REPORT

Hydrogeological Investigation - Updated

Proposed Residential Redevelopment, 8243 and 8282 Wellington Road 19, Fergus, Ontario

Submitted to:

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1.0 INTRODUCTION

WSP Canada Inc. (WSP) has been retained by 883890 Ontario Limited c/o Fergus Development Inc. to conduct a hydrogeological investigation as part of the draft plan submission process for the proposed residential redevelopment to be located on the existing Fergus Golf Club property, located at 8243 and 8282 Wellington Road 19 in Fergus, Ontario (the Site), as shown on Site Location Plan (Figure 1). This updated report includes additional water level monitoring data obtained in October and December 2022 and a revised water budget assess that reflects the current site designs.

The purposes of this hydrogeological investigation are to assess the existing hydrogeological conditions, to prepare a pre- and post-development water budget assessment based on current designs, to assess the potential hydrogeological impacts of development and to assess the feasibility of potential low impact development (LID) options to mitigate against any reductions in post-development infiltration rates. In addition, a preliminary assessment of the need for construction dewatering permitting is included.

The factual data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site location. If the project is modified in concept, location, elevation, or if the project is not initiated within eighteen months of the date of the report, WSP should be given an opportunity to confirm that the recommendations are still valid. In addition, this report should be read in conjunction with the attached "*Important Information and Limitations of This Report*" which are included in Appendix A. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

2.0 BACKGROUND

2.1 Site and Project Description

The Site consists of two parcels; one is located at the south side of Wellington Road 19 on the existing Fergus Golf Club property (labelled as the Southeast [SE] Site on Figure 1). The adjoining portion of the Fergus Golf Club (labelled as the Northwest [NW] Site on Figure 1) is located to the north of Wellington Road 19. The SE Site is bounded to the east by 3rd Line, to the south by agricultural land, and to the west by a rural residential property. The SE Site is currently occupied by grass fields, a residential house and a nine-hole golf course. There is a large wooded and wetland area between fairways on the east-central portion that covers approximately one third of the SE Site area, with three small ponds adjacent to its north and west limits.

The conceptual plan (GSP Group, *Fergus Golf Course Development*, October 24, 2022) for the proposed residential development is provided in Appendix B. Based on the conceptual plan, it is understood that the overall development area of the SE Site is approximately 39.85 ha (98.5 ac) in area and is to be comprised of 118 single-family residential lots, one Storm Water Management (SWM) pond, two open space blocks the largest of which includes the existing wooded and wetland area mentioned above, a sanitary pumping station and associated roads, walkways, trail and landscape strips. The conceptual plan is shown on Figure 2.

The golf course on the NW Site (see Figure 1) will remain operational. The proposed residential development will be provided with private communal water supply and sewage treatment. The communal water supply well will be located on the NW Site as detailed in the following hydrogeological investigation for the proposed communal water supply:

- Golder Associates Ltd., January 2022: *Water Supply Investigation, Proposed Residential Development, Fergus Golf Club, 8243 County Road 19, Fergus, Ontario* (WSP Golder 2022a).

Water and wastewater treatment plants will be located on the NW Site, and treated effluent will be directed to ten dispersal beds also located on the NW Site (see Figure 2).

2.2 Topography and Drainage

Based on the Plan of Survey prepared by R-PE Surveying Ltd. O.L.S. (RPE, 2021; see Appendix B), the ground surface at the SE Site is gently undulating, with elevations ranging from approximately 424 metres above sea level (masl) to 437 masl (Figure 2). There is a high ground elevation of 437 masl in the southwestern part of the SE Site. The SE Site is generally trough-shaped, draining from the west, northeast and east to central low point, which in turn drains southward via Black Drain.

The SE Site is located within the Grand River watershed. The Grand River flows in a southwest direction in the area of the Lake Belwood reservoir located less than 100 m from the SE Site at its closest point. Locally the SE Site is within the Irvine Creek subwatershed. Irvine Creek and its tributaries generally flow in a southwest direction and discharge into the Grand River in Elora. At its closest point, Irvine Creek is located approximately 150 m from the SE Site. The upstream limit of Black Drain is present on the SE Site (see Figure 1), receiving run off from roadside drainage ditches on Wellington Road 19 and draining eastward to the central wetland area. Subsequently, Black Drain flows in a south direction through the low portion of the SE Site and discharges into Irvine Creek approximately 2.5 km west of the SE Site. Three off-site agricultural drains discharge westward to Black Drain at the southern end of the SE Site (see RPE 2021, Appendix B).

The SE Site is comprised primarily of anthropogenic land use as an active golf course, with a grass field located at the south portion. Three small irrigation/aesthetic ponds are located adjacent to the north limit of the central forested area. The smallest pond, approximately 40 m by 15 m, is located approximately 300 m south of 3rd Line. The other two ponds, approximately 78 m by 30 m and 53 m by 25 m, are located approximately 210 m and 440 m south of 3rd Line, respectively. The ponds will not be retained post-development and are not discussed further in this report.

Based on available on-line natural heritage mapping from the Ministry of Natural Resources and Forestry (MNRF; http://www.gisapplication.lrc.gov.on.ca), four unevaluated wetlands, ranging in size from approximately 70 m by 70 m to approximately 275 m by 25 m, are located centrally on the site from approximately 140 m to 850 m south of 3rd Line. The largest and central wetland, located on either side of Black Drain, will be retained in the central 5.31 ha open space block and is discussed in this report. The three smaller wetlands will not be retained post-development and are not discussed further.

2.3 Physiography and Surficial Geology

The physiography in the area of the site (Source: Quaternary Mapping Ontario Geological Survey, Queen's Printer 2006) is shown on Figure 3A, Physiography and Drainage, attached. In general, the areas proximal to Irvine Creek and Black Drain, including the majority of the SE Site, are located in spillways. Between the two, across the southern two-thirds of the NW Site and off-site to the east, a drumlinized till plain is mapped.

The surficial geology mapped in the area by the Ontario Geological Survey-Geological Survey of Canada (OGS-GSC, 2020) is shown on Figure 3B, Quaternary Geology Map, attached. The surficial soils at the SE Site consist mainly of relatively thin distal deposits of sand and gravel overlying glacial till deposits. The glacial till deposits are exposed at surface in the area along Wellington Road 19, being comprised of the Tavistock Till (i.e., with a fine-grained matrix) in the vicinity of 3rd Line, and the Port Stanley Till (ablation till) further to the west.

2.4 Water Well Records

Water well records were obtained from the Ministry of the Environment, Conservation and Parks (MECP). Approximately 96 water well records were reported within 500 m of the SE and NW Sites. Of the 96 well records, 90 have water supply (e.g., domestic, geothermal, stock watering) as their designated use. The remaining wells are either abandoned, or have no use listed. Of the 90 water supply wells, 69 (77%) are completed in the bedrock and 21 (23%) are completed in the overburden. The depths of the overburden wells range from 5.2 m to 65.8 m (average 16.5 m) and the depths of the bedrock wells range from 29.9 m to 108.5 m (average 55.6 m). The locations of the reported water well records are shown on Figure 4, Ministry Recorded Wells. All of the overburden water wells within 500 m of the SE and NW Sites are located east of 3rd Line and are associated with the residential properties near Lake Belwood. A table summarizing the water well record data is provided in Appendix C, MECP Recorded Wells. Two hydrostratigraphic cross-sections, Figure 6, Section A-A' and Figure 7, Section B-B', based on the water well record data, are attached. It is noted that historically there was not a requirement to register dug wells with the MECP, and they can be under-represented in the water well record database.

There are four existing bedrock wells on the NW Site and SE Site that are used by Fergus Golf Club as shown on Figure 1. The North Irrigation Well (MOE#6712549) and Clubhouse Well (MOE#6714026) are located on the NW Site and completed in the bedrock to depths of 86.0 m and 74.7 m, respectively. The South Irrigation Well (MOE#6713016) and Old Clubhouse Well (possibly MOE#6706408) are located on the SE Site and completed in the bedrock to depths of 94.5 m and 108.5 m, respectively.

The water supply wells were generally reported to encounter thin surficial topsoil or various fill materials overlying clay or sandy units that sometimes-contained gravel and/or boulders (i.e. are interpreted as glacial till), which commonly contained confined sand or gravel layers/units or was underlain by confined sand or gravel units. These various confined sand or gravel layers/units are inferred to be the overburden aquifers utilized by the private wells. The bedrock consisted of shale and limestone.

Based on the MECP water well record search and our experience in the area, active private well use is expected around the SE Site.

2.5 Previous Reports

WSP (as WSP Golder) conducted a preliminary geotechnical investigation at the SE and NW Sites, referenced as follows:

- Golder Associates Ltd. (February 2022). *Preliminary Geotechnical Investigation, Proposed Residential Development – Fergus Golf Club, 8243 and 8282 Wellington Road 19, Fergus, Ontario.* (WSP Golder, 2022b).

The factual subsurface data and information obtained in the preliminary geotechnical investigation was reviewed and pertinent data was used in preparation of this report. The existing borehole and monitoring well locations from the geotechnical investigation are provided on Figure 2, and the accompanying Record of Borehole sheets are attached in Appendix D.

3.0 SITE CHARACTERIZATION

3.1 Drilling and Monitoring Well Installation

As reported in our geotechnical investigation report, the geotechnical field investigation was carried out between March 22 and March 31, 2021, during which time at total of eighteen boreholes (designated as Boreholes BH21-1 to BH21-18) were advanced on both the SE Site and NW Site to depths between about 3 m and 10 m below existing ground surface at the approximate locations shown on the Borehole Location Plan, Figure 2. The reader is referred to the concurrent geotechnical report (WSP Golder 2022b) for additional details.

Groundwater monitoring wells were installed in 16 of the boreholes to monitor groundwater levels and allow further testing. The wells consist of single nominal 50 mm diameter PVC pipe screens surrounded with filter sand pack, PVC riser pipes sealed with bentonite, and completed with flush-mount or stick-up monument casings. At Borehole 21-7, a bi-level installation was completed, with PVC pipe screens set at different elevations in two separate boreholes.

In addition, five shallow piezometer (P) and staff gauge (SG) pairs, PZ1/SG1, PZ2/SG2, PZ3/SG3, PZ4/SG4 and PZ5/SG5 were manually installed at the SE Site in Black Drain (PZ1/SG1) and the wetlands (PW2/SG2 to PZ5/SG5), as shown on Figure 2. The shallow piezometers (19 mm inside diameter stainless steel drive point model) were installed to an approximate depth of 0.76 to 1.16 mbgs. The pairs were installed to assess the vertical gradient in the drain and the wetlands.

The as-installed borehole, monitoring well, piezometer and staff gauge locations and the ground surface and top-of-pipe/gauge elevations were surveyed by R-PE Surveying Ltd. of Woodbridge Ontario based on UTM coordinates and Geodetic elevation (CGVD2013).

The subsurface soil and groundwater conditions encountered in the boreholes, and details of the monitoring well installations are provided on the Record of Borehole sheets (Appendix D). It should be noted that the boundaries between the strata on the borehole records have been inferred from drilling observations and non-continuous sampling. They generally represent a transition from one soil type to another and should not be inferred to represent an exact plane of geological change. Further, conditions will vary between and beyond the boreholes.

3.2 Subsurface Soil Conditions

A detailed summary of subsurface soil conditions encountered at the borehole locations is provided in our geotechnical investigation (WSP Golder, 2022b), to which the reader is referred. The Record of Borehole sheets, grain size distribution curves and Atterberg limits testing results for selected soil samples are provided in Appendix D.

Boreholes BH21-9, BH21-10, BH21-12, BH21-13, BH21-14 and BH21-15 were advanced on the NW Site in the general area of the proposed leaching beds. In general, the subsurface conditions encountered at these boreholes typically consist of a surficial topsoil layer underlain by a native soil deposit consisting of sandy silty clay, underlain by a silty clay to clayey silt glacial till deposit. A silty sand and gravel layer was encountered underlying or interlayered within the glacial till deposit at some borehole locations.

Boreholes BH21-1 through BH21-8, BH21-11, BH21-16, BH21-17 and BH21-18 were advanced on the SE Site in the area of the proposed residential development. In general, the subsurface conditions encountered at the boreholes advanced at the SE Site typically consist of a surficial topsoil layer underlain by native soil deposits consisting of silty sand to sand or clayey silt with sand containing varying amounts of gravel. These deposits are in turn underlain by silty clay to clayey silt and silt and sand glacial till deposits. Some granular layers of silty sand and gravel are present within and above the till deposit.

Topsoil was encountered in all boreholes on the south side of the SE Site, ranging in thickness from about 50 mm to 300 mm. An underlying organic silt layer was found in Boreholes BH21-1 and BH21-3, extending to depths of about 0.7 m and 0.9 m (Elevations 425.7 m and 434.1 m).

A deposit of sand to silty sand, trace gravel to silty sand and gravel was encountered below the topsoil and surficial organic layers in Boreholes BH21-1, BH21-2, BH21-4, BH21-5, BH21-6, BH21-11, BH21-17 and BH21-18. This deposit extended to depths between about 0.7 m to 3.5 m below ground surface (Elevations 429.0 m and 423.0 m). This deposit was layered with a glacial till deposit in Borehole BH21-8 and contained a clayey silt to silt layer in Borehole BH21-18.

A cohesive deposit of silty clay to clayey silt with sand to silt with sand was encountered below the topsoil in Boreholes BH21-3, BH21-7 and BH21-16, and below the sand to silty sand in Borehole BH21-2. This cohesive deposit extended to depths between about 2.2 m to 2.6 m below ground surface (Elevations 432.8 m and 426.4 m).

A deposit of silty clay to clayey silt till was encountered below the sand to silty sand in Boreholes BH21-1, BH21-4, BH21-5, BH21-6, BH21-11, BH21-17 and BH21-18, below the silty clay to silt with sand in Boreholes BH21-2, BH21-3, BH21-7 and BH21-16 and the topsoil in BH21-08. The till deposit was penetrated to depths between about 5.0 m to 9.6 m below ground surface (Elevations 428.3 m and 419.4 m). In Borehole BH21-8, the till deposit contained interlayers of silty sand approximately 1.3 m thick. All boreholes containing the glacial till were terminated within the till except Borehole BH21-18. Presence of cobbles and boulders in the till deposit was inferred during the field investigation due to auger grinding and difficulty advancing the boreholes.

Based on the subsurface investigation results, groundwater elevation data are presented in plan view on Figure 5, Groundwater Flow, and two shallow hydrostratigraphic sections, Figure 7, Section C-C' and Figure 8, Section D-D', are attached.

3.3 Water Level Monitoring

Groundwater levels were manually measured at the monitoring wells on April 5, April 8/9/12, and April 14, 2021, and on October 7, 2022. Water level depths and elevations are provided in Table E-1, Water Level Depths and Elevations (Appendix E). It should be noted that these observations reflect the groundwater conditions encountered at the time of the field investigation (selected dates in April 2021, October 2022) and some seasonal and annual fluctuations should be anticipated.

In April 2021, the depth to groundwater at the monitoring wells ranged from -0.09 mbgs (Borehole BH21-17 on April 5, 2021) to 2.36 mbgs (Borehole BH21-01 on April 9, 2021) and from elevations of 423.97 masl (Borehole BH21-01 on April 9, 2021) to 434.56 masl (Borehole BH21-03 on April 14, 2021) on the dates monitored. The groundwater elevation data on April 14, 2021 are shown on the Record of Borehole Sheets (Appendix D), Figure 5A, *Groundwater Flow, April 14, 2021*, Figure 7, *Section C-C'*, and Figure 8, *Section D-D'*.

On October 7, 2022, the depth to groundwater at the shallow monitoring wells (i.e., excluding BH21-07D) ranged from 1.30 mbgs (Borehole BH21-06) to 3.37 mbgs (Borehole BH21-09) and from elevations of 424.51 masl (Borehole BH21-01) to 431.91 masl (Borehole BH21-03). The groundwater elevation data on October 7, 2022, are shown on Figure 5B, *Groundwater Flow, October 7, 2022*, Figure 7, *Section C-C'*, and Figure 8, *Section D-D'*. In all but two locations, the measured groundwater levels in October 2022 were on average 1.6 m deeper than the highest measured groundwater levels in April 2021, ranging from 0.9 m to 2.6 m deeper.

The presence of several shallow groundwater flow divides were inferred from topographic and shallow groundwater elevation data. Shallow groundwater at most of the SE Site was inferred to flow in an easterly, southerly or westerly direction towards Black Drain, except along the eastern edge of the SE Site where shallow groundwater was inferred to flow in a northeasterly direction towards Lake Belwood (see Figure 5).

The groundwater elevations at Borehole BH21-7S (shallow) were higher than Borehole BH21-7D (deep) during the monitoring event on April 8, 2021, indicating a downward vertical gradient at that location, although stabilized groundwater conditions may not have been present at Borehole BH21-7D following well development. During the monitoring events on April 14, 2021 and October 7, 2022, the groundwater elevations at Borehole BH21-7D were 0.19 m and 1.63 m higher, respectively, than Borehole 21-7S, indicating an upward vertical gradient.

Black Drain was flowing at the time of piezometer and staff gauge installation on March 29, 2021. No flowing water was observed in Black Drain during the April monitoring events. On the monitoring event when the staff gauge was dry, stagnant water was observed. Rainfall was recorded (Fergus Shand Dam, ID 6142400[1]) on April 5 (0.2 mm), April 8 (0.4 mm), April 10 (4.4 mm), April 11 (30.9 mm), and April 12 (4 mm) 2021. The April 14, 2021 monitoring event was carried out two days after the three-day long precipitation event, at which point water was observed at all of the staff gauges except SG5, located within the central wetland, which remained dry following the precipitation events.

During the three monitoring events in April 2021, the following measurements were taken, and the vertical hydraulic gradient was inferred from the relative elevation of groundwater and stage measurements. Staff gauge SG1 at Black Drain was dry and below grade groundwater levels were measured at PZ1 during the first two monitoring events in April, and on the third event a water depth of 0.05 m was measured at SG1 an upward hydraulic gradient was present. At staff gauge SG2 (northeast wetland area), the water depth ranged from 0.02 to 0.10 m, and an upward vertical gradient was present on the first event and a downward vertical gradient was present during the last two monitoring events. At staff gauge SG3 (southwest wetland area), the water depth ranged from dry to 0.09 m, and an upward vertical gradient was present on all three events. Staff gauge SG4 (east wetland area) was dry on the first two events and a water depth of 0.07 m was measured on the third event. Above grade heads were measured at PZ and the vertical gradient was upward on the first and third events and a below grade head and downward vertical gradient was present on the second event. Staff gauge SG5 (central wetland) was dry, groundwater levels at PZ5 were below grade, and a downward vertical gradient was present on all three monitoring events.

No water was observed in Black Drain during the October monitoring event, and all five of the staff gauge/ piezometer pairs were dry.

3.4 Hydraulic Testing

Single well response testing (i.e. rising head tests) was carried out at Boreholes BH21-01, BH21-03, BH21-05, BH21-06, BH21-07S, BH21-08, BH21-10, BH21-16, BH21-17 and BH21-18 on April 8, April 9, and April 14, 2021. The rising head tests were carried out by rapidly lowering the water levels by purging with a dedicated Waterra footvalve and tubing. The resulting water level recoveries were monitored with an electronic water level tape or an automatic data logger. The recovery data were analyzed using the AQTESOLV for Windows (1996 – 2007) Version 4.5 software. The Bouwer and Rice (1976) method for unconfined conditions was applied to the rising head test data. Estimates of hydraulic conductivity (K) obtained from the rising head tests are summarized below in Table 1. Summary printouts of the rising head test data and results from AQTESOLV are included in Appendix F.

[1] Daily Data Report for April 2021 - Climate - Environment and Climate Change Canada (weather.gc.ca)

Table 1: Summary of Estimated Hydraulic Conductivity

Borehole	Unit Screened	Depth of Monitoring Well (mbgs)	Method	K (m/s)
Screened Intervals including Non-Cohesive Soil Units				
BH21-05	(SM) Silty Sand; (SM-ML) Silt and Sand (CL) Clayey Silt TILL	4.0	Bouwer and Rice (1976), unconfined	$2x10^{-6}$
BH21-06	(SM) Silty Sand; (CL) Sandy Silty Clay TILL	4.9	Bouwer and Rice (1976), unconfined	$2x10^{-7}$
BH21-08	(SM) Silty Sand; (CL) Clayey Silt TILL	4.2	Bouwer and Rice (1976), unconfined	$4x10^{-6}$
BH21-18	(ML) Sandy Silt; (SM-GM) Silty Sand and Gravel; (CL) Silty Clay TILL; (SM/ML) Silt and Sand TILL	4.2	Bouwer and Rice (1976), unconfined	$2x10^{-7}$
Screened Intervals with only Cohesive Soil Units				
BH21-01	(CL) Silty Clay TILL	5.8	Bouwer and Rice (1976), unconfined	$8x10^{-9}$
BH21-03	(CL-ML) Silty Clay-Clayey Silt; (CL) Silty Clay TILL	4.1	Bouwer and Rice (1976), unconfined	$6x10^{-6}$
BH21-07S (Shallow)	(CL-ML) Silty Clay-Clayey Silt; (CM-ML) Sandy Silty Clay-Clayey Silt (TILL)	2.7	Bouwer and Rice (1976), unconfined	$6x10^{-7}$
BH21-10	(CL) Sandy Silty Clay TILL	5.9	Bouwer and Rice (1976), unconfined	$2x10^{-8}$
BH21-16	(CL-ML) Silty Clay-Clayey Silt TILL	5.1	Bouwer and Rice (1976), unconfined	$6x10^{-8}$
BH21-17	(CL-ML) Sandy Silty Clay-Clayey Silt TILL	4.6	Bouwer and Rice (1976), unconfined	$1x10^{-8}$

Note:
mbgs – metres below ground surface. m/s –metres per second--

The hydraulic conductivity estimates from screened intervals that included non-cohesive soil units are most likely to be representative of the hydraulic conductivity of those units, and ranged from $2x10^{-7}$ m/s to $4x10^{-6}$ m/s with a geometric mean of $7x10^{-7}$ m/s (n = 4). These values are considered to be reasonable for the units tested.
The hydraulic conductivity estimates from screened intervals that included mainly cohesive and non-cohesive soils and glacial till units ranged from $8x10^{-9}$ m/s to $6x10^{-6}$ m/s, with a geometric mean of $8x10^{-8}$ m/s (n=6). These values are considered to be reasonable for the units tested, with the exception of the hydraulic conductivity value estimated from Borehole BH21-03 ($6x10^{-6}$ m/s), which is higher than expected for silty clay-clayey silt and clayey silt till soils.

3.5 Summary

The SE Site is currently occupied by a nine-hole golf course including grass fields and a residential house. There is a large wooded and wetland area between fairways on the east-central portion that covers approximately one third of the SE Site area, with three small ponds adjacent to its north and west limits. The SE Site is proposed to be redeveloped with a 118-lot residential subdivision development.

Based on a review of the published information and the results of the subsurface investigations, the surficial soil conditions at the SE Site consist of relatively thin (i.e., 0.7 m to 3.5 m thick) native soil deposits consisting of silty sand to sand or clayey silt with sand containing varying amounts of gravel. These deposits are in turn underlain by silty clay to clayey silt and silt and sand glacial till deposits. Some granular layers of silty sand and gravel are present within the till deposit. The estimated geometric mean hydraulic conductivity of the surficial non-cohesive soils at the tested locations is $7x10^{-4}$ m/s (n = 4), and of the underlying cohesive soils and glacial till is $8x10^{-8}$m/s (n = 6).

Except for the northeast edge of the SE Site which grades toward Lake Belwood located off-site to the northeast, the majority of the SE Site grades toward, and is drained by, Black Drain. The upstream limit of Black Drain is present on the SE Site, receiving run off from roadside drainage ditches on Wellington Road 19 and draining eastward to a central wetland area. Subsequently, Black Drain drains in a south direction through the low portion of the SE Site toward into Irvine Creek approximately 2.5 km to the west.

The depth to groundwater at the monitoring wells ranged from -0.09 mbgs to 2.36 mbgs and from approximate elevations of 423.97 masl to 434.56 masl on the dates monitored in April 2021. The depth to groundwater at the monitoring wells ranged from 1.30 mbgs to 3.37 mbgs and from approximate elevations of 424.51 masl to 431.97 masl on October 7, 2022. As detailed in Section 3.3, groundwater levels were on average 1.6 m deeper in October 2022 than the highest readings in April 2021. Seasonal and annual fluctuations should be expected. Shallow groundwater at most of the SE Site was inferred to flow in an easterly, southerly or westerly direction towards Black Drain, except along the eastern edge of the SE Site where shallow groundwater was inferred to flow in a northeasterly direction towards Lake Belwood.

A bi-level monitoring well installation and five piezometer/staff gauge pairs installed near Black Drain and wetland features on the SE Site indicate variable recharging and discharging conditions during the four monitoring events carried out in April 2021 and October 2022. A central wetland area is present on either side of Black Drain in the topographically low central portion of the SE Site. Beacon indicates that the wetland is characterized by seasonally high groundwater conditions followed by a seasonal dry period in the summer months. It is inferred that the seasonally high groundwater levels are supported by groundwater recharge to the predominant thin non-cohesive soils during the cool, wet spring months with a groundwater flow direction toward Black Drain and the central wetland area, followed by a decline in groundwater levels in the non-cohesive soils during the warmer, drier summer months. This is corroborated by the observation of dry conditions at all five piezometer and staff gauge pairs on October 7, 2022, and the absence of water in Black Drain.

Water well records indicate 90 water supply wells within 500 m of the SE and NW Sites, including 4 existing irrigation wells on the NW Site and SE Site that are used by Fergus Golf Club. The water supply wells were generally reported to encounter thin surficial topsoil or various fill materials overlying clay or sandy units that sometimes-contained gravel and/or boulders (i.e., are interpreted as glacial till), which commonly contained confined sand or gravel layers/units or was underlain by confined sand or gravel units, all of which was underlain by shale or limestone bedrock. Of the 90 water supply wells, 69 (77%) are completed in the bedrock and 21 (23%) are completed in the overburden. The shale and limestone bedrock was therefore utilized by the majority of the water wells, and various confined sand or gravel layers/units were inferred to be the aquifers utilized by the overburden wells.

4.0 WATER TAKING REQUIREMENTS

This section provides a preliminary assessment of temporary groundwater taking requirements for construction purposes at the SE Site, and the need to obtain dewatering permitting. The engineering information and recommendations for the proposed construction activities are provided in our concurrent geotechnical investigation report (WSP Golder, 2022b) to which the reader is referred for additional information.

4.1 Temporary Construction Dewatering Permitting

Based on the Conceptual Underground Servicing Plan prepared by Burnside (dated November 17, 2022; Appendix B), the maximum depth of the underground services is at about 6.9 m below the existing ground surface. The proposed development will also include a 20 m long by 20 m wide sanitary pumping station between Boreholes BH21-04 and BH21-18 with sewer connection invert depth at about 7.2 mbgs (Elevation 422.21 masl) and a proposed wet well, the depth of which will be confirmed at detailed design and is assumed to be at about 14 m bgs (Elevation 415.41 masl). It should be noted that WSP has not completed a borehole to a depth of 14 m at the SE Site, and as such, should advance at least one borehole to this depth or greater at the proposed pumping station location.

A SWM pond is proposed in the vicinity of Boreholes BH21-04 and BH21-18. Based on the preliminary pond designs prepared to date, the following comments and recommendations are provided. The elevation of the base of the SWM pond is proposed to be at about Elevation 424.6 masl (or approximately 2.13 mbgs to 2.64 mbgs).

