and 1 drive-point piezometer. The measured water table at the site corresponds to the top of the saturated zone within the unconfined surficial sand and gravel aquifer.

Therefore, as noted in **Section 5** of this report, based on the 1 year of data currently available, the predicted maximum water table elevation at the site is shown on **Figure 8**. The maximum predicted water table elevation varies across the proposed extraction area from approximately 242.1 to 242.2 mASL. We proposed ongoing monitoring to confirm water table elevations as extraction proceeds (see **Section 9.2**).

We note that because the existing approved and proposed extraction extends below the water table. Given the depth to water table below ground surface and the overall site setting, the high water table elevation definition does not have any operational implications.

The final extraction pond would extend across both the existing and proposed new licence. Therefore the predicted average pond level, and seasonal range in pond level, is based on average water table elevations at the four monitors installed for this study (MW1, MW2, MW3 and DP1). The predicted seasonal low pond level (based on September 2021 data) is 241.5 mASL. The predicted seasonal high pond level (based on May 2022 data) is 242.1 mASL.

We also note that based on the setting and relatively flat water table elevation at the site, there are no potential significant water level changes associated with the proposed extraction (see **Section 9**). Therefore, although the final pond level range is used as part of the impact assessment, the predicted maximum pond level does not have any significant implications with regard to the impact assessment.

# 8.0 WATER REPORT LEVEL 1

The purposed of the Water Report Level 1 is to identify if the site is within a WHPA-Q area (and identify if related Source Protection Policies should be implemented), and, to determine the potential for adverse effects to groundwater and surface water resources and their uses (e.g. water wells, ground water aquifers, surface water courses and bodies, springs, discharge areas).

A review of the kettle Creek Source Protection Plan and Source Protection Policy Mapping Tool indicates that the site is not located within an identified WHPA-Q area.

We note that existing approved extraction and rehabilitation would result in a large pond at the site. For the purposes of an impact assessment, the "existing condition" includes the approved extraction and associated final land configuration (with pond).

Based on the size and location of the proposed pond extension, no overall change in site-scale groundwater flow direction would be anticipated. While some local water level change along the perimeter of the pond may occur, given the relatively "flat" water table at the site, the magnitude of water level change is expected to be minor (for both the approved and proposed pond configurations).

Potential physical changes to the groundwater system related to the proposed amendment that should be assessed include: temporary water table effects during below water table extraction; long-term changes to the water table at the edges of the proposed pond; and, changes in the overall site water balance due to the extraction.

To assess the significance of potential on-site water table effects due to the proposed extraction on water wells and natural environment features in the area of the site, a Water Report Level 2 evaluation is required. The Level 2 evaluation is included as **Section 9** of this report.

# 9.0 WATER REPORT LEVEL 2

The Level 2 evaluation is completed to examine issues related to the potential for the proposal to affect the local water table or water balance at the site.

## 9.1 POTENTIAL IMPACTS

The potential for impact is examined in the context of the site setting, existing extraction and proposed new extraction.

### 9.1.1 Site Water Balance

For completeness the water balance assessment considers and compares existing conditions; approved rehabilitation conditions; and, proposed final conditions. Water balance calculations are included in **Appendix E**.

The assessment area includes the existing licenced area, the proposed licenced area, and, the small residence area which may contribute some precipitation runoff (overland sheetflow in response to snowmelt or rainfall) to the site(s). The road ditch system along Truman Line is interpreted to be the northern boundary of the assessment (runoff catchment) area. The proposed east licence boundary and agricultural field edge is also interpreted to be a catchment boundary (based on topography and observed conditions). The west boundary of the existing licence is interpreted to be a catchment boundary based on topography and historical extraction. All runoff within the existing pit is retained. Potential runoff within the surrounding assessment area (on-site agricultural fields and residence area) is interpreted to move either into the existing pit or off-site southward to adjacent agricultural fields.

Under current conditions there is some potential precipitation runoff into the existing pit (licenced area) from the residence area and a portion of the proposed licenced area, comprising approximately 3.5 ha. The interpreted runoff drainage boundary is shown on **Figure E1** (**Appendix E**), and is based on the mapped topography (see Site Plan) and observed field conditions. The boundary includes the field edge along the existing fence on the east side of the pit (interpreted to limit overland flow), and, is defined by the topography within the residence area. Existing ponds on the pit floor, as shown on the Site Plan, are approximately 1.5 ha in size (total area).

Under approved extraction and rehabilitation conditions runoff potential remains the same, however includes a final single approved pond approximately 3.2 ha in size.

Under proposed conditions all runoff from the assessment area would be retained within the combined existing and proposed licenced areas, and a single 19.3 ha pond would be created (12.1 ha of the pond is within the proposed new licence).

The water balance is based on long-term average climate conditions (1981 – 2010 Climate Normals) reported by Environment Canada for the London International Airport station. The average annual precipitation is approximately 1,011.5 mm/year.

Evapotranspiration rates for existing and future land surfaces are calculated using the Thornthwaite and Mather method, assuming a Soil Moisture Retention of 150 mm (representative of moderately deep rooted pasture crops on fine sandy loam). The annual evapotranspiration rate at the site is estimated to be 583.45 mm/yr. Given the nature of

the existing and proposed ponds (small in size, shallow to moderate depths, set deep within the local landscape), a free water surface evaporation of 615.6 mm/yr is estimated based on the calculated Potential Evapotranspiration (PET) rate.

Runoff and infiltration rates within the remainder of the site (primarily farm fields) are estimated in accordance with MECP development application guidelines (*Hydrogeological Technical Information Requirements for Land Development Applications*, April 1995) and stormwater management guidelines (*Stormwater Management Planning and Design Manual*, March 2003).

Within the MECP methodology, the difference between precipitation falling on the assessment area (direct input) and evaporation/evapotranspiration (direct initial output) is termed the water "surplus". Based on existing conditions the annual water surplus within land areas is estimated to be 428.05 mm/yr. The water surplus (i.e. recharge) within pond areas is estimated to be 395.9 mm/yr.

Surplus water at the land surface can either infiltrate to recharge the groundwater system or form surface water runoff. Land surface runoff rates at the site are calculated according to the MECP development application guidelines methodology, which assigns an infiltration factor to apply to the water "surplus" in order to calculate recharge. The infiltration factor depends on individual factors related to topography, soil type and vegetation/cover. Based on a characterization of the site (flat lands, open sandy loam soil, cultivated lands) an infiltration factor of 0.8 (80%) is estimated. The remainder of the surplus (20%) becomes runoff.

Based on existing conditions within the assessment area (developed pit with small ponds, runoff retention within pit and some adjacent lands, remainder of runoff moving off-site to the south), existing groundwater recharge is estimated to be 129,303 $m^3$/yr (4.1 L/s). The equivalent unit recharge rate would be 0.369 m/yr. Total runoff moving off-site to the south is estimated to be 20,033 $m^3$/yr (0.64 L/s). Based on local topography much of this runoff would be directed toward the local agricultural drain system. Where retained (e.g. at field edges along woodlot, low areas, etc.) this water would likely infiltrate to form groundwater recharge within the surrounding landscape.

Based on the approved extraction and rehabilitation, runoff conditions would not change significantly as compared to existing. The major difference would be an increase in the size of pond area, and associated evaporation. Groundwater recharge is projected to be 118,837 $m^3$/yr (3.77 L/s). The equivalent unit recharge rate would be 0.340 m/yr.

Under future proposed conditions all runoff within the assessment area would be retained (increasing local surplus) and a single large pond created (increasing evaporation). Final groundwater recharge is projected to be 143,613 $m^3$/yr (4.55 L/s). The equivalent unit recharge rate would be 0.410 m/yr.

As illustrated by the calculations, overall groundwater recharge is expected to increase slightly at the site with respect to both existing and approved conditions.

### 9.1.2 Temporary Water Table Effects

The below water excavation is expected to have a typical extraction rate is conservatively estimated to be on the order of 1,000 $m^3$/day. Actual extraction would likely be limited by demand or equipment used, and would likely be lower.

The removal of aggregate from below the water table results in an inflow of water to replace the solid material removed, forming a pond. As the aggregate is removed by excavator from the working edge of the pond, it is stockpiled adjacent to the pond and most of the retained groundwater drains back into the excavation. Using an average sand and gravel aquifer porosity of 0.3, 70% of the extracted volume is aggregate and 30% is groundwater. It is generally assumed that a water volume equivalent of 5% of the aquifer volume can be retained and removed with the aggregate, and 25% drains back into the excavation. Therefore an estimated total of 75% of the aggregate volume removed during excavation must be replaced by water inflow. The water filling the excavation can be groundwater inflow from the surrounding aquifer, direct precipitation or precipitation runoff from the surrounding area.

This effect is often analyzed as an equivalent pumping assuming all of the water flowing into the excavation is groundwater. However, it is important to note that little actual water is removed from the site. The "pumping" is essentially an intermittent transfer of water from the aquifer to the pond, generally resulting in a short-term water table decline in the vicinity of the excavation. Prior to extraction water is "stored" within the porosity of the sand and gravel deposit (generally assumed to be 30%). Once the aggregate is removed, the on-site storage volume increases within the extracted area (pond). The drawdown is short-term in that "recovery" occurs between excavation periods (overnight and on weekends); and, during rainfall recharge events.

Measurable drawdown at the pond and within the surrounding aquifer can occur in response to aggregate removal during the initial stages of extraction. However as the extraction pond enlarges and off-setting effects such as daily recovery and occasional precipitation recharge events begin to occur, actual drawdown at, and adjacent to, the pond becomes more difficult to measure. Once the pond is established the pond volume tends to buffer instantaneous pond level drawdown related to the aggregate removal. Therefore the approved pond would help to mitigate potential impacts related to the proposed pond expansion. Therefore this assessment applies primarily to the existing approved below water extraction, however is also used in a conservative approach to simulate the proposed extraction also.

As a conservative approach for this impact analysis, it is assumed that below water extraction would occur on a continual basis for 60 days with no daily recovery or recharge events.

For the purposes of this discussion a theoretical maximum "equivalent pumping" effect at the proposed west pond was assessed using the Aqtesolv® pumping test analysis program. A forward Neuman unconfined aquifer analysis was completed using the following site-specific assumptions (in addition to the typical analytical assumptions associated with the Neuman method):

- aquifer thickness (b) of 12.9 m, extends laterally in all directions;
- aquifer K = 1 x $10^{-4}$ m/s (**Section 4.4**), Kz/Kr = 0.1;
- T = Kb = 0.00129 $m^2$/s, S = 0.25 (drainable porosity);
- 60 day below water table extraction period, average pond depth of 12.9 m;
- below water table extraction of 1,000 $m^3$/day;

- groundwater inflow (75% of extraction volume) Q = 750 $m^3$/day (0.0651 $m^3$/min) averaged over 60 day extraction period;
- after 60 days pond area is 10,000 $m^2$, equates to a circle of radius 38.5 m;
- drawdown simulated using 8 wells (each 0.1 m radius) equally spaced along the outside of a circular "excavation pond" of radius 38.5 m, individual pumping rates of 0.0651 $m^3$/min;
- no precipitation recharge for analysis period.

The program output for the west pond is included in **Appendix F**. The drawdown analysis calculated the expected water level decline in an idealized aquifer at distances of 50 m, 100 m, 200 m, and 400 m from the excavation. As illustrated by the analysis results, the expected drawdown within the aquifer system decreases with distance from the pond edge and will recover after the extraction ends each season. Note that the analysis does not include recharge, therefore the drawdown prediction as illustrated continues after the 60 day period, however we would expect recharge effects to moderate water levels over this period. Under the "worst case scenario" of 60 days of continual extraction at the west pond and no recharge, the maximum water table change at 200 m distance is projected to be approximately 19 cm. At additional distance no appreciable drawdown is projected over the 60 day period.

The assumptions used for the analysis are conservative in that: water table effects over the entire extraction period are assumed to radiate immediately from the full extent of the pond (whereas actual water table effects will slowly develop from the initial below water extraction area and would not reach the full pond extent for some time); some water level recovery would be expected during non-operational periods (overnight and during weekends); and, some recharge would be expected during the extraction period. Any direct precipitation or recharge would reduce "drawdown"; therefore actual water table effects are typically less than projected using an equivalent pumping approach. As noted above, drawdowns shown on the graph in **Appendix F** would not likely continue as shown past 60 days if recharge occurs. Also, due to seasonal recharge, the water table recovery after annual operations cease is more rapid than predicted by the analysis.

It is also important to note that the extraction pond represents an increase in storage, and there will be an increase in rainfall water volume retained on-site during fall and spring (outside of the annual operating period), specifically during snowmelt. Once the approved pond is developed, the storage volume would tend to reduce the daily response of the pond and water table to the proposed new extraction.

### 9.1.3 Long-Term Water Table Effects

As the below water table extraction forms a pond, a level (pond) water surface replaces what was previously a sloping water table within the aquifer. In most cases the pond level is typically lower than the water table was on the upgradient side, and higher than the water was on the downgradient side. This typically causes a water table decline immediately upgradient of the pond and rise immediately downgradient of the pond. The magnitude of change is dependent on the final pond level, which in this setting would be the average of the original upgradient and downgradient elevations.

As noted previously, the water table at the site is relatively flat, with a total water level difference of approximately 0.1 to 0.15 m across the site. Therefore the magnitude of

water table change associated with both the approved pond and proposed expansion will be minor.

Therefore no significant change in groundwater level, or overall groundwater flow pattern, in the area of the site is expected.

### 9.1.4 Potential For Impact To Water Wells

Below water extraction to form a permanent pond is an approved activity at the site. The proposed extraction would expand the pond to the east and south, however would remain within the land ownership parcel.

The nearest water well is at the on-site residence owned by the pit operator, and is located upgradient of the pit. Two additional water wells are located north of Truman Line, across from the pit, and are also located upgradient of the site at distances greater than 200 m from the proposed pond edge. Remaining wells in the area, including those located downgradient along Ferguson Line are greater than 500 m from the (approved and) proposed pond.

Based on the water balance assessment, groundwater recharge is expected to increase slightly, therefore overall groundwater volumes will be maintained within the local aquifer system. Based on the drawdown analysis, potential for short-term groundwater level changes (during extraction) associated with the approved and proposed below water extraction are expected to be minor. Based on the projected pond level and limited nature of potential permanent water level changes, overall flow direction and groundwater levels will be maintained in the long term.

Therefore the proposed additional below water extraction does not represent a significant potential negative impact to local water supplies. As noted below, we propose a water level and water quality monitoring program to confirm groundwater conditions as extraction proceeds.

### 9.1.5 Potential For Impact to Natural Environment Features

The nearest significant natural environment is the Glanworth Wetland (swamp) Complex (PSW), located northwest of the existing pit. Based on the wetland elevation as compared to the existing pit floor ponds and defined water table, the wetland is perched relative to the groundwater system at the site. Therefore there is no groundwater contribution, or direct relationship, from the site to the feature.

Based on the lack of groundwater relationship, and minimal projected groundwater changes associated with the new proposed below water extraction, there is no potential impact to the PSW due to the proposal.

The drainage system west and southwest of the site is also developed above the water table at the site. Similarly, due to the lack of groundwater interaction with the feature, there is no potential impact to the drain system due to the proposed extraction.

Based on this assessment, there are no significant potential impacts to local natural environment features anticipated with the proposed extraction.

## 9.2 MONITORING, MITIGATION AND CONTINGENCY PLAN

The following general private water supply protection recommendation should be listed on the Site Plan:

> *Where the Ministry of Northern Development, Mines, Natural Resources and Forestry with the assistance of the Ministry of the Environment Conservation and Parks, according to existing water well interference complaint protocols, has determined that the operation of the pit has caused any well water to be adversely affected, the licensee shall, at the licensee's expense, either deepen the well or replace the well to ensure that historic water production quality standards are maintained for that well. If this pit operation has caused a water supply problem, the licensee shall, at their expense, ensure a continuous supply of potable water to the affected landowner.*

In order to track water table elevations and groundwater quality at the site, the following monitoring program is recommended:

1. *Water level measurements shall be obtained on a quarterly (seasonal) basis at MW1, MW2 and MW3, as accessible.*
2. *Annual water quality samples for general parameters (anions and metals) and petroleum hydrocarbons shall be obtained at MW1 and MW3 (as accessible) on an annual basis.*
3. *The monitoring results will be summarized and submitted in an annual report to the Ministry of Northern Development, Mines, Natural Resources and Forestry.*

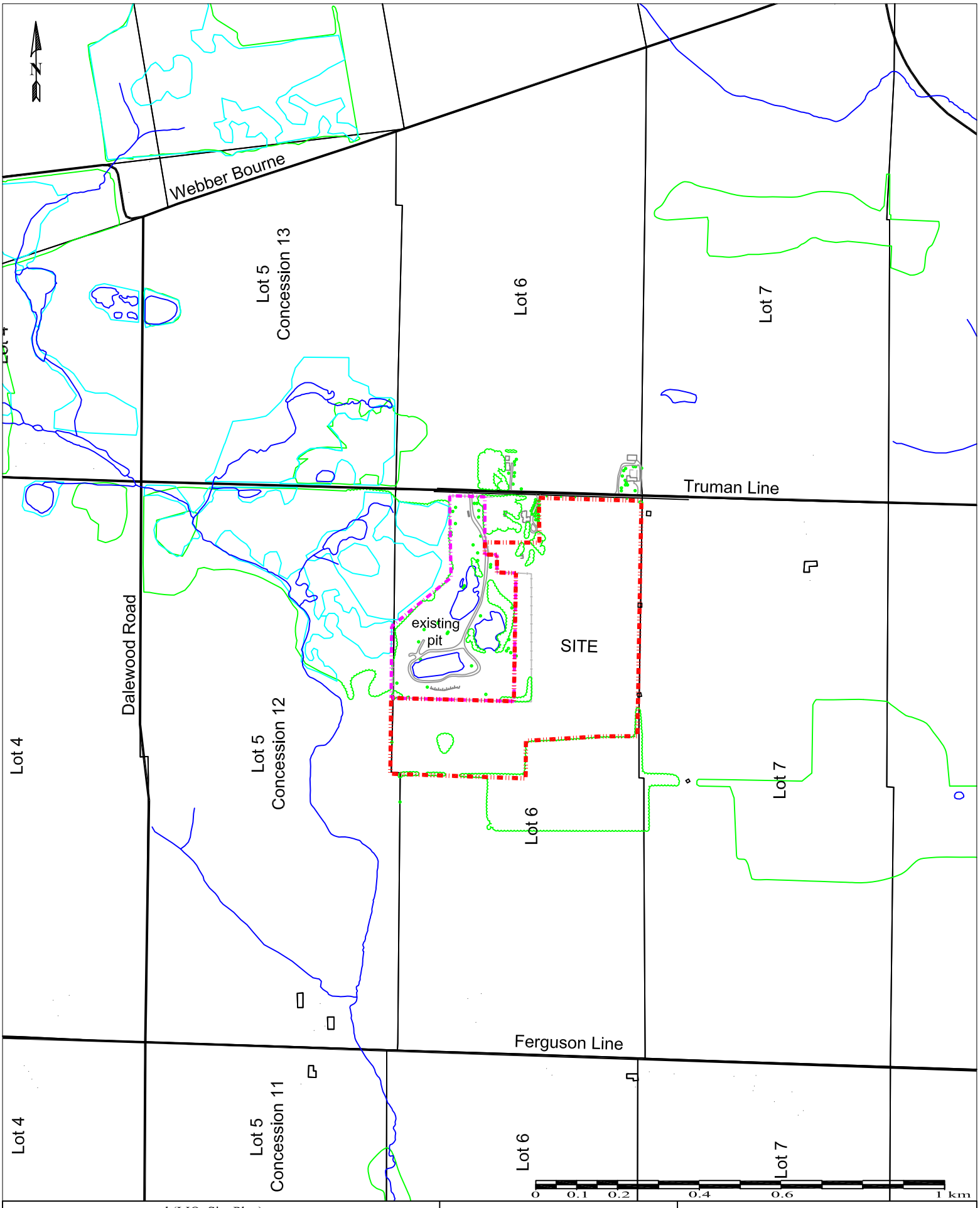
# 10.0 CONCLUSIONS

Based on the results of the impact assessment, and, proposed monitoring and mitigation plan, there are no potential for significant adverse effects to groundwater and surface water resources and their uses; and, there is no potential for significant impacts to local groundwater aquifers, natural environment features or water supply associated with the proposed Macpherson Pit extraction.

All of which is respectfully submitted,


Andrew Pentney, P.Geo.
Senior Hydrogeologist
Groundwater Science Corp.

# *Figures*




stream, pond (LIO, Site Plan)

wetland (LIO, Site Plan)

proposed Licence (approximate)

existing Licence (approximate)

modified from: OBM mapping, Site Plan

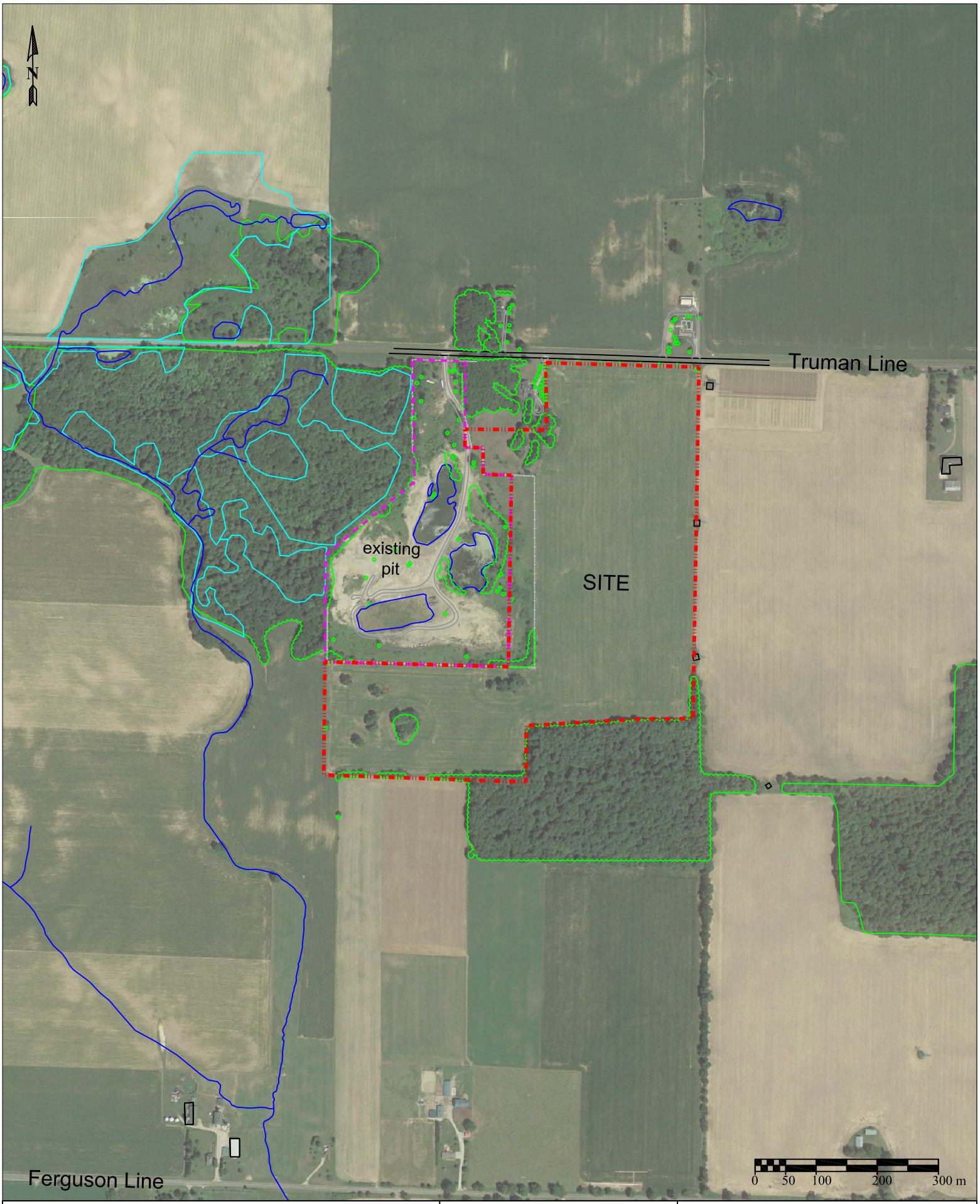


June 2022
Scale: as shown

*Groundwater Science Corp.*

# Figure 1: Site Location

Talbot Sand and Gravel Limited
Proposed Macpherson Pit




stream, pond (LIO, Site Plan)

wetland (LIO, Site Plan)

proposed Licence (approximate)

existing Licence (approximate)

air photo: Google Earth, 2018

modified from: OBM mapping, Site Plan



June 2022

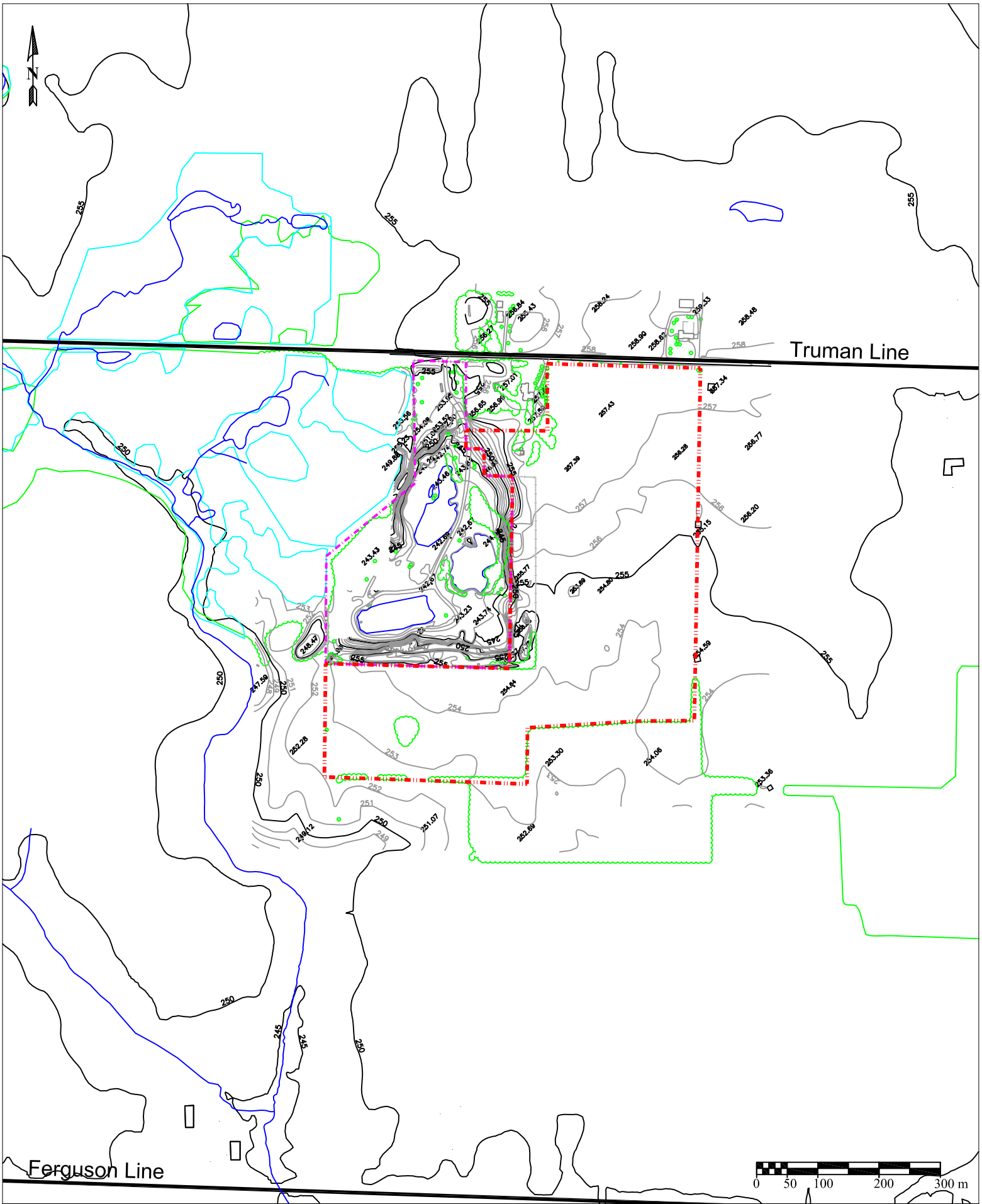
Scale: as shown

*Groundwater Science Corp.*

# Figure 2: Site Setting

Talbot Sand and Gravel Limited

Proposed Macpherson Pit




topographic contours and spot elevations (mASL) as shown (LIO, Site Plan)

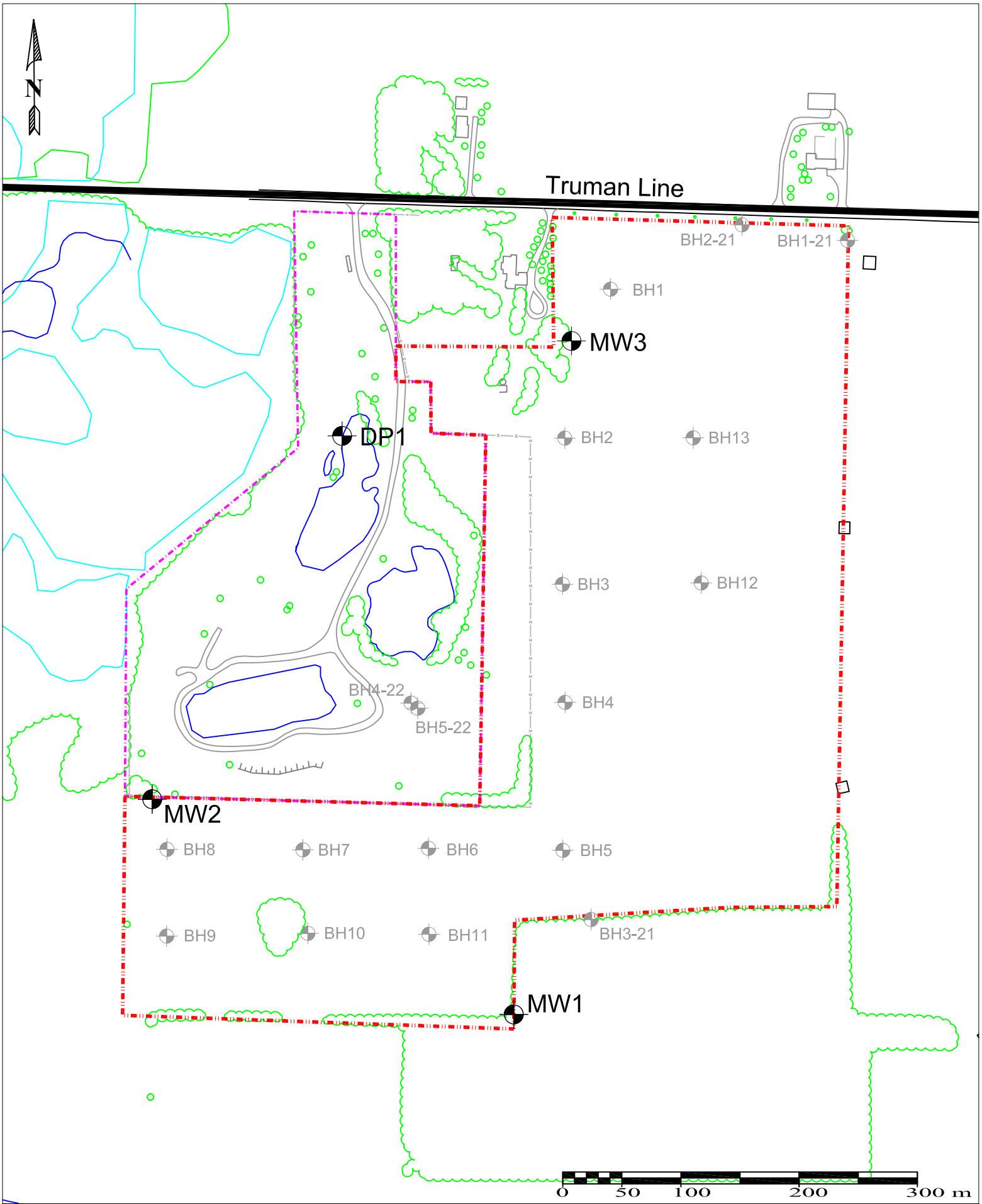
modified from: OBM mapping, Site Plan


June 2022
Scale: as shown

*Groundwater Science Corp.*

# Figure 3: Local Topography

Talbot Sand and Gravel Limited
Proposed Macpherson Pit




drilling/monitoring locations:
BH1 to BH13 = 1994 geotechnical investigation
BH1-21 to BH5-22 = 2021/2022 drilling program
MW1, MW2, MW3, DP1 = monitoring locations

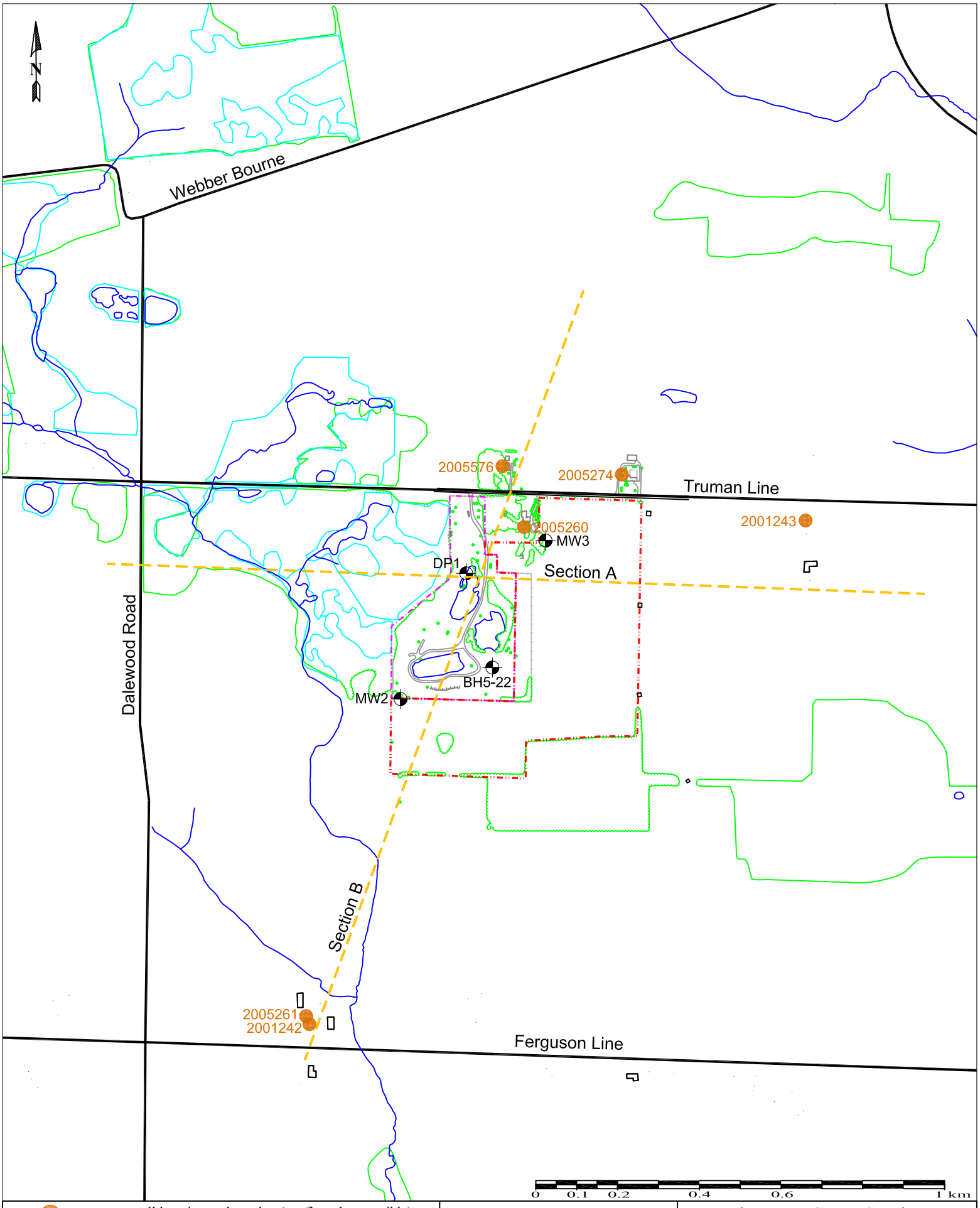
modified from: OBM mapping, Site Plan


June 2022
Scale: as shown

*Groundwater Science Corp.*

# Figure 4: Drilling Locations

Talbot Sand and Gravel Limited
Proposed Macpherson Pit




water well location and number (confirmed as possible)

schematic section location and reference

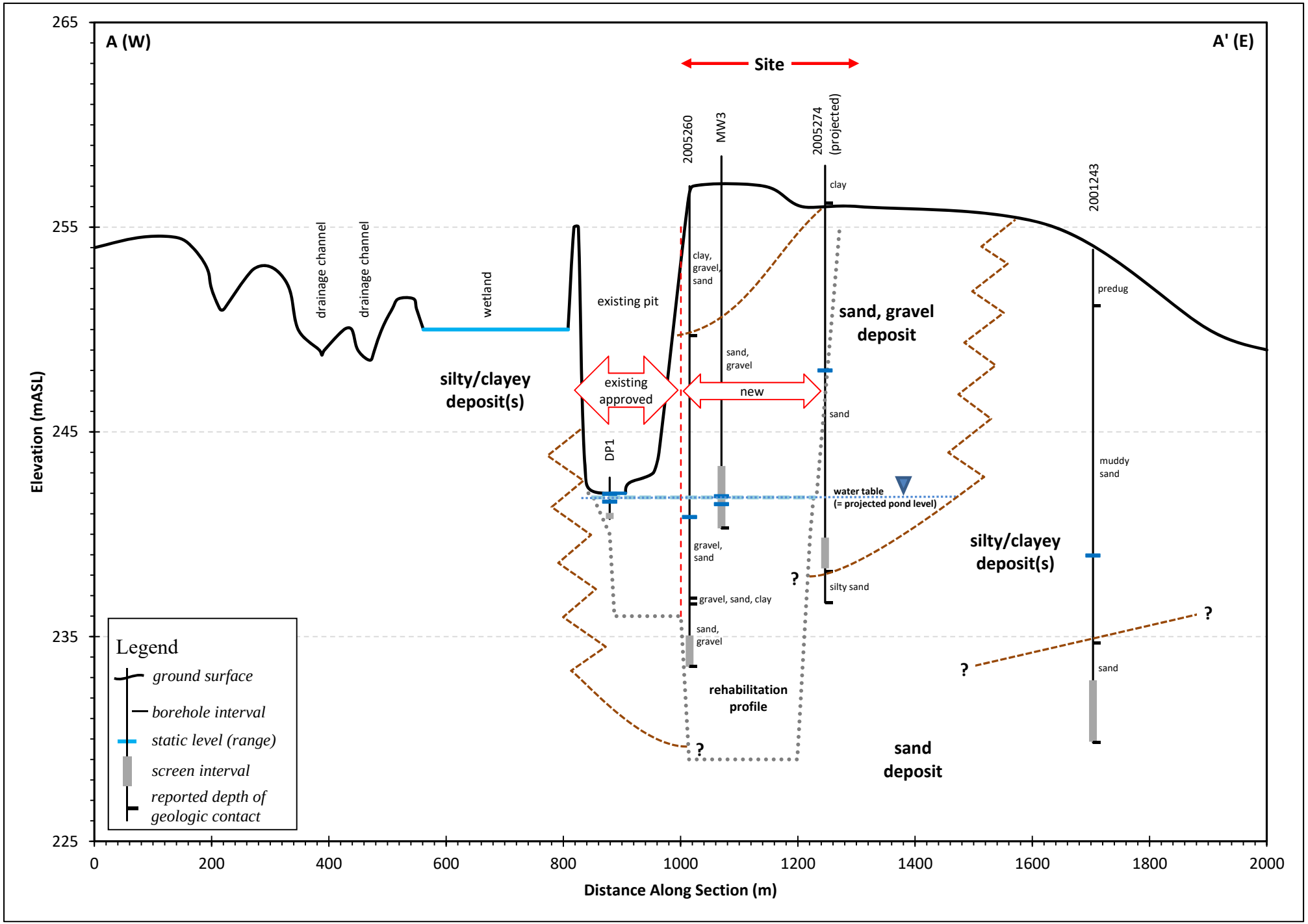
modified from: OBM mapping, Site Plan
UNDER LICENSE, WITHOUT PREJUDICE OR ENDORSEMENT, FROM THE QUEEN'S PRINTER OF ONTARIO, 2005