Groundwater levels across the SE Site were observed to range from -0.09 mbgs to 3.37 mbgs on the dates measured in April 2021 and October 2022, although seasonal and annual groundwater fluctuations should be expected. It is expected that excavations below the water table will be required for underground servicing, sanitary pump station and SWM pond, and the need for temporary groundwater control during construction is anticipated. Groundwater seepage through the glacial till deposits is anticipated to be minor and can probably be handled by pumping from properly constructed and filtered sumps located within the excavations. It is noted, however, that locally higher groundwater inflow may be experienced from saturated non-cohesive soil layers or lenses which are common in glacial till deposits and may not have been encountered in the drilling program, and from areas such as Borehole BH21-03 where higher than expected hydraulic conductivity was estimated from hydraulic testing at that monitoring well location. For deeper excavations that will extend below the groundwater table, significant groundwater inflow into the excavations may be expected from the saturated surficial non-cohesive silty sand, sand and sand and gravel deposits. Excavation sideslopes and basal stability will need to be reviewed at detailed design.

In order to control groundwater inflow and reduce the potential for instability of the sidewalls and base of the excavation in these areas, some form of positive groundwater control (e.g. well point or eductors) is recommended to sufficiently lower the groundwater level in the non-cohesive, granular deposits. The method of construction dewatering should be solely determined by the Contractor based on their own assessment of the site-specific conditions, and likely by their specialist dewatering contractor. In any case, the groundwater level should be lowered to a minimum of 1 m below the inverts in advance of the excavation reaching the invert levels. Surface water runoff must be directed away from any open excavation.

It is recommended that a licensed, specialist dewatering subcontractor supervise the installation, operation and decommissioning of any dewatering systems for this project, in accordance with applicable legislation. It is understood that a dewatering plan from a specialist subcontractor has not yet been prepared.

Water takings in excess of 50 m^3/day are regulated by the MECP. Certain takings of groundwater and storm water for construction dewatering purposes with groundwater takings less than 400 m^3/day qualify for self-registration on the MECP's Environmental Activity and Sector Registry (EASR). A Category 3 PTTW is required where the proposed groundwater taking is greater than 400 m^3/day.

The rate of groundwater inflow to excavations will vary during construction. Initially, higher inflow rates will occur as groundwater is removed from storage within the zone of influence. With time, rates will decrease toward a steady-state condition. Incident precipitation into excavations will also need to be managed with the groundwater contributions.

Based on the hydrogeological conditions encountered at the borehole locations, the steady state groundwater inflow rate for typical servicing excavations encountering cohesive and glacial till soils may not individually exceed 50 m^3/day. The presence of saturated non-cohesive soil units overlying or within the glacial till soils, if encountered, are expected to generate higher steady state dewatering rates. Including the initial removal of groundwater from storage and excluding contributions from incident precipitation that must be handled along with the groundwater, the total groundwater pumping rate for a typical servicing excavation, or the pumping station building, or the SWM pond, will individually exceed 50 m^3/day but not likely exceed 400 m^3/day. Accordingly, the need to register a construction dewatering taking on the EASR is anticipated to be required at a minimum. However, if multiple dewatering activities occur simultaneously, the need to obtain a Category 3 PTTW could be conservatively anticipated at this time. Additional investigation and assessment will be required to prepare the hydrogeological reporting to accompany the dewatering permitting. These findings should be re-evaluated as SE Site designs progress, construction plans are developed, and on the basis of the additional investigation and assessment activities. It is also recommended that trench plugs be installed in the servicing trenches to limit the preferential migration of groundwater in the permeable pipe bedding materials, and that watertight sewer connections be implemented.

5.0 HYDROLOGIC WATER BALANCE

A water balance assessment for the 39.85 ha SE Site was carried out to assess the potential hydrogeological impacts of the proposed site development with respect to post-development infiltration rates, including potential impacts to groundwater-dependent resources. The assessment included the pre- and post-development conditions within the SE Site boundary.

5.1 Methods

The water balance assessment was based on meteorological data obtained from Environment and Climate Change Canada (ECCC) for the Fergus Shand Dam Meteorological Station (ID 6142400), which was the nearest station to the SE Site with a substantial period of historical data (1965 to 2020), information on current and proposed land uses, and native soil types as identified through the subsurface investigation activities at the SE Site.

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

$$P = S + ET + R + I$$

Where: P = precipitation;

S = change in soil water storage;

ET = evapotranspiration;

R = surface runoff; and

I = infiltration (groundwater recharge).

Precipitation data obtained from ECCC for the Fergus Shand Dam station indicate a mean annual precipitation (P) of 966 mm/yr.

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

Evapotranspiration (ET) refers to water lost to the atmosphere from vegetated surfaces. The term combines evaporation (i.e., water lost from soil or water surfaces) and transpiration (i.e. water lost from plants and trees). Potential ET refers to the loss of water from a vegetated surface to the atmosphere under conditions of an unlimited water supply. The actual rate of ET is typically less than the potential rate under dry conditions (e.g. during the summer months when there is a moisture deficit). The mean annual potential ET for the areas considered in the water balance is approximately 596 mm/yr based on data provided by ECCC.

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

Infiltration rates were estimated using the method presented in the Ontario Ministry of the Environment (MOE) (now the Ministry of Environment, Conservation and Parks [MECP]) *Stormwater Management Planning and Design (SWM) Manual* (MOE, 2003). There are three main factors that determine the percent infiltration of the water surplus: topography, soil type and ground cover. The sum of the fractions representing these three factors establishes the approximate annual percentage of surplus which can be infiltrated in an area with a sufficient downward groundwater gradient. Water bodies and wetlands (e.g., the on-site wetlands and ponds) were assumed to have an upward or negligible downward gradient, resulting in all surpluses being contained in these areas, which were assumed to provide increased evaporation and no infiltration. Furthermore, irrigation was not explicitly included in the pre-development condition water balance, recognizing that the majority of withdrawals would be lost to evapotranspiration. Pertinent assumptions for pre-development and post-development conditions are described in the following subsections.

5.1.1 Pre-Development Condition

Land use at the SE Site under the existing (pre-development) condition was inferred from details shown on the Topographic Survey (R-PE Surveying Ltd., 2021; see Appendix B) and available aerial imagery. The SE Site is currently occupied by grass fields, a residential house and a nine-hole golf course, including gravel roadways. There is a large wooded and wetland area between fairways on the east-central portion of the SE Site that covers approximately one third of the site area, with three small ponds adjacent to its north and west limits.

5.1.2 Post-Development Condition

Land use at the SE Site under post-development conditions was based on the Development Concept Plan (GSP Group 2022; see Appendix B). The largest wetland in the centre of the SE Site and nearby golf course pond will be retained, while the other three wetlands and golf course ponds will be removed. The development will include 118 single-family home dwelling lots, one SWM pond, as well as open space, wetland, trail/walkway/cart path, landscape and sanitary pumping station blocks. Infiltration rates were estimated using the method presented in the MOE *SWM Manual* (MOE, 2003). The sanitary pumping station, roads, and walkways, cart paths and trails

were considered to be impervious, while the urban lawn and open space on the development were considered to be pervious. Each single-family lot was assumed to include an impervious roof area of 345 m^2 and an impervious driveway area of 85 m^2, as per Figure 6 of the SWM Report (Burnside 2022; Appendix B).

5.2 Water Balance Parameters

Based on the results of subsurface investigation activities at the SE Site (see Section 3), the existing surficial soils were divided into three categories and considered for the purposes of this report to be sand loam, silt loam or clay loam given the results of grain size distribution curves obtained from selected soil samples. For the purpose of this report, the post-development surficial soil types were also considered to be sand loam, silt loam and clay loam noting that this assumption will need to be confirmed during detailed design on the basis of any soil movement or importation requirements. Sand loam soil was assumed to be present on the northeast end of the SE Site, approximately 17 ha in area. Silt loam was assumed to be present in the centre of the SE Site, approximately 20 ha in area, and the southwest end of the site was assumed to be clay loam, approximately 2 ha in area. Water holding capacities were assigned to the soil types using the values listed in Table 3.1: Hydrologic Cycle Component Values, from the MOE *SWM Manual* (MOE, 2003), as summarized in Table G-2, Appendix G.

The surplus data obtained from ECCC for the respective water holding capacities were split into infiltration and runoff components by applying infiltration factors based on Table 3.1 from the MOE *SWM Manual* (MOE, 2003). The infiltration factors were based on a sum of site-specific topography, surficial soil type and vegetative cover factors as presented in Table G-2 of Appendix G. Based on the Topographic Survey (R-PE Surveying Ltd., 2021; see Appendix B), topography factors of 0.1, representing hilly land (with an average slope of 28 m/km to 47 m/km), and 0.15 representing rolling to hilly land (with an average slope between 3.8 m/km to 28 m/km), were applied to the pre-development and post-development conditions at the SE Site, where applicable. Based on the Grading Plan (Burnside 2022; Appendix B), the post-development grading will be similar to pre-development conditions. The sand loam soil was considered to be open sandy loam, having an infiltration factor of 0.4. The silt loam soil was considered to be between clay loam and open sandy loam and was assigned an infiltration factor of 0.3. The clay loam soil was considered to be medium combinations of clay and loam, having an infiltration factor of 0.2. Grass-covered areas, meadows and shrubs were assigned a cover factor of 0.1, representing cultivated land. Forested areas were assigned a cover factor of 0.2, representing woodland. For impervious surfaces (buildings, gravel paths, and paved areas), no infiltration factor was applied.

The water balance analysis was developed under the following assumptions:

- WHCs were chosen based on Table 3.1 in the MOE *SWM Manual* (2003) corresponding to the soil types, existing land uses and proposed post-development conditions.
  - Forested Area (Mature Forest):
    - Sand Loam: 300 mm WHC and 0.75 infiltration factor.
    - Silt Loam: 400 mm WHC and 0.60 infiltration factor.
    - Clay Loam: 400 mm WHC and 0.50 infiltration factor.
  - Undeveloped Area (Pasture and Shrubs):
    - Sand Loam: 150 mm WHC and 0.65 infiltration factor.
    - Silt Loam: 250 mm WHC and 0.50 infiltration factor.
    - Clay Loam: 250 mm WHC and 0.40 infiltration factor.

  - Golf Course Lawns, Residential Lawns and Landscaping (Urban Lawn):
    - Sand Loam: 75 mm WHC and 0.65 infiltration factor.
    - Silt Loam: 125 mm WHC and 0.50 infiltration factor.
    - Clay Loam: 100 mm WHC and 0.40 infiltration factor.
  - Wetlands, Existing Ponds, and SWM Pond: Surplus assumed to equal precipitation minus potential evapotranspiration, with a null (i.e., 0%) infiltration factor.
  - Impervious Areas (i.e., roads, pathways, and rooftops): Surplus assumed as 90% of precipitation and null (i.e., 0%) infiltration factor (Conservation Authorities Geoscience Group, 2013).
- Net surplus was estimated by multiplying the estimated monthly surplus (mm/month) for the assumed WHC by the associated drainage area. Annual evapotranspiration and surplus values were obtained from the meteorological data from the Fergus Shand Dam ECCC Meteorological Station based on the WHC assigned to each land use area.
- Runoff was calculated as the difference between surplus and infiltration.

5.3 Water Balance Results

Average annual water balance assessments were carried out on a site-wide basis for the SE Site, as described in Sections 5.1 and 5.2. The results for the pre-development, post-development, and mitigated post-development scenarios are presented in this section.

5.3.1 Pre-Development Condition

Based on the results of the assessment, the average annual pre-development water balance was estimated as summarized in Table 2, and as detailed in Table G-3, Appendix G.

Table 2: Pre-Development Average Annual Water Balance Results

Component	Average Annual Volume m^3/yr
	Site-Wide
Precipitation (P)	384,950
Evapotranspiration (ET)	226,610
Surplus (S)	157,520
Infiltration (I)	87,150
Runoff (R)	70,380

For the pre-development condition, the estimated average annual runoff from the SE Site is approximately 70,380 m^3 and the average annual infiltration on the SE Site is approximately 87,150 m^3.

5.3.2 Post-Development Condition

Based on the results of the assessment, the average annual post-development water balance was estimated as summarized in Table 3, and as detailed in Table G-4, Appendix G.

Table 3: Post-Development Average Annual Water Balance Results

Component	Average Annual Volume m^3/yr
	Site-Wide
Precipitation (P)	384,950
Evapotranspiration (ET)	182,730
Surplus (S)	201,680
Infiltration (I)	64,530
Runoff (R)	137,150

For the post-development condition, the estimated average annual runoff from the SE Site is approximately 137,150 m^3 and the estimated average annual infiltration on the SE Site is approximately 64,530 m^3. As a result of land use changes, runoff is expected to increase by 95% (i.e., 70,380 m^3 to 137,150 m^3) and infiltration is expected to decrease by 26% (i.e., 87,150 m^3 to 64,530 m^3) on an average annual basis.

5.3.3 Post-Development Condition Including Mitigation

Average annual infiltration volumes at the SE Site are expected to decrease relative to pre-development conditions and runoff volumes are expected to increase as a result of development. Groundwater recharge at the site assists to maintain seasonally high groundwater levels that are understood to support the central wetland area which requires seasonally high groundwater levels followed by a drier period in the summer months. In addition, potable groundwater use is present in the SE Site area, although the predominant aquifer hydraulically downgradient of the majority of the SE Site is the bedrock which receives recharge from an extensive geographical area and not just from the site. Therefore, it is considered prudent to incorporate LID measures into the development design to mitigate against reductions to post-development infiltration rates to the extent practical. Further, the use of LID measures for stormwater runoff from the development assists to support the natural hydrologic cycle by helping to maintain groundwater recharge, provide additional water quality treatment and reduce the volume of runoff from a site.

It is understood that a foundation drain collector (FDC) is proposed for a number of residential homes in the southern portion of the SE Site. The FDC is a third pipe system that will segregate groundwater inputs to the residential foundation drains from the stormwater management system, in order to maintain its thermal properties. As a LID measure, the FDC will discharge to Black Drain on the downstream side of the central wetland area. This location was selected so that the seasonally dry conditions in the wetland would be maintained while directing groundwater from the FDC to Black Drain to off-set the reduction in average annual post-development infiltration rates.

The LID mitigation scheme includes lot-level infiltration galleries for the entire roof areas at 91 lots and downspout disconnection at the remaining 27 lots as per design information provided by Burnside. Lots were selected for infiltration galleries based on Burnside's comparison of proposed grading versus seasonally high groundwater levels. The following assumes that a 1 m separation will be maintained between the infiltration gallery invert and seasonally high groundwater conditions (April 14, 2021, water level data). Assumed infiltration rates were obtained from published sources for each surficial soil types encountered at the borehole locations (sandy loam, silt loam and clay loam), incorporating a 2.5 factor of safety (TRCA & CVC, 2010). Resultant runoff reduction rates for roof areas were estimated to be 55%, 72% or 77% for infiltration galleries and 25%, 25% or 50% for downspout disconnections, for clay loam, silt loam and sandy loam respectively. In-situ infiltration rate testing is recommended to facilitate detailed design of infiltration galleries and refine estimates of runoff reduction rates.

Based on the above mitigation, the average annual mitigated post-development water balance was estimated as summarized in Table 4, and as detailed in Table G-5, Appendix G.

Table 4: Mitigated Post-Development Average Annual Water Balance Results

Component	Annual Volume m^3/yr
	Site-Wide
Precipitation (P)	384,950
Evapotranspiration (ET)	182,730
Surplus (S)	201,680
Infiltration (I)	87,490
Runoff (R)	114,190

The proposed LID mitigation scheme, relying on lot-level infiltration galleries and downspout disconnection, is estimated to increase average annual infiltration by approximately 22,960 m^3 and reduce average annual runoff similarly, compared to the un-mitigated post-development condition. As a result, on a site-wide basis, average annual infiltration is estimated to remain approximately unchanged (i.e., 87,150 m^3 to 87,490 m^3) and average annual runoff is expected to increase by 62% (i.e., 70,380 m^3 to 114,190 m^3 to) as a result of development with mitigation compared to pre-development conditions.

6.0 DISCUSSION

The 39.85 ha SE Site, currently developed as a nine-hole golf course, is proposed to be redeveloped as a residential subdivision comprised of 118 single-family home dwelling lots, one SWM pond, as well as open space, park, wetland, trail/walkway/cart path, landscape and sanitary pumping station blocks.

The surficial soil conditions at the SE Site consist of relatively thin (i.e., 0.7 m to 3.5 m thick) native soil deposits consisting of silty sand to sand or clayey silt with sand, underlain by silty clay to clayey silt and silt and sand glacial till deposits. Some granular layers of silty sand and gravel are present within the till deposit. The estimated geometric mean hydraulic conductivity of the surficial non-cohesive soils at the tested locations is $7x10^{-7}$ m/s, and of the underlying cohesive soils and glacial till is $8x10^{-8}$m/s.

Except for the northeast edge of the SE Site which grades toward Lake Belwood located off-site to the northeast, the majority of the SE Site grades toward, and is drained by, Black Drain. The upstream limit of Black Drain is present on the SE Site, receiving run off from roadside drainage ditches on Wellington Road 19 and draining eastward to a central wetland area. Subsequently, Black Drain flows in a south direction through the low portion of the SE Site and discharges into Irvine Creek approximately 2.5 km to the west.

The depth to groundwater at the monitoring wells ranged from -0.09 mbgs to 2.36 mbgs and from approximate elevations of 423.97 masl to 434.56 masl on the dates monitored in April 2021. The depth to groundwater at the monitoring wells ranged from 1.30 mbgs to 3.37 mbgs and from approximate elevations of 424.51 masl to 431.97 masl on October 7, 2022. Groundwater levels were on average 1.6 m deeper on October 7, 2022 than the highest readings in April 2021. Seasonal and annual fluctuations should be expected. Shallow groundwater at most of the SE Site was inferred to flow in an easterly, southerly or westerly direction towards Black Drain, except along the eastern edge of the SE Site where shallow groundwater was inferred to flow in a northeasterly direction towards Lake Belwood.

A bi-level monitoring well installation and five piezometer/staff gauge pairs installed near Black Drain and wetland features on the SE Site indicate variable recharging and discharging conditions during the four monitoring events carried out in April 2021 and October 2022. The central wetland area is present on either side of Black Drain in the topographically low central portion of the SE Site. Beacon indicates that the wetland is characterized by seasonally high groundwater conditions followed by a seasonal dry period in the summer months. It is inferred that the seasonally high groundwater levels are supported by groundwater recharge to the predominant thin non-cohesive soils during the cool, wet spring months with a groundwater flow direction toward Black Drain and the central wetland area, followed by a decline in groundwater levels in the non-cohesive soils during the warmer, drier summer months. This is corroborated by the observation of dry conditions at all five piezometer and staff gauge pairs on October 7, 2022, and the absence of water in Black Drain.

Water well records indicate 90 water supply wells within 500 m of the SE and NW Sites, including 4 existing irrigation wells on the NW Site and SE Site that are used by Fergus Golf Club. The water supply wells were generally reported to encounter thick glacial till, which commonly contained confined sand or gravel layers/units or was underlain by confined sand or gravel units, all of which was underlain by shale and limestone bedrock. Of the 90 water supply wells, 69 (77%) are completed in the bedrock and 21 (23%) are completed in the overburden. The shale and limestone bedrock was therefore utilized by the majority of the water wells, and various confined sand or gravel layers/units were inferred to be the aquifers utilized by the overburden wells.

A site-wide water balance estimate was carried out for the SE Site to assess the potential hydrogeological impacts of the proposed development with respect to average annual post-development infiltration rates. The development of the 39.85 ha SE Site, without the implementation of mitigation measures, is expected to result in a 26% reduction in average annual infiltration.

Average annual infiltration volumes at the SE Site are expected to decrease relative to pre-development conditions and runoff volumes are expected to increase as a result of development. Groundwater recharge at the SE Site assists to maintain seasonally high groundwater levels that are understood to support the central wetland area. In addition, potable groundwater use is present in the SE Site area, although the predominant aquifer hydraulically downgradient of the majority of the SE Site is the bedrock which receives recharge from an extensive geographical area and not just from the SE Site. Therefore, it is considered prudent to incorporate LID measures into the development design to mitigate against reductions to post-development infiltration rates to the extent practical. Further, the use of LID measures for stormwater runoff from the development assists to support the natural hydrologic cycle by helping to maintain groundwater recharge, provide additional water quality treatment and reduce the volume of runoff from a site.

Lot-level infiltration galleries are proposed to infiltrate runoff from house roofs where groundwater levels allow. Based on a review of monitored groundwater levels versus the proposed grading, it is understood that 91 lots will be able to accommodate lot-level infiltration galleries while maintaining 1 m separation between the invert of the gallery and the seasonally high groundwater level. Downspouts will be disconnected at the remaining 27 lots to further facilitate infiltration. It is understood that a foundation drain collector (FDC) is proposed for a number of residential homes in the southern portion of the SE Site. The FDC will segregate groundwater from the residential foundation drains from the stormwater management system, in order to maintain its thermal properties. As a LID measure, the FDC will discharge to Black Drain on the downstream side of the central wetland area. This location was selected so that the seasonally dry conditions in the wetland would be maintained while directing groundwater from the FDC to Black Drain to off-set the reduction in average annual post-development infiltration rates.

Lot-level infiltration galleries and downspout disconnection for the entire roof area of each house are proposed as LID measures to promote infiltration and reduce stormwater runoff. With the implementation of lot-level infiltration galleries and downspout disconnection, the development is expected to result in the approximate maintenance of average annual infiltration rates. Average annual runoff is expected to increase by 62% post-development, including LID mitigation.

The designs for the SE Site are at a conceptual or preliminary stage, and therefore a preliminary assessment of short-term (construction) dewatering needs and permitting requirements is provided at this time. The steady state groundwater inflow rate for typical servicing excavations encountering cohesive and glacial till soils may not individually exceed 50 m^3/day. The presence of saturated non-cohesive soil units overlying or within the glacial till soils, if encountered, are expected to generate higher steady state dewatering rates. Including the initial removal of groundwater from storage and excluding contributions from incident precipitation that must be handled along with the groundwater, the total groundwater pumping rate for a typical servicing excavation, or the pumping station building, or the SWM pond, will individually exceed 50 m^3/day but not likely exceed 400 m^3/day. Accordingly, the need to register a construction dewatering taking on the EASR is anticipated to be required at a minimum. However, if multiple dewatering activities occur simultaneously, the need to obtain a Category 3 PTTW could be conservatively anticipated at this time. This assessment will need to be confirmed at the time of detailed design once additional details are available.

Private water well use is present in the SE Site area and on the SE Site for golf course uses. The use of the deep, confined bedrock aquifer is predominant, although some overburden water well use, including shallow dug wells, is present at residences between the SE Site and Lake Belwood to the northeast. The bedrock aquifer receives recharge from a large geographical area well beyond the site limits. Given the approximate maintenance of average annual post-development infiltration rates at the SE Site, no noticeable reduction in groundwater quantity downgradient of the SE Site is expected. Similarly, given the small portion of the SE Site with an inferred groundwater flow direction toward the northeast to Lake Belwood, negligible impacts, if any, to groundwater quantity in shallow water wells in this area are anticipated.

Roof runoff from all houses is proposed to be directed to lot-level infiltration galleries or pervious areas within lawns to promote additional infiltration of clean water. Some precipitation from paved areas (e.g., driveways) may also infiltrate. This infiltration is not expected to significantly degrade the groundwater quality at the SE Site, although stormwater from driveways and roads may have increased concentrations of one or more of reduced metals, oil and grease, and road salt. With the exception of road salt, these materials quickly become immobile in the shallow subsurface.

7.0 RECOMMENDATIONS

Based on the findings of this hydrogeological investigation, the following are recommended:

- The monitoring well network can be maintained and used for further monitoring. Continued monitoring of water levels in the monitoring wells, piezometers and staff gauges can be carried out to assess seasonal conditions, such as groundwater conditions in the summer/fall months. Once the monitoring wells are no longer required, decommissioning should occur in accordance with applicable legislation.
- In-situ infiltration rate testing is recommended to facilitate detailed design of lot-level infiltration galleries and refine estimates of runoff rate reductions.

- A detailed assessment of construction dewatering needs and potential impacts to receptors should be carried out at the time of detailed design and in conjunction with obtaining dewatering permitting from the MECP, and on the basis of the additional investigation activities.
- Trench plugs should be installed in the servicing trenches to limit the preferential migration of groundwater in the permeable pipe bedding materials, and watertight sewer connections should be utilized.
- All unused private water wells (i.e., golf irrigation wells) at the SE Site should be decommissioned in accordance with applicable legislation as part of site development activities.

8.0 CLOSURE

We trust that this submission meets your current requirements. If you have any questions regarding the contents of this report, please contact the undersigned.