June 2022
Scale: as shown

*Groundwater Science Corp.*

# Figure 5: Cross Section Locations

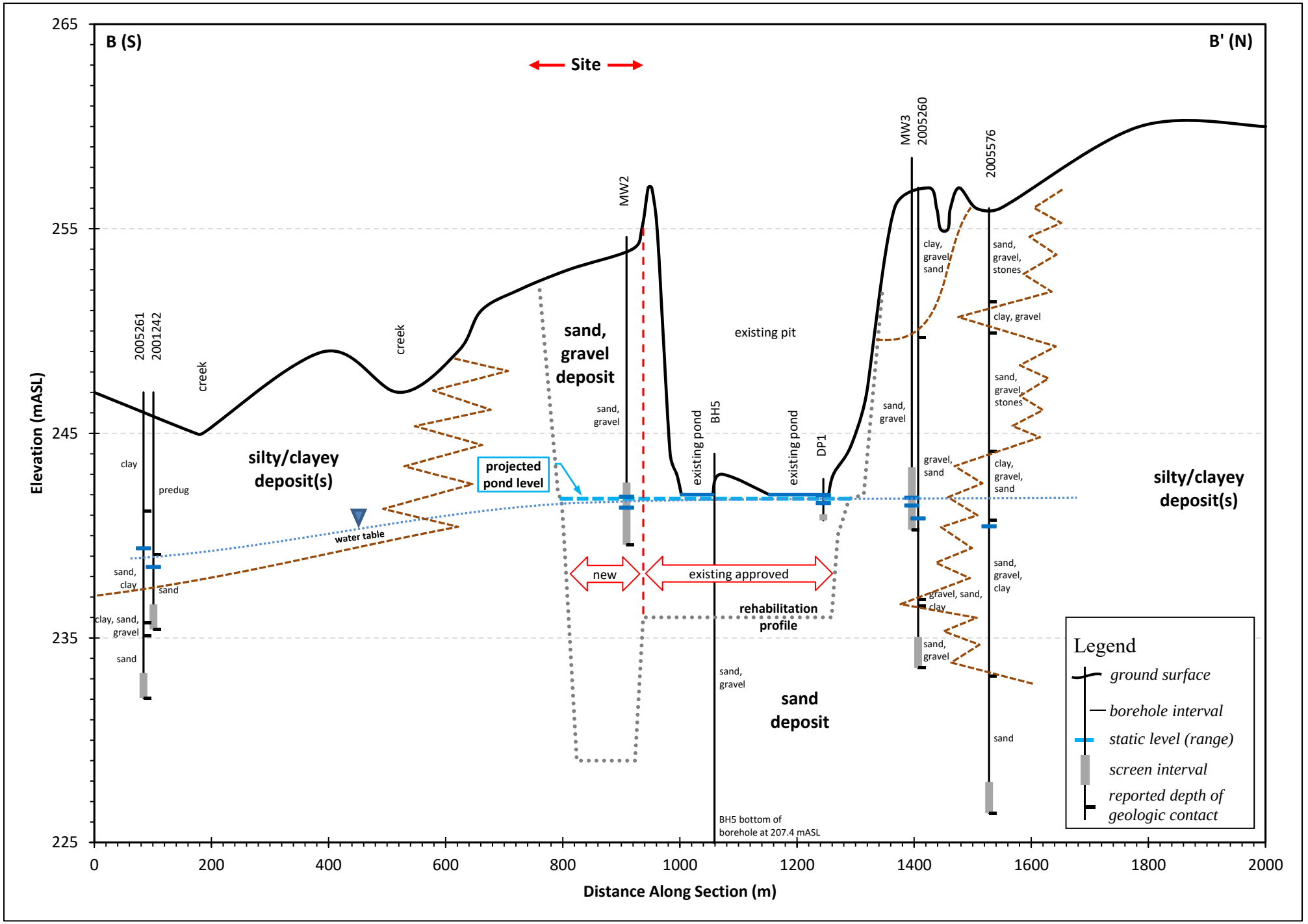
Talbot Sand and Gravel Limited
Proposed Macpherson Pit




Talbot Sand and Gravel Limited
Proposed Macpherson Pit

**Figure 6: Section A**

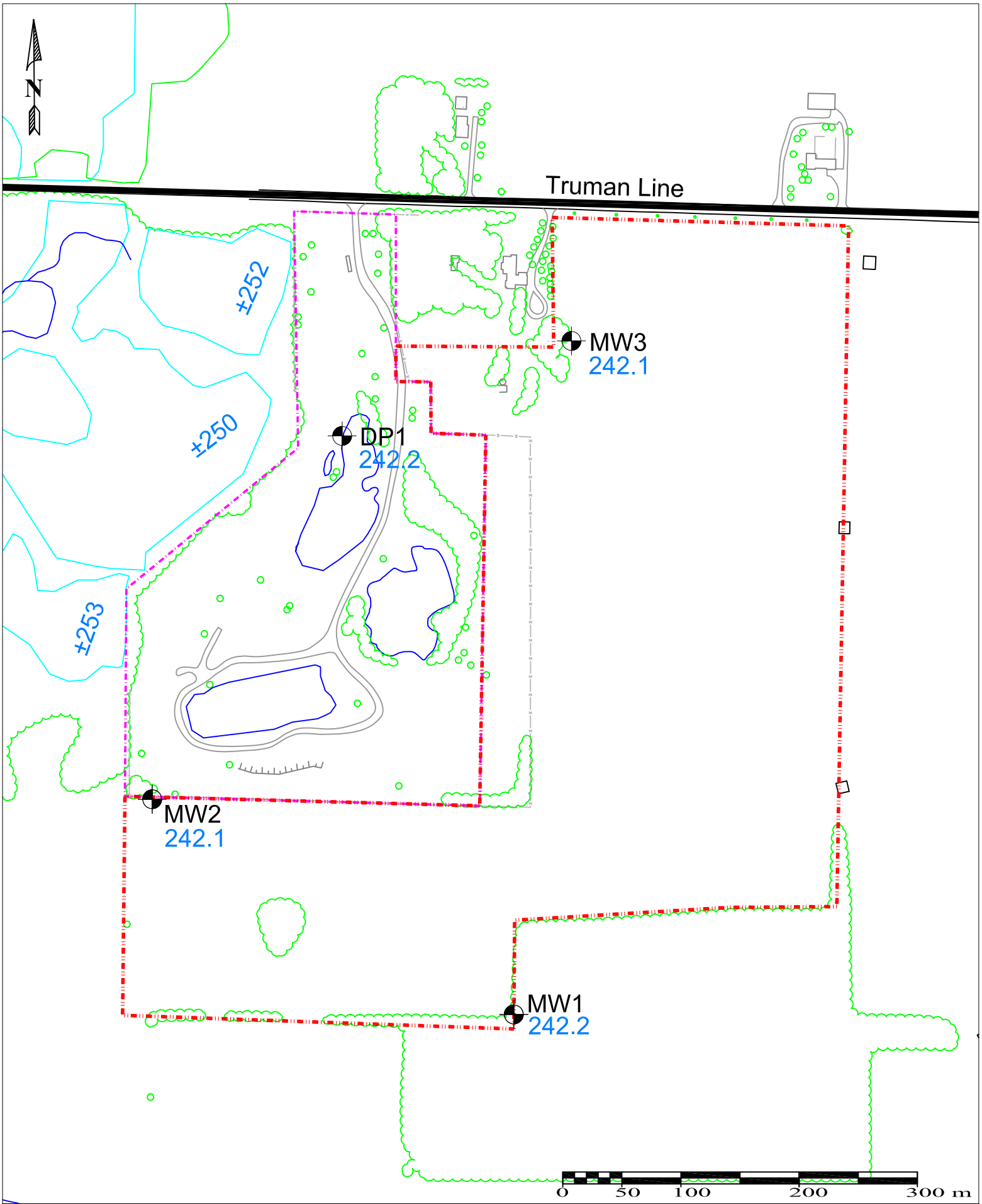
Groundwater Science Corp.
Hydrogeologic Assessment




Talbot Sand and Gravel Limited
Proposed Macpherson Pit

**Figure 7: Section B**

Groundwater Science Corp.
Hydrogeologic Assessment




high water table elevations (May 2022) as shown (mASL)

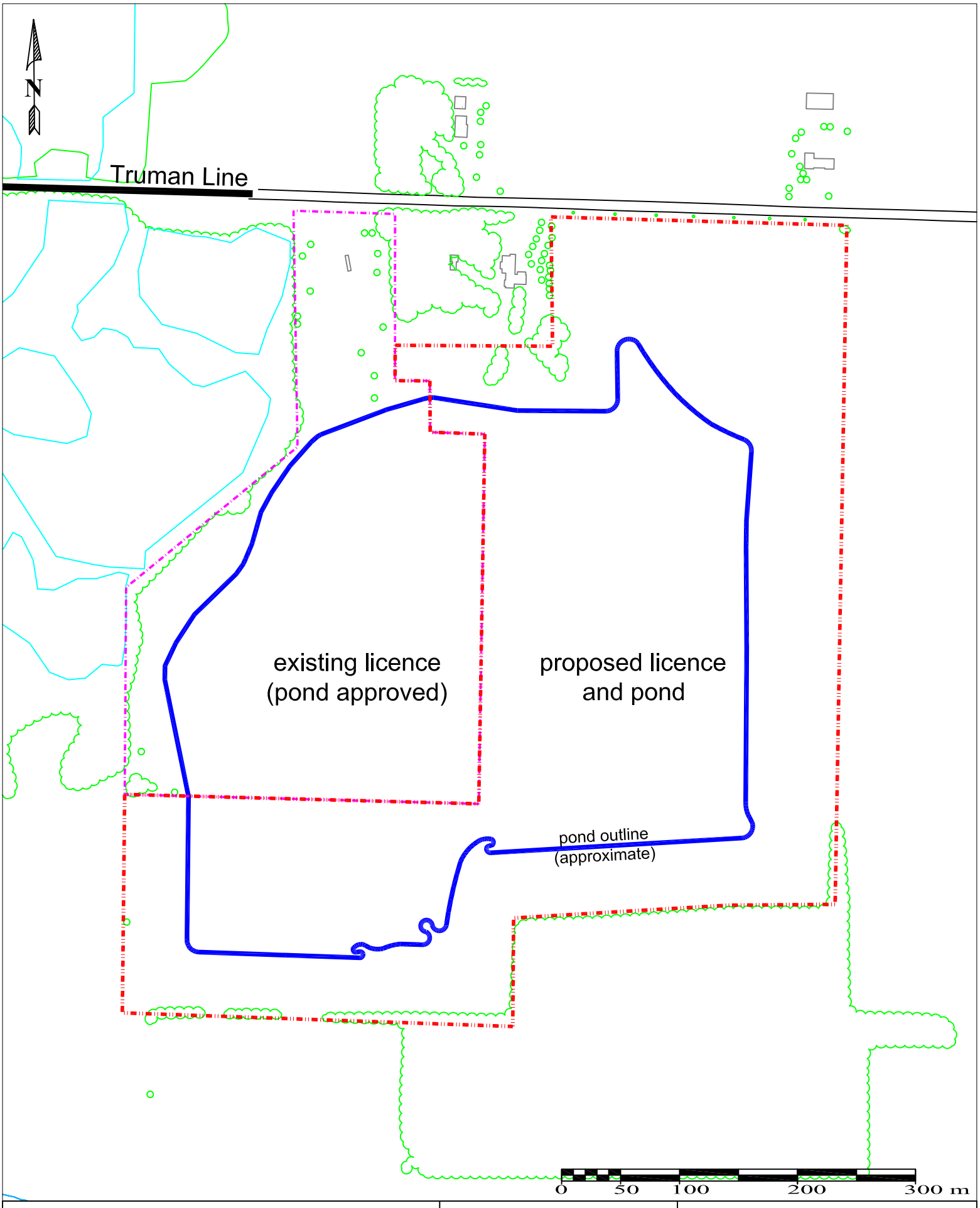
modified from: OBM mapping, Site Plan


June 2022
Scale: as shown

*Groundwater Science Corp.*

Figure 8: High Water Table Conditions

Talbot Sand and Gravel Limited
Proposed Macpherson Pit




modified from: OBM mapping, Site Plan
UNDER LICENSE, WITHOUT PREJUDICE OR ENDORSEMENT, FROM THE QUEEN'S PRINTER OF ONTARIO, 2005

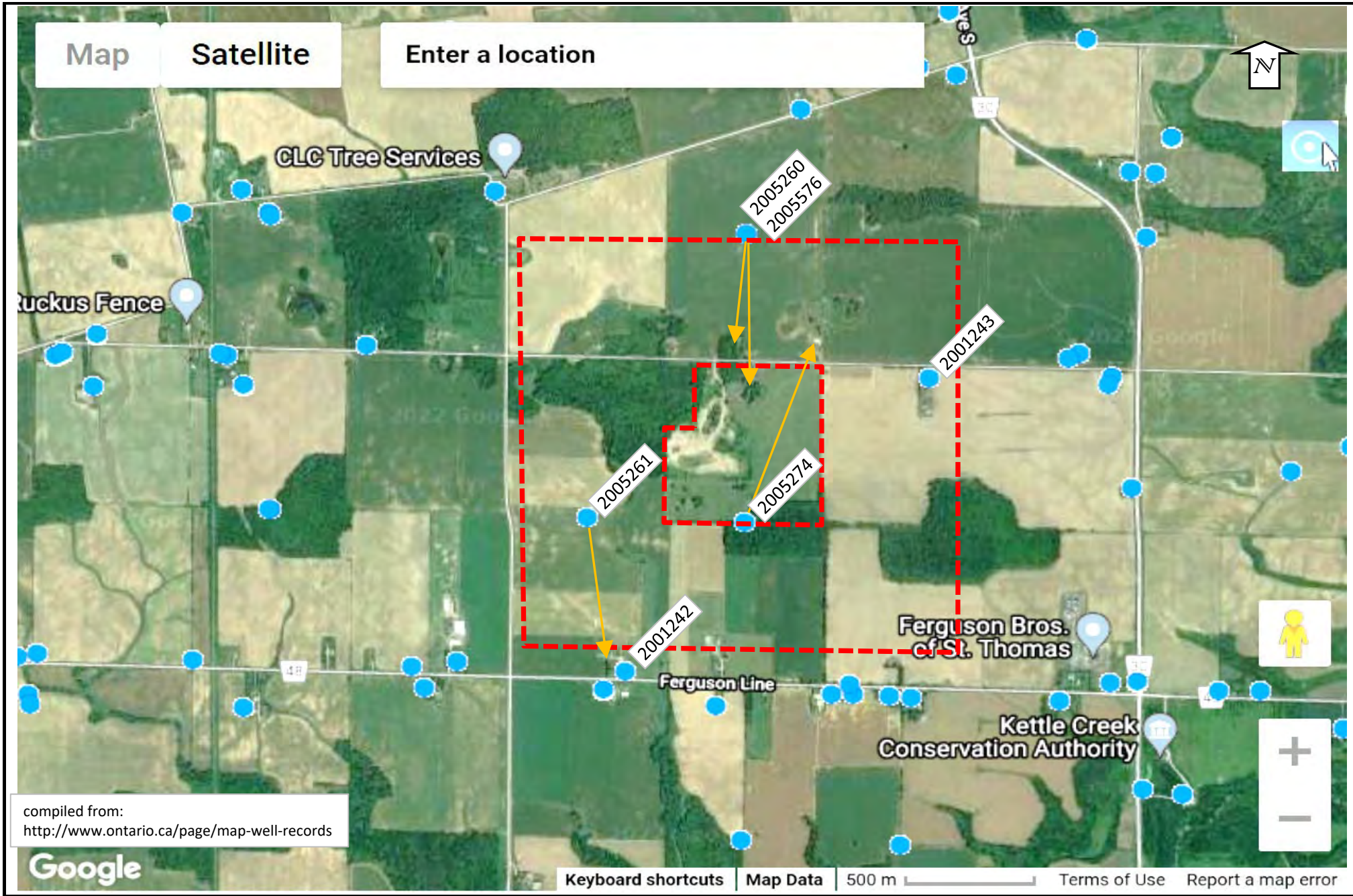
Figure 9: Proposed Pond

June 2022
Scale: as shown

*Groundwater Science Corp.*

Talbot Sand and Gravel Limited
Proposed Macpherson Pit

# *Appendix A*
# *Private Water Well Information*




study area and water well record search area (approximate 500m)

reported water well record locations and references as shown (corrections based on WWR information)

Date: January 2022
scale: not to scale

*Groundwater Science Corp.*

**Figure A1: Reported Water Well Locations**

Talbot Sand and Gravel Limited Macpherson Pit
Hydrogeologic Assessment

| Record No. | Date | Total Depth (m) | Type | | Use | Static Level (m) | Bedrock Depth (m) | Source Classification |
|---|---|---|---|---|---|---|---|---|
| | | | constr. | source unit | | | | |
| 2001242 | 14-Dec-63 | 11.6 | drilled | sand | domestic, stock | 8.5 | - | unconfined overburden aquifer |
| 2001243 | 21-Jun-62 | 24.1 | drilled | sand | domestic, stock | 14.9 | - | unconfined overburden aquifer |
| 2005260 | 14-Oct-95 | 23.5 | drilled | sand, gravel | domestic | 16.2 | - | confined overburden aquifer |
| 2005261 | 22-Sep-95 | 14.9 | drilled | sand | domestic, stock | 7.6 | - | confined overburden aquifer |
| 2005274 | 29-Nov-95 | 21.3 | drilled | sand | domestic | 10.0 | - | unconfined overburden aquifer |
| 2005576 | 6-Aug-99 | 29.6 | drilled | sand | domestic, crop | 15.5 | - | confined overburden aquifer |

Groundwater Science Corp.

Unit 2, 465 Kingscourt Drive,
Waterloo, ON N2K 3R5
Phone: (519) 746-6916
groundwatercience.ca

February 4, 2022

**RE: Private Water Well Survey**
**Talbot Sand and Gravel Limited Macpherson Pit.**

Dear Resident:

Groundwater Science Corp. is completing a survey of private water wells in the area of the proposed Macpherson Pit (located next to the existing gravel pit on Truman Line, within Lot 6, Concession 12, Municipality of Central Elgin, County of Elgin) on behalf of Talbot Sand and Gravel Limited. The survey is being completed as part of a groundwater assessment for the site.

The private water well survey includes properties within approximately 500 m of the site. Your residence is in the survey area. The survey will collect information regarding well locations, construction, depth, etc. The results will be used as part of the groundwater assessment.

**Participation in the private water well survey program is voluntary**. This letter is to inform you of the survey and to request your participation. Due to current concerns regarding Covid-19, a copy of this letter and survey package will be delivered to each resident's mailbox within the survey area by a representative of Groundwater Science Corp. No personal contact will be made at this time. If you have questions or would like to request additional information, please call or email us using the contact information provided below.

The survey package includes an information sheet that can be filled out to summarize details regarding your well. If you are interested in participating please complete and return the survey form (only) in the self-addressed stamped envelope. Please retain this letter for your information. Scans or photographs of the completed forms can also be sent by email to: apentney@rogers.com.

If you have any questions or require assistance with the survey form, please call Andrew Pentney at 519-746-6916 (Waterloo). We would like to have the survey completed by February 18, 2022.

Thank-you in advance for your consideration in this matter.

Sincerely,

Andrew Pentney, P.Geo.
Hydrogeologist.

| Water Well Inventory | Project: **Macpherson Pit** | Date: |
|---|---|---|

Some personal information (name, address and phone number) is collected as part of this survey for the sole purpose of identifying and communicating with the respondent. There will be no electronic copy made of this information and the data will not be disclosed to third parties or referenced in the environmental study report.

☐ I consent to the collection and use of the following personal information for the above stated purpose.

Respondent: _____ Emergency Locate (Road) No.: _____

Mailing Address: _____ Telephone No.: _____

**1. How old is the house?** _____ **2. How old is the well?** _____

**3. Water Use:**

Domestic ☐ Pool ☐ Livestock ☐ Garden ☐ other: _____

Well Water Treatment (filter, softener, etc.): _____

**4. Alternative Water Sources Used:**

Bottled ☐ Cistern ☐ Bulk Delivery ☐ other: _____

**5. Well Water Quality and Quantity Comments:**

Quality (colour, odour, taste, staining, etc.) _____

Quantity (eg. does the well go dry?) _____

Has the well ever been tested for quality or quantity? _____

Results of testing: _____

**6. Water Well Record:**

Do you have a copy of the MOE Water Well Record? _____ Record #: _____

Who drilled the well? _____

**7.** **Sketch Map of Well Location** (show road, driveway, house and septic bed)

**8. Well Construction:**

**Well Type** Drilled ☐ Dug ☐ **Well Casing** Cement Tile ☐ Steel ☐ Buried ☐ **Diameter:** _____

**Well Depth (feet):** _____ Describe well access (easy / not easy): _____

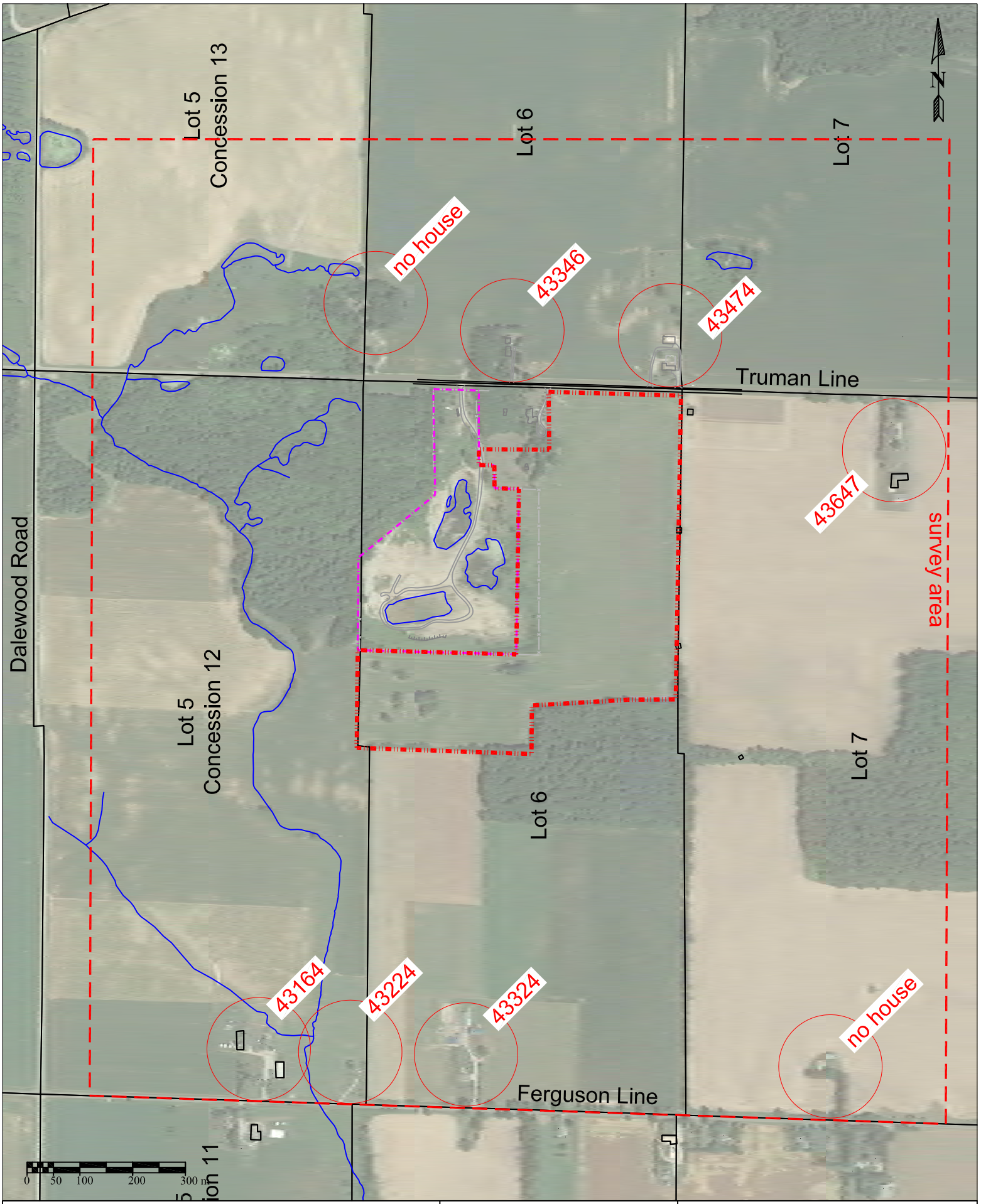
**9. Pump Details:**

Type: jet ☐ submersible ☐ other ☐ intake setting: _____

**10. Monitoring:**

Would you like to have a water level measurement taken at your well? _____

Requested by: _____ Date: _____




Site (approx.)

air photo: Google Earth, 2018

modified from: OBM mapping, Site Plan


February 2022
Scale: as shown

*Groundwater Science Corp.*

# Figure A2: Water Well Survey Area

Talbot Sand and Gravel Limited
Proposed Macpherson Pit

| 911 Locate Number | Road | Date of Survey | Survey Response Date | Depth (m) | MOE Well # | Well Type | Note (well record match information, etc.) |
|---|---|---|---|---|---|---|---|
| 43346 | Truman Line | 4-Feb-22 | no response | - | 2005576 | drilled | match based on WWR info, drilled overburden, depth 29.6m |
| 43474 | Truman Line | 4-Feb-22 | no response | - | 2005274 | drilled | match based on WWR info, drilled overburden, depth 21.3m |
| 43647 | Truman Line | 4-Feb-22 | n/a | n/a | 2001243 | drilled | match based response and WWR, drilled overburden, depth 24.1m |
| 43164 | Ferguson Line | 4-Feb-22 | no response | - | 2001242 | drilled | match based on WWR info, drilled overburden, depth 11.6m |
| | | | | | 2005261 | drilled | match based on WWR info, drilled overburden, depth 14.9m |
| 43224 | Ferguson Line | 4-Feb-22 | no response | - | - | - | no matching WWR located (possible 2005261) |
| 43324 | Ferguson Line | 4-Feb-22 | no response | - | - | - | no matching WWR located |

n/a = information not provided

WWR = water well record

**Table A2: Private Water Well Survey Results Summary**

# *Appendix B*
# *Borehole Logs*

# BOREHOLE LOG

**Borehole: MW1**

Project: MacPherson Pit
Location: southeast corner of western field
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: January 7, 2021.
Supervisor: EP/AP
Elevations TOC: 254.61 mASL
GS: 253.61 mASL

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 0 | 0 | A | | | | **Topsoil -** dark brown silty / sandy | protective casing, cement and bentonite (holeplug) seal to surface. |
| | 1 | A | | | | **Silt / Clay**<br>- brown, silty clay, moist | |
| 5 | 2 | A | | | | **Sand and Gravel**<br>- change in drilling and auger cuttings to brown sand at 1.8 m, stony at 2.8 m (gravel, small stones and cobbles) | |
| 10 | 3 | S | 1 | 3.0 to 3.7 | | - grey/tan fine to medium grained sand, gravel and intermittent small stones, clean, dry | |
| | 4 | | | | | | |
| 15 | 5 | A | | | | - stony layer at 4.6 m (gravel, small stones and cobbles) | |
| 20 | 6 | S | 2 | 6.1 to 6.7 | | - grey/tan fine sand with intermittent layers of medium sand and fine gravel, clean, dry | |
| 25 | 8 | | | | | - stony layer | |
| 30 | 9 | S | 3 | 9.1 to 9.8 | | - grey fine sands with cross bedded layers of silt | |
| 35 | 11 | | | | | - consistent drilling. | silica sand pack. |
| | 12 | | | | | - stony layer | water level 11.85 mBGS January 7, 2021. |
| 40 | | S | 4 | 12.2 to 12.8 | | - dark grey, medium to coarse grained sand with traces of fine sand and intermittent fine gravel | |

# BOREHOLE LOG

**Borehole: MW1**

Project: MacPherson Pit
Location: Southeast corner of field alone pit edge.
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: January 7, 2021.
Supervisor: EP/AP
Elevations TOC: 254.61 mASL
GS: 253.61 mASL

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| | | | | | | - continued - | |
| 40 | | S | 4 | 12.2 to 12.8 | | - dark grey, medium to coarse grained sand with traces of fine sand and intermittent fine gravel, clean, wet | screen length 3.0 m |
| | 13 | | | | | | nominal 5.1 cm diameter PVC riser and slotted screen |
| 45 | | | | | | - consistent drilling | |
| | 14 | | | | | End of Hole at 13.7 m | |
| | 15 | | | | | | |
| 50 | | | | | | | |
| | 16 | | | | | | |
| 55 | | | | | | | |
| | 17 | | | | | | |
| | 18 | | | | | | |
| 60 | | | | | | | |
| | 19 | | | | | | |
| 65 | | | | | | | |
| | 20 | | | | | | |
| | 21 | | | | | | |
| 70 | | | | | | | |
| | 22 | | | | | | |
| | 23 | | | | | | |
| 75 | | | | | | | |
| | 24 | | | | | | |
| 80 | | | | | | | |

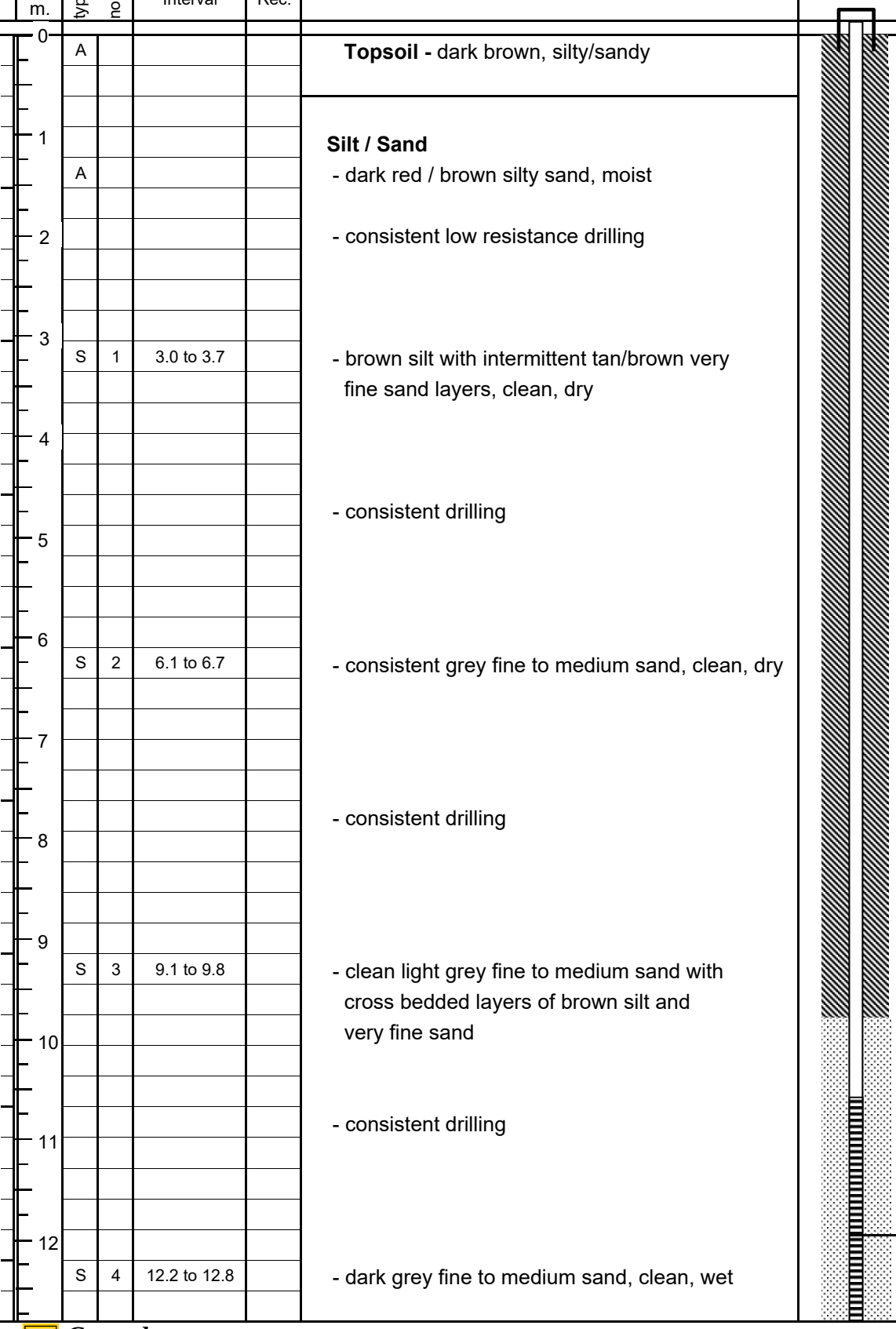
# BOREHOLE LOG

**Borehole: MW2**

Project: MacPherson Pit
Location: southwest corner of existing pit
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: January 7, 2021.
Supervisor: EP/AP
Elevations TOC: 254.60 mASL
GS: 253.69 mASL

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 0 | 0 | A | | | | **Topsoil -** dark brown, silty/sandy | protective casing, cement and bentonite (holeplug) seal to surface. |
| | 1 | | | | | **Silt / Sand** | |
| 5 | | A | | | | - dark red / brown silty sand, moist | |
| | 2 | | | | | - consistent low resistance drilling | |
| 10 | 3 | S | 1 | 3.0 to 3.7 | | - brown silt with intermittent tan/brown very fine sand layers, clean, dry | |
| | 4 | | | | | | |
| 15 | | | | | | - consistent drilling | |
| | 5 | | | | | | |
| 20 | 6 | S | 2 | 6.1 to 6.7 | | - consistent grey fine to medium sand, clean, dry | |
| | 7 | | | | | | |
| 25 | | | | | | - consistent drilling | |
| | 8 | | | | | | |
| 30 | 9 | S | 3 | 9.1 to 9.8 | | - clean light grey fine to medium sand with cross bedded layers of brown silt and very fine sand | |
| | 10 | | | | | | |
| 35 | | | | | | - consistent drilling | silica and native material sand pack |
| | 11 | | | | | | |
| | 12 | | | | | | water level 11.94 mBGS January 7, 2021. |
| 40 | | S | 4 | 12.2 to 12.8 | | - dark grey fine to medium sand, clean, wet | |



BOREHOLE LOG

**Borehole: MW2**

Project: MacPherson Pit
Location: southwest corner of existing pit
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: January 7, 2021.
Supervisor: EP/AP
Elevations TOC: 254.60 mASL
GS: 253.69 mASL

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| | | | | | | - continued - | |
| 40 | | S | 4 | 12.2 to 12.8 | | - consistent dark grey fine to medium sand, clean, wet | screen length 3.0 m |
| | 13 | | | | | | nominal 5.1 cm diameter PVC riser and slotted screen |
| | | A | | | | - consistent drilling | |
| 45 | | | | | | End of Hole at 13.7 m | |
| | 14 | | | | | | |
| | 15 | | | | | | |
| 50 | | | | | | | |
| | 16 | | | | | | |
| 55 | | | | | | | |
| | 17 | | | | | | |
| | 18 | | | | | | |
| 60 | | | | | | | |
| | 19 | | | | | | |
| 65 | | | | | | | |
| | 20 | | | | | | |
| | 21 | | | | | | |
| 70 | | | | | | | |
| | 22 | | | | | | |
| 75 | | | | | | | |
| | 23 | | | | | | |
| | 24 | | | | | | |
| 80 | | | | | | | |

# BOREHOLE LOG

**Borehole: MW3**

Project: MacPherson Pit
Location: southeast of residence
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: January 7, 2021.
Supervisor: EP/AP
Elevations TOC: 258.46 mASL
GS: 257.53 mASL