Signature Page

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https://golderassociates.sharepoint.com/sites/142682/project files/6 deliverables/hydrogeological/21456909 (2100) rep 2023'04'28 hydrogeological investigation - fergus development (rev2).docx

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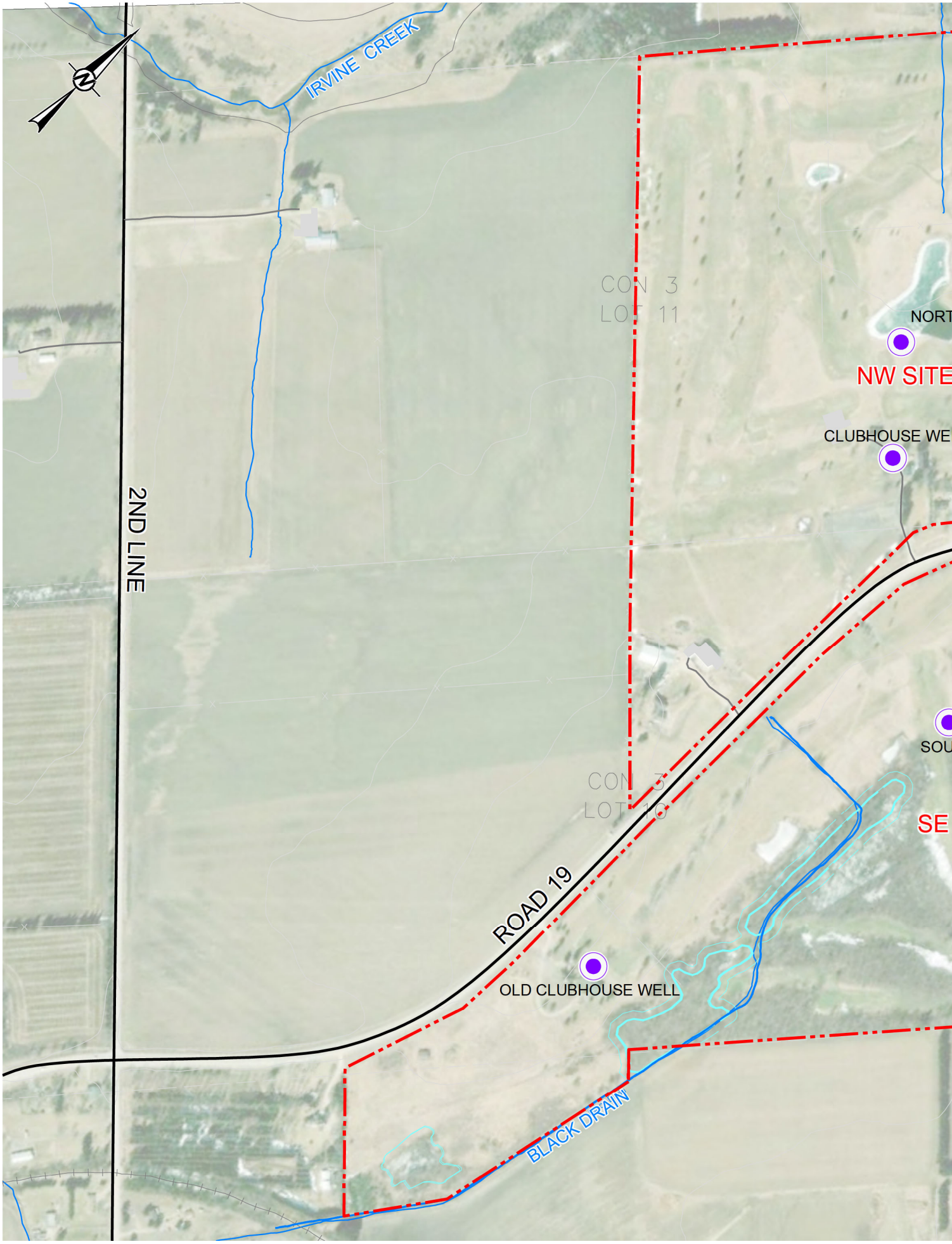
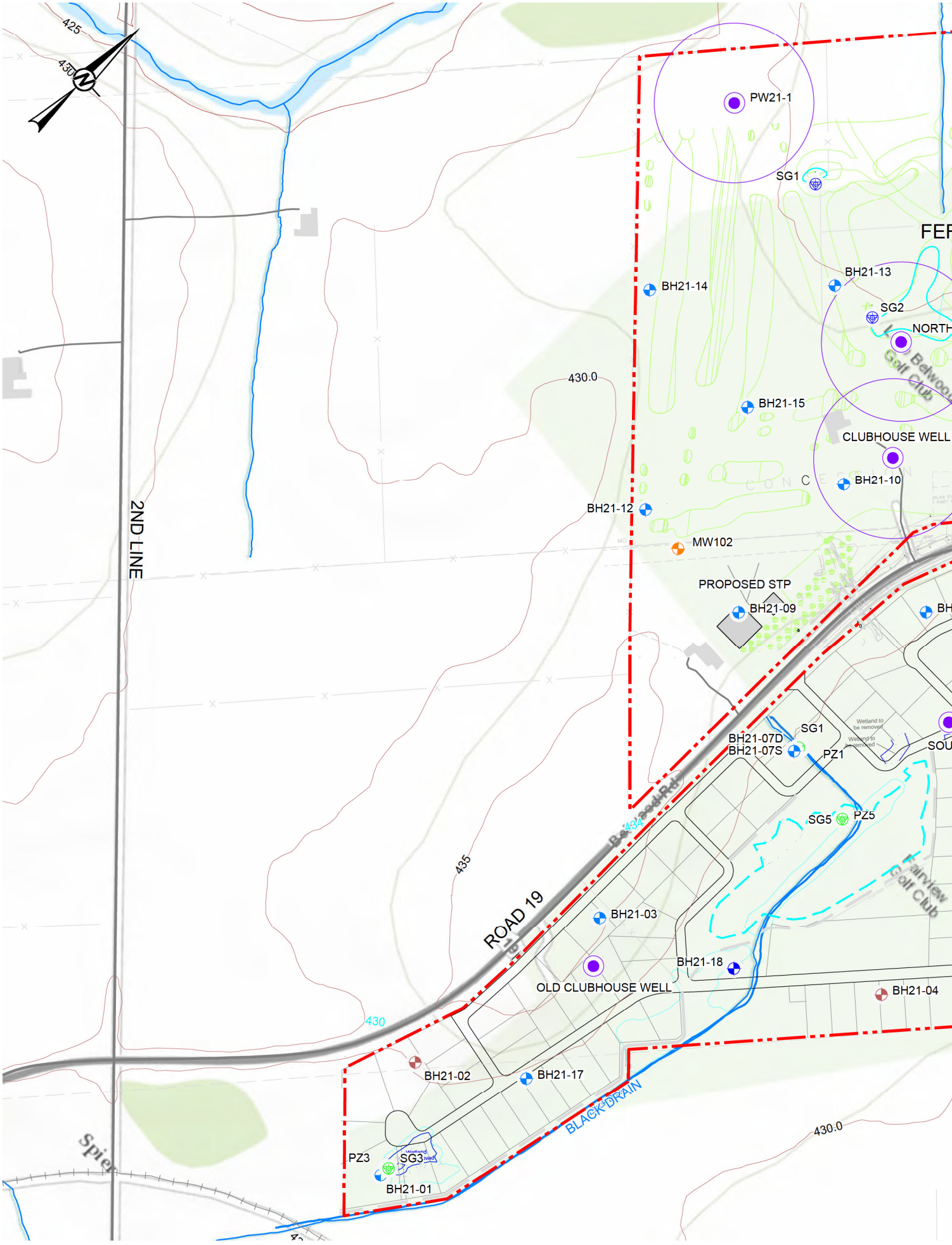
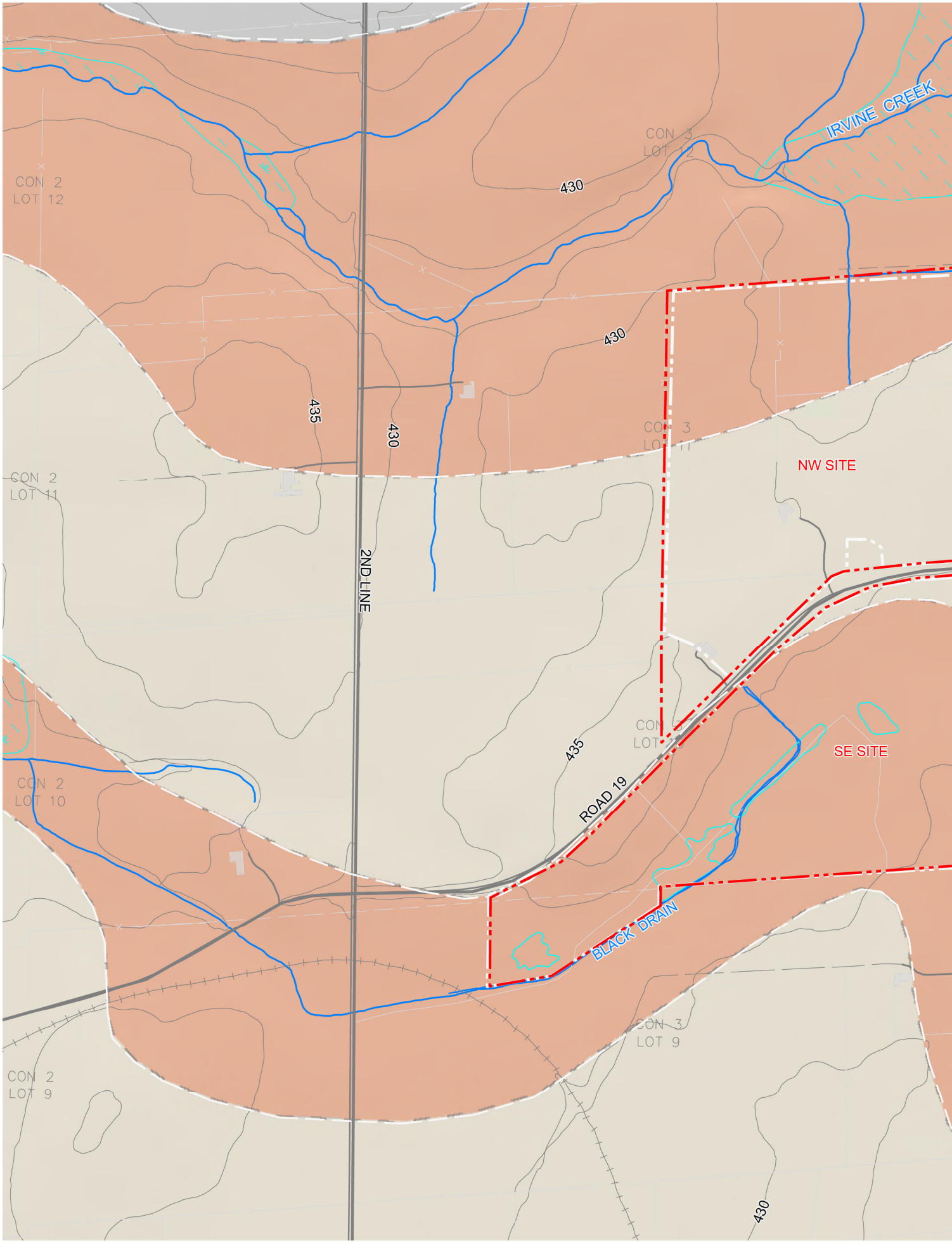
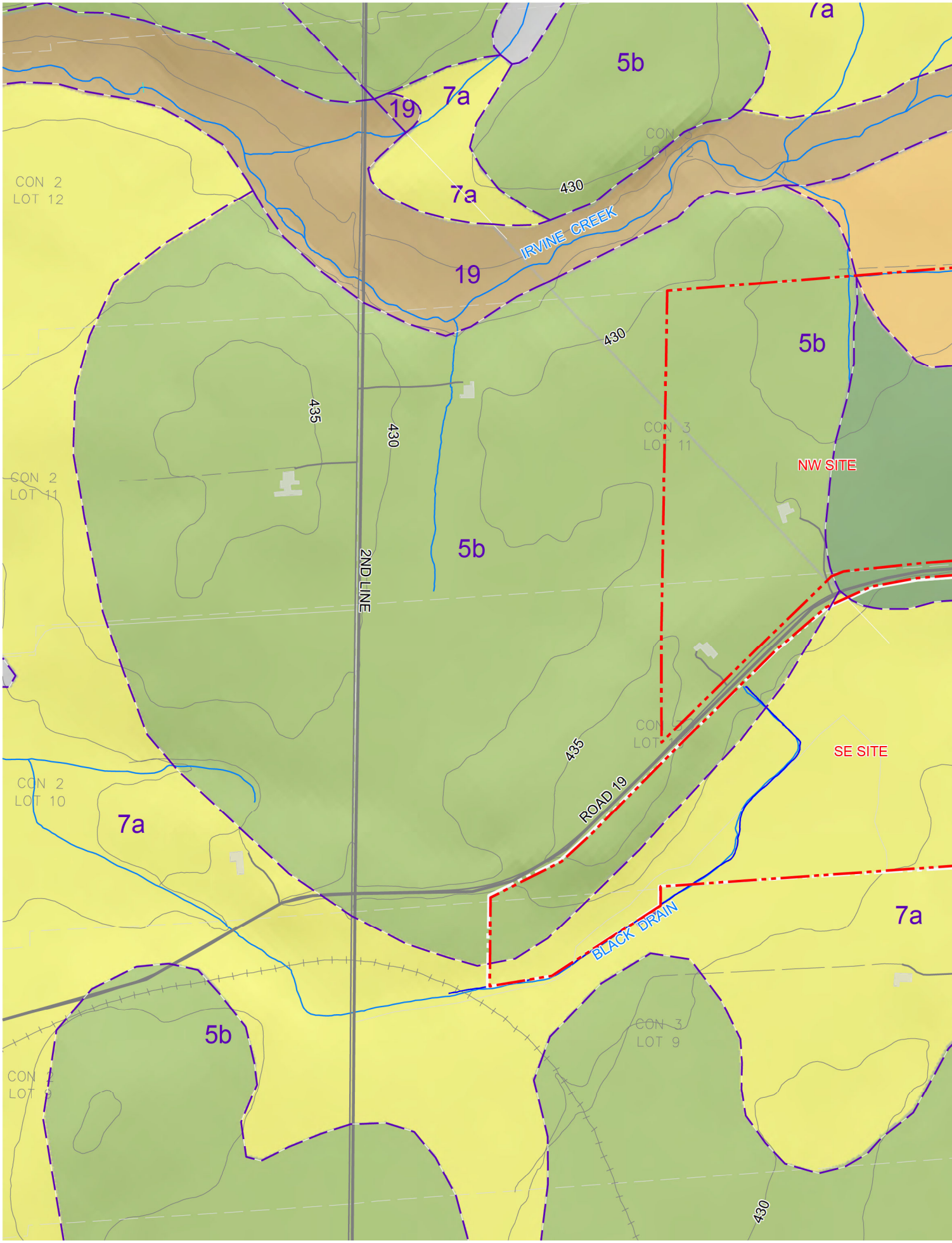
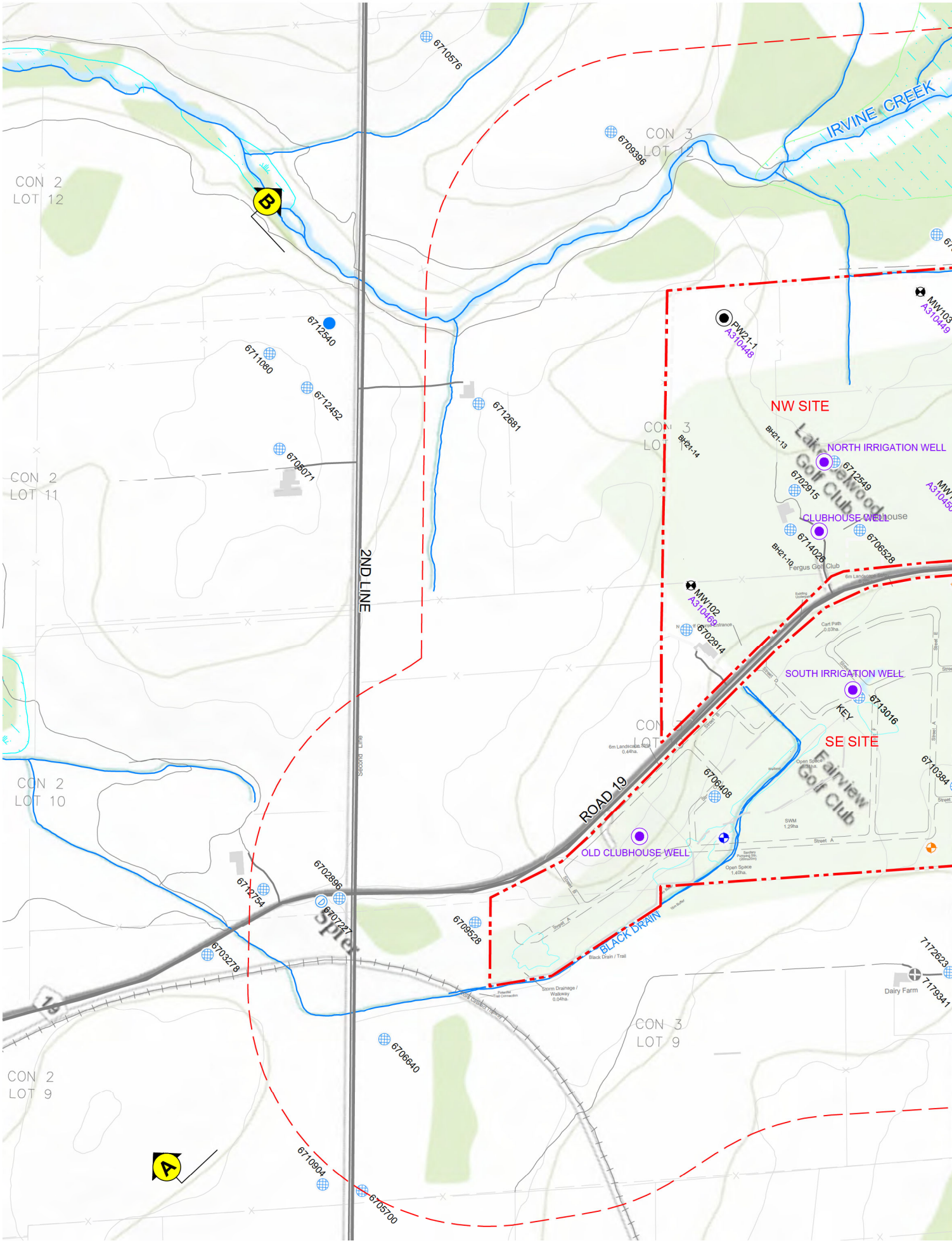
FIGURES