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 0 | 0 | A | | | | **Topsoil -** dark brown, silty/sandy | protective casing, cement and bentonite (holeplug) seal to surface. |
| | | | | | | **Sand and Gravel** | |
| | 1 | A | | | | - dark red / brown silty sand, moist. | |
| 5 | | | | | | | |
| | 2 | | | | | - consistent low resistance drilling | |
| 10 | 3 | S | 1 | 3.0 to 3.7 | | - brown fine to medium sands with intermittent very fine gravel, clean, dry | |
| | 4 | | | | | | |
| 15 | | A | | | | - decrease in stoniness after 4.6 m, transition to light brown/tan auger cuttings | |
| | 5 | | | | | | |
| 20 | 6 | S | 2 | 6.1 to 6.7 | | - consistent tan fine sand, clean, dry | |
| | 7 | | | | | - consistent low resistance drilling | |
| 25 | | | | | | - increase in stoniness at 7.6 m (gravel) | |
| | 8 | | | | | | |
| 30 | 9 | S | 3 | 9.1 to 9.8 | | - grey/tan fine sand, traces of coarse sand and intermittent fine gravel, clean, dry | |
| | 10 | | | | | | |
| 35 | | | | | | - consistent drilling | |
| | 11 | | | | | | |
| 40 | 12 | S | 4 | 12.2 to 12.8 | | - tan fine sand with intermittent gradational layering, clean, dry | |

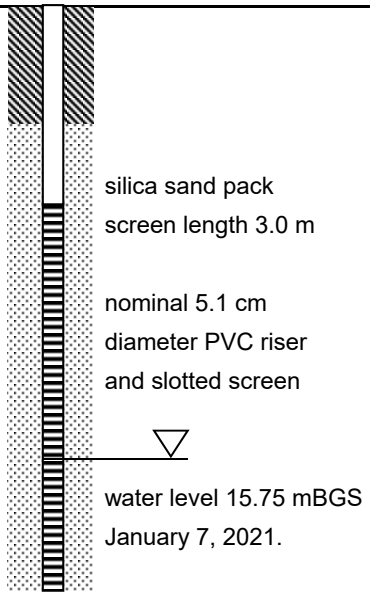
# BOREHOLE LOG

**Borehole: MW3**

Project: MacPherson Pit
Location: Southeast of home.
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: January 7, 2021.
Supervisor: EP/AP
Elevations TOC: 258.46 mASL
GS: 257.53 mASL

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description - continued - | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 40 | | S | 4 | 12.2 to 12.8 | | - tan fine sand with intermittent gradational layering, clean, dry | |
| | 13 | | | | | | |
| 45 | | | | | | - consistent drilling | |
| | 14 | | | | | | |
| | 15 | | | | | | |
| 50 | | S | 5 | 15.2 to 15.8 | | - grey/tan very fine sand with traces of silt, wet | |
| | 16 | | | | | | |
| 55 | | | | | | End of Hole at 16.8 m | |
| | 17 | | | | | | |
| | 18 | | | | | | |
| 60 | | | | | | | |
| | 19 | | | | | | |
| 65 | | | | | | | |
| | 20 | | | | | | |
| | 21 | | | | | | |
| 70 | | | | | | | |
| | 22 | | | | | | |
| 75 | | | | | | | |
| | 23 | | | | | | |
| | 24 | | | | | | |
| 80 | | | | | | | |



# BOREHOLE LOG

**Borehole: BH1-21**

Project: MacPherson Pit
Location: northeast corner of site.
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: January 6, 2021.
Supervisor: AP/EP
Elevations TOC:
GS: 257.8 mASL (approx)

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 0 | 0 | A | | | | **Topsoil -** dark brown, silty / sandy | no monitor installed |
| | | | | | | **Clay** | |
| | 1 | | | | | - rich red/brown clay with minor medium grained sand, moist | borehole backfilled and sealed with bentonite |
| 5 | | | | | | - consistent drilling to 1.8 m | |
| | 2 | | | | | **Sand** | |
| | | A | | | | - change in drilling from clay to sand at 1.8 m | |
| 10 | 3 | S | 1 | 3.0 to 3.7m | | - brown fine to medium grained sands with intermittent pebbles | |
| | | | | | | - consistent drilling to 4.4 m | |
| | 4 | | | | | | |
| 15 | | | | | | **Silt / Clay Till** | |
| | 5 | A | | | | - drilling resistance increase at 4.4 m, with increase in silt/clay content, minor fine sand noted in auger cuttings | |
| | 6 | | | | | | |
| 20 | | S | 2 | 6.1 to 6.7m | | - dry grey silt/clay till with intermittent pebbles, dense | |
| | 7 | | | | | End of Hole at 6.7 m | |
| 25 | | | | | | | |
| | 8 | | | | | | |
| 30 | 9 | | | | | | |
| | 10 | | | | | | |
| 35 | | | | | | | |
| | 11 | | | | | | |
| | 12 | | | | | | |
| 40 | | | | | | | |

# BOREHOLE LOG

**Borehole: BH2-21**

Project: MacPherson Pit
Location: northern edge of site, west of BH1-21
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: January 6, 2021.
Supervisor: AP/EP
Elevations TOC:
GS: 258.0 mASL (approx)

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 0 | 0 | A | | | | **Topsoil -** dark brown, silty / sandy | no monitor installed |
| | | | | | | **Cay** | |
| | 1 | | | | | - rich red/brown clay with minor medium grained sand to 1.2 m, moist | borehole backfilled and sealed with bentonite |
| 5 | | | | | | **Sand** - change in drilling at 1.2 m to brown sand | |
| | 2 | A | | | | - few intermittent stones/cobbles | |
| 10 | 3 | S | 1 | 3.0 to 3.7m | | - brown fine to medium grained sands with intermittent pebbles, dry | |
| | 4 | | | | | | |
| 15 | | A | | | | - consistent drilling to 5.8 m | |
| | 5 | | | | | | |
| | 6 | | | | | **Silt / Sand Till** | |
| 20 | | S | 2 | 6.1 to 6.7m | | - drilling resistance increase at 5.8 m, significant increase in silt/clay content | |
| | 7 | A | | | | - brown sandy/silty till with minor clay traces and intermittent pebbles, sand seam at 6.7 m | |
| 25 | | A | | | | - greying downward with increase in clay/silt | |
| | 8 | | | | | | |
| | 9 | | | | | | |
| 30 | | S | 3 | 9.1 to 9.8m | | - dense dry grey/brown silty till with intermittent fine to coarse gravel | |
| | 10 | | | | | End of Hole at 9.8 m | |
| 35 | 11 | | | | | | |
| | 12 | | | | | | |
| 40 | | | | | | | |

*Groundwater Science Corp.*

# BOREHOLE LOG

**Borehole: BH3-21**

Project: MacPherson Pit
Location: south edge of east field, along treeline.
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: January 6, 2021.
Supervisor: AP/EP
Elevations TOC:
GS: 253.4 mASL (approx)

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 0 | 0 | A | | | | **Topsoil -** dark brown, silty / sandy | no monitor installed. |
| | | | | | | **Silt / Clay Till** | |
| | | A | | | | - rich red/brown tight silty clay till with minor medium grained sand and intermittent pebbles, moist | borehole backfilled and sealed with bentonite |
| | 1 | | | | | | |
| 5 | | | | | | | |
| | 2 | | | | | - consistent drilling | |
| | | | | | | | |
| 10 | 3 | S | 1 | 3.0 to 3.7m | | - brown tight silty clay till with minor medium grained sand and intermittent pebbles and gravel | |
| | 4 | A | | | | - increase in stoniness between 3.0 to 3.4 m. based on drilling observations and cuttings | |
| 15 | | A | | | | - sand seam from 4.3 to 4.5 m | |
| | 5 | A | | | | - brown sandy/silty till from 4.5 to 5.8 m | |
| | | | | | | - increase in sand content after 5.8 m | |
| 20 | 6 | S | 2 | 6.1 to 6.7m | | - brown coarse sandy till with intermittent pebbles, minor silt content, compact, dry | |
| | 7 | | | | | | |
| 25 | | A | | | | - consistent drilling to 7.6 m, dry | |
| | 8 | | | | | End of Hole at 7.6 m | |
| 30 | 9 | | | | | | |
| | 10 | | | | | | |
| 35 | | | | | | | |
| | 11 | | | | | | |
| | | | | | | | |
| 40 | 12 | | | | | | |

# BOREHOLE LOG

**Borehole: BH4-22**

Project: MacPherson Pit
Location: existing pit floor
Method: Hollow stem auger
Samples: auger cuttings (A) and split spoon (S)

Date: February 25, 2022
Supervisor: AP
Elevations TOC:
GS: 244 mASL (approx)

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 0 | 0 | | | | | **Sand, transition to Gravel** | no monitor installed. |
| | | A | | | | - tan to light brown very fine sand, some silt, moist | borehole backfilled and sealed with bentonite |
| | 1 | | | | | - water table estimated at 1 m depth (approx) | |
| 5 | | S | 1 | 1.5 to 2.1 | 70% | - as above, wet | |
| | 2 | | | | | | |
| 10 | 3 | S | 2 | 3.0 to 3.7m | 80% | - fine sand, minor silt, wet | |
| | 4 | | | | | | |
| 15 | | S | 3 | 4.6 to 5.2 | 80% | - as above | |
| | 5 | | | | | | |
| 20 | 6 | S | 4 | 6.1 to 6.7m | 100% | - fine to medium gravel and fine to medium sand, minor silt, wet | |
| | 7 | | | | | End of Hole at 6.7 m | |
| 25 | | | | | | unable to drill further below water table due to heaving sands | |
| | 8 | | | | | | |
| 30 | 9 | | | | | | |
| | 10 | | | | | | |
| 35 | | | | | | | |
| | 11 | | | | | | |
| | 12 | | | | | | |
| 40 | | | | | | | |

# BOREHOLE LOG

**Borehole: BH5-22**

Project: MacPherson Pit
Location: existing pit floor, near BH4
Method: Auger to 3m, then Mud Rotary
Samples: drill cuttings (D) and split spoon (S)

Date: May 19, 2022
Supervisor: AP
Elevations TOC:
GS: 244 mASL (approx)

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval (m) | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 0 | 0 | | | | | **Sand, transition to Gravel** | no monitor installed. |
| | | | | see | | - tan to light brown very fine sand, some silt, moist | |
| | | | | BH4 log | | | borehole backfilled and sealed with bentonite |
| | 2 | | | detailed | | - water table estimated at 1 m depth (approx) | |
| | | | | sampling | | | |
| 10 | | | | to 6.7m | | - fine sand, minor silt, wet | |
| | 4 | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 20 | 6 | | | | | - fine to medium gravel and fine to medium sand, minor silt, wet | |
| | | | | | | | |
| | 8 | D | | | | - fine sand, some clay (thin layer) | |
| | | | | | | | |
| 30 | | | | | | | |
| | 10 | | | | | | |
| | | S | 1 | 10.7 to 11.3 | 50% | - interlayed: 0.06m clean fine to medium sand and gravel; 0.06m very fine sand; 0.06m clean medium sand; 0.06m medium sand and fine gravel, some silt and clay; remainder clean fine sand and fine gravel | |
| | | | | | | | |
| 40 | 12 | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | 14 | | | | | | |
| | | | | | | | |
| 50 | | | | | | | |
| | 16 | D | | | | - primarily fine to medium sand | |
| | | | | | | | |
| | | | | | | | |
| | 18 | | | | | | |
| 60 | | D | | | | - as above | |
| | | | | | | | |
| | 20 | | | | | | |
| | | | | | | | |
| 70 | | | | | | | |
| | 22 | D | | | | - as above | |
| | | | | | | | |
| | | | | | | | |
| | 24 | | | | | | |
| 80 | | D | | | | - very fine sand | |

# BOREHOLE LOG

**Borehole: BH5-22**

Project: MacPherson Pit
Location: existing pit floor, near BH4
Method: Auger to 3m, then Mud Rotary
Samples: drill cuttings (D) and split spoon (S)

Date: May 19, 2022
Supervisor: AP
Elevations TOC:
GS: 244 mASL (approx)

| Depth Ft. | Depth m. | Sample type | Sample no. | Sample Interval (m) | Sample Rec. | Description | Monitor Installation |
|---|---|---|---|---|---|---|---|
| 80 | | D | | | | - very fine sand | no monitor installed. |
| | 26 | D | | | | - fine to medium sand | borehole backfilled and sealed with bentonite |
| 90 | | D | | | | - as above | |
| | 28 | D | | | | - as above | |
| | 30 | | | | | | |
| 100 | | D | | | | - compact very fine sand layer, then fine sand with fine gravel | |
| | 32 | D | | | | - drilling indicates 1m coarse layer: sand, gravel, some stones possible | |
| 110 | | D | | | | - primarily very fine sand | |
| | 34 | D | | | | - drilling indicates 1 m gravelly layer then compact sand, silt possible | |
| | 36 | D | | | | - very fine sand | |
| 120 | | | | | | **End of hole at 36.6m** | |
| | 38 | | | | | | |
| 130 | | | | | | | |
| | 40 | | | | | | |
| | 42 | | | | | | |
| 140 | | | | | | | |
| | 44 | | | | | | |
| 150 | | | | | | | |
| | 46 | | | | | | |
| | 48 | | | | | | |
| 160 | | | | | | | |

1994 Drilling Results, from:

**HAROLD E. STAFFORD, Q.C.**
**Barrister and Solicitor**
P.O. Box 575
458 Talbot Street
St. Thomas Ontario
N5P 3V8

# Report On
# GEOTECHNICAL INVESTIGATION
# to
# ASSESS COMMERCIAL AGGREGATE SUPPLY, DONALD FERGUSON ESTATE,
# North Half of Lot 6, Concession 12, Township of Yarmouth

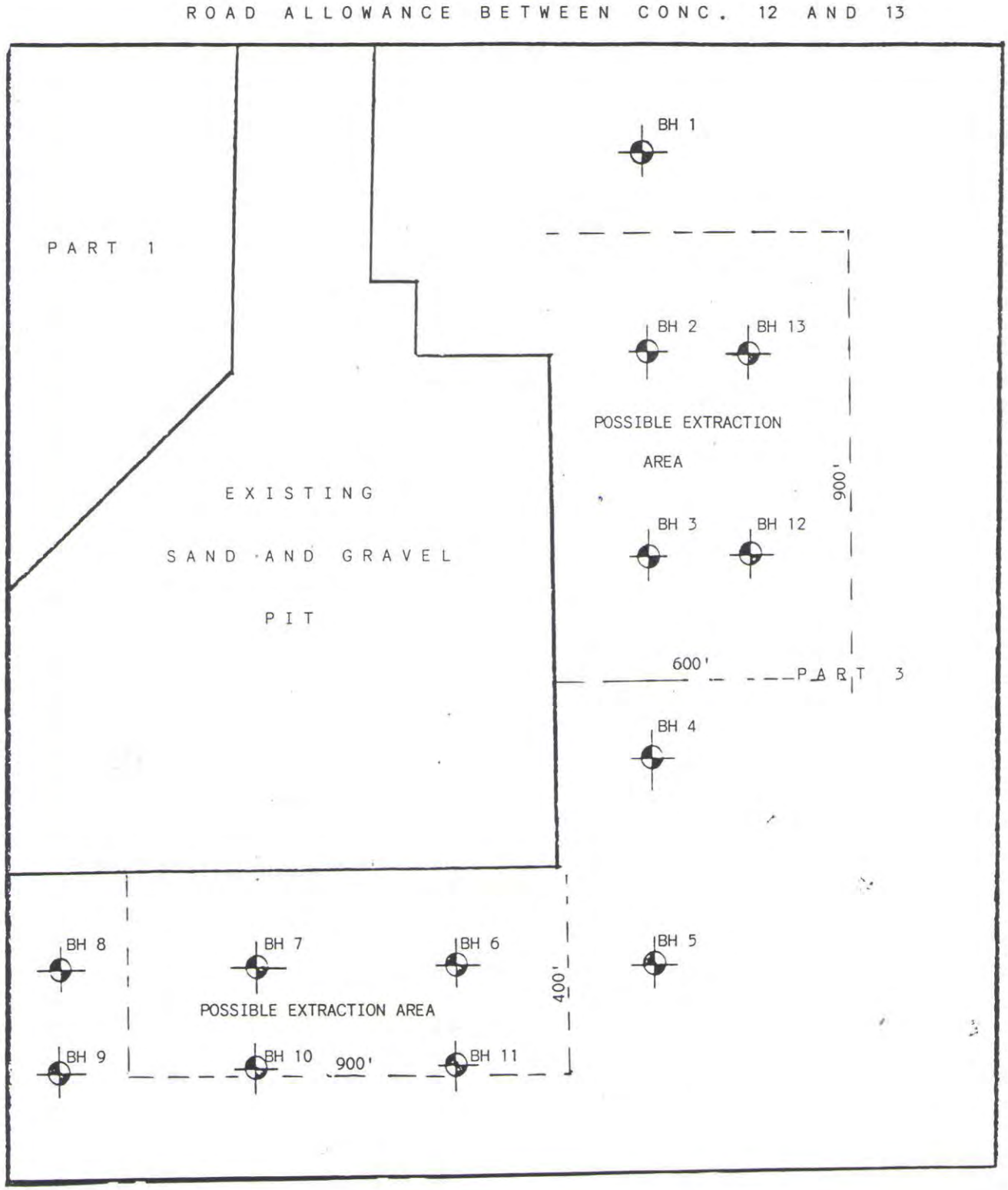
*Ref.: 1-2044*

September 16, 1994

**ATKINSON, DAVIES INC.**

Ref: 1-2044

Enclosure No.2




SITE PLAN

Scale 1 inch = 300 feet

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 1

Encl. No. 3
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | NUMBER | TYPE | 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 10" Topsoil. | | | | | | | | | |
| | | Loose dark brown silt and fine sand. | | | 1 | SS | 7 | | | | |
| | 5.0 | Dense fine sand, trace of gravelly silt. | | | 2 | SS | 40 | | | | |
| | 11.5 | Hard grey/brown silty clay. | | | 3 | SS | 82 | | | | |
| | | | | | 4 | SS | 97 | | | | |
| | 20.0 | Very dense sand, trace to some gravel, trace of silt. | | | 5 | SS | 89 | | | | |
| | | | | | 6 | SS | 55/6" | | | | |
| | 30.0 | Very dense fine sand, trace to some silt. | | | 7 | SS | 95 | | | | |
| | | | | | 8 | SS | 83 | | | | |
| | | | | | 9 | SS | 86 | | | | |
| | | | | | 10 | SS | 67 | | | | |

ATKINSON DAVIES INC.

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 2

Encl. No. 4
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | NUMBER | TYPE | 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 10" Topsoil. | | | | | | | | | |
| | | Compact | | | 1 | SS | 21 | | | | |
| | | to | | | 2 | SS | 32 | | | | |
| | | dense | | | 3 | SS | 18 | | | | |
| | | brown | | | 4 | SS | 33 | | | | |
| | | fine | | | 5 | SS | 83 | | | | |
| | | sand, | | | 6 | SS | 66 | | | | |
| | | some | | | 7 | SS | 52 | | | | |
| | | silt. | | | 8 | SS | 63 | | | | |
| | | Sieve Analyses see Enclosure No. 17 | | | | | | | | | |
| | 40.0 | Very dense | | | 9 | SS | 50/6" | | | | |
| | | fine to | | | 10 | SS | 66 | | | | |
| | | coarse | | | | | | | | | |
| | | sand, | | | | | | | | | |
| | | some silt, | | | | | | | | | |
| | | trace of gravel. | | | | | | | | | |
| | | Sieve- Enclosure No. 18 | | | 11 | SS | 64 | | | | |

ATKINSON DAVIES INC.