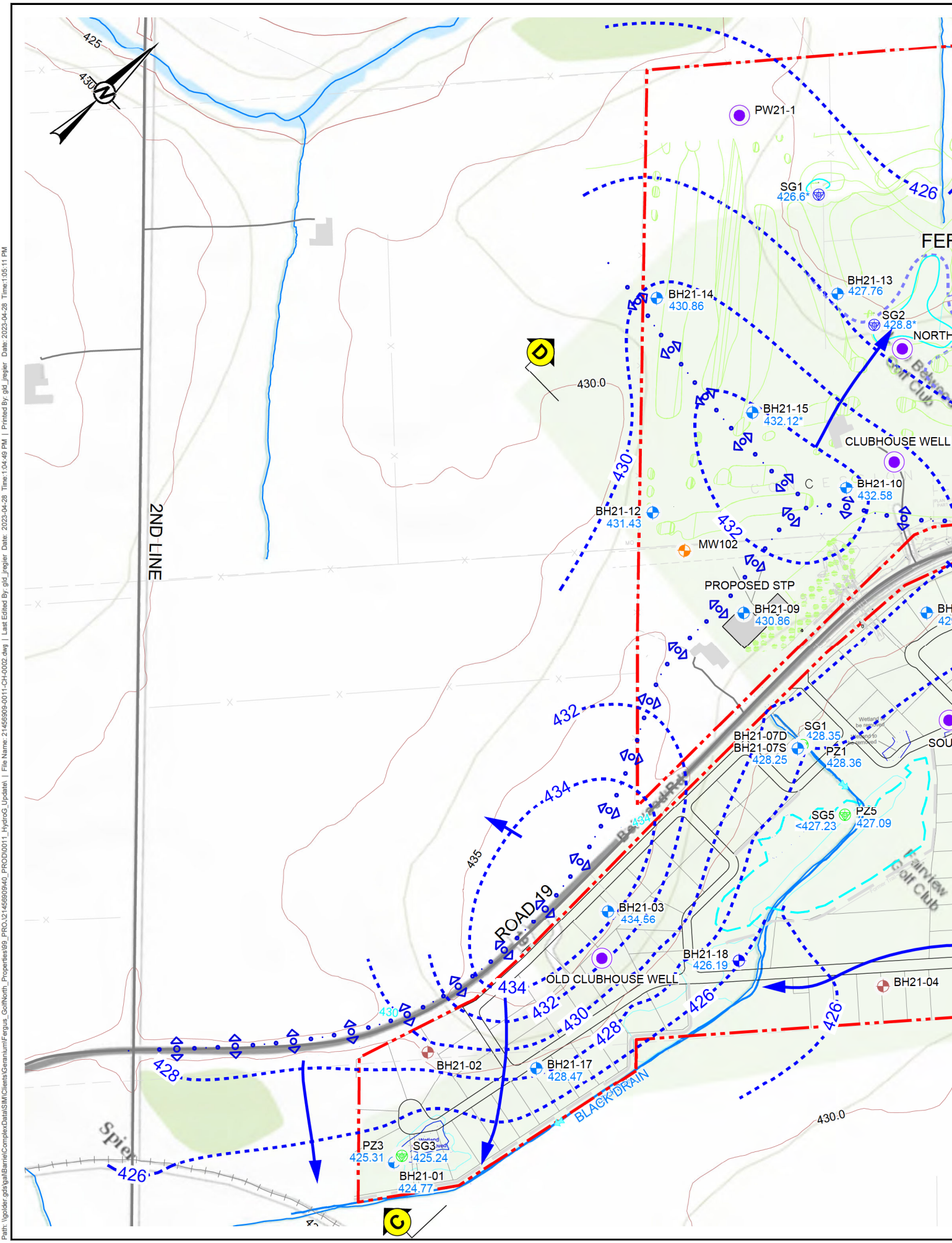


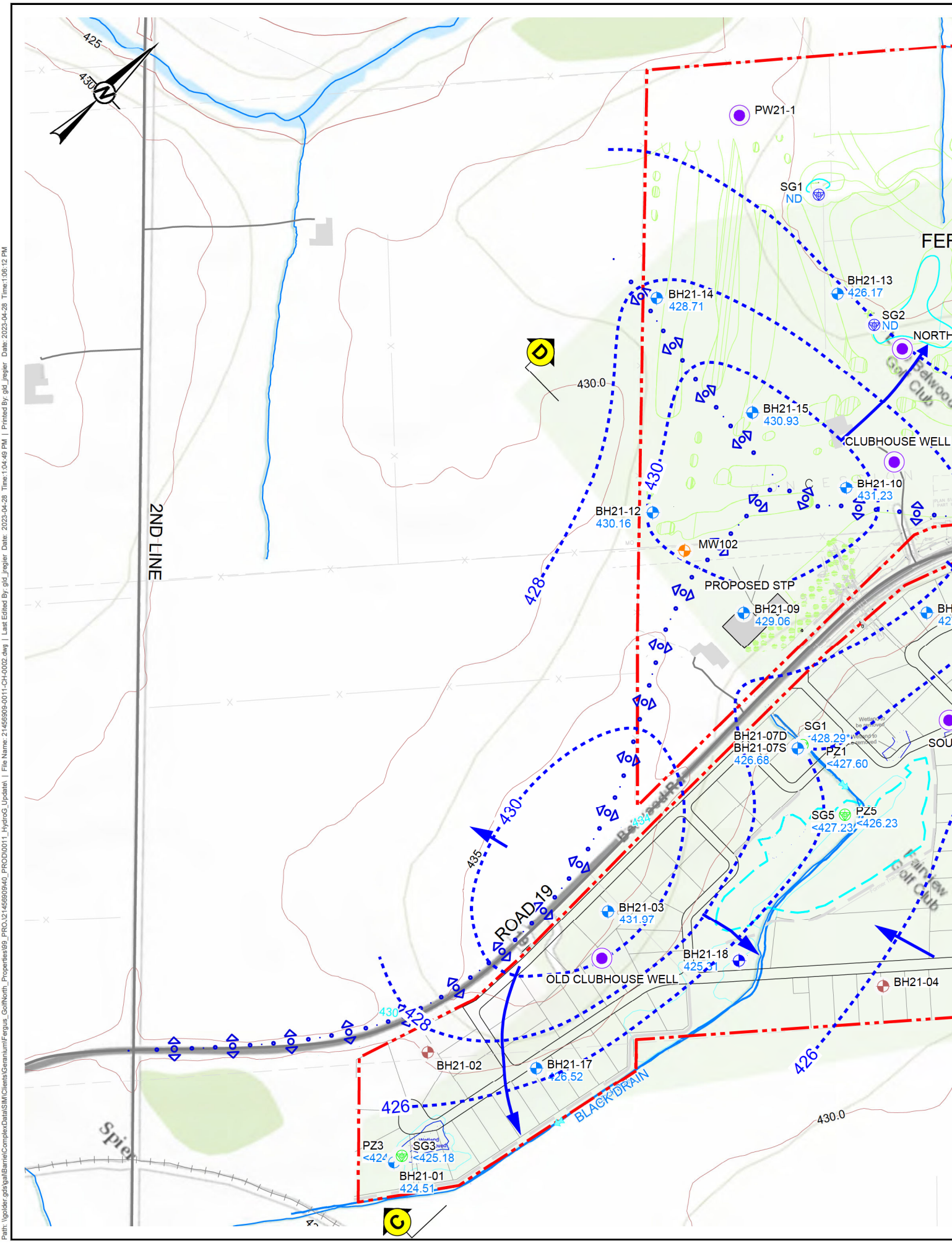


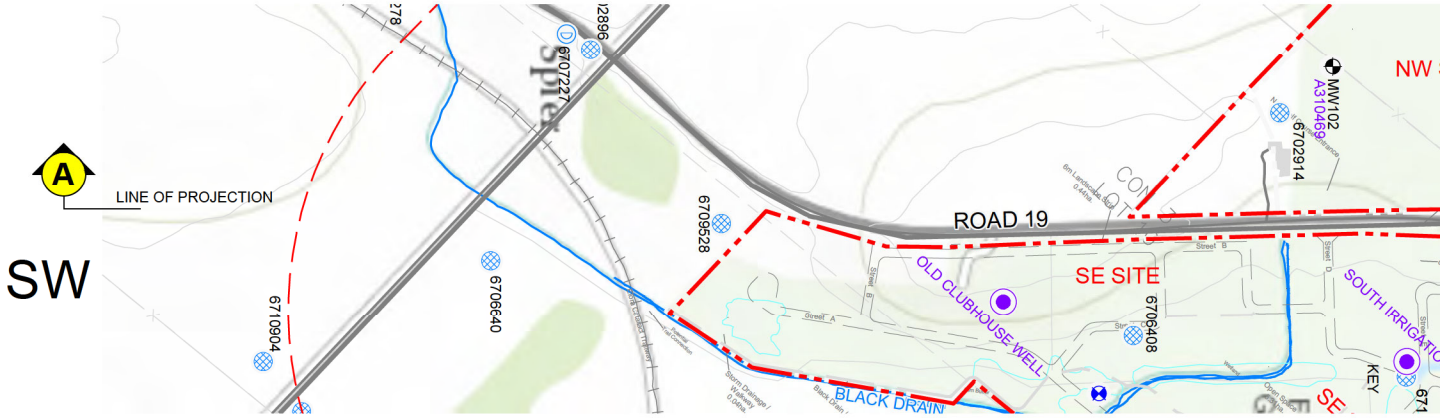


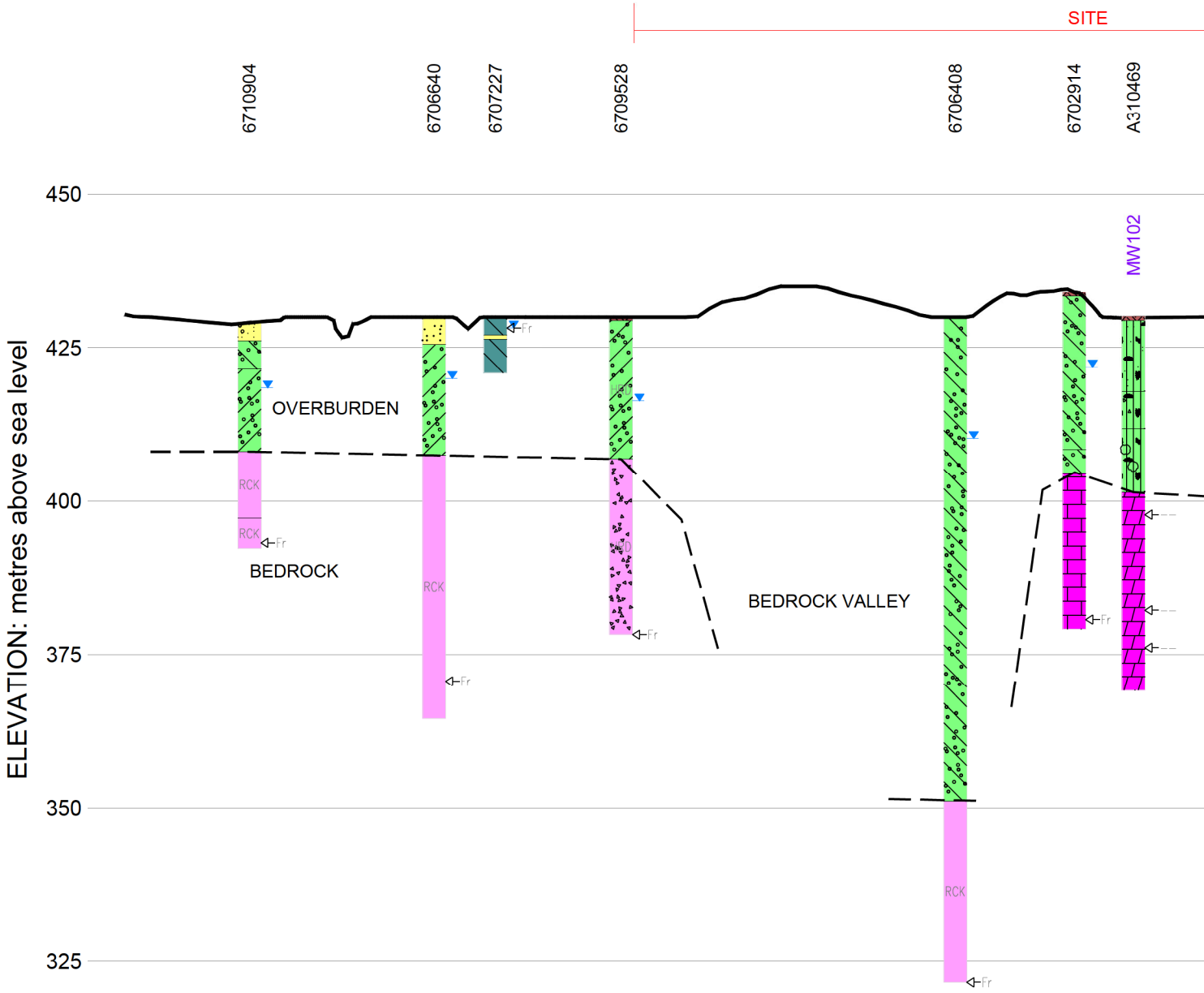


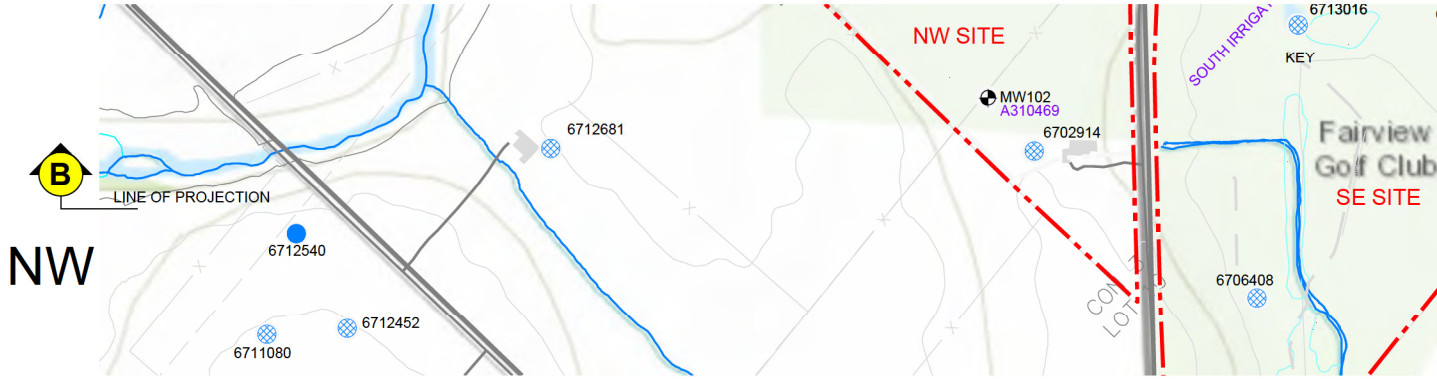


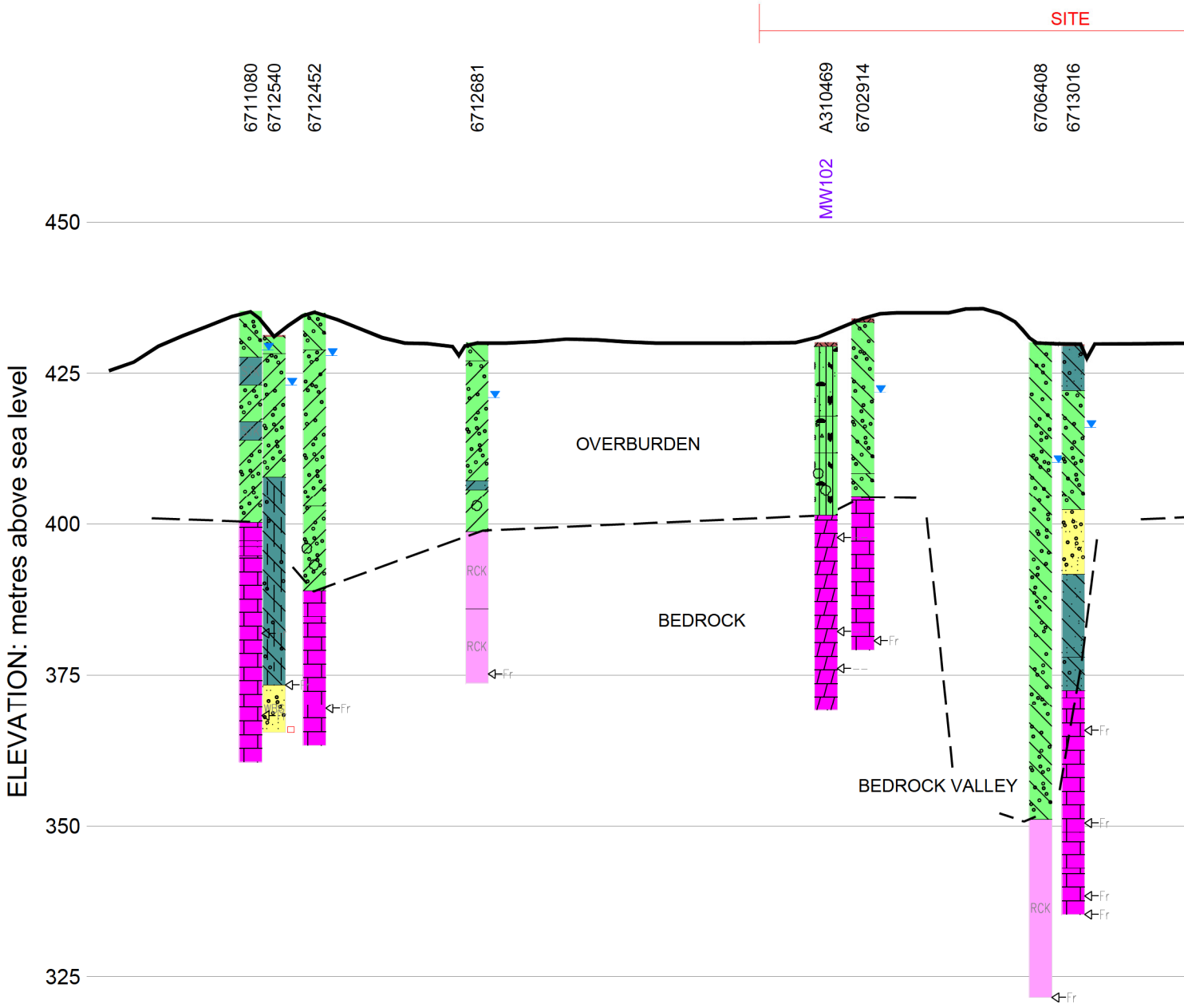


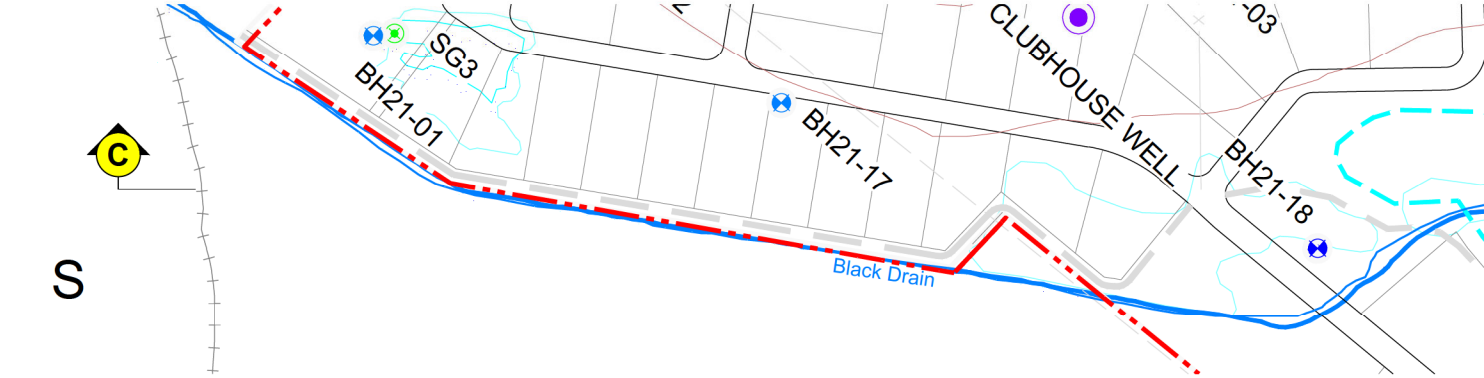






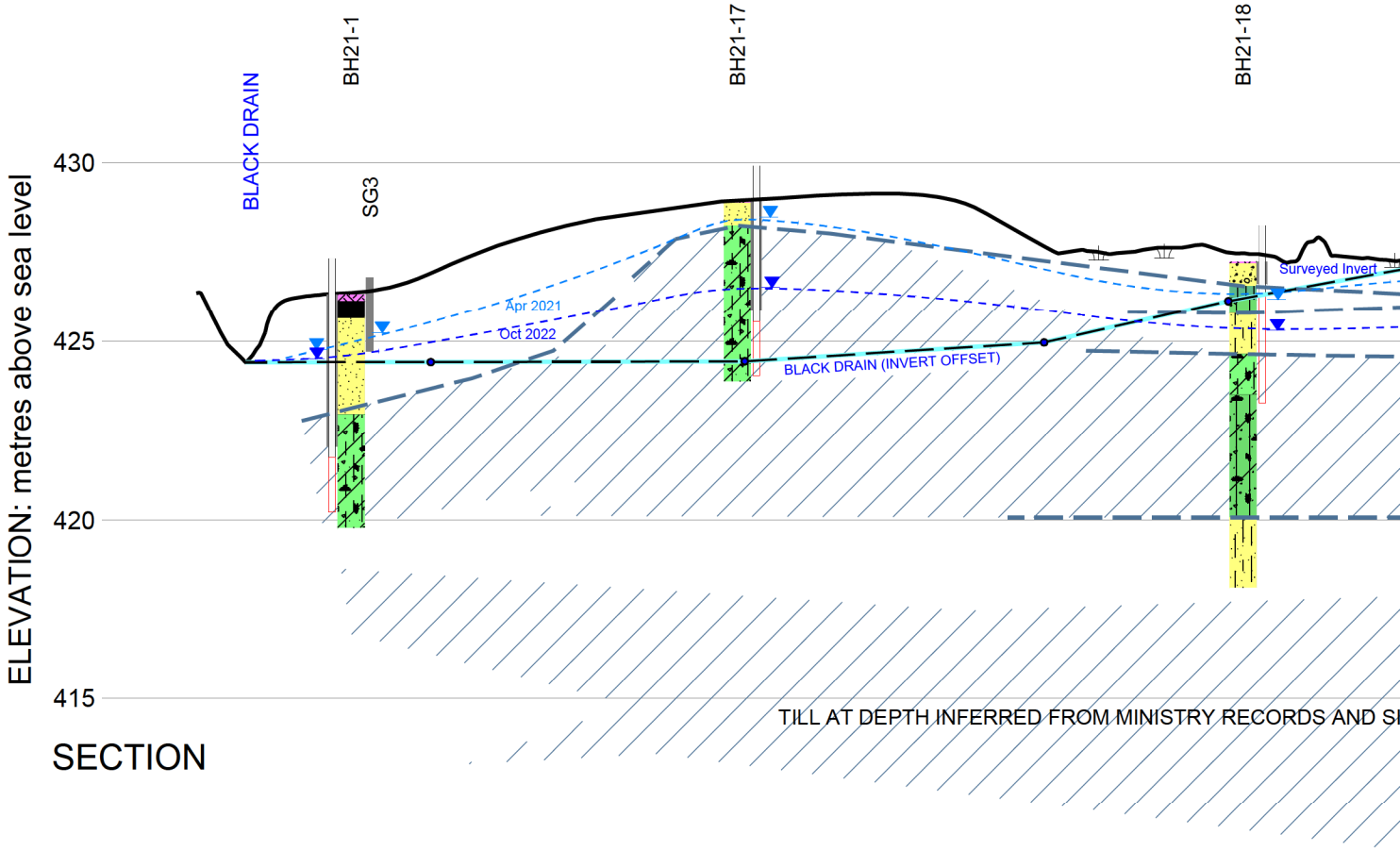






S

PLAN



SECTION

SOIL PATTERN LEGEND AND GENERIC SHADING

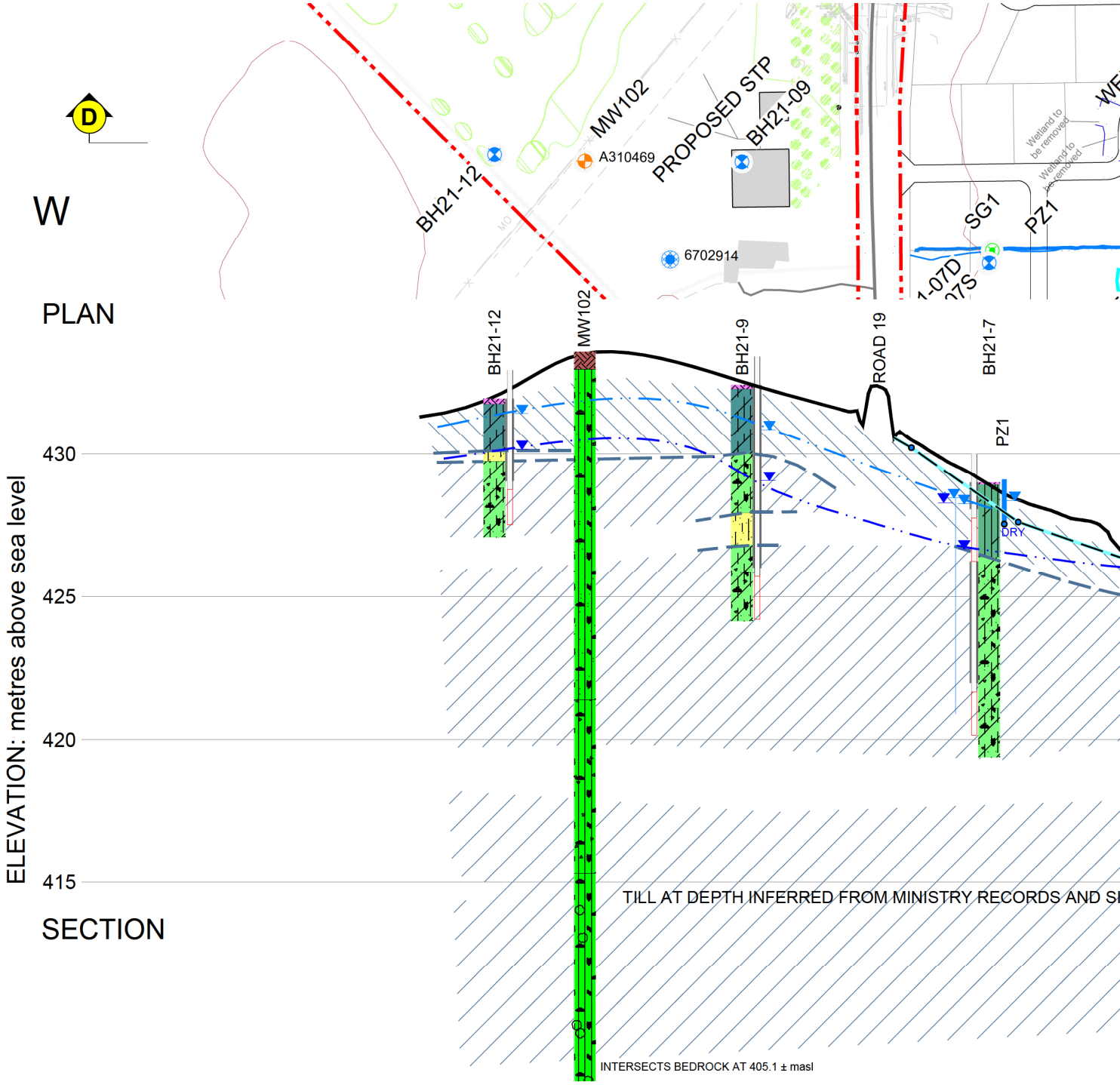
- ORGANICS / TOPSOIL
- FILL
- SAND & GRAVEL
- SAND
- SAND TRACE SILT
- SILTY SAND
- SILT
- SANDY SILT
- SANDY SILT WITH TO SOME CLAY
- CLAYEY SILT
- SILTY CLAY
- SILT TILL
- SILTY CLAY TILL
- SILTY SAND / SANDY SILT TILL

PLAN LEGEND

- PROPERTY BOUNDARY

SITE EXISTING & PROPOSED WELLS

- TEST BOREHOLE
- PROPOSED MONITORING WELL / TO BE SURVEYED
- MONITORING WELL (SURVEYED)
- ENVIRONMENTAL SAMPLING LOCATION
- STAFF GAUGE
- PIEZOMETER
- EXISTING PRODUCTION WELL



SOIL PATTERN LEGEND AND GENERIC SHADING

- ORGANICS / TOPSOIL
- FILL
- SAND & GRAVEL
- SAND
- SAND TRACE SILT
- SILTY SAND
- SILT
- SANDY SILT
- SANDY SILT WITH TO SOME CLAY
- CLAYEY SILT
- SILTY CLAY
- SILT TILL
- SILTY CLAY TILL
- SILTY SAND / SANDY SILT TILL

PLAN LEGEND

- PROPERTY BOUNDARY

SITE EXISTING & PROPOSED WELLS

- TEST BOREHOLE
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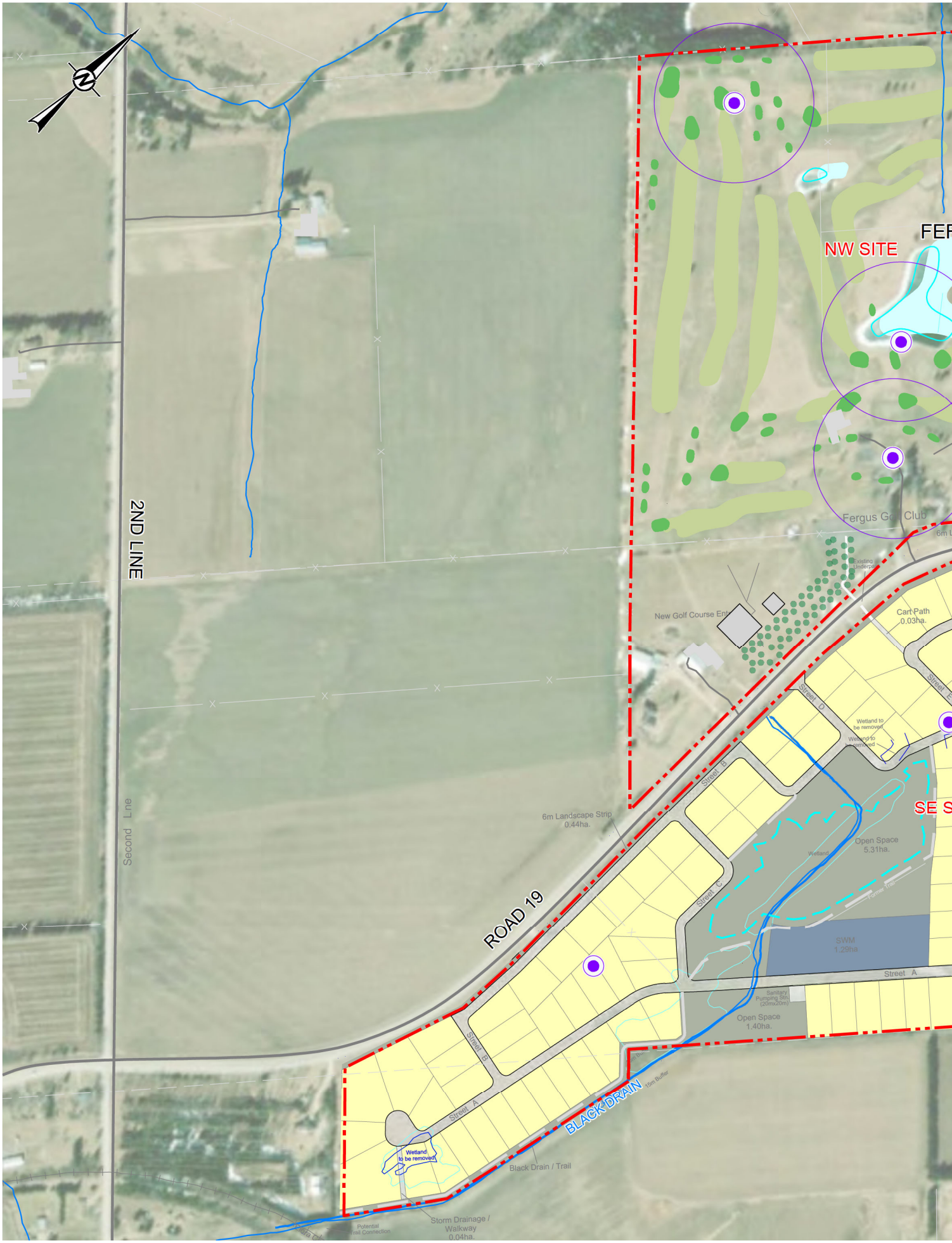
- PIEZOMETER
- EXISTING PRODUCTION WELL



APPENDIX A

Important Information and Limitations of this Report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practicing under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder cannot be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder cannot be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

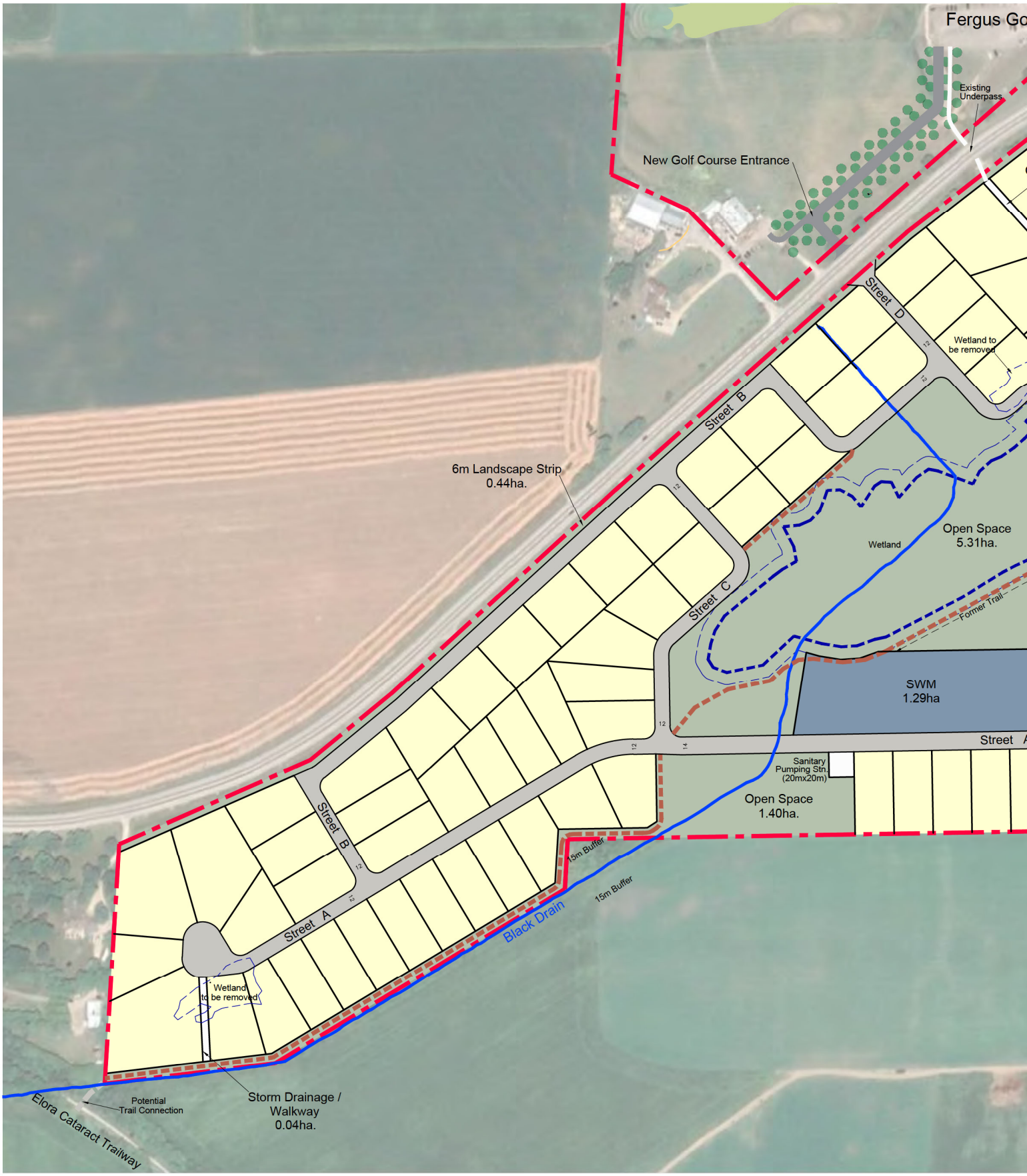
During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

APPENDIX B

Supporting Documentation



DEVELOPMENT CONCEPT

The Village At Fairview Greens

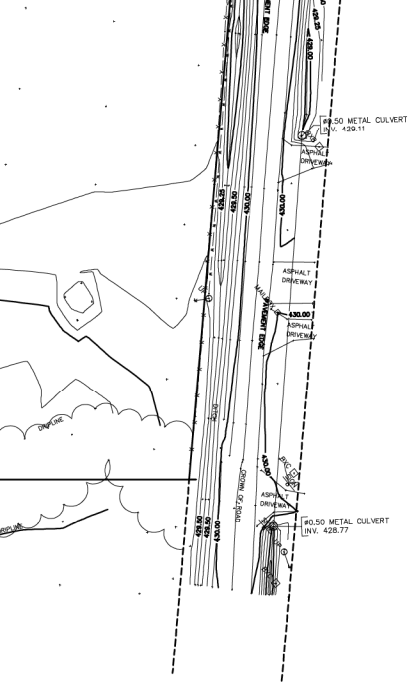
1/2 Acre Residential Lots

GRCA Wetland / OP Core Greenlands

10m Wetland Buffer

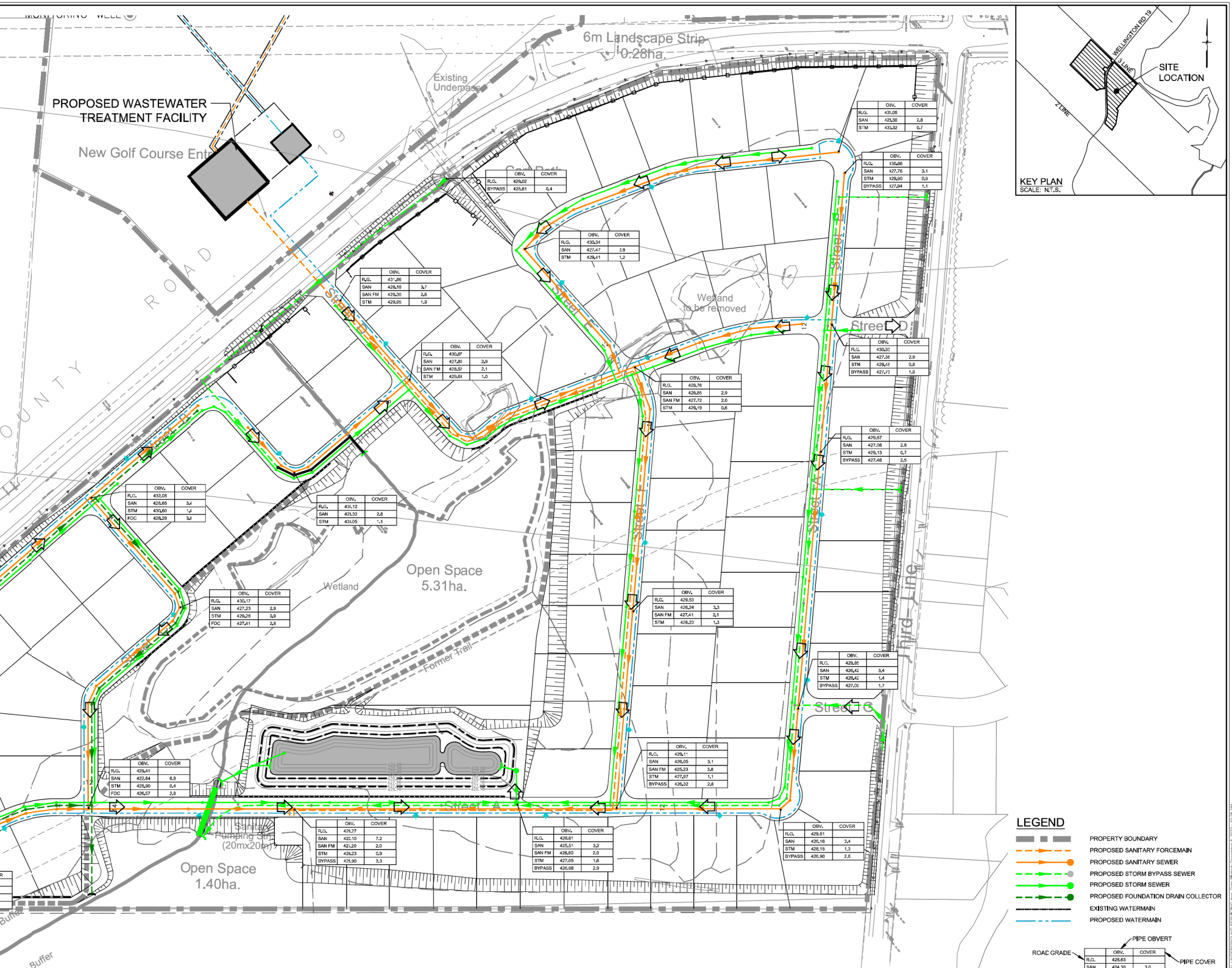
Potential Trails

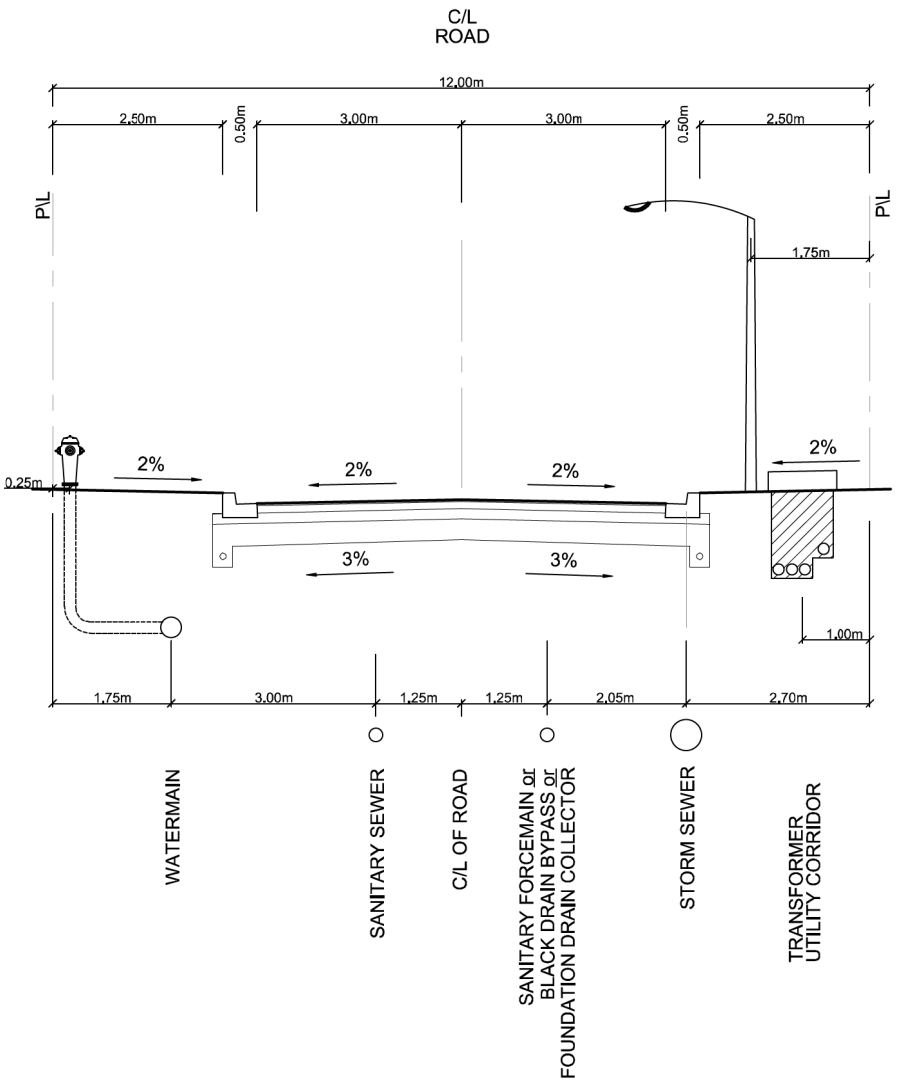
Site Area:
No. of Lots
Area of we



R-PE SURVEYING LTD.
ONTARIO LAND SURVEYORS
643 Chrislea Road, Suite 7
Woodbridge, Ontario L4L 8A3
Tel.(416)635-5000 Fax (416)635-5001
Tel.(905)264-0881 Fax (905)264-2099
Website: www.r-pe.ca

DRAWN: S.L. CHECKED:
JOB No. 21-016 CAD FILE No.21016TP1d


PROPOSED WASTEWATER TREATMENT FACILITY
New Golf Course Entrance
6m Landscape Strip
0.28ha.
Existing Underpass
Wetland to be removed
Wetland
Open Space
5.31ha.
Open Space
1.40ha.
Sanitary Pumping Stn.
(20mx20m)
Former Trail
Third Line
Street A
Street B
Street C
Street D
Street E
Street F
Street G
Buffer
Buffer
R.G. OBV. COVER
BYPASS 429.02 0.4
R.G. 431.06
SAN 425.30 2.8
STM 433.32 0.7
R.G. 430.86
SAN 427.76 3.1
STM 429.90 0.9
BYPASS 427.94 1.1
R.G. 430.34
SAN 427.47 2.9
STM 429.41 1.2
R.G. 431.66
SAN 428.16 3.7
SAN FM 429.30 2.6
STM 429.96 1.9
R.G. 430.87
SAN 427.80 2.9
SAN FM 428.52 2.1
STM 429.61 1.0
R.G. 430.33
SAN 427.38 2.9
STM 429.48 0.8
BYPASS 427.73 1.0
R.G. 429.76
SAN 426.85 2.9
SAN FM 427.72 2.0
STM 429.19 0.6
R.G. 429.87
SAN 427.06 2.8
STM 429.13 0.7
BYPASS 427.46 2.5
R.G. 432.08
SAN 428.65 3.4
STM 430.60 1.4
FDC 428.29 3.8
R.G. 431.12
SAN 428.32 2.8
STM 430.05 1.1
R.G. 430.17
SAN 427.23 2.9
STM 429.26 0.9
FDC 427.41 2.8
R.G. 429.53
SAN 426.24 3.3
SAN FM 427.41 2.1
STM 428.23 1.3
R.G. 429.85
SAN 428.42 3.4
STM 428.42 1.4
BYPASS 427.05 1.7
R.G. 429.41
SAN 422.84 6.8
STM 426.90 0.4
FDC 426.57 2.8
R.G. 429.11
SAN 426.05 3.1
SAN FM 425.23 3.8
STM 427.97 1.1
BYPASS 426.32 2.8
R.G. 429.27
SAN 421.10 7.2
SAN FM 421.20 2.0
STM 428.23 0.9
BYPASS 425.90 3.3
R.G. 428.61
SAN 425.51 3.2
SAN FM 426.60 2.0
STM 427.05 1.6
BYPASS 426.06 2.9
R.G. 429.51
SAN 426.16 3.4
STM 428.15 1.3
BYPASS 426.90 2.6
KEY PLAN
SCALE: N.T.S.
WELLINGTON RD 19
3 LINE
2 LINE
SITE LOCATION
LEGEND
PROPERTY BOUNDARY
PROPOSED SANITARY FORCEMAIN
PROPOSED SANITARY SEWER
PROPOSED STORM BYPASS SEWER
PROPOSED STORM SEWER
PROPOSED FOUNDATION DRAIN COLLECTOR
EXISTING WATERMAIN
PROPOSED WATERMAIN
PIPE OBVERT
ROAD GRADE
PIPE COVER
R.G. 428.63
SAN 424.30 3.0



PROPOSED 12.0m PRIVATE ROAD WIDTH
N.T.S.

BURNSIDE

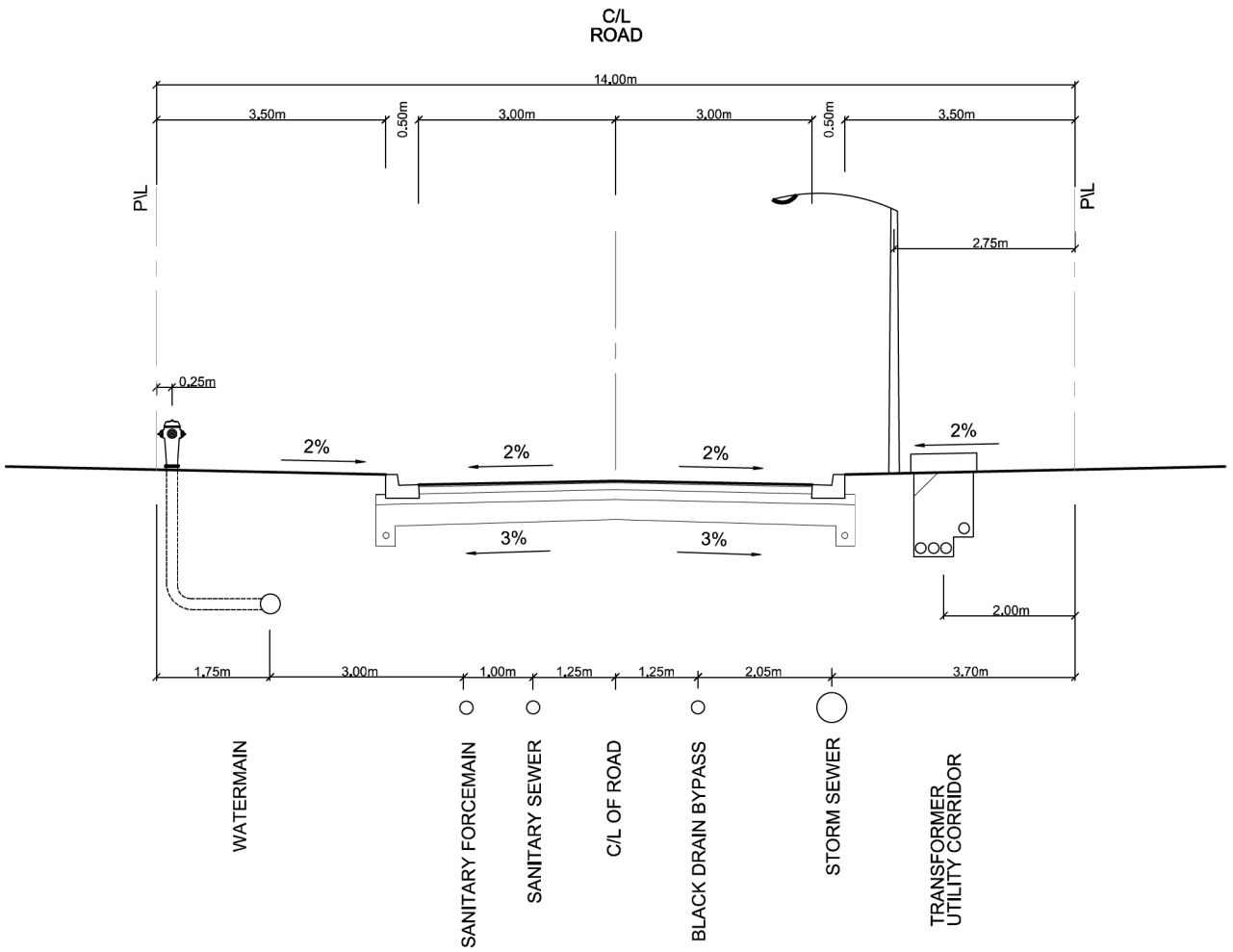
Client
FERGUS DEVELOPMENT INC.

Figure Title
THE VILLAGE AT FAIRVIEW GREENS

TYPICAL CROSS SECTION OF PROPOSED STREET - 12.0m WIDTH

Drawn	Checked	Date	Figure No.
BF	DN	22/10/18	8
Scale		Project No.	
N.T.S.		300052719	

File: \\elfmo\Shared Work Areas\052719 Fergus Cdf Course\052719.05 FSR\07_Figures\FSR FIGURES\052719.05 PROPOSED ROW.dwg Date Plotted: December 7, 2022 - 4:55 PM



PROPOSED 14.0m PRIVATE ROAD WIDTH
N.T.S.

BURNSIDE

Client

FERGUS DEVELOPMENT INC.

Figure Title

THE VILLAGE AT FAIRVIEW GREENS

TYPICAL CROSS SECTION OF PROPOSED STREET - 14.0m WIDTH

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Scale		Project No.	
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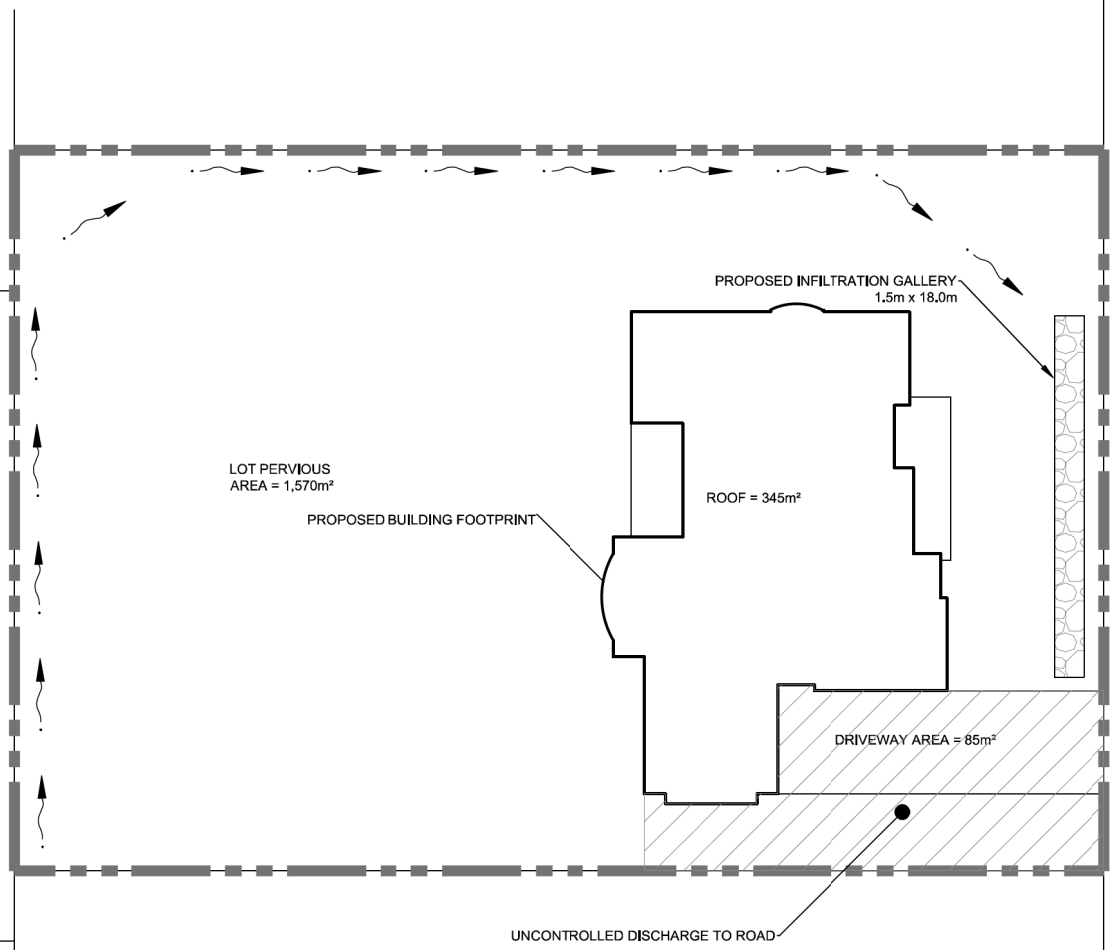


PROPOSED STREET

LOT AREA AVERAGE +/- 2000m²

IMPERVIOUS AREA = 430m²
PERVIOUS AREA = 1,570m²

LOT % IMPERVIOUS = 21.5%

% IMPERVIOUS USED IN SWM MODELLING = 25%

DISCHARGE TO INFILTRATION GALLERY = 1820m²
DISCHARGE UNCONTROLLED TO R.O.W. = 180m²

BURNSIDE

Client

FERGUS DEVELOPMENT INC.

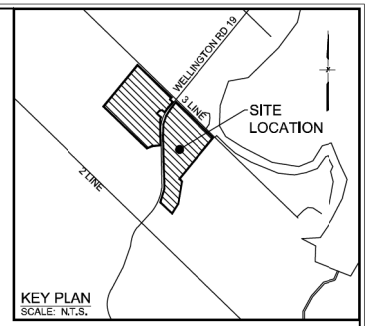
Figure Title

THE VILLAGE AT FAIRVIEW GREENS

SAMPLE LOT IMPERVIOUS BREAKDOWN

Drawn	Checked	Date	Figure No.
BF	LG	22/11/03	6
Scale		Project No.	
1:250		300052719	

File: \\efpnt\Shared Work Areas\052719 Fergus Cdf Course\052719.05 FSR\07_Figures\FSR FIGURES\052719.05 FIG6_SAMPLE LOT.dwg Date Plotted: December 8, 2022 - 11:34 AM



LEGEND

- PROPERTY BOUNDARY
- EASEMENT
- EXISTING CONTOUR
- ×319.36 EX — EXISTING ELEVATION
- ×326.26 — PROPOSED ELEVATION
- 2.00% — PROPOSED SLOPE
- PROPOSED OVERLAND FLOW DIRECTION
- MAX. 3:1 SIDE SLOPES
- PROPOSED RETAINING WALL
- PROPOSED NOISE WALL (BY OTHERS)
- PROPOSED SWALE

LOT TYPES:

- F — FRONT DRAINAGE
- S — SPLIT DRAINAGE


KEY PLAN
SCALE: N.T.S.
WELLINGTON RD 19
3 LINE
2 LINE
SITE LOCATION
REFER TO DWG G3
DITCH TO BE REGRADED
DICB
NW INV = 427.27
DITCH TO BE REGRADED
LEGEND
PROPERTY BOUNDARY
EASEMENT
EXISTING CONTOUR
EXISTING ELEVATION
PROPOSED ELEVATION
PROPOSED SLOPE
PROPOSED OVERLAND FLOW DIRECTION
MAX. 3:1 SIDE SLOPES
PROPOSED RETAINING WALL
PROPOSED NOISE WALL (BY OTHERS)
PROPOSED SWALE
LOT TYPES:
FRONT DRAINAGE
SPLIT DRAINAGE


ergus Golf Club
6m Landscape Strip
0.28ha.
Wellington
Existing
Underpass
Cart Path
0.03ha.
Wetland
to be removed
Street D
Street C
Street A
DITCH TO BE REGRADED
HEADWALL
SW INV = 427.40
EXTENT OF DITCH REGRADING
HEADWALL
SW INV = 426.88
431.52 BW
432.31 TW
432.40 TW
LEGEND
PROPERTY BOUNDARY
EASEMENT
EXISTING CONTOUR
EXISTING ELEVATION
PROPOSED ELEVATION
PROPOSED SLOPE
PROPOSED OVERLAND FLOW DIRECTION
MAX. 3:1 SIDE SLOPES
PROPOSED RETAINING WALL
PROPOSED NOISE WALL (BY OTHERS)
PROPOSED SWALE
LOT TYPES:
F
FRONT DRAINAGE
S
SPLIT DRAINAGE

WELLINGTON RD 19
3 LINE
2 LINE
SITE
LOCATION
KEY PLAN
SCALE: N.T.S.

APPENDIX C

MECP Water Well Records

LEV masl	WTR mbgl	FND Qu	SCR TOP mbgl	LEN m	SWL mbgl	RATE L/min	TIME min	PL mbgl	DRILLER METHOD	TYPE STAT	WELL NAME DESCRIPTION OF MATERIALS
27.3	53.9	Fr			10.7	41	270	18.3	1659 CT	WS DO	**MOE# 6702896** 0.0 CLAY MSND 4.6 CLAY STNS 12.2 BLUE CLAY 23.5 GREY LMSN 53.9
33.7	53.3	Fr			12.2	45	90	18.3	2406 CT	WS ST	**MOE# 6702914** 0.0 TPSL 0.6 BRWN CLAY STNS 25.6 BRWN CLAY GRVL 29.6 BRWN LMSN 54.9
29.8	47.5	Fr			7.0	45	30	9.1	2521 CT	WS ST	**MOE# 6702915** 0.0 CLAY 24.4 MSND 36.6 LMSN 47.5
26.7	7.6	Fr			7.6				5001 BR	WS DO	**MOE# 6702928** 0.0 TPSL 0.6 TPSL MSND 3.0 CLAY STNS 10.1 CLAY GRVL 10.7
25.2	6.1	Fr			4.6			6.1	2519 BR	WS DO	**MOE# 6702930** 0.0 CLAY 4.6 BLDR 6.7
25.2	6.7	Fr			6.1				2519 BR	WS DO	**MOE# 6702931** 0.0 BLDR CLAY 6.7 MSND 7.0 BRWN CLAY 8.5
25.2	4.3	Fr			4.6				2519 CT	WS ST	**MOE# 6702932** 0.0 MSND 5.2
25.2	3.0	Fr			3.0				2519 BR	WS DO	**MOE# 6702933** 0.0 BRWN CLAY 3.0 CLAY BLDR 5.2
25.2	38.1 33.5	Fr Fr			6.7	45	240	12.2	1906 CT	WS DO	**MOE# 6702934** 0.0 CLAY MSND STNS 3.0 BLUE CLAY STNS 24.4 CLAY MSND 28.7 GREY LMSN 32.0 LMSN 38.4
26.7	5.2	Fr			1.5	9		8.8	2519 BR	WS DO	**MOE# 6702935** 0.0 TPSL 0.3 BRWN CLAY 0.9 MSND 1.5 BLUE HPAN 5.2 MSND 6.1 HPAN STNS 9.1
25.2	33.5 32.6	Fr Fr			2.4	68	300	6.1	1906 CT	WS DO	**MOE# 6702936** 0.0 CLAY STNS 7.6 CLAY 21.3 CLAY STNS 27.1 BLUE LMSN 33.2 GRVL 33.5
26.7	26.8	Fr			5.5	14	960	8.5	1905 CT	WS DO	**MOE# 6702937** 0.0 TPSL 0.3 GREY CLAY STNS 26.5 SHLE 29.9
26.7	61.0	Fr			8.8	55	30	18.3	2406 CT	WS DO	**MOE# 6703278** 0.0 TPSL 0.3 BRWN CLAY STNS 3.0 GREY CLAY STNS 23.2 GREY LMSN 33.5 BRWN LMSN 61.0
26.7	26.2	Fr			7.6	45		12.2	2414 CT	WS DO	**MOE# 6703402** 0.0 TPSL 0.3 BRWN CLAY STNS 10.7 BRWN CLAY MSND STNS 13.7 BRWN CLAY GRVL 22.9 BRWN MSND GRVL 26.2
26.7	38.7 27.4	Fr Fr			3.7	45	60	13.7	2406 CT	WS DO	**MOE# 6704618** 0.0 TPSL 0.3 BRWN CLAY SAND STNS 6.1 BRWN CLAY GRVL 23.8 BRWN ROCK 27.4 GREY ROCK 38.7
26.7	36.6	Fr			3.0	45	60	18.3	2406 CT	WS DO	**MOE# 6704650** 0.0 TPSL 0.3 BRWN CLAY SAND STNS 4.6 BRWN CLAY SAND GRVL 24.4 GREY ROCK 35.1 BRWN ROCK 36.6
34.3	65.5	Fr			9.1	91	60	18.3	2336 RC	WS DO	**MOE# 6705071** 0.0 TPSL 0.3 BRWN CLAY STNS 3.0 GREY CLAY STNS 36.3 GREY ROCK 45.1 BRWN ROCK 65.5
23.1	51.8	Fr			8.8	45	60	15.2	2336 RC	WS DO	**MOE# 6705285** 0.0 TPSL 0.3 BRWN CLAY STNS 7.0 GREY CLAY 21.3 BRWN ROCK FCRD 25.0 GREY ROCK 47.2 BRWN ROCK 51.8

LEV masl	WTR mbgl	FND Qu	SCR TOP mbgl	LEN m	SWL mbgl	RATE L/min	TIME min	PL mbgl	DRILLER METHOD	TYPE STAT	WELL NAME DESCRIPTION OF MATERIALS
28.2	79.2	Fr			11.9	45	60	19.8	2336 RC	WS DO	**MOE# 6705605** 0.0 TPSL 0.3 BRWN CLAY SAND 4.6 GREY CLAY STNS 44.2 GREY SAND 46.3 GREY CLAY 63.4 BRWN SAND 73.5 BRWN ROCK 79.2
28.2	1.8	Fr			1.8	14	60	7.6	2519 BR	WS DO	**MOE# 6705693** 0.0 BRWN SAND 1.8 GREY SAND 3.0 GREY CLAY 7.6
28.2	1.8	Fr			1.8	14	60	7.6	2519 BR	WS DO	**MOE# 6705694** 0.0 BRWN SAND 1.8 GREY SAND 3.0 GREY CLAY 7.6
27.3	1.8	Fr			1.8	14	60	7.6	2519 BR	WS DO	**MOE# 6705695** 0.0 BRWN SAND 1.8 GREY SAND 3.0 GREY CLAY 7.6
30.4	4.0	Fr			3.0	14	60	7.6	2519 BR	WS DO	**MOE# 6705698** 0.0 BRWN SAND 4.6 GREY CLAY 7.6
29.8	63.1	Fr			10.4	55	60		4320 RC	WS DO	**MOE# 6705700** 0.0 BRWN CLAY BLDR 11.0 GREY CLAY BLDR 21.9 LMSN CLAY 31.7 GREY LMSN HARD 47.2 BRWN DLMT 63.1
28.2	57.9	Fr			10.7	45	60	22.9	2336 RC	WS DO	**MOE# 6706075** 0.0 BRWN SAND 3.7 GREY CLAY GRVL 29.6 GREY ROCK 38.7 BRWN ROCK 61.3
29.8	1.8	Fr			1.8		120		2519 BR	WS DO	**MOE# 6706242** 0.0 BRWN SAND 4.3 GREY CLAY 7.3
29.8	1.2	Fr			1.2		180		2519 BR	WS DO	**MOE# 6706243** 0.0 BRWN SAND 4.3 GREY CLAY 6.4
25.2	3.7	Fr			3.4				2519 BR	WS DO	**MOE# 6706396** 0.0 BLCK TPSL 0.3 BRWN CLAY BLDR 3.7 BRWN SAND 4.0 BRWN CLAY BLDR 6.7
29.8	108.5	Fr			19.8	68	300	25.9	1906 RC	WS DO	**MOE# 6706408** 0.0 BRWN CLAY STNS 78.9 GREY STNS 108.5
26.7	30.5	Fr			15.8	45	60	23.8	2336 RC	WS DO	**MOE# 6706452** 0.0 BRWN TPSL 0.3 GREY CLAY SAND STNS 26.5 BRWN ROCK 36.6
29.8	54.9	Fr			8.2	41	60	22.9	3740 RA	WS DO	**MOE# 6706528** 0.0 BRWN CLAY SAND 10.4 GREY HPAN STNS 15.2 BRWN SAND 23.2 GREY CLAY 30.5 GREY LMSN 54.9
35.9	93.0	Fr			10.7	50	180	25.3	3317 RC	WS PU	**MOE# 6706586** 0.0 SAND 8.5 GREY CLAY STNS 36.9 GREY LMSN 50.3 BRWN LMSN 91.4 BRWN ROCK 97.5
28.2	59.4	Fr			10.1	32	180	14.3	2332 RC	WS DO	**MOE# 6706640** 0.0 BRWN CSND 4.6 GREY CLAY STNS 22.6 GREY ROCK 65.5
26.7	2.1	Fr			3.0	23	60	9.1	5469 BR	WS DO	**MOE# 6706753** 0.0 BRWN SAND 3.0 GREY CLAY 9.1
26.7	7.9 Fr 2.7	Fr			2.7				5469 BR	WS DO	**MOE# 6706784** 0.0 TPSL 0.3 BRWN CLAY SNDY 2.7 GREY CLAY STNS 7.9 BRWN SAND 8.5 GREY CLAY STNS 12.2