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 3

Encl. No. 5
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | SAMPLES NUMBER | TYPE | 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 10" Topsoil. | | | | | | | | | |
| | | Compact brown sandy silt. | | | 1 | SS | 16 | | | | |
| | 6.0 | Loose brown fine sand, trace of silt. | | | 2 | SS | 3 | | | | |
| | 12.0 | Compact to very dense sand and gravel, trace of silt. Sieve- Enclosure No. 19 | | | 3 | SS | 17 | | | | |
| | | | | | 4 | SS | 62 | | | | |
| | 21.0 | Very dense brown fine sand, some silt. Sieve- Enclosure No. 20 | | | 5 | SS | 54 | | | | |
| | | | | | 6 | SS | 93 | | | | |
| | | | | | 7 | SS | 96 | | | | |
| | | | | | 8 | SS | 58 | | | | |
| | | | | | 9 | SS | 73 | | | | |
| | 48.5 | Very dense coarse sand, traces of gravel and silt. | | ▽ | 10 | SS | 69 | | | | |
| | | | | | 11 | SS | 101 | | | | |

ATKINSON DAVIES INC

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 4

Encl. No. 6
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 9" Topsoil. | | | | | | | | | |
| | | Loose rusty brown fine sand, some silt. | | | 1 | SS | 3 | | | | |
| | 5.0 | Compact silt and fine sand. | | | 2 | SS | 18 | | | | |
| | 11.0 | Dense to very dense fine sand, trace to some silt, silt layers. | | | 3 | SS | 37 | | | | |
| | | | | | 4 | SS | 55 | | | | |
| | | | | | 5 | SS | 38 | | | | |
| | | | | | 6 | SS | 51 | | | | |
| | | | | | 7 | SS | 69 | | | | |
| | | | | | 8 | SS | 74 | | | | |
| | | | | | 9 | SS | 72 | | | | |
| | | | | | 10 | SS | 41 | | | | |
| | 47.5 | End of Borehole | | | | | | | | | |

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 5

Encl. No. 7
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | SAMPLES NUMBER | TYPE | 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 — Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 10" Topsoil. | | | | | | | | | |
| | | Very stiff brown clayey silt. | | | 1 | SS | 15 | | | | |
| | 6.0 | Very dense brown silt. | | | 2 | SS | 56 | | | | |
| | 11.0 | Very dense brown sandy silt, embedded gravel. | | Hole dry at completion | 3 | SS | 76 | | | | |
| | | | | | 4 | SS | 50/5" | | | | |
| | | | | | 5 | SS | 105 | | | | |
| | 24.0 | End of Borehole | | | | | | | | | |

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 6

Encl. No. 8
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| SUBSURFACE PROFILE | | | | | SAMPLES | | | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | NUMBER | TYPE | 'N' Blow/Ft | | | | |
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 10" Topsoil. | | | | | | | | | |
| | | Sandy silt. | | | | | | | | | |
| | 2.0 | Compact to very dense brown fine sand, some silt, seams and layers of silt. | | | 1 | SS | 16 | | | | |
| | | | | | 2 | SS | 47 | | | | |
| | | | | | 3 | SS | 45 | | | | |
| | | | | | 4 | SS | 66 | | | | |
| | | | | | 5 | SS | 63 | | | | |
| | 25.0 | Very dense fine sand, trace of silt. | | | 6 | SS | 51 | | | | |
| | 31.0 | Very dense fine to coarse sand, some gravel, trace of silt. Sieve- Enclosure No. 21 | | | 7 | SS | 66 | | | | |
| | | | | | 8 | SS | 62 | | | | |
| | 41.0 | Grey fine sand, trace of silt. | | | 9 | SS | 58 | | | | |
| | 46.0 | Sand and gravel, trace of silt. | | | 10 | SS | 52 | | | | |
| | 49.0 | End of Borehole | | | | | | | | | |

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 7

Encl. No. 9
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 — Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 9" Topsoil. | | | | | | | | | |
| | | Sandy silt. | | | | | | | | | |
| | 3.3 | Sand and gravel, trace of silt. | | | 1 | SS | 22 | | | | |
| | 6.0 | Very dense brown fine sand, trace of silt. | | | 2 | SS | 65 | | | | |
| | | | | | 3 | SS | 62 | | | | |
| | 15.0 | Very dense sand and gravel, trace of silt. | | | 4 | SS | 66/6" | | | | |
| | | | | | 5 | SS | 74/4" | | | | |
| | | Sieve- Enclosure No. 22 | | | | | | | | | |
| | 27.0 | Very dense fine to coarse sand, some gravel, trace of silt. | | | 6 | SS | 98 | | | | |
| | | | | | 7 | SS | 68 | | | | |
| | | | | | 8 | SS | 91 | | | | |
| | | Sieve- Enclosure No. 22 | | | | | | | | | |
| | 41.0 | Very dense fine sand, trace of silt. | | | 9 | SS | 82 | | | | |
| | 46.0 | Very dense fine to coarse sand, trace of silt. | | | 10 | SS | 105 | | | | |
| | 49.0 | End of Borehole | | | | | | | | | |

ATKINSON DAVIES INC.

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 8

Encl. No. 10

DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 9" Topsoil. | | | | | | | | | |
| | | Compact brown sandy silt. | | | 1 | SS | 12 | | | | |
| | 5.0 | Loose fine to medium sand, traces of gravel and silt. | | | 2 | SS | 6 | | | | |
| | 10.0 | Very dense silty fine sand. | | | 3 | SS | 76 | | | | |
| | | | | | 4 | SS | 62 | | | | |
| | | | | | 5 | SS | 53 | | | | |
| | | | | | 6 | SS | 55 | | | | |
| | | Sieve- Enclosure No. 23 | | | | | | | | | |
| | 31.0 | Very dense sand and gravel, trace of silt. | | | 7 | SS | 87 | | | | |
| | | | | | 8 | SS | 61 | | | | |
| | | Sieve- Enclosure No. 24 | | | | | | | | | |
| | 42.0 | Fine sand. | | | 9 | SS | 102 | | | | |
| | 44.0 | End of Borehole | | | | | | | | | |

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 9

Encl. No. 11
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 8" Topsoil. | | | | | | | | | |
| | 2.8 | Clayey sandy silt. | | | | | | | | | |
| | | Loose to dense fine sand, some silt, trace of gravel. | | | 1 | SS | 6 | | | | |
| | | | | | 2 | SS | 19 | | | | |
| | | | | | 3 | SS | 3 | | | | |
| | | | | | 4 | SS | 51 | | | | |
| | | | | | 5 | SS | 41 | | | | |
| | | Sieve- Enclosure No. 25 | | | | | | | | | |
| | 26.0 | Very dense gravelly sand, trace of silt. | | | 6 | SS | 70 | | | | |
| | | | | | 7 | SS | 86 | | | | |
| | | Sieve- Enclosure No. 25 | | | 8 | SS | 58 | | | | |
| | 40.0 | Compact grey silty fine sand. | | ▽ | 9 | SS | 24 | | | | |
| | 44.0 | End of Borehole | | | | | | | | | |

ATKINSON DAVIES INC.

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 10

Encl. No. 12
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | SAMPLES NUMBER | TYPE | 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 10" Topsoil. | | | | | | | | | |
| | | Dark brown clayey silt. | | | 1 | SS | 9 | | | | |
| | 5.0 | Very dense silty fine to coarse sand and gravel. Sieve- Enclosure No. 26 | | | 2 | SS | 52 | | | | |
| | | | | | 3 | SS | 79 | | | | |
| | | | | | 4 | SS | 60 | | | | |
| | | | | | 5 | SS | 100 | | | | |
| | 25.0 | Very dese brown fine sand, trace to some silt. | | | 6 | SS | 107 | | | | |
| | | | | | 7 | SS | 56 | | | | |
| | | | | | 8 | SS | 80 | | | | |
| | | | | | 9 | SS | 73 | | | | |
| | 44.0 | End of Borehole | | | | | | | | | |

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 11

Encl. No. 13
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 8" Topsoil. | | | | | | | | | |
| | | Dark brown sandy silt. | | | 1 | SS | 7 | | | | |
| | 5.0 | Dense brown fine sand, trace of silt. | | | 2 | SS | 47 | | | | |
| | 11.0 | Dense to very dense sand and gravel, trace of silt. | | | 3 | SS | 49 | | | | |
| | | | | | 4 | SS | 82 | | | | |
| | | Sieve- Enclosure No. 27 | | | 5 | SS | 60 | | | | |
| | 25.0 | Very dense brown fine sand, some silt. | | | 6 | SS | 45 | | | | |
| | | | | | 7 | SS | 81 | | | | |
| | | | | | 8 | SS | 101 | | | | |
| | | | | | 9 | SS | 82 | | | | |
| | 44.0 | End of Borehole | | | | | | | | | |

ATKINSON, DAVIES INC.

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 12

Encl. No. 14
DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | SAMPLES NUMBER | SAMPLES TYPE | SAMPLES 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 10" Topsoil. | | | | | | | | | |
| | | Sandy clayey silt. | | | | | | | | | |
| | 3.0 | Loose brown fine sand, some silt. | | | 1 | SS | 9 | | | | |
| | 6.0 | Dense to very dense silty fine sand. | | | 2 | SS | 30 | | | | |
| | | | | | 3 | SS | 40 | | | | |
| | | | | | 4 | SS | 56 | | | | |
| | | Sieve- Enclosure No. 28 | | | 5 | SS | 60 | | | | |
| | 26.0 | Very dense silty fine to coarse sand, trace of gravel. | | | 6 | SS | 68 | | | | |
| | | Sieve- Enclosure No. 28 | | | 7 | SS | 85 | | | | |
| | | | | | 8 | SS | 58 | | | | |
| | 41.0 | Very dense fine sand, trace of silt. | | | 9 | SS | 71 | | | | |
| | 47.0 | Very dense gravelly fine to coarse sand, trace of silt. | | | 10 | SS | 82 | | | | |

ATKINSON DAVIES INC.

REF. NO.: 1-2044
CLIENT: Harold E. Stafford Q.C.
PROJECT: Gravel Exploration
LOCATION: Donald Ferguson Estate, N½ Lot 6, Conc. 12, Yarmouth
DATUM ELEVATION: Ground Surface

# LOG OF BOREHOLE NO. 13

Encl. No. 15

DRILLING DATA:
METHOD: Auger
DIAMETER: hollow stem
DATE: Aug. 31 to Sept. 9, 1994

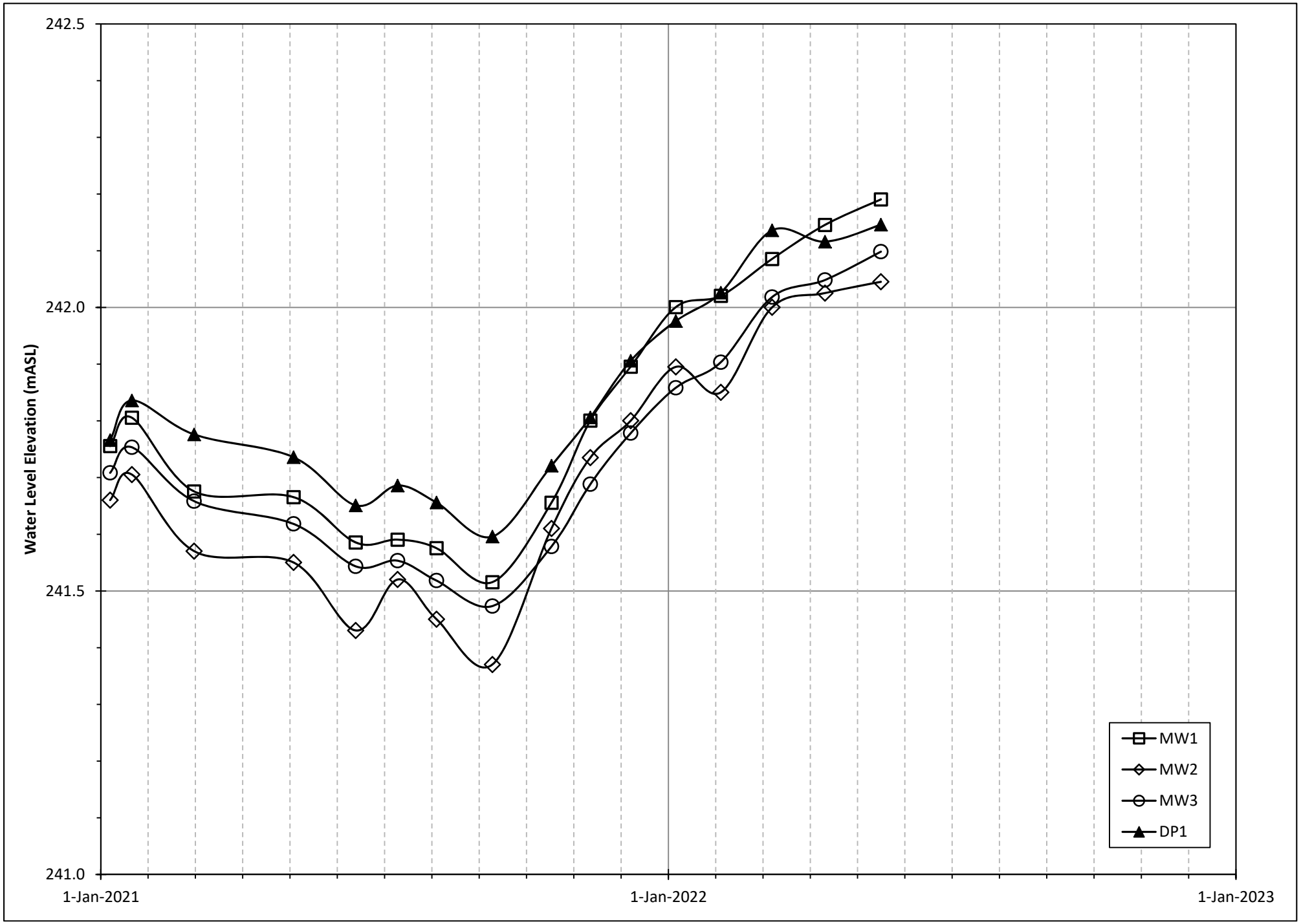
| Elev. feet | Depth feet | DESCRIPTION | SYMBOL | GROUND WATER | NUMBER | TYPE | 'N' Blow/Ft | Penetration Resistance Blows/Ft. 20 40 60 80 100 / Undrained Shear Strength p.s.f. + Field Vane Test • Compression Test | PLASTIC LIMIT % | NATURAL WATER % | LIQUID LIMIT % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | Ground Surface | | | | | | | | | |
| | | 10" Topsoil. | | | | | | | | | |
| | 2.0 | Silty sand. | | | | | | | | | |
| | | Loose | | | 1 | SS | 9 | | | | |
| | | to | | | 2 | SS | 22 | | | | |
| | | very | | | | | | | | | |
| | | dense wet silt layer | | | 3 | SS | 28 | | | | |
| | | fine | | | | | | | | | |
| | | sand, | | | 4 | SS | 70 | | | | |
| | | trace | | | 5 | SS | 70 | | | | |
| | | of | | | | | | | | | |
| | | silt. | | | 6 | SS | 77 | | | | |
| | | Sieve- Enclosure No. 29 | | | 7 | SS | 59 | | | | |
| | 36.0 | Very dense | | | 8 | SS | 91 | | | | |
| | | silty | | | | | | | | | |
| | | fine | | | 9 | SS | 77 | | | | |
| | | sand. | | | | | | | | | |
| | | | | | 10 | SS | 72 | | | | |
| | 54.0 | | | | 11 | SS | 72 | | | | |

ATKINSON, DAVIES INC

# *Appendix C*
# *Water Level Monitoring Results*

| Date | Water Level Elevation (mASL) | | | |
|---|---|---|---|---|
| | MW1 | MW2 | MW3 | DP1 |
| TOW: | 254.61 | 254.60 | 258.46 | 242.77 |
| 7-Jan-21 | 241.76 | 241.66 | 241.71 | 241.77 |
| 21-Jan-21 | 241.81 | 241.71 | 241.75 | 241.84 |
| 2-Mar-21 | 241.68 | 241.57 | 241.66 | 241.78 |
| 5-May-21 | 241.67 | 241.55 | 241.62 | 241.74 |
| 14-Jun-21 | 241.59 | 241.43 | 241.54 | 241.65 |
| 11-Jul-21 | 241.59 | 241.52 | 241.55 | 241.69 |
| 5-Aug-21 | 241.58 | 241.45 | 241.52 | 241.66 |
| 10-Sep-21 | 241.52 | 241.37 | 241.47 | 241.60 |
| 18-Oct-21 | 241.66 | 241.61 | 241.58 | 241.72 |
| 12-Nov-21 | 241.80 | 241.74 | 241.69 | 241.81 |
| 8-Dec-21 | 241.90 | 241.80 | 241.78 | 241.91 |
| 6-Jan-22 | 242.00 | 241.90 | 241.86 | 241.98 |
| 4-Feb-22 | 242.02 | 241.85 | 241.90 | 242.03 |
| 9-Mar-22 | 242.09 | 242.00 | 242.02 | 242.14 |
| 12-Apr-22 | 242.15 | 242.03 | 242.05 | 242.12 |
| 18-May-22 | 242.19 | 242.05 | 242.10 | 242.15 |