LEV masl	WTR mbgl	FND Qu	SCR TOP mbgl	LEN m	SWL mbgl	RATE L/min	TIME min	PL mbgl	DRILLER METHOD	TYPE STAT	WELL NAME DESCRIPTION OF MATERIALS
26.7	35.7	Fr			9.8	91	60	16.8	2336 RC	WS DO	**MOE# 6707006** 0.0 BRWN TPSL 0.3 BRWN CLAY STNS 4.6 GREY CLAY STNS GRVL 24.4 GREY STNS CLAY FCRD 25.3 GREY STNS 35.1 BRWN STNS 36.0
31.0	41.1	Fr			11.0	23	180	18.3	1669 CT	WS DO	**MOE# 6707095** 0.0 BLCK TPSL 0.6 YLLW CLAY 3.0 YLLW CLAY STNS 9.1 BRWN HPAN 18.3 BRWN HPAN SAND 24.4 BRWN CLAY 26.2 BRWN LMSN 41.1
26.7	10.1	Fr			1.2	18		12.2	5477 BR	WS DO	**MOE# 6707096** 0.0 BRWN SAND GRVL 1.2 GREY CLAY 3.0 GREY MARL SAND 3.7 GREY CLAY 4.9 GRVL 5.2 GREY CLAY 9.1 GREY MARL SAND 10.1 GREY CLAY 12.2
	4.9	Fr									
	3.0	Fr									
	3.0	Fr									
26.7	29.3	Fr			6.1	91	180	12.2	2564 CT	WS DO	**MOE# 6707132** 0.0 CLAY 7.6 GRVL 9.1 CLAY GRVL LYRD 28.3 GREY STNS 29.3
29.8	1.8	Fr			1.8	14		1.8	5477 RC	WS DO	**MOE# 6707227** 0.0 BRWN TPSL 0.3 BRWN CLAY 3.0 BRWN SAND 3.7 BRWN CLAY 9.1
28.9	34.7	Fr			13.1	68	60	19.8	2336 RC	WS DO	**MOE# 6707302** 0.0 BRWN FSND 3.7 GREY CLAY GRVL 27.1 GREY ROCK 36.0
26.7	53.6	Fr			4.9	50	720	7.3	3317 RC	WS DO	**MOE# 6707789** 0.0 CLAY GRVL 1.8 CLAY STNS 16.8 GREY CLAY 21.3 CLAY STNS 32.0 CLAY SOFT SNDY 52.4 STNS 53.6 53.9
26.1	38.1	Fr			7.0	36	120	19.8	5317 RC	WS DO	**MOE# 6708187** 0.0 CLAY STNS 28.7 LMSN 42.7
27.0	64.9	Sa			7.9	41	90	25.9	3740 RC	WS DO	**MOE# 6708208** 0.0 BLCK TPSL 0.3 BRWN CLAY 2.4 GREY CLAY STNS 27.4 GREY LMSN 46.3 BRWN LMSN 64.9
	59.4	Sa									
27.9	50.3	Fr			12.8	45	60	17.7	3740 RC	WS DO	**MOE# 6708405** 0.0 BLCK TPSL 0.3 BRWN CLAY SAND 3.7 GREY CLAY STNS 29.0 GREY LMSN SHLE 51.5
	47.9	Fr									
29.8	56.4	Fr			7.3	32	60	18.3	3740 RC	WS DO	**MOE# 6708435** 0.0 BRWN CLAY SAND 3.4 GREY CLAY STNS 27.4 GREY LMSN 61.0
27.0	50.3	Fr			2.1	91		6.1	2564 CT	WS DO	**MOE# 6708706** 0.0 GRVL 3.0 CLAY 30.5 SAND 33.5 LMSN 50.3
	45.7	Fr									
28.9	38.1	Fr			15.2	23	60	30.5	4643 RC	WS DO	**MOE# 6708770** 0.0 BLCK TPSL 0.3 BRWN SAND 3.4 BLUE CLAY 34.4 GREY LMSN 38.7
25.8	53.3	Fr			8.5	45	60	15.2	2336 RC	WS DO	**MOE# 6708832** 0.0 BRWN CLAY STNS 4.6 GREY CLAY STNS 24.1 GREY ROCK 53.3
	28.0	Fr									
28.9	48.8	Fr			11.6	41	90	21.3	3317 RC	WS DO	**MOE# 6708835** 0.0 BRWN CLAY STNS 1.5 SAND 2.4 GREY CLAY STNS 22.3 GREY CLAY STKY 23.8 GREY CLAY STNS 29.3 GREY CLAY STKY 29.9 ROCK 30.5 GREY LMSN 39.0 BRWN LMSN 53.0
	42.7	Fr									

LEV masl	WTR mbgl	FND Qu	SCR TOP mbgl	LEN m	SWL mbgl	RATE L/min	TIME min	PL mbgl	DRILLER METHOD	TYPE STAT	WELL NAME DESCRIPTION OF MATERIALS
27.0	42.1	Fr			9.1	41	75	13.7	3317 RC	WS DO	**MOE# 6708836** 0.0 BRWN CLAY STNS 3.0 GREY CLAY STNS 18.9 GREY CLAY STKY 25.9 GREY CLAY STNS 40.2 GREY LMSN 44.2
28.9	79.2	Fr			12.8	41	60	20.7	3740 RC	WS DO	**MOE# 6708893** 0.0 BRWN FILL 0.9 BRWN CLAY 3.7 GREY CLAY STNS 50.3 GREY SAND 59.4 GREY CLAY STNS 61.3 BRWN SNDS SHLE 63.1 BRWN LMSN 79.2
27.0	41.1	Fr			4.6	91	60	24.4	2336 RC	WS DO	**MOE# 6708933** 0.0 BRWN CLAY GRVL STNS 5.5 GREY CLAY 36.9 GREY ROCK 41.1
31.9	56.1	Fr			5.2	45	180	29.0	1906 RC	WS DO	**MOE# 6709396** 0.0 BRWN CLAY STNS 36.0 BLUE ROCK 37.5 GREY ROCK 42.7 LMSN 56.4
27.9	39.3	Fr			15.8	32	60	21.3	3740 RC	WS DO	**MOE# 6709484** 0.0 BLCK TPSL 0.3 BRWN SAND CLAY 3.7 BRWN CLAY STNS 10.4 GREY CLAY STNS 30.5 GREY LMSN 39.3
28.9	51.8	Fr			13.7	45	60	39.6	3518 RA	WS DO	**MOE# 6709528** 0.0 BLCK TPSL SOFT 0.6 GREY CLAY STNS HARD 23.2 BRWN ROCK LMSN HARD 51.8
27.9	36.3	Fr			13.7	68	60	19.8	2336 RA	WS DO	**MOE# 6709642** 0.0 BRWN CLAY STNS 4.6 BRWN CLAY GRVL 25.6 GREY ROCK 33.5 BRWN ROCK 36.6
31.0	50.6	Fr			12.2	68	60		2663 RA	WS DO	**MOE# 6710384** 0.0 TPSL 0.3 SAND 4.6 CLAY HPAN 24.4 BLDR GRVL 29.0 GREY LMSN 39.6 BRWN LMSN 50.6
27.0	54.9 29.0	Fr Fr			8.2	36	60	25.9	2336 RA	WS DO	**MOE# 6710457** 0.0 BRWN CLAY STNS 6.1 GREY CLAY STNS GRVL 25.6 GREY ROCK 51.8 BRWN ROCK 55.2
27.0	41.1	Fr			4.9	45	90	8.2	3317 RC	WS DO	**MOE# 6710559** 0.0 BRWN CLAY STNS 3.0 GREY CLAY STNS 29.0 GREY LMSN 43.9
27.9	36.0	Fr			10.7	55	60	18.3	2336 RA	WS DO	**MOE# 6710904** 0.0 BRWN SAND STNS 3.0 BRWN CLAY GRVL 7.6 GREY CLAY GRVL 21.0 GREY ROCK 32.0 BRWN ROCK 36.9
29.8	50.9	Fr			12.2	45	60		3740 RC	WS DO	**MOE# 6711036** 0.0 BRWN SAND FILL 0.6 BRWN CLAY SAND 3.4 GREY CLAY STNS 29.6 GREY LMSN 50.9
34.9	38.1	Fr			12.2	45	90	15.2	3317 RC	WS DO	**MOE# 6711078** 0.0 SAND GRVL CLAY 4.6 GREY CLAY 30.5 GREY CLAY STNS 34.7 GREY LMSN 41.1
28.9	50.3 44.2 36.6 36.6	Fr Fr Fr Fr			23.8	41	60	27.4	2663 RA	WS DO	**MOE# 6711152** 0.0 TPSL 0.3 BRWN SAND CLAY 5.5 BRWN CLAY SAND HPAN 7.9 BRWN CLAY SAND GRVL 33.2 GREY LMSN 50.3
27.0	42.1	Fr			7.6	45	60	9.8	3740 RC	WS DO	**MOE# 6711170** 0.0 BLCK TPSL 0.3 BRWN CLAY STNS 8.2 GREY CLAY STNS 25.9 GREY LMSN 42.1

LEV masl	WTR mbgl	FND Qu	SCR TOP mbgl	LEN m	SWL mbgl	RATE L/min	TIME min	PL mbgl	DRILLER METHOD	TYPE STAT	WELL NAME DESCRIPTION OF MATERIALS
27.9	48.8	Fr			7.9	18	480	16.8	2336 RA	WS DO	**MOE# 6711422** 0.0 BRWN CLAY STNS 3.0 GREY CLAY STNS 22.9 GREY CLAY GRVL 26.5 GREY ROCK 38.1 BRWN ROCK 48.8
28.2	28.7 26.2	Fr Fr			13.7	36	120	14.6	2336 CT	WS DO	**MOE# 6711924** 0.0 BRWN CLAY 5.5 GREY CLAY SAND 7.6 GREY CLAY SOFT 16.8 GREY CLAY HARD 23.2 GREY ROCK 24.1 GREY ROCK LOOS 25.9 GREY ROCK 33.5
27.9	65.5	Fr			12.5	91	60	15.2	6865 RC	WS DO	**MOE# 6711958** 0.0 TPSL 0.3 BRWN SAND 3.4 BRWN GRVL SAND 4.9 GREY CLAY STNS 25.3 GREY CLAY GRVL 35.7 GREY CLAY SILT STNS 51.2 GREY LMSN 70.1
26.4	42.7	Fr			10.7	27	120	32.0	2336 RR	WS DO	**MOE# 6712080** 0.0 BRWN CLAY STNS 4.6 GREY CLAY SAND 13.7 GREY CLAY GRVL 24.1 BRWN ROCK 25.0 GREY ROCK 42.7
34.9	65.5	Fr			7.0	91	90	22.9	3317 RC	WS DO	**MOE# 6712452** 0.0 BRWN CLAY STNS 6.1 GREY CLAY STNS 32.0 GREY CLAY STNS BLDR 46.0 GREY LMSN 50.3 GREY LMSN 71.6
24.9	49.7 44.2	Fr Fr			12.8	68	60	27.4	2663 RA	WS DO	**MOE# 6712484** 0.0 BRWN CLAY SAND GRVL 12.2 GREY CLAY SAND STNS 28.3 GREY LMSN 28.7 BRWN LMSN LTCL 49.7
31.3	57.9	Fr	64.9	-0.9	8.2	91	90		2576 RA	WS DO	**MOE# 6712540** 0.0 TPSL 0.3 BRWN CLAY GRVL 3.0 GREY CLAY GRVL 23.5 BRWN CLAY SLTY GRVL 57.9 GREY SAND GRVL WBRG 65.8
30.1	86.0 79.2 44.2 44.2 44.2 44.2	Fr Fr Fr Fr Fr Fr			8.5	136	60	26.8	2663 RA	WS DO	**MOE# 6712549** 0.0 BRWN CLAY SAND GRVL 7.6 GREY CLAY SAND GRVL 29.0 GREY CLAY GRVL LMSN 32.0 BRWN LMSN LTCL 38.1 BRWN LMSN 47.2 BRWN LMSN LTCL 71.6 GREY LMSN LTCL 76.2 GREY LMSN 79.2 GREY LMSN LTCL 86.0
30.1	54.9	Fr			9.1	136	60	16.8	2336 RA	WS DO	**MOE# 6712681** 0.0 BRWN CLAY STNS 3.0 GREY CLAY STNS 22.9 GREY CLAY SAND GRVL 24.4 GREY CLAY BLDR 31.4 GREY ROCK 44.2 BRWN ROCK 56.4
28.5	35.1	Fr			18.3	55	60	25.9	2336 RA	WS DO	**MOE# 6712754** 0.0 BRWN CLAY SAND 7.6 GREY CLAY STNS 23.8 BRWN ROCK 33.5 GREY ROCK 36.6
28.2	37.8	Fr			17.4	55	60	21.9	2336 RA	WS DO	**MOE# 6712755** 0.0 BRWN CLAY STNS 7.6 GREY CLAY STNS 26.8 GREY ROCK 37.8
27.9	53.3	Fr			11.3	45	90	24.4	3317 RC	WS DO	**MOE# 6712869** 0.0 TPSL 0.3 BRWN CLAY STNS 4.9 GREY CLAY STNS 27.4 SAND CLAY 29.3 BRWN LMSN 56.1
23.1	86.3	Fr			14.0	45	90	21.3	3317 RC	WS DO	**MOE# 6712871 TAG#ASSMNT** 0.0 TPSL 0.9 BRWN CLAY SAND 1.8 BRWN CLAY STNS 5.5 GREY CLAY STNS 51.8 SAND CLAY 72.5 GREY LMSN 86.3

LEV masl	WTR mbgl	FND Qu	SCR TOP mbgl	LEN m	SWL mbgl	RATE L/min	TIME min	PL mbgl	DRILLER METHOD	TYPE STAT	WELL NAME DESCRIPTION OF MATERIALS
27.0	36.6	Fr			6.7	45	60	15.2	2336 RA	WS DO	**MOE# 6712964** 0.0 BRWN CLAY STNS 9.1 GREY CLAY STNS 24.4 BRWN GRVL SAND 25.6 GREY ROCK 36.6
30.1	94.5 91.4 79.2 79.2 79.2 79.2	Fr Fr Fr Fr Fr Fr			13.7	136	60	33.5	2663 RA	WS DO	**MOE# 6713016** 0.0 TPSL 0.3 BRWN CLAY SAND STNS 7.6 BRWN CLAY GRVL 27.4 GREY SAND GRVL 38.1 BRWN CLAY SAND 51.8 BRWN CLAY SAND GRVL 57.3 BRWN LMSN FCRD 58.5 BRWN LMSN 80.8 GREY LMSN 86.9 GREY LMSN 94.5
28.9	76.2 75.0	Fr Fr			9.1	45	60	32.3	6865 RC	WS DO	**MOE# 6713066** 0.0 TPSL 0.3 BRWN SAND GRVL CLAY 1.2 BRWN CLAY STNS 2.7 GREY CLAY GRVL 8.2 GREY CLAY STNS 47.9 GREY CLAY GRVL 52.1 GREY GRVL SAND SILT 70.1 GREY LMSN 76.2
29.5	60.4 52.4	Fr Fr			13.7	45	90	16.8	3317 RC	WS DO	**MOE# 6713242** 0.0 BRWN TPSL 0.3 BRWN CLAY STNS SNDY 3.7 GRN CLAY STNS 30.2 GRN LMSN 61.6
30.7	42.7	Fr			12.5	45	60	21.3	2336 RA	WS DO	**MOE# 6713880** 0.0 BRWN CLAY STNS 8.5 GREY CLAY STNS 24.4 BRWN GRVL SAND 26.5 GREY ROCK 42.7
30.1	74.7	Fr			9.4	68	60	36.3	2663 RA	WS DO	**MOE# 6714026** 0.0 BLCK TPSL 0.9 BRWN CLAY STNS 10.7 BRWN CLAY HPAN 25.9 BRWN CLAY GRVL 31.7 GREY LMSN FCRD 32.9 GREY LMSN 35.1 BLUE LMSN 74.7
25.8	37.5	Un			8.5	55	60	11.3	2663 RA	WS DO	**MOE# 6714970 TAG#A001865** 0.0 BRWN TPSL 0.6 BRWN CLAY SAND GRVL 28.3 GREY LMSN 37.5
27.6	61.9	Un			12.8	59	60	14.6	6865 RC	RC DO	**MOE# 6715076 TAG#A005682** 0.0 BRWN SAND CLAY 3.7 GREY CLAY STNS 21.0 GREY CLAY 29.3 BRWN LMSN 32.0 GREY LMSN 44.2 BRWN LMSN 62.8
33.1					NR				2663 -	AS -	**MOE# 6715584** 0.0
26.1	77.1	Fr			11.3	32	60	32.9	6865 RC	WS DO	**MOE# 6715622 TAG#A026051** 0.0 BRWN TPSL 0.3 BRWN GRVL STNS CLAY 22.6 BRWN LMSN LYRD 77.4
24.9	54.3	Fr			13.4	55	60	17.1	7385 RA	WS DO	**MOE# 7139684 TAG#A079614** 0.0 BRWN CLAY STNS 7.6 GREY CLAY STNS 21.3 GREY CLAY SAND GRVL 22.9 BRWN ROCK FCRD 27.1 GREY ROCK 48.8 BRWN ROCK 54.9
30.7	54.9	Fr			7.9	23	360	26.2	7385 RA	WS DO	**MOE# 7149767 TAG#A079617** 0.0 BRWN SAND STNS 3.7 GREY CLAY STNS 29.0 GREY CLAY SAND GRVL 31.4 GREY ROCK 41.1 BRWN ROCK 54.9
32.5					NR				6475 -	- -	**MOE# 7166124 TAG#A103263** 0.0
25.8	62.5	Fr			12.8	68	60	19.8	7154 RC	WS DO	**MOE# 7170379 TAG#A115054** 0.0 BRWN CLAY 11.3 GREY CLAY 34.1 GREY CLAY STNS 43.6 GREY CLAY SLTY 59.7 GREY LMSN 63.4

LEV masl	WTR mbgl	FND Qu	SCR TOP mbgl	LEN m	SWL mbgl	RATE L/min	TIME min	PL mbgl	DRILLER METHOD	TYPE STAT	WELL NAME DESCRIPTION OF MATERIALS
31.3	41.1	Fr			16.5	45	60	28.3	7221 RC	WS DO	**MOE# 7172623 TAG#A104425** 0.0 BRWN CLAY SLTY 1.5 BRWN CLAY SAND 3.7 GREY CLAY STNS 28.3 GREY LMSN 41.1
31.3					NR				7221 -	AS DO	**MOE# 7179341** 0.0
30.1	75.6	Fr			15.2	55	720	15.8	7154 RC	WS DO	**MOE# 7185591 TAG#A125533** 0.0 BRWN SAND 4.9 BRWN CLAY STNS 31.1 GREY CLAY 57.6 GREY CLAY STNS 74.7 GREY LMSN 75.6
32.2	33.5	Fr			12.2	45	60		2576 OTH	WS DO	**MOE# 7186074 TAG#A123030** 0.0 BRWN CLAY GRVL SNDY 3.7 GREY CLAY STNS 27.4 BRWN CLAY STNS 31.1 GREY LMSN 35.4

YPE:		USE:			METHOD :	
Vater Supply	CO	Comercial	NU	Not Used	CT	Cable Tool
bandoned Quality	DO	Domestic	IR	Irrigation	JT	Jetting
bandoned Supply	MU	Municipal	AL	Alteration	RC	Rotary Conventional
bandonment Record	PU	Public	MO	Monitoring	RA	Rotary Air
est Hole or Observation	ST	Stock	-	Not Recorded	BR	Boring

one 17, Translated from Recorded UTM NAD, subject to Field Verified Location or Improved Location Accuracy.
ment Queen's Printer. Selected information tabulated to metric with changes and corrections subject to Driller's Records.

APPENDIX D

Method of Soil Classification

Abbreviations and Terms Used on Records of Boreholes and Test Pits

List of Symbols

Record of Borehole Sheets (BH20-1 to BH20-18)

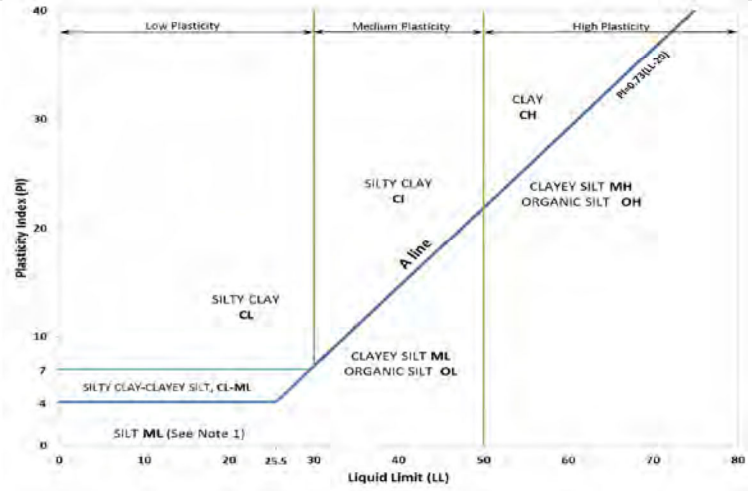
Plasticity Chart and Grain Size Analysis

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

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

Dynamic Cone Penetration Resistance (DCPT); N_d:

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

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_P	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

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

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

2 shear strength = (compressive strength)/2

PROJECT: 21456909

LOCATION: N 4843275.90; E 551475.50

RECORD OF BOREHOLE: BH21-1

SHEET 1 OF 1

BORING DATE: March 25, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		426.33							GR SA SI CL
0		TOPSOIL (200 mm)		0.00 / 426.13	1A	SS	5				
		(OH) ORGANIC SILT; brown; non-cohesive, moist, loose		0.20 / 425.65	1B						
1	Power Auger 102 mm O.D. Solid Stem	(SP) SAND, some gravel to gravelly; black to brown; non-cohesive wet, compact to very dense		0.68	2	SS	16				
2					3	SS	12		○	MH	April 14, 2021 ▽ Bentonite
					4	SS	12				
3				422.95	5A				○		
		(CL) SILTY CLAY, some gravel with silty sand seams; grey (TILL); cohesive, w<PL, hard - Auger grinding at 3.7 m		3.38	5B	SS	43		○		
4					6	SS	57				Sand
5					7	SS	50/ 0.10		○		Screen
6					8	SS	81/ 0.28				
				419.80							
		END OF BOREHOLE		6.53							
7		NOTES: 1. Groundwater measured at 1.5 m below ground surface upon completion of drilling. 2. Groundwater measured at 1.56 m below ground surface on April 14, 2021.									
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

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PROJECT: 21456909

LOCATION: N 4844290.00; E 551238.50

RECORD OF BOREHOLE: BH21-10

SHEET 1 OF 1

BORING DATE: March 24, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		433.20							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (300 mm) - Sandy ORGANIC SILT		0.00	1A	SS	3				
				432.90							
		(CL) Sandy SILTY CLAY, some gravel with occasional cobbles; brown to grey at 4.57 m (TILL); cohesive, w<PL, soft to hard		0.30	1B						
1					2	SS	12				Bentonite
2					3	SS	11				
					4	SS	35				Sand
3					5	SS	28				
4											
					6	SS	10				Screen
5											
6					7	SS	40			MH	
7											Bentonite
				425.35	8	SS	50/ 0.07				
8		END OF BOREHOLE		7.85							
		NOTES:									
9		1. Groundwater in monitoring well measured at 3.0 m below ground level on March 26, 2021.									
		2. Groundwater measured at 0.62 m below ground surface on April 14, 2021.									
10											

April 14, 2021

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

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PROJECT: 21456909

LOCATION: N 4844264.70; E 551602.20

RECORD OF BOREHOLE: BH21-11

SHEET 1 OF 1

BORING DATE: March 31, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		428.46							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (250 mm)		0.00 / 428.21	1	SS	3				
		(SP) SAND, some silt; brown; non-cohesive, moist, loose to compact		0.25							
1					2	SS	7				April 14, 2021
2					3	SS	11				
				426.02	4A	SS	8				Hole Plug
		(CL) SILTY CLAY, some sand to SANDY, some gravel; grey (TILL); cohesive, w<PL, firm		2.44	4B						
3					5	SS	14				
4					6	SS	12				
5					7	SS	11			MH	Sand
6											Screen
					8	SS	11				
				421.75							
		END OF BOREHOLE		6.71							
7		NOTES:									
		1. Groundwater in open borehole at 1.5 m below ground surface upon completion of drilling.									
8		2. Groundwater measured at 1.07 m below ground surface on April 14, 2021.									
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

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PROJECT: 21456909

LOCATION: N 4844086.60; E 551092.60

RECORD OF BOREHOLE: BH21-12

SHEET 1 OF 1

BORING DATE: March 23, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		431.95							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (200 mm)-SILTY SAND		0.00 / 431.75	1A						
		(CL) SILTY CLAY, some sand, some gravel; brown; cohesive, w<PL, soft to stiff		0.20	1B	SS	8		W		April 14, 2021
1					2	SS	7				Hole Plug
				430.12	3	SS	9				
2		(SM-GM) SILTY SAND and GRAVEL; brown; non-cohesive, moist, compact		1.83 / 429.74							
		(CL-ML) Gravelly SILTY CLAY-CLAYEY SILT with SAND; brown (TILL); cohesive, w<PL, very stiff to hard		2.21	4	SS	28				Sand
3					5	SS	28				
4											Screen
					6	SS	50/ 0.13			MH	
				427.10							
5		END OF BOREHOLE		4.85							
		NOTES:									
		1. Groundwater measured at 3.7 m below ground surface upon completion of drilling.									
6		2. Groundwater measured at 0.52 m below ground surface on April 14, 2021.									
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: MWK

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PROJECT: 21456909

LOCATION: N 4844451.50; E 551049.00

RECORD OF BOREHOLE: BH21-13

SHEET 1 OF 1

BORING DATE: March 23, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		429.07							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (300 mm)- (OH) CLAYEY ORGANIC SILT		0.00 / 428.77	1A	SS	5				
		(CL) SILTY CLAY, some sand, some gravel, some organics to 0.61 m; brown; non-cohesive, w<PL, firm		0.30	1B						
1					2	SS	5				
		(CL) SILTY CLAY, some sand, some gravel, occasional cobbles; brown to grey (TILL); cohesive, w<PL, stiff to hard		427.62 / 1.45	3	SS	10			MH	April 14, 2021
2					4	SS	30				Hole Plug
3					5	SS	50/ 0.13				
4		- Auger grinding between 4.6 m and 6.9 m			6	SS	91				
5											Sand
6					7	SS	93/ 0.25				Screen
				422.14							
7		(SM-GM) SILTY SAND and GRAVEL; grey; non-cohesive, wet, very dense		6.93 / 421.70	8	SS	50/ 0.05				
		END OF BOREHOLE		7.37							
		NOTE:									
8		1. Groundwater measured at 1.31 m below ground surface on April 14, 2021.									
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: MWK

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PROJECT: 21456909

LOCATION: N 4844278.70; E 550895.00

RECORD OF BOREHOLE: BH21-14

SHEET 1 OF 1

BORING DATE: March 23, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		431.06							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (300 mm)		0.00	1A	SS	1				April 14, 2021
				430.76	1B						Hole Plug
		(CL) Sandy SILTY CLAY, some gravel, cobbles present; brown; cohesive, w<PL, very soft to very stiff		0.30							
1					2	SS	6				Sand
2		- Auger grinding between 2.1 m and 6.9 m			3	SS	17			MH	
											Screen
					4	SS	50/ 0.15				
3				427.94	5	SS	50/ 0.08				
		END OF BOREHOLE		3.12							
4		NOTES:									
		1. Groundwater measured at 1.7 m below ground surface upon completion of drilling.									
		2. Groundwater measured at 0.2 m below ground surface on April 14, 2021.									
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: MWK

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PROJECT: 21456909

LOCATION: N 4844267.20; E 551086.40

RECORD OF BOREHOLE: BH21-15

SHEET 1 OF 1

BORING DATE: March 24, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		432.16									GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (300 mm) - ORGANIC SILT and SAND		0.00	1A	SS	1						April 14, 2021
		(SM) SILTY SAND, some gravel		432.16 0.30	1B								
		(CL) SILTY CLAY, some gravel with occasional cobbles; brown; cohesive, w<PL, firm to stiff		431.85 0.61	2	SS	4						Hole Plug
1													
					3	SS	11				○		
2													
		(CL) Sandy SILTY CLAY, some gravel; brown to grey (TILL); cohesive, w<PL, hard - Auger grinding at 2.3 m		430.25 2.21	4	SS	30						Sand
3													
					5	SS	33				○	MH	
													Screen
4													
					6	SS	50						
5				427.30									
		END OF BOREHOLE		5.16									
6		NOTES: 1. Groundwater measured at 3.8 m below ground surface upon completion of drilling. 2. Groundwater measured at 0.34 m below ground surface on April 14, 2021.											
7													
8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

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PROJECT: 21456909

LOCATION: N 4844256.07; E 551424.87

RECORD OF BOREHOLE: BH21-16

SHEET 1 OF 1

BORING DATE: March 31, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		429.46							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (50 mm)		0.00 0.05							April 14, 2021
		(SM/ML) Gravelly SILT with slight plasticity and SAND, cobbles; brown; cohesive, w<PL, firm to very stiff			1	SS	4				
1					2	SS	17				
					3	SS	13			MH	Hole Plug
2				427.25							
		(CL-ML) SILTY CLAY-CLAYEY SILT, some sand, some gravel, some cobbles; brown to grey (TILL); cohesive, w<PL, hard		2.21	4	SS	61				
3					5	SS	64				Sand
4					6	SS	66				Screen
					7	SS	88				
5											
6					8	SS	50/ 0.13				
				423.08							
		END OF BOREHOLE		6.38							
7		NOTES:									
		1. Groundwater at 0.6 m below ground surface upon completion of drilling.									
8		2. Groundwater measured at 0.13 m below ground surface on April 14, 2021.									
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

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PROJECT: 21456909

LOCATION: N 4843491.90; E 551511.50

RECORD OF BOREHOLE: BH21-17

SHEET 1 OF 1

BORING DATE: March 26, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		428.92							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (50 mm)		0.00							
		(SP) SAND, some gravel, trace organics; brown; non-cohesive, wet		0.05	1	SS	2				April 14, 2021
				428.24							
1		(CL-ML) Sandy SILTY CLAY-CLAYEY SILT, some gravel; brown to grey (TILL); cohesive, w>PL to w<PL, soft to hard at 3.05 m		0.68	2	SS	3		W		Hole Plug
					3	SS	10				
2		- Auger grinding at 2.3 m			4	SS	31		W	MH	
					5	SS	41				Sand
3											
4					6	SS	58				Screen
					7	SS	50/ 0.13				
5				423.89							
		END OF BOREHOLE		5.03							
6		NOTES:									
		1. Groundwater measured at 2.13 m below ground surface on completion of drilling.									
		2. Groundwater measured at 0.46 m below ground surface on April 14, 2021.									
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

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PROJECT: 21456909

LOCATION: N 4843775.60; E 551588.20

RECORD OF BOREHOLE: BH21-18

SHEET 1 OF 2

BORING DATE: March 29, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		427.21							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (50 mm)		0.00							
		(SP-GP) SAND and GRAVEL, some silt; brown; non-cohesive, moist, compact		0.05	1	SS	10				Bentonite
				426.56							
1		(CL) CLAYEY SILT, some gravel, some sand, trace organics; cohesive, w<PL, very stiff		0.68	2A	SS	5				Sand
				426.17							
		(ML) Sandy SILT, some gravel; brown (TILL); non-cohesive, moist, loose		1.07	2B						April 14, 2021
				425.79							
2		(SM-GM) SILTY SAND and GRAVEL; brown; non-cohesive, moist, compact		1.45	3		16				Screen
					4A						
				424.64							
		(CL) SILTY CLAY, some gravel, trace sand; brown (TILL); cohesive, w~PL, stiff		2.60	4B		11				
3					5		33				
				423.51							
		(SM/ML) SILT with slight plasticity and SAND, some gravel, trace clay; grey (TILL); cohesive, w<PL, hard		3.73	6		68				
4											
					7		66			MH	
5											
6					8		85/ 0.28				
7				420.08							
		(SM) SILTY SAND, some gravel; grey; non-cohesive, wet, dense		7.16							
					9		32				
8											
				418.10							
9		END OF BOREHOLE		9.14							
		NOTES:									
		1. Groundwater measured at 1.2 m below ground surface upon completion of drilling.									
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: EN

CHECKED: MWK

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PROJECT: 21456909

LOCATION: N 4843775.60; E 551588.20

RECORD OF BOREHOLE: BH21-18

SHEET 2 OF 2

BORING DATE: March 29, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp ⊖W WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		--- CONTINUED FROM PREVIOUS PAGE ---									GR SA SI CL
10		2. Groundwater measured at 1.05 m below ground surface on April 14, 2021.									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: EN

CHECKED: MWK

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PROJECT: 21456909

LOCATION: N 4843404.00; E 551401.70

RECORD OF BOREHOLE: BH21-2

SHEET 1 OF 1

BORING DATE: March 25, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		429.80							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (50 mm)		0.00	1A						
		(SM) SILTY SAND, some clay, some gravel, trace organics; brown; non-cohesive, moist, loose		0.05	1B	SS	9		○		
				428.97	2A	SS	8				
1		(CL) SILTY CLAY, some sand, some gravel; brown; cohesive, w<PL, firm		0.83	2B				○		
					3	SS	8		○		
2				427.59							
		(CL) Sandy SILTY CLAY, some gravel, sand seams; brown (TILL); cohesive, w<PL, very stiff to hard		2.21	4	SS	22				
3					5	SS	54		○ ⊢	MH	▽ March 25, 2021
4					6	SS	50/ 0.23				
					7	SS	69		○		
5											
6					8	SS	50/ 0.13				
				423.42							
		END OF BOREHOLE		6.38							
7		NOTE: 1. Groundwater measured at 3.4 m below ground surface upon completion of drilling.									
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

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PROJECT: 21456909

LOCATION: N 4843696.30; E 551427.00

RECORD OF BOREHOLE: BH21-3

SHEET 1 OF 1

BORING DATE: March 29, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		434.96							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (250 mm)		0.00 / 434.71	1A						April 14, 2021 Bentonite
		(OH) Sandy ORGANIC SILT, some gravel; non-cohesive, moist, loose		0.25	1B	SS	1				
				434.05	2A	SS	7				
1		(CL-ML) SILTY CLAY-CLAYEY SILT, trace sand to sandy, some gravel; brown; cohesive, w<PL, firm		0.91	2B						Sand
2					3	SS	5			MH	
		- Auger grinding between 2.1 m and 3.4 m		432.75							
		(CL) SILTY CLAY, trace sand to sandy, some gravel; brown to grey (TILL); cohesive, w~PL to w<PL, very stiff to hard		2.21	4	SS	29				
3					5	SS	50/ 0.03				Screen
4					6	SS	50/ 0.13				
					7	SS	50/ 0.15				
5											
6					8	SS	30				
				428.25							
		END OF BOREHOLE		6.71							
7		NOTES:									
		1. Groundwater measured at 2.13 m below ground surface upon completion of drilling.									
8		2. Groundwater measured at 0.4 m below ground surface on April 14, 2021.									
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

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PROJECT: 21456909

LOCATION: N 4843888.70; E 551737.90

RECORD OF BOREHOLE: BH21-4

SHEET 1 OF 1

BORING DATE: March 30, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		426.73							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (300 mm)		0.00	1A	SS	4				
		(SM/ML) SILT and SAND, trace gravel; brown; non-cohesive, moist to wet, loose		426.43 0.30	1B						▽ March 30, 2021
1					2	SS	8		○	MH	
					3	SS	6				
2		(CL) SILTY CLAY, trace sand to Sandy, trace to some gravel; grey (TILL); cohesive, w~PL to w<PL, stiff to very stiff		424.62 2.11	4	SS	8		○		
3					5	SS	20				
4					6	SS	29				
5					7	SS	20		○	MH	
		END OF BOREHOLE		421.55 5.18							
6		NOTE: 1. Groundwater measured at 0.6 m below ground surface upon completion of drilling.									
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: EN

CHECKED: MWK

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PROJECT: 21456909

LOCATION: N 4844077.10; E 551875.60

RECORD OF BOREHOLE: BH21-5

SHEET 1 OF 1

BORING DATE: March 30, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		428.71							GR SA SI CL
0		TOPSOIL (150 mm)		0.00							
		(SM) SILTY SAND, trace gravel, trace organics; brown; non-cohesive, moist, very loose to loose		0.15	1A	SS	2				Bentonite
					1B						
				427.80	2A	SS	7				April 14, 2021 Sand
1		(SM/ML) SILT and SAND, trace gravel; brown; non-cohesive, wet, loose to compact		0.91	2B						
					3	SS	7			MH	
2	Power Auger 102 mm O.D. Solid Stem				4	SS	10				Screen
3		- gravel seam at 3.45 m			5A						
				425.21	5B	SS	10				
		(CL) CLAYEY SILT, trace sand, trace gravel; brown to grey (TILL); cohesive, w~PL to w<PL, stiff to very stiff		3.50							
4					6	SS	20				Sand
					7	SS	16				
5				423.53							
		END OF BOREHOLE		5.18							
6		NOTES:									
		1. Groundwater measured at 0.6 m below ground surface upon completion of drilling.									
		2. Groundwater measured at 0.76 m below ground surface on April 14, 2021.									
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: EN

CHECKED: MWK

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PROJECT: 21456909

LOCATION: N 4844124.90; E 551636.50

RECORD OF BOREHOLE: BH21-6

SHEET 1 OF 1

BORING DATE: March 30, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		427.33							GR SA SI CL
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (150 mm)		0.00	1A						
		(SP) SAND, some silt; brown; non-cohesive, moist to wet, loose to compact		0.15	1B	SS	4		○		April 14, 2021
1					2	SS	13				Bentonite
2					3	SS	15		○	MH	
				424.89	4A	SS	20				
		(SM) SILTY SAND; brown; non-cohesive, wet, compact		2.44	4B						
				424.36							
3		(CL) Sandy SILTY CLAY, some gravel with sand seams; grey (TILL); cohesive, w<PL, firm to stiff		2.97	5A	SS	9				
					5B				○		Screen
4					6A						
					6B	SS	7		⊖	MH	
					7	SS	7				
5				422.15							
		END OF BOREHOLE		5.18							
6		NOTES:									
		1. Groundwater measured at 0.9 m below ground surface upon completion of drilling.									
		2. Groundwater measured at 0.41 m below ground surface on April 14, 2021.									
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: MWK

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PROJECT: 21456909

LOCATION: N 4844015.70; E 551439.30

RECORD OF BOREHOLE: BH21-7

SHEET 1 OF 2

BORING DATE: March 30, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		428.99									GR SA SI CL
0		TOPSOIL (75 mm)		0.00	1A								
		(CL-ML) SILTY CLAY-CLAYEY SILT with SAND, some gravel; brown; cohesive, w<PL, firm to stiff		0.07	1B	SS	4						Bentonite
													April 14, 2021 (D)
													April 14, 2021 (S)
1					2	SS	6					MH	Sand
					3	SS	9						
2													Screen
					4A	SS							
				426.39		SS	37						
		(CL-ML) Sandy SILTY CLAY-CLAYEY SILT, some gravel; brown to grey (TILL); cohesive, w<PL, hard		2.60	4B								
3					5	SS	64					MH	
4					6	SS	67						
					7	SS	100/ 0.25						Bentonite
5	Power Auger 102 mm O.D. Solid Stem												
6					8	SS	78						
7													Sand
					9	SS	80/ 0.18						
8													Screen
9													Sand
					10	SS	67						
				419.39									
		END OF BOREHOLE		9.60									
10		*CONTINUED NEXT PAGE*											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

GTA-BHS 005 S:\CLIENTS\GERANIUM\FERGUS_GOLFNORTH_PROPERTIES\02_DATA\GINT\FERGUS_GOLFNORTH_PROPERTIES.GPJ GAL-MIS.GDT 11/29/21

PROJECT: 21456909

LOCATION: N 4844015.70; E 551439.30

RECORD OF BOREHOLE: BH21-7

SHEET 2 OF 2

BORING DATE: March 30, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									GR SA SI CL
		NOTES: 1. Groundwater measured at 3.0 m below ground surface upon completion of drilling. 2. Groundwater measured at 0.74 m below ground surface in shallow well and at 0.53 m below ground surface in deep well on April 14, 2021.									
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

CHECKED: EN

GTA-BHS 005 S:\CLIENTS\GERANIUM\FERGUS_GOLFNORTH_PROPERTIES\02_DATA\GINT\FERGUS_GOLFNORTH_PROPERTIES.GPJ GAL-MIS.GDT 11/29/21

PROJECT: 21456909

LOCATION: N 4844379.70; E 551552.80

RECORD OF BOREHOLE: BH21-8

SHEET 1 OF 1

BORING DATE: March 30, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp W WI) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		427.75							GR SA SI CL ▽
0	Power Auger 102 mm O.D. Solid Stem	TOPSOIL (200 mm)		0.00 / 427.55	1	SS	WH				April 14, 2021
		(CL) CLAYEY SILT, trace sand, trace gravel; brown (TILL); cohesive, w<PL, stiff to very stiff		0.20							Bentonite
1					2	SS	14		W		Sand
					3A						
2		(SM) SILTY SAND, trace gravel; brown; non-cohesive, wet, compact to dense		425.77 / 1.98	3B	SS	19				
					4	SS	30		W		
3					5A						Screen
		(CL) CLAYEY SILT, trace sand, trace gravel; grey (TILL); cohesive, w<PL, very stiff		424.40 / 3.35	5B	SS	15				
		(SM) SILTY SAND, some gravel; grey; non-cohesive, wet, compact		423.94 / 3.81	6	SS	29		W	MH	
4					7	SS	22				
5				422.72							
		END OF BOREHOLE		5.03							
6		NOTES:									
		1. Groundwater measured at 0.2 m below ground surface upon completion of drilling.									
		2. Groundwater measured at -0.02 m below ground surface on April 14, 2021.									
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: EN

CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\FERGUS_GOLFNORTH_PROPERTIES\02_DATA\GINT\FERGUS_GOLFNORTH_PROPERTIES.GPJ GAL-MIS.GDT 11/29/21

PROJECT: 21456909

LOCATION: N 4844084.50; E 551266.00

RECORD OF BOREHOLE: BH21-9

SHEET 1 OF 1

BORING DATE: March 22, 2021

DATUM:

DRILL RIG: Geoprobe

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION / GRAIN SIZE DISTRIBUTION (%)
		GROUND SURFACE		432.13							GR SA SI CL
0		TOPSOIL (150 mm)- (SM) SILTY SAND		0.00	1A						
		(CL) Sandy SILTY CLAY, some gravel, occasional cobbles; brown; cohesive, w<PL, firm		0.15	1B	SS	6				
1					2	SS	9				
					3	SS	7				April 14, 2021
2											
		- Auger grinding between 2.4 m and 4.5 m		429.99							
		(CL-ML) Sandy SILTY CLAY-CLAYEY SILT, some gravel; brown (TILL); cohesive, w<PL, hard		2.44	4	SS	46			MH	
3					5	SS	50/ 0.05				Bentonite
4	Power Auger 102 mm O.D. Solid Stem				6	SS	50/ 0.07				
		(SM-GM) SILTY SAND and GRAVEL; brown; non-cohesive, dry, very dense - Auger grinding between 4.5 m and 5.6 m		427.93 4.50	7	SS	50/ 0.07				
5											
		(CL) Sandy SILTY CLAY, some gravel; grey (TILL); cohesive, w<PL, hard - Auger grinding between 5.6 m and 6.1 m		426.83 5.60							
6					8	SS	50/ 0.07				Sand
7											Screen
					9	SS	50/ 0.07				
8					10	SS	50/ 0.05				
		END OF BOREHOLE		424.15 8.28							
9		NOTES: 1. Groundwater measured at 7.3 m below ground surface upon completion of drilling. 2. Groundwater measured at 1.57 m below ground surface on April 14, 2021.									
10											

DEPTH SCALE

1 : 50

GOLDER
MEMBER OF WSP

LOGGED: SM

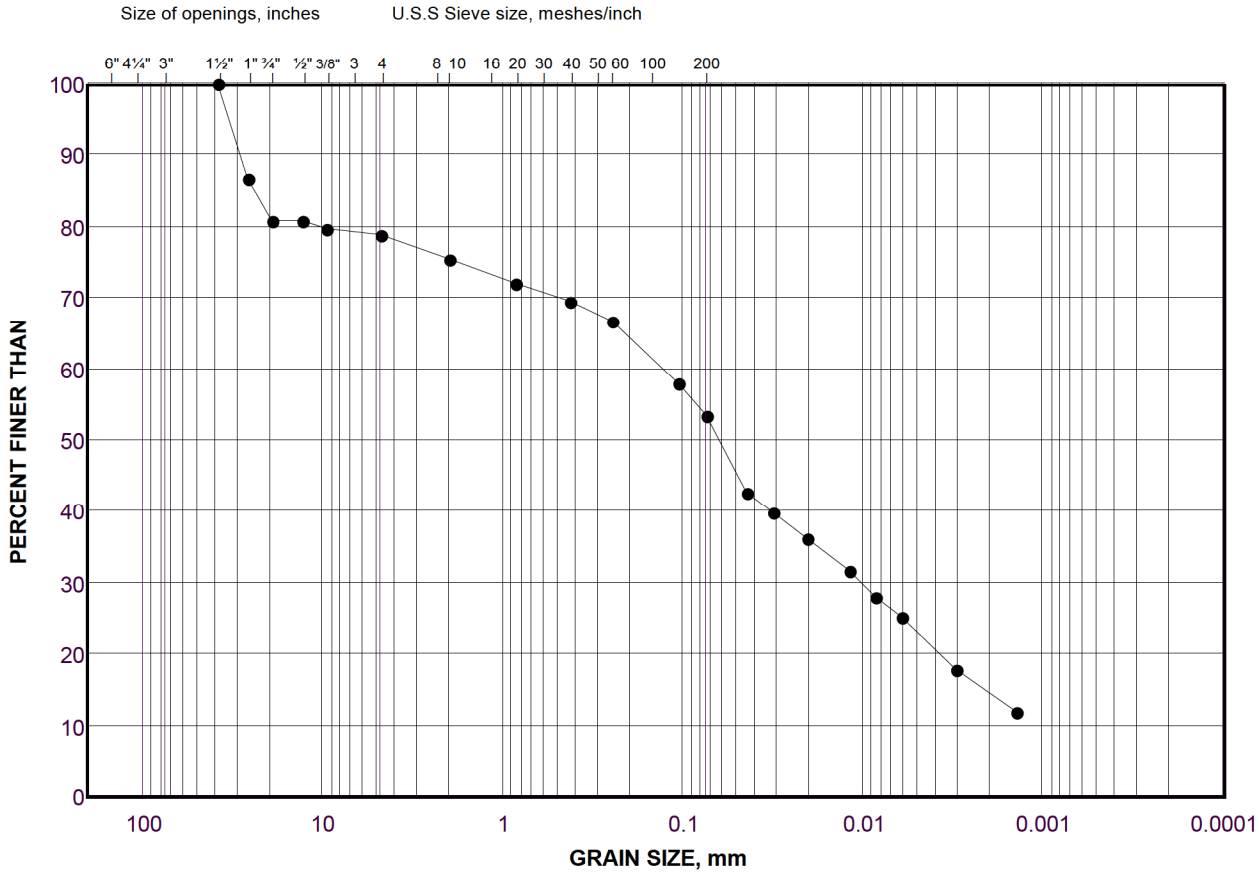
CHECKED: MWK

GTA-BHS 005 S:\CLIENTS\GERANIUM\FERGUS_GOLFNORTH_PROPERTIES\02_DATA\GINT\FERGUS_GOLFNORTH_PROPERTIES.GPJ_GAL-MIS.GDT 11/29/21

GRAIN SIZE DISTRIBUTION

(CL) Sandy Silty Clay

FIGURE C1



LEGEND

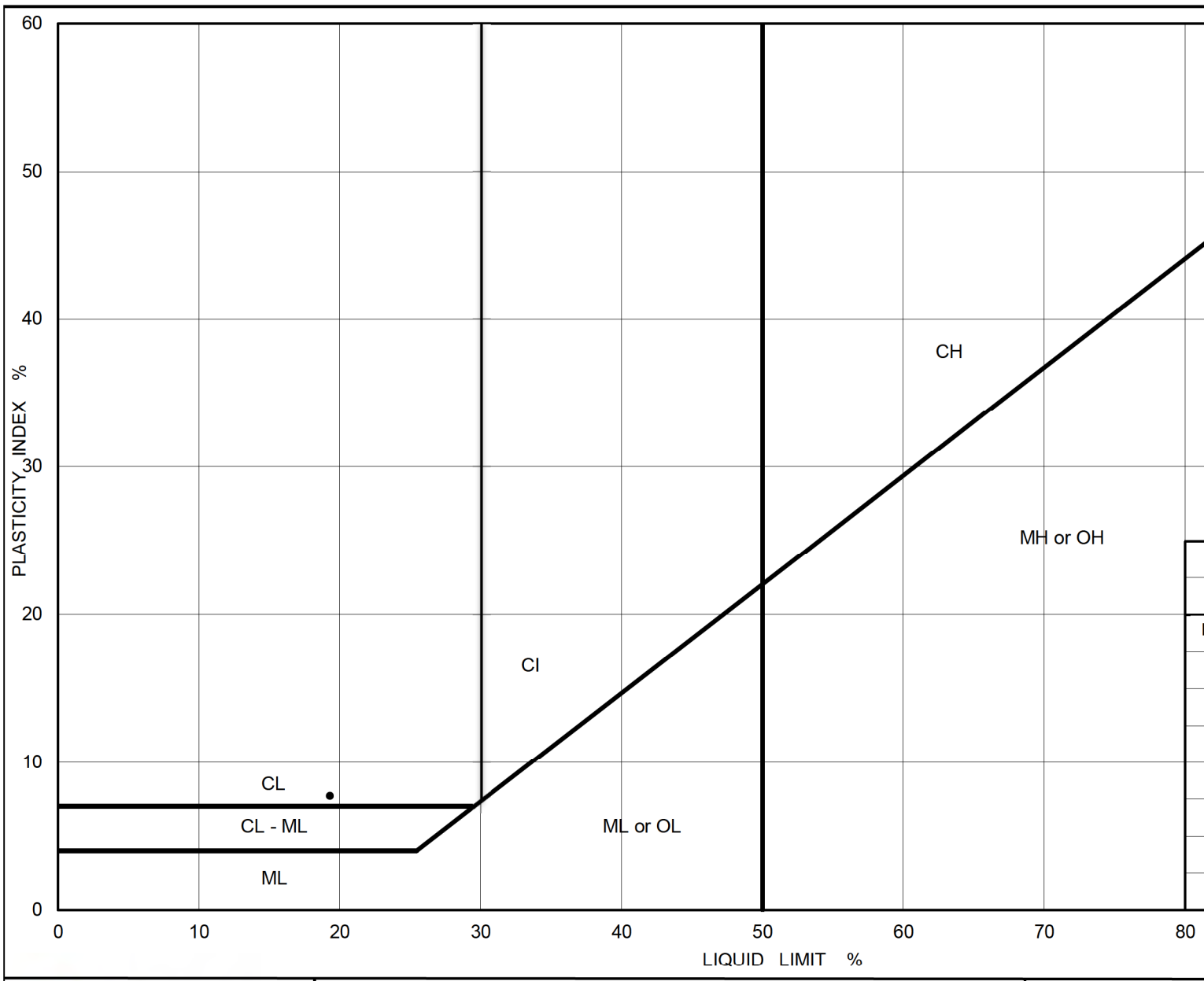
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	BH21-14	3	429.3

Project Number: 21456909 (1000)