notes:
mASL = metres above sea level
TOW = top of well

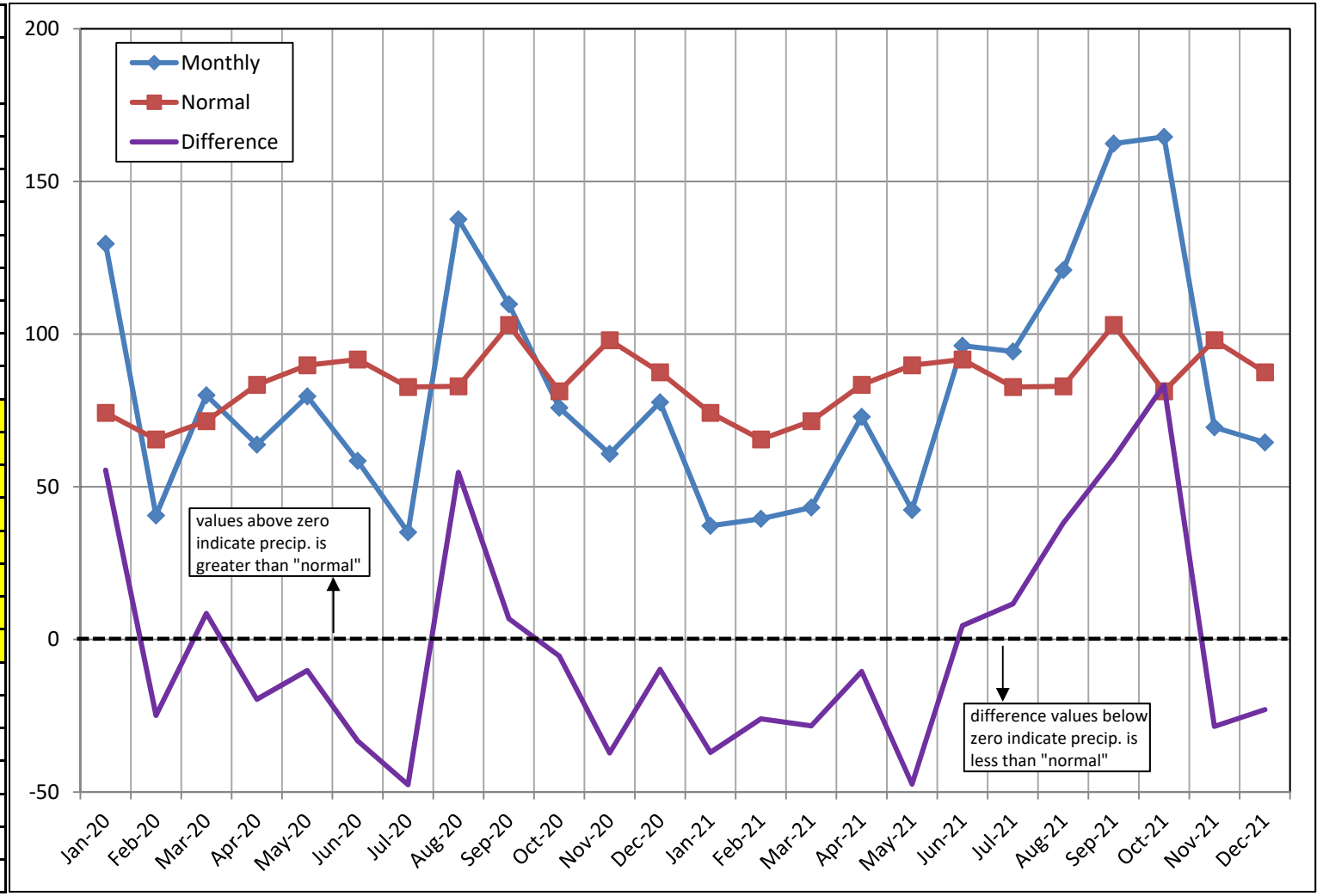



Talbot Sand and Gravel Limited
Proposed Macpherson Pit

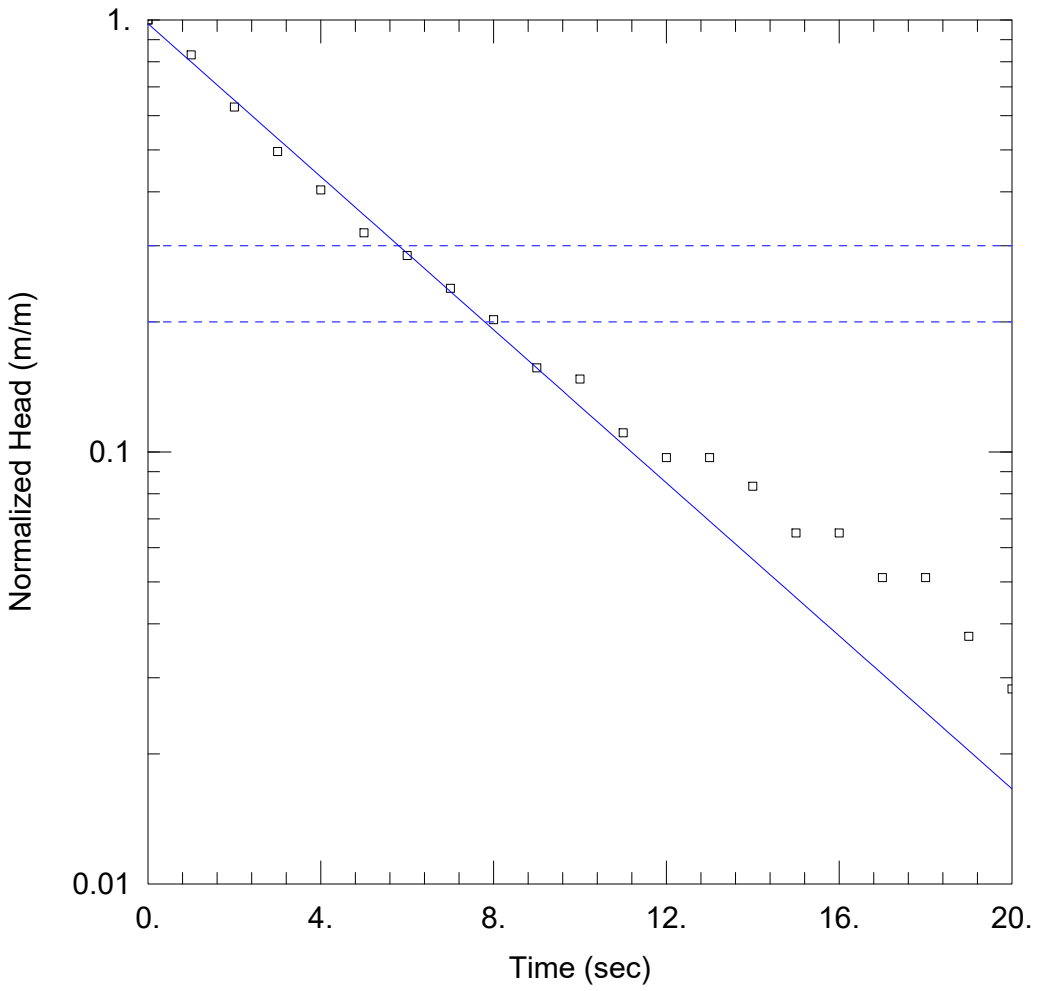
**Water Level Hydrograph**

Groundwater Science Corp.
Hydrogeologic Assessment

| Month | Reported Monthly Precipitation | | |
|---|---|---|---|
| | Monthly (mm) | Normal (mm) | Difference (mm) |
| Jan-20 | 129.6 | 74.2 | 55.4 |
| Feb-20 | 40.6 | 65.5 | -24.9 |
| Mar-20 | 80 | 71.5 | 8.5 |
| Apr-20 | 63.8 | 83.4 | -19.6 |
| May-20 | 79.6 | 89.8 | -10.2 |
| Jun-20 | 58.5 | 91.7 | -33.2 |
| Jul-20 | 35.1 | 82.7 | -47.6 |
| Aug-20 | 137.6 | 82.9 | 54.7 |
| Sep-20 | 109.8 | 103 | 6.8 |
| Oct-20 | 75.9 | 81.3 | -5.4 |
| Nov-20 | 60.8 | 98 | -37.2 |
| Dec-20 | 77.7 | 87.5 | -9.8 |
| Jan-21 | 37.2 | 74.2 | -37 |
| Feb-21 | 39.5 | 65.5 | -26 |
| Mar-21 | 43.2 | 71.5 | -28.3 |
| Apr-21 | 72.9 | 83.4 | -10.5 |
| May-21 | 42.4 | 89.8 | -47.4 |
| Jun-21 | 96.2 | 91.7 | 4.5 |
| Jul-21 | 94.3 | 82.7 | 11.6 |
| Aug-21 | 121 | 82.9 | 38.1 |
| Sep-21 | 162.4 | 103 | 59.4 |
| Oct-21 | 164.6 | 81.3 | 83.3 |
| Nov-21 | 69.5 | 98 | -28.5 |
| Dec-21 | 64.5 | 87.5 | -23 |



# *Appendix D*
# *Response Test Analysis*




## WELL TEST ANALYSIS

### PROJECT INFORMATION

Company: Groundwater Science Corp.
Client: Talbot Sand and Gravel Limited
Location: Macpherson Pit
Test Well: MW2
Test Date: January 21, 2021

### AQUIFER DATA

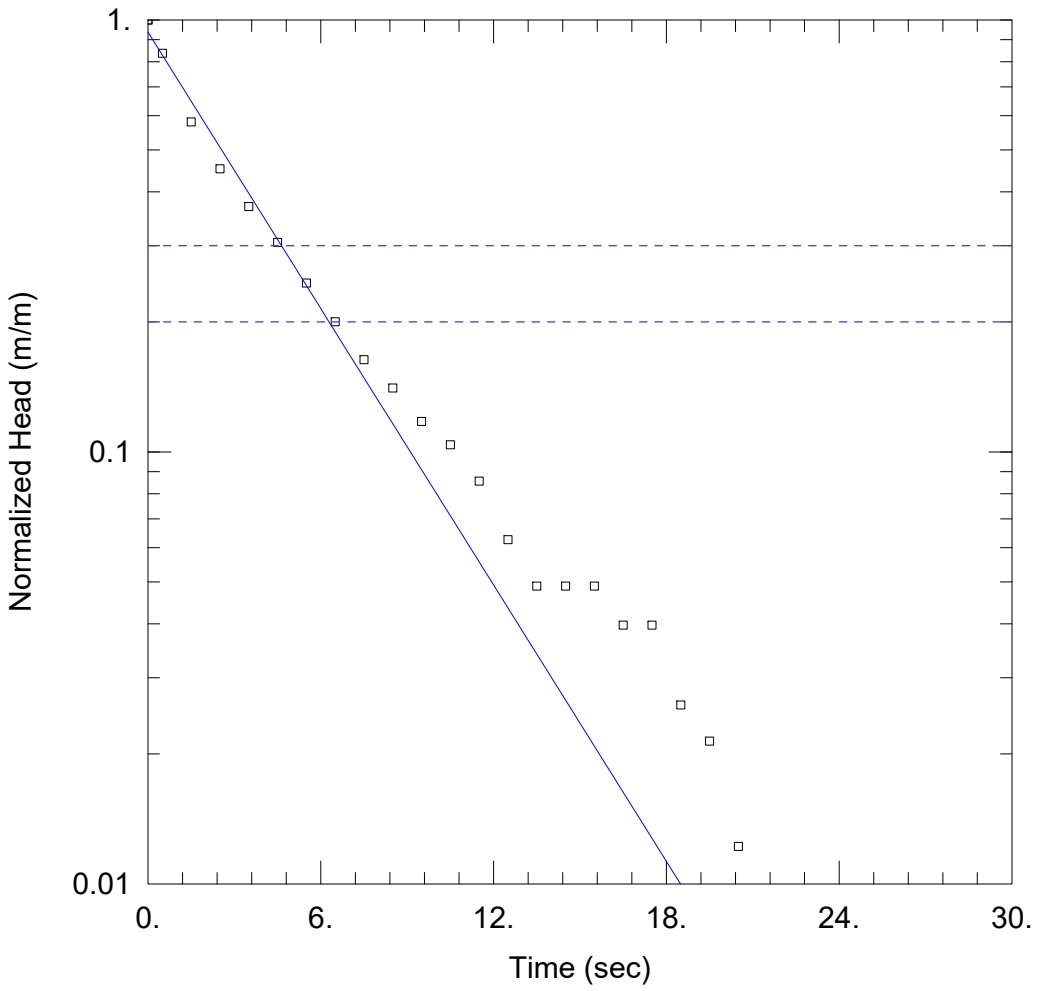
Saturated Thickness: 11. m
Anisotropy Ratio (Kz/Kr): 0.1

### WELL DATA (MW2 rising head #1)

Initial Displacement: 0.2 m
Total Well Penetration Depth: 3. m
Casing Radius: 0.0254 m
Static Water Column Height: 2.16 m
Screen Length: 3. m
Well Radius: 0.1016 m
Gravel Pack Porosity: 0.

### SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 6.665E-5 m/sec
y0 = 0.196 m




## WELL TEST ANALYSIS

### PROJECT INFORMATION

Company: Groundwater Science Corp.
Client: Talbot Sand and Gravel Limited
Location: Macpherson Pit
Test Well: MW2
Test Date: January 21, 2021

### AQUIFER DATA

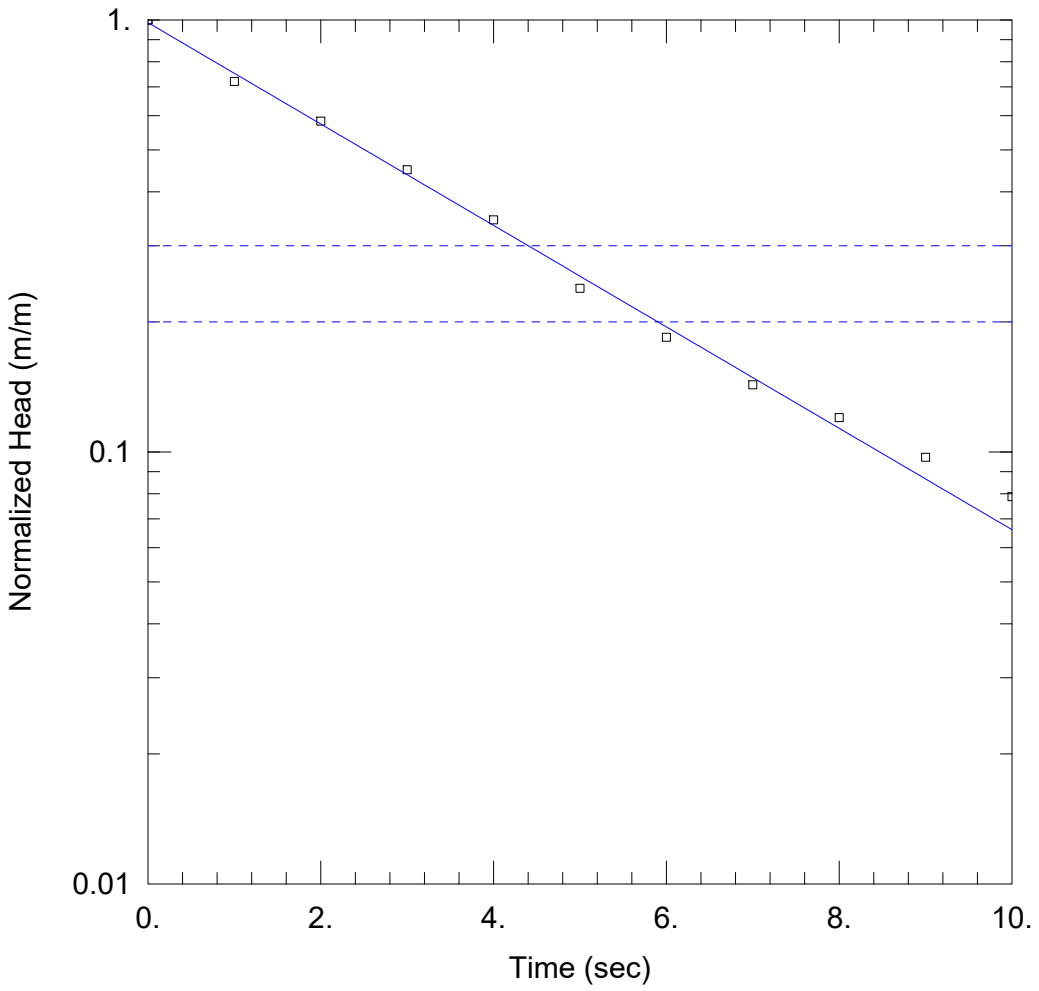
Saturated Thickness: 11. m
Anisotropy Ratio (Kz/Kr): 0.1

### WELL DATA (MW2 rising head #2)

Initial Displacement: 0.2 m
Total Well Penetration Depth: 3. m
Casing Radius: 0.0254 m
Static Water Column Height: 2.16 m
Screen Length: 3. m
Well Radius: 0.1016 m
Gravel Pack Porosity: 0.

### SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 8.028E-5 m/sec
y0 = 0.1874 m




## WELL TEST ANALYSIS

### PROJECT INFORMATION

Company: Groundwater Science Corp.
Client: Talbot Sand and Gravel Limited
Location: Macpherson Pit
Test Well: MW3
Test Date: January 21, 2021

### AQUIFER DATA

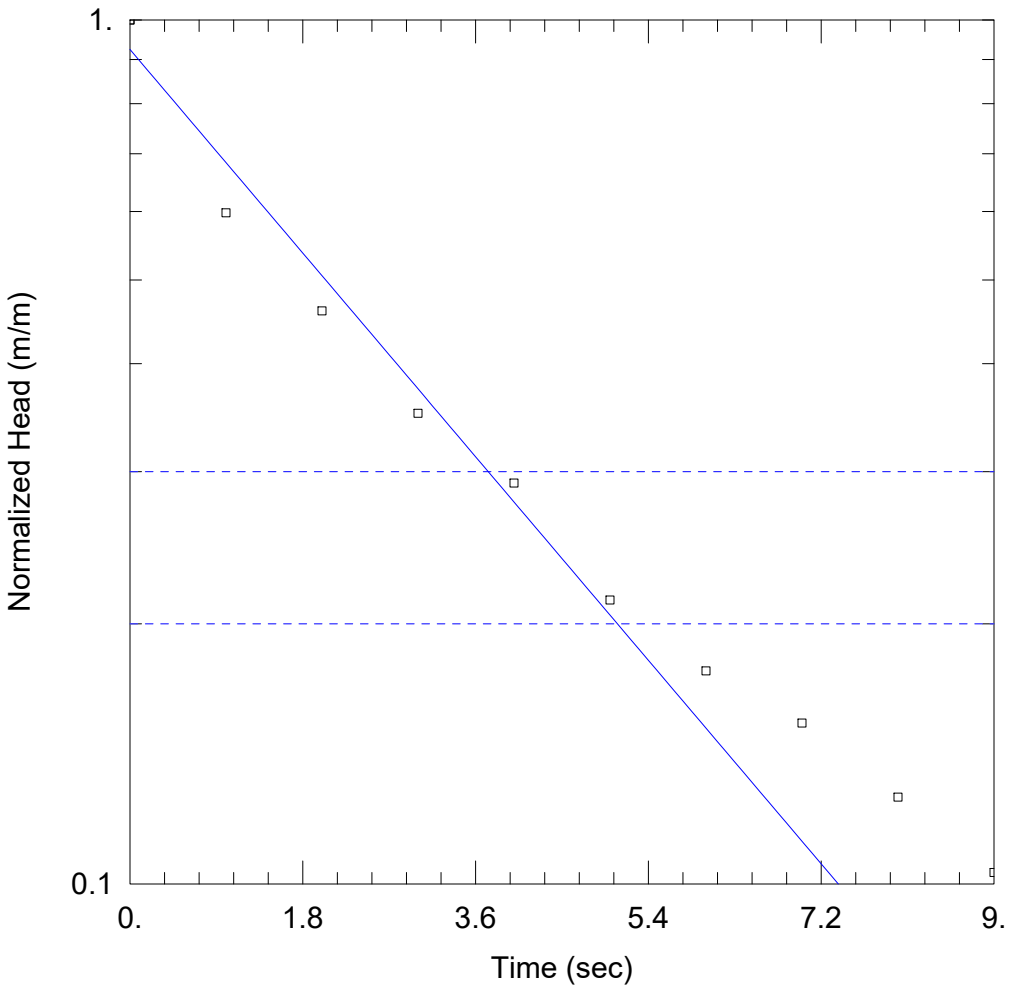
Saturated Thickness: 11. m
Anisotropy Ratio (Kz/Kr): 0.1

### WELL DATA (MW3 rising head #1)

Initial Displacement: 0.2 m
Total Well Penetration Depth: 3. m
Casing Radius: 0.0254 m
Static Water Column Height: 1.45 m
Screen Length: 3. m
Well Radius: 0.1016 m
Gravel Pack Porosity: 0.

### SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 8.834E-5 m/sec
y0 = 0.1971 m




## WELL TEST ANALYSIS

### PROJECT INFORMATION

Company: Groundwater Science Corp.
Client: Talbot Sand and Gravel Limited
Location: Macpherson Pit
Test Well: MW3
Test Date: January 21, 2021

### AQUIFER DATA

Saturated Thickness: 11. m
Anisotropy Ratio (Kz/Kr): 0.1

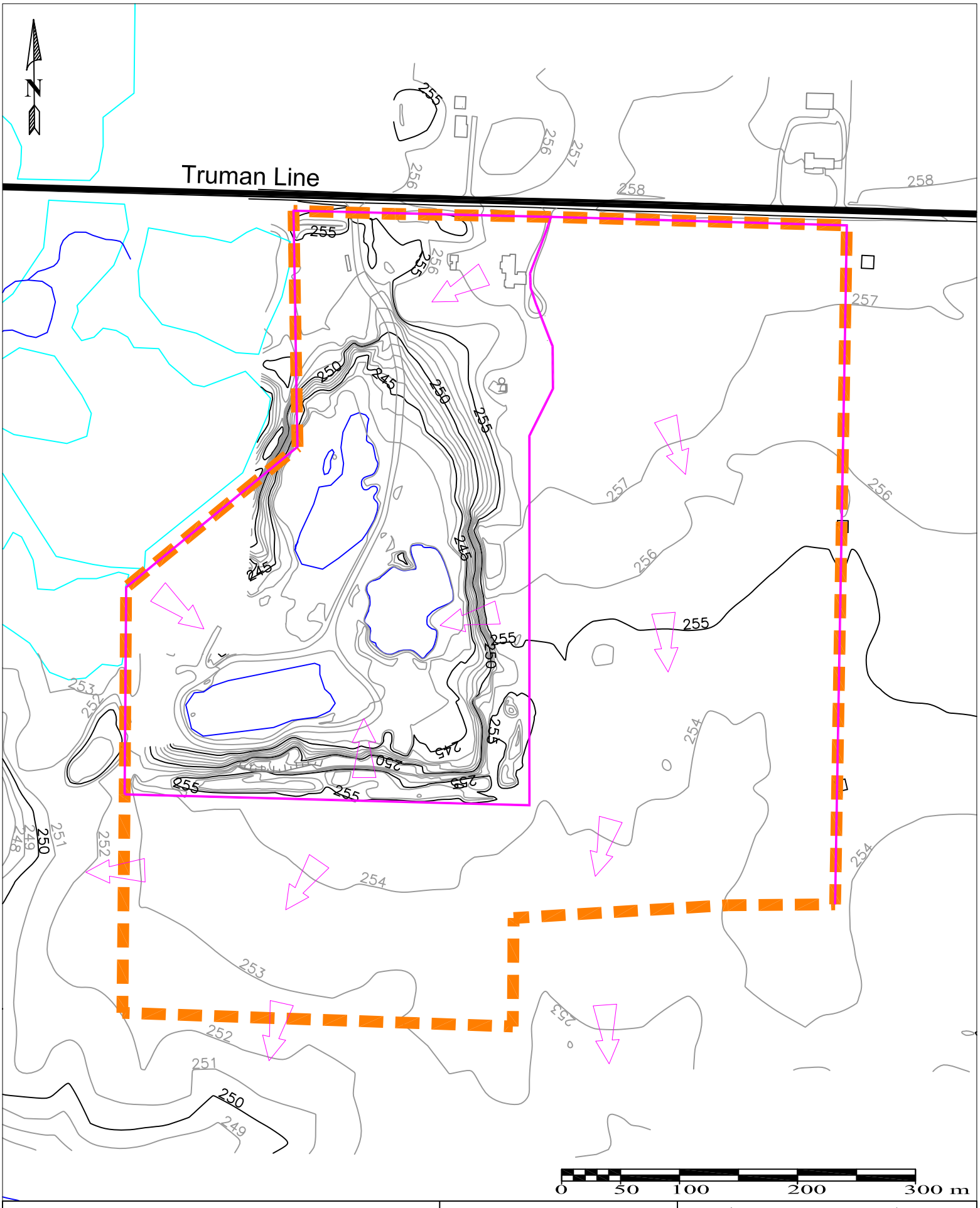
### WELL DATA (MW3 rising head #2)

Initial Displacement: 0.2 m
Total Well Penetration Depth: 3. m
Casing Radius: 0.0254 m
Static Water Column Height: 1.45 m
Screen Length: 3. m
Well Radius: 0.1016 m
Gravel Pack Porosity: 0.

### SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 9.853E-5 m/sec
y0 = 0.1848 m

# *Appendix E*
# *Water Balance Calculations*




water balance assessment area

drainage divide (direction of overland flow as shown)

modified from: OBM mapping, Site Plan
UNDER LICENSE, WITHOUT PREJUDICE OR ENDORSEMENT, FROM THE QUEEN'S PRINTER OF ONTARIO, 2005

February 2022
Scale: as shown

*Groundwater Science Corp.*

# Figure E1: Water Balance Assessment Area

Talbot Sand and Gravel Limited
Proposed Macpherson Pit

| **SMR = Soil Moisture Retention (mm)** | | | | | |
|---|---|---|---|---|---|
| Soil Type | Vegetation Type | | | | |
| | Shallow Rooted Crops (e.g. beans) | Moderately Deep Rooted Crops (e.g. corn) | Deep Rooted Crops (e.g. pasture) | Orchards | Closed Mature Forest |
| Fine Sand | 50 | 75 | 100 | 150 | 250 |
| Fine Sandy Loam | 75 | **150** | 150 | 250 | 300 |
| Silt Loam | 125 | 200 | 250 | 300 | 400 |
| Clay Loam | 100 | 200 | 250 | 250 | 400 |
| Clay | 75 | 50 | 200 | 200 | 350 |

Source: *Instructions and Tables For Computing Potential Evapotranspiration And The Water Balance,* C.W. Thornthwaite and J.R. Mather, 1957

**Estimated Evapotranspiration Values (mm) using Environment Canada LONDON INT'L AIRPORT Weater Station 1981 to 2010 Climate Normals**

| Month | Daily Average Temperature (C.) | Average Monthly Precipitaiton (mm) | Pond Evap. = PET (mm)* | AET (mm)* (150 mm SMR) |
|---|---|---|---|---|
| January | -5.6 | 74.20 | 0.00 | 0.00 |
| February | -4.5 | 65.50 | 0.00 | 0.00 |
| March | -0.1 | 71.50 | 0.00 | 0.00 |
| April | 6.8 | 83.40 | 33.60 | 33.60 |
| May | 13.1 | 89.80 | 79.38 | 79.38 |
| June | 18.3 | 91.70 | 115.20 | 113.70 |
| July | 20.8 | 82.70 | 135.45 | 121.70 |
| August | 19.7 | 82.90 | 118.80 | 101.90 |
| September | 15.5 | 103.00 | 81.12 | 81.12 |
| October | 9.2 | 81.30 | 39.90 | 39.90 |
| November | 3.4 | 98.00 | 12.15 | 12.15 |
| December | -2.6 | 87.50 | 0.00 | 0.00 |
| Annual Total (mm): | | 1011.50 | 615.60 | 583.45 |

* Source: *Computer Program for Estimating Evapotranspiration Using the Thornthwaite Method* , United States Department of Commerce, National Oceanic and Atmosphere Administration (NOAA) Technical Memorandum ERL GLERL-101 (November 1996)

MOE Infiltration Factors

| **Topography Factor** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Classification | Criteria | | | | | Slope (%) | Value of Infiltration Factor |
| Flat land | Average Slope Not Exceeding: | 0.6 | m per | 1 | km | 0.06 | 0.3 |
| Rolling land | Average slope of: | 2.8 | m per | 1 | km | 0.28 | 0.2 |
| | to: | 3.8 | m per | 1 | km | 0.38 | |
| Hilly land | Average slope of: | 28 | m per | 1 | km | 2.8 | 0.1 |
| | to: | 47 | m per | 1 | km | 4.7 | |

| **Soil Factor** | |
|---|---|
| Soil Type | Value of Infiltration Factor |
| Tight impervious clay | 0.1 |
| Medium combinations of clay and loam | 0.2 |
| Open sandy loam | 0.4 |

| **Cover Factor** | |
|---|---|
| Classification | Value of Infiltration Factor |
| Cultivated lands | 0.1 |
| Woodland | 0.2 |

Source:
*MOEE Hydrogeological Technical Information Requirements for Land Development Applications,*
Ontario Ministry of the Environment and Energy, April 1995

**Proposed Macpherson Pit Below Water Extraction - Recharge Water Balance**

Purpose:

To assess present and future recharge contributions to the local groundwater system

Assumptions:

- climate conditions at the site represented by Environment Canada reported 1981 - 2010 Climate Normals LONDON INT'L AIRPORT ON Station
- evapotranspiration rates estimated using the Thornthwaite and Mather method
- pond evaporation rates estimated using Potential Evapotranspiration (calculated maximum)
- runoff rates estimated using MOE Infiltration Factors (*MOEE Hydrogeological Technical Information Requirements For Land Development Applications* , April 1995)
- the assessment area (existing and proposed Licence and residence) is approximately 35 ha
- current runoff from existing licence and 3.5 ha of adjacent lands is retained within existing pit
- remaining runoff within assessment area can flow off-site to the south
- under future conditions runoff within the assessment area is retained
- area of existing pond (open water as per Site Plan) is approximately 1.5 ha
- area of currently approved pond is approximately 3.2 ha
- area of total proposed final pond (open water and wetland) is approximately 19.3 ha, of which approximately 12.1 ha is within new proposed licence area

**1) Water Balance Components**

Infiltration Factor for Land Surface Within Runoff Areas

| | | | |
|---|---|---|---|
| Hilly Land | 0.3 | surplus = precipitation - evapotranspiration | |
| Open sandy loam | 0.4 | | |
| Cultivated | 0.1 | | |
| Factor: | 0.8 | 80 | % of surplus becomes infiltration recharge |
| | 0.2 | 20 | % of surplus becomes runoff |

General Site Recharge Calculation (includes pond areas)

site recharge = precipitation - evapotranspiration - runoff

**1) Estimate of Existing Recharge**

| | | |
|---|---|---|
| Precipitation Rate = | 1.01150 | m/yr |
| PET Rate = | 0.61560 | m/yr |
| Evapotrans. Rate = | 0.58345 | m/yr |
| Land Water Surplus = | 0.42805 | m/yr |
| Land Recharge Rate = | 0.34244 | m/yr |
| Land Runoff Rate = | 0.08561 | m/yr |
| Pond Recharge Rate = | 0.39590 | m/yr |
| Assessment Area = | 35 | ha |
| = | 350,000 | $m^2$ |
| Existing Runoff Area = | 23.4 | ha |
| | 234,000 | $m^2$ |
| Existing Pond Area = | 1.5 | ha |
| | 15,000 | $m^2$ |
| Site Precip. Input = | 354,025 | $m^3/yr$ |
| Site Evapotrans. = | 195,456 | $m^3/yr$ |
| Site Pond Evap. = | 9,234 | $m^3/yr$ |
| Site Runoff = | 20,033 | $m^3/yr$ |
| **Existing Recharge =** | 129,303 | $m^3/yr$ |
| Average Site Rate = | 0.369 | m/yr |
| = | 4.10 | L/s |
| **Existing Runoff =** | 20,033 | $m^3/yr$ |
| Average Site Rate = | 0.057 | m/yr |
| = | 0.64 | L/s |

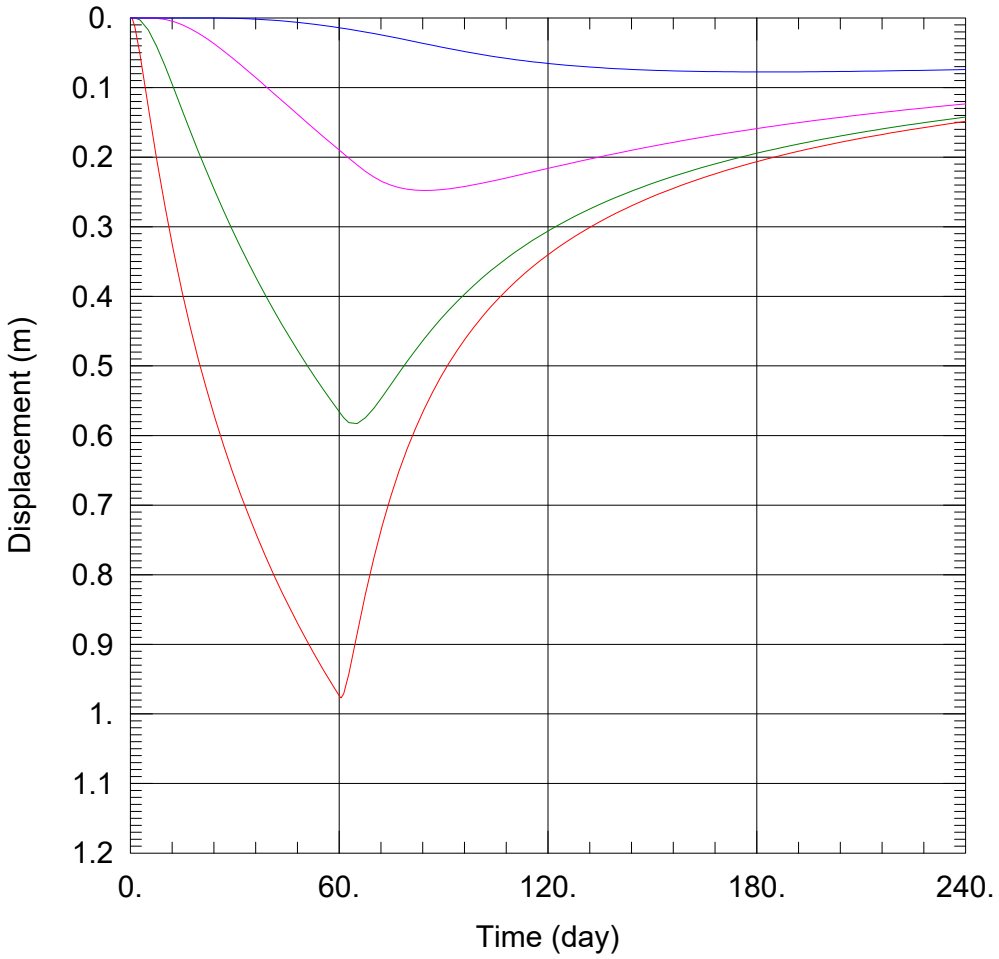
**2) Estimate of Future Recharge Under Approved Extraction**

| | | |
|---|---|---|
| Approved Pond Area = | 3.2 | ha |
| = | 32,000 | $m^2$ |
| Site Precip. Input = | 354,025 | $m^3/yr$ |
| Site Evapotrans. = | 195,456 | $m^3/yr$ |
| Site Pond Evap. = | 19,699 | $m^3/yr$ |
| Site Runoff = | 20,033 | $m^3/yr$ |
| **Future Recharge =** | 118,837 | $m^3/yr$ |
| Average Site Rate = | 0.340 | m/yr |
| = | 3.77 | L/s |

**3) Estimate of Future Recharge Under Proposed Extraction**

| | | |
|---|---|---|
| Future Runoff = | 0 | $m^3/yr$ |
| Proposed Pond Area = | 19.3 | ha |
| = | 193,000 | $m^2$ |
| Site Precip. Input = | 354,025 | $m^3/yr$ |
| Site Evapotrans. = | 91,602 | $m^3/yr$ |
| Site Pond Evap. = | 118,811 | $m^3/yr$ |
| Site Runoff = | 0 | $m^3/yr$ |
| **Future Recharge =** | 143,613 | $m^3/yr$ |
| Average Site Rate = | 0.410 | m/yr |
| = | 4.55 | L/s |

# *Appendix F*
# *Drawdown Predictions*




## PROJECT INFORMATION

Company: Groundwater Science Corp.
Client: Talbot Sand and Gravel
Location: Macpherson pit
Test Well: Pond Extraction Simulation

## WELL DATA

Pumping Wells

| Well Name | X (m) | Y (m) |
|---|---|---|
| 1 | 0 | 38.5 |
| 2 | 11.3 | 65.7 |
| 3 | 38.5 | 77 |
| 4 | 65.7 | 65.7 |
| 5 | 77 | 38.5 |
| 6 | 65.7 | 11.3 |
| 7 | 38.5 | 0 |
| 8 | 11.3 | 11.3 |

Observation Wells

| Well Name | X (m) | Y (m) |
|---|---|---|
| ▫ 50 m | 127 | 38.5 |
| ▫ 100 m | 177 | 38.5 |
| ▫ 200 m | 277 | 38.5 |
| ▫ 400 m | 477 | 38.5 |

## SOLUTION

Aquifer Model: Unconfined
Solution Method: Neuman

T = 0.00129 $m^2$/sec
S = 0.25
Sy = 0.1
Kz/Kr = 0.1

# *Appendix G*
# *Qualifications*

Groundwater Science Corp.

Unit 2, 465 Kingscourt Drive,
Waterloo, ON N2K 3R5
Phone: (519) 746-6916
groundwaterscience.ca

# QUALIFICATIONS

June 2022

## Andrew Pentney, B.Sc., P.Geo.

**Current Position**

**Principal, Senior Hydrogeologist**

Groundwater Science Corp., Waterloo, ON

Providing hydrogeological consulting expertise to regulatory agencies, environmental consultants and industry. Services ranging from individual consulting and assessments to project support for larger study teams, including testimony at OMB (now OLT) hearings.

Over 35 years of hydrogeologic consulting experience.

**Education**

**B.Sc. (1987) :** University of Waterloo, Waterloo, ON

General Science, including Geology courses (stratigraphy, quaternary geology and hydrogeology).

**Professional memberships**

Registered Professional Geoscientist in Ontario

Licenced MECP Contractor

**Range of Experience**

- Technical consultation for 8 Subwatershed Scale characterization studies (GRCA, CVC). Focus on assessing groundwater – surface water interaction (at rivers, streams, wetlands, ponds).
- Planning approval and environmental peer review, watershed planning support to Credit Valley Conservation on an as-needed basis from 2001 to 2014. Focus on protecting stream and wetland systems.
- Community Scale Septic System Impact studies for Alton, Cheltenham and Erin as part of Village Planning Assessments.
- Water supply development, testing and impact assessment, Permit To Take Water consulting, Source Water Protection characterization and water balance studies for municipal water supplies, golf courses, industrial supply (over 20 assessments).
- Aggregate Resource Act groundwater assessments, and associated Zoning and Official Plan amendment impact assessments, at over 35 above water and 30 below water extraction sites. Extensive assessment and analysis of groundwater impact potential, private wells, groundwater-surface water interactions (most studies assessed, rivers, streams, wetlands, springs and/or ponds).
- Aggregate Resource Act compliance monitoring at over 40 above water or below water extraction sites. Includes measurement and analysis of water level, water quality, private well impact potential, thermal impact potential and groundwater-surface water interaction.