Checked By: EN

Golder Associates

Date: 04-May-21



GOLDER

PLASTICITY CHART
(CL) Sandy Silty Clay

Figure No. C2

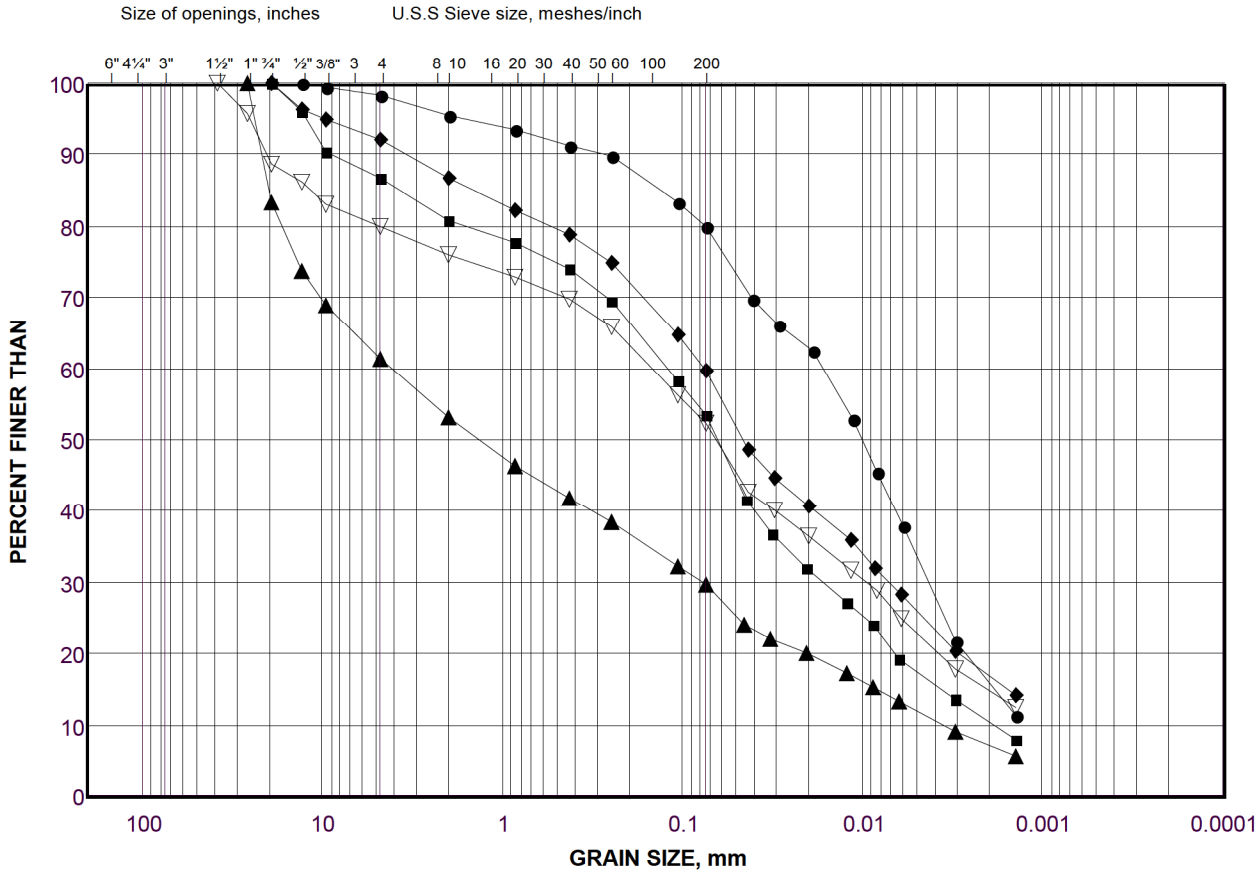
Project No. 2145

Checked By: EN

GRAIN SIZE DISTRIBUTION

(CL) Silty Clay to Clayey Silt Till

FIGURE C3



LEGEND

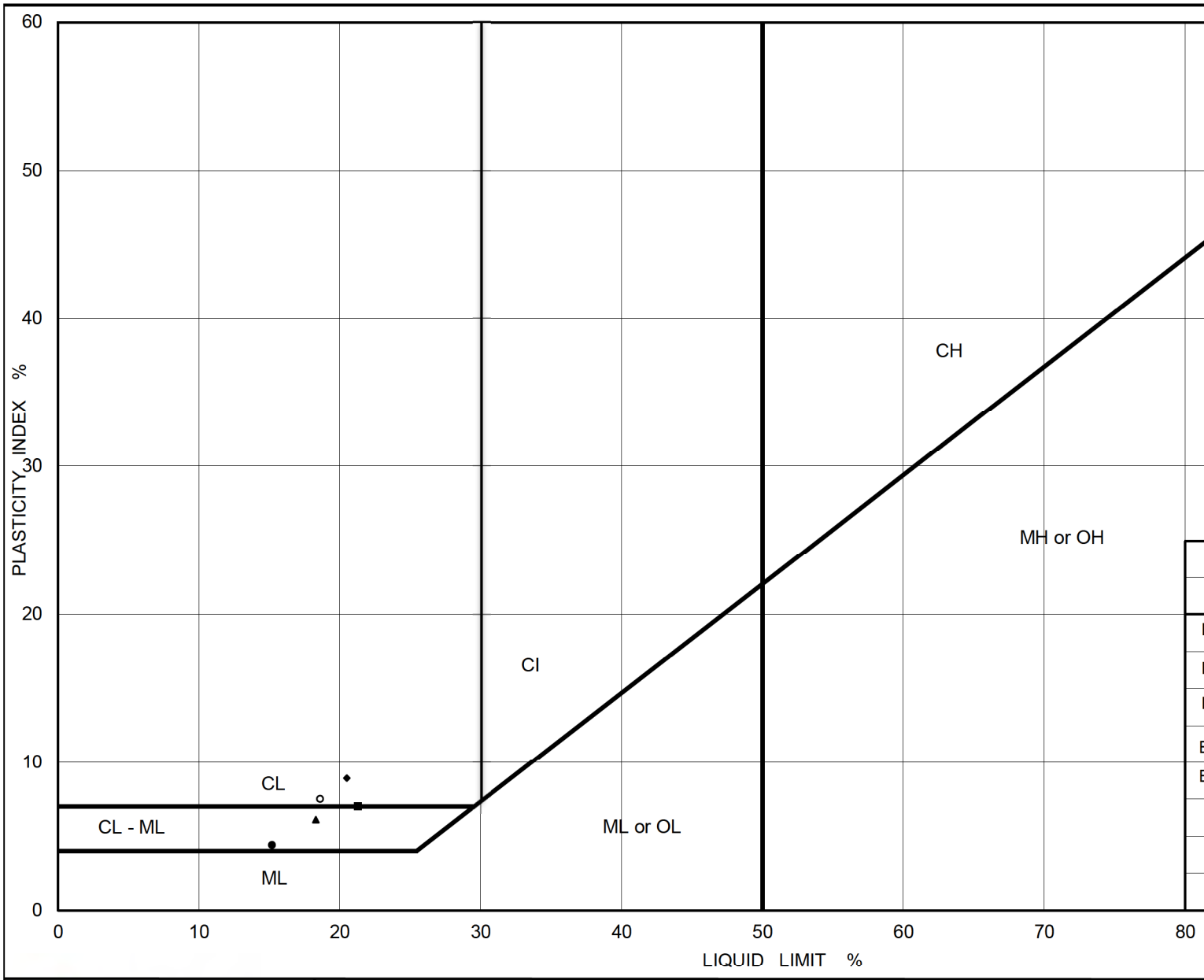
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	BH21-13	3	427.3
■	BH21-09	4	429.8
◆	BH21-15	5	429.2
▲	BH21-12	6	427.3
▽	BH21-10	7	428.3

Project Number: 21456909 (1000)

Checked By: EN

Golder Associates

Date: 04-May-21



GOLDER

PLASTICITY CHART
(CL) Silty Clay to Clayey Silt Till

Figure No. C4

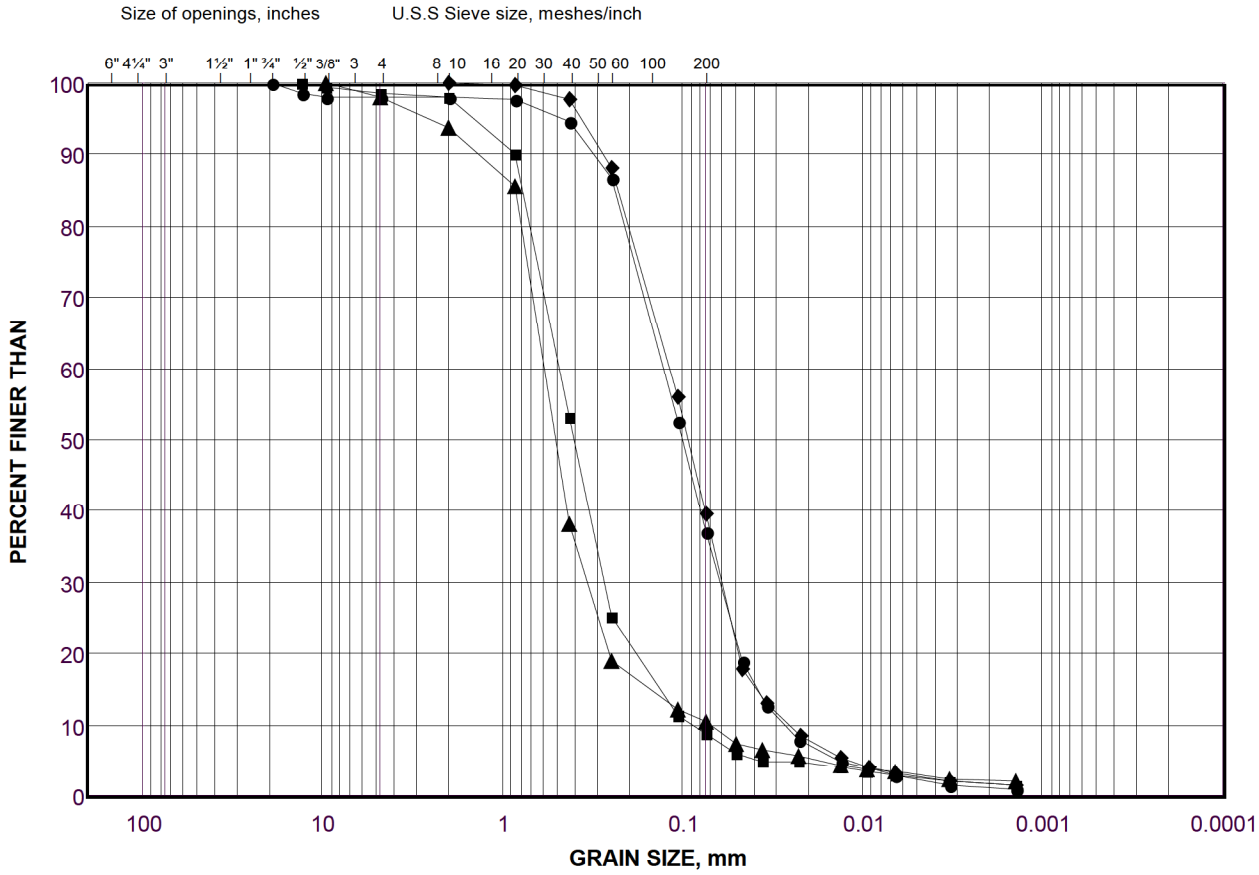
Project No. 2145

Checked By: EN

GRAIN SIZE DISTRIBUTION

(SP/SM) Sand to Silty Sand

FIGURE C5



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	BH21-04	2	425.6
■	BH21-06	3	425.5
◆	BH21-05	3	426.9
▲	BH21-01	3	424.5

Project Number: 21456909 (1000)

Checked By: EN

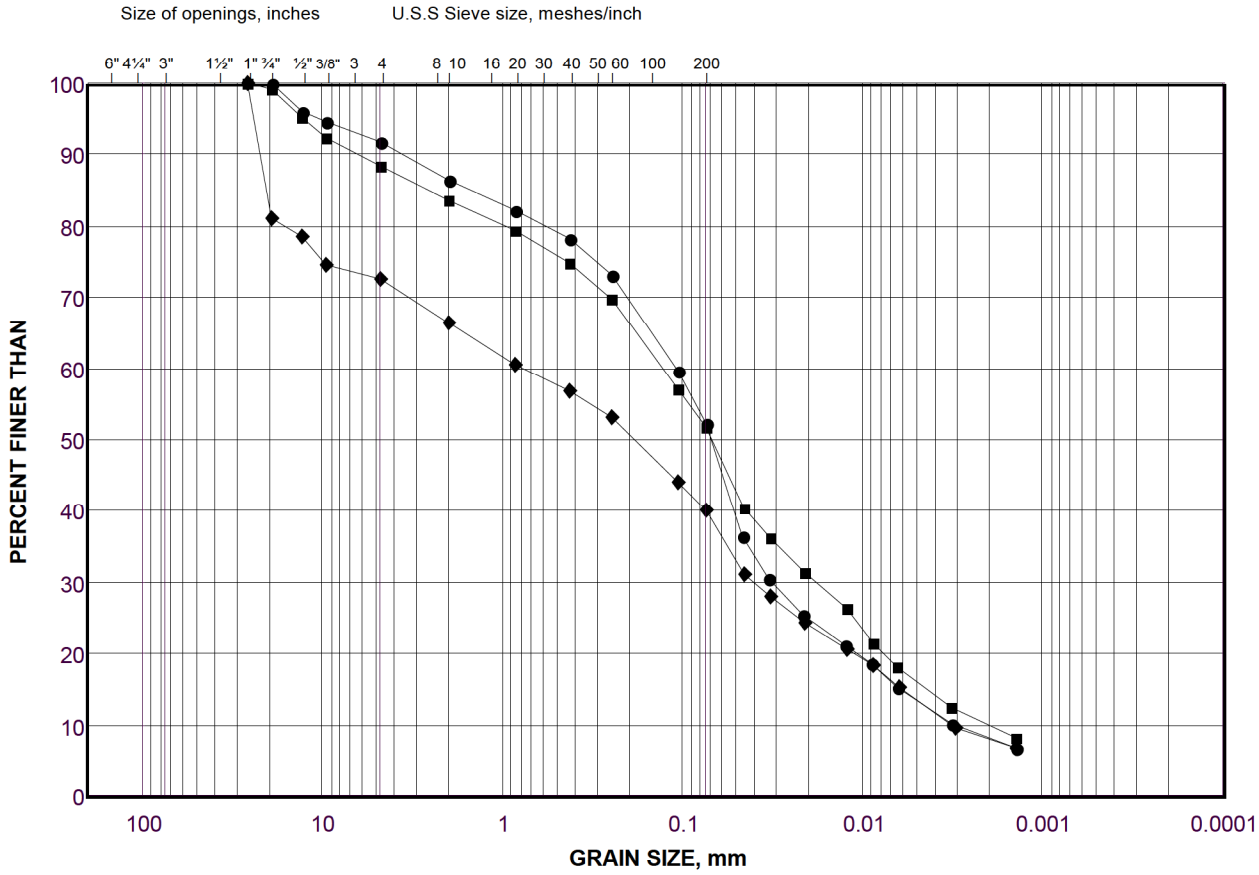
Golder Associates

Date: 04-May-21

GRAIN SIZE DISTRIBUTION

(CL-ML) Silty Clay to Clayey Silt with Sand to Silt with Sand

FIGURE C6



LEGEND

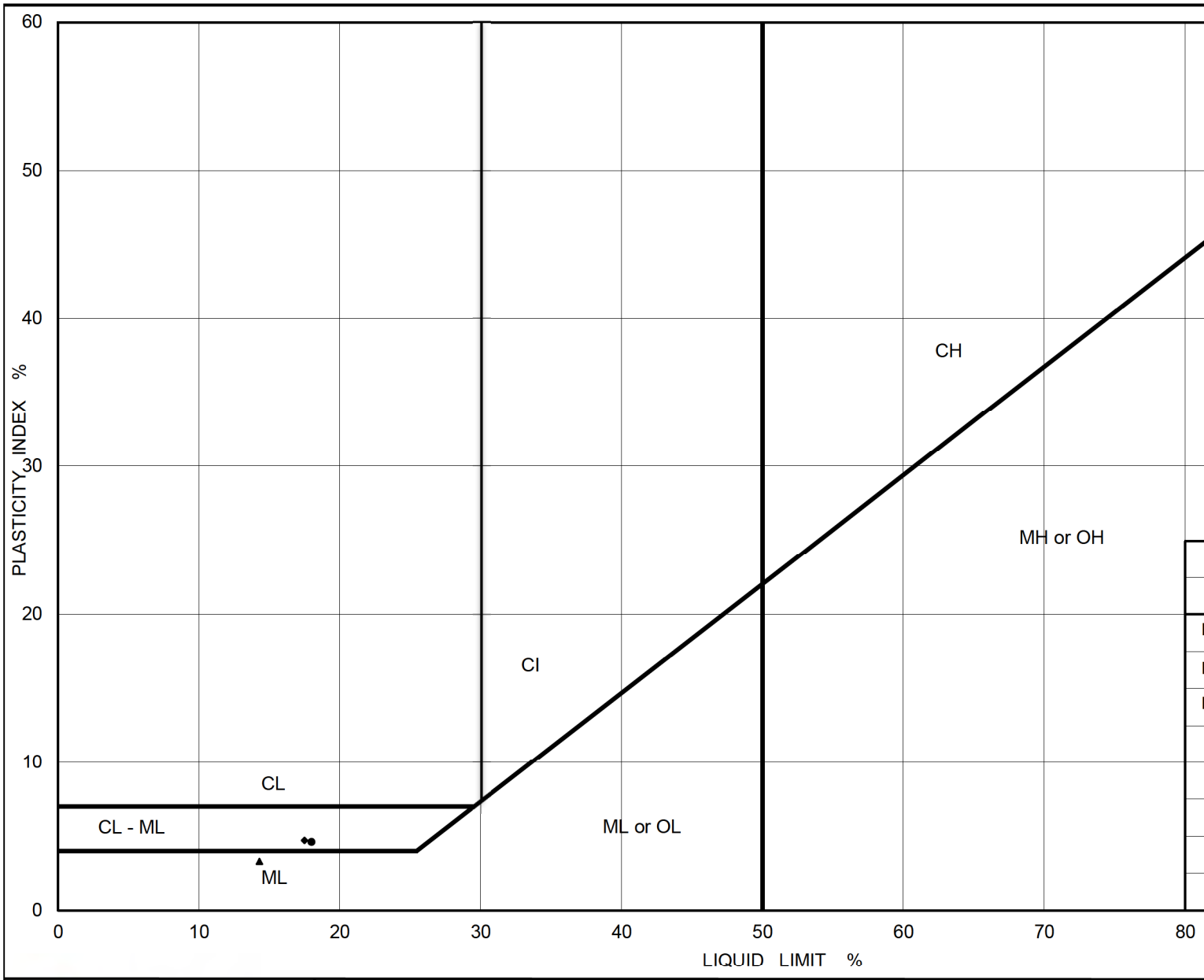
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	BH21-07	2	427.9
■	BH21-16	3	427.7
◆	BH21-03	3	433.2

Project Number: 21456909 (1000)

Checked By: EN

Golder Associates

Date: 04-May-21



GOLDER

PLASTICITY CHART

(CL-ML) Silty Clay to Clayey Silt with Sand to Silt with Sand

Figure No. C7

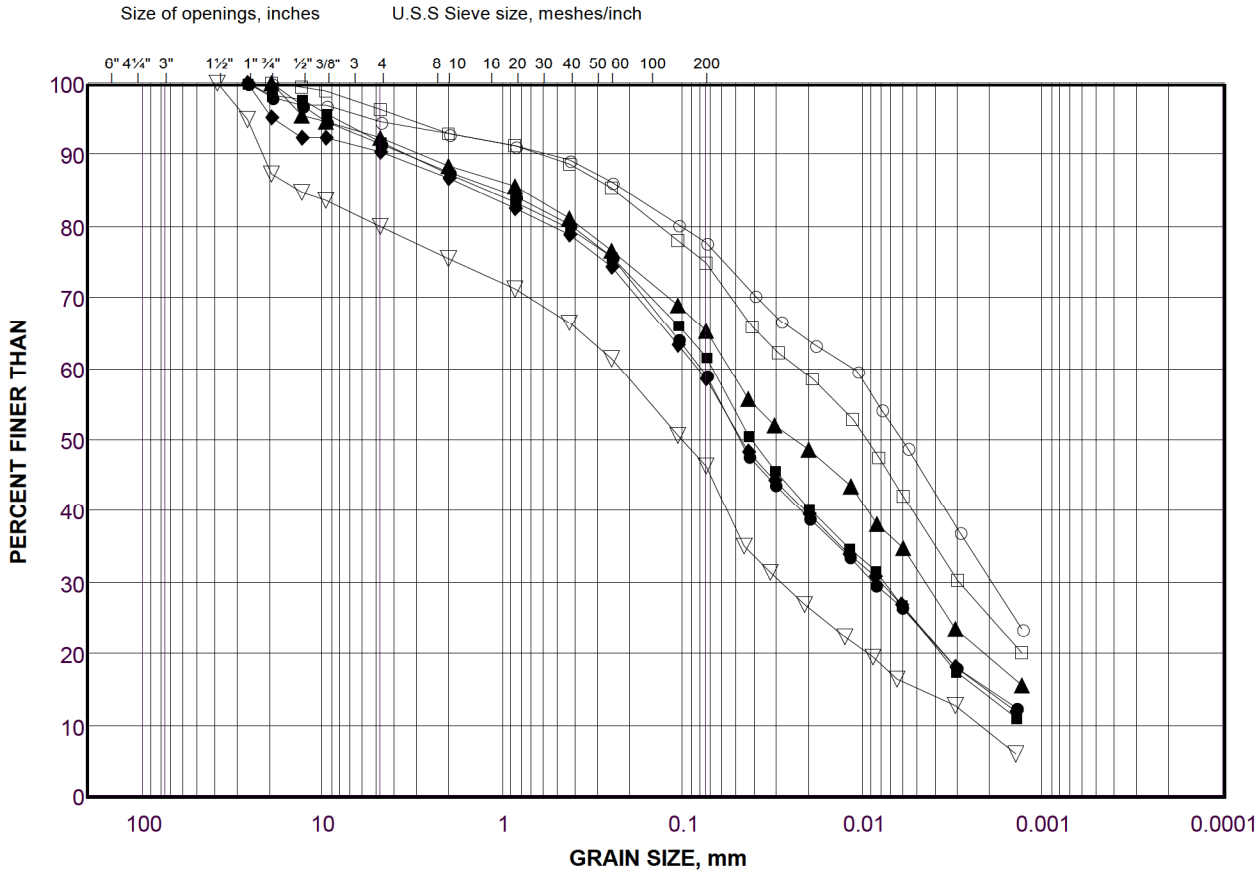
Project No. 2145

Checked By: EN

GRAIN SIZE DISTRIBUTION

(CL-ML) Silty Clay to Clayey Silt Till

FIGURE C8



LEGEND

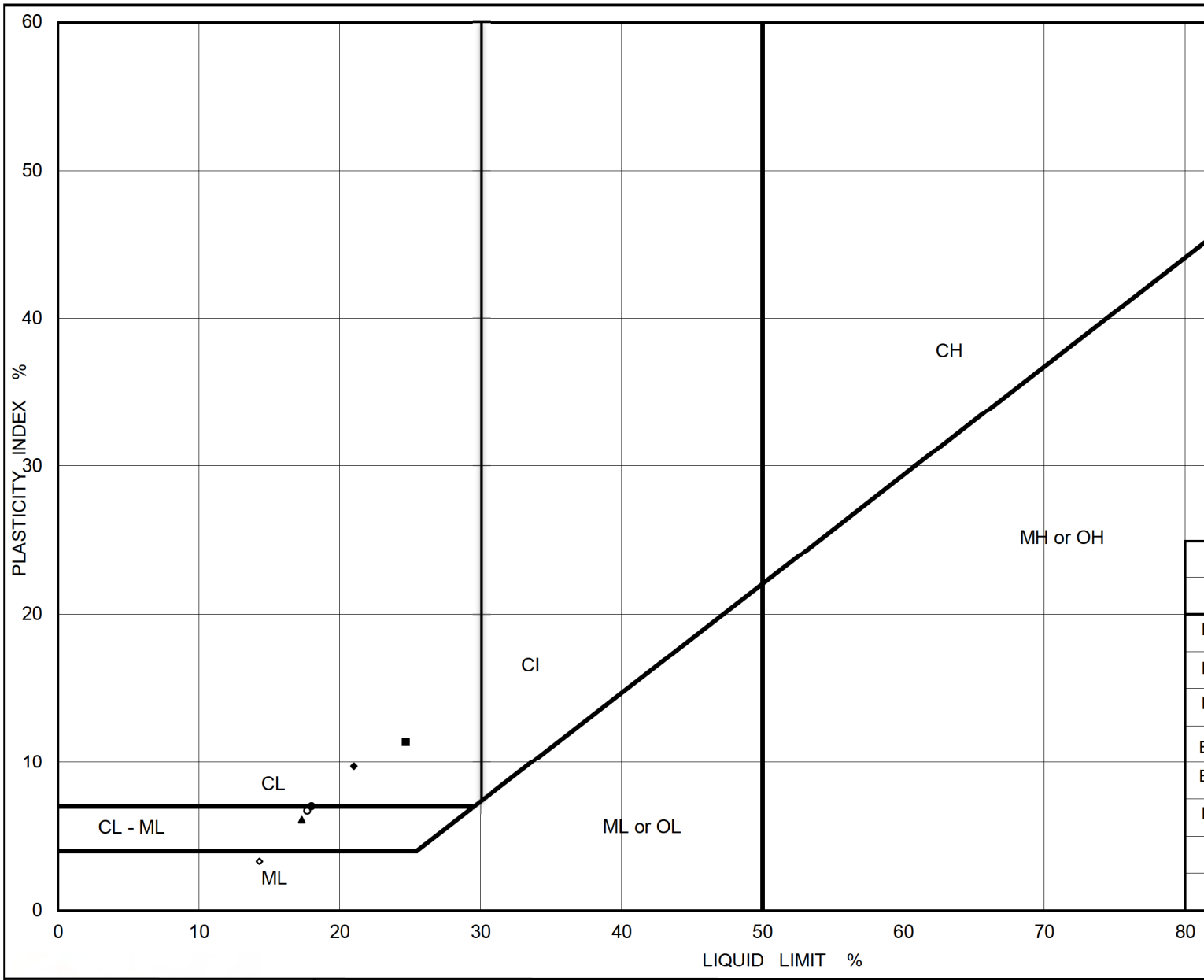
SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	BH21-17	4	426.3
■	BH21-07	5	425.6
◆	BH21-02	5	426.4
▲	BH21-06	6B	423.0
▽	BH21-18	7	422.3
○	BH21-11	7	423.6
□	BH21-04	7	421.8

Project Number: 21456909 (1000)

Checked By: EN

Golder Associates

Date: 04-May-21



GOLDER

PLASTICITY CHART
(CL-ML) Silty Clay to Clayey Silt

Figure No. C9

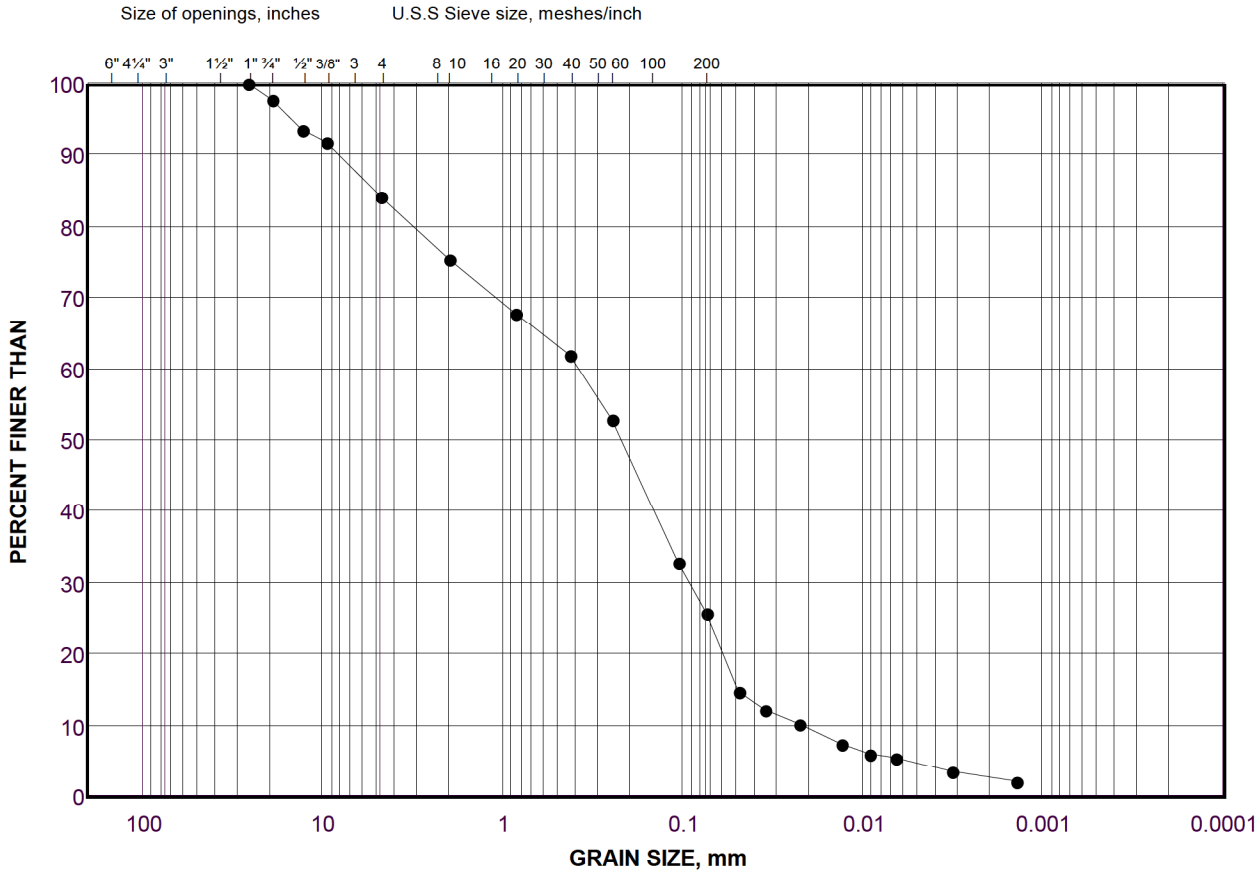
Project No. 2145

Checked By: EN

GRAIN SIZE DISTRIBUTION

(SM) Silty Sand

FIGURE C10



LEGEND

SYMBOL	Borehole	SAMPLE	ELEVATION(m)
●	BH21-08	6	423.7

Project Number: 21456909 (1000)

Checked By: EN

Golder Associates

Date: 04-May-21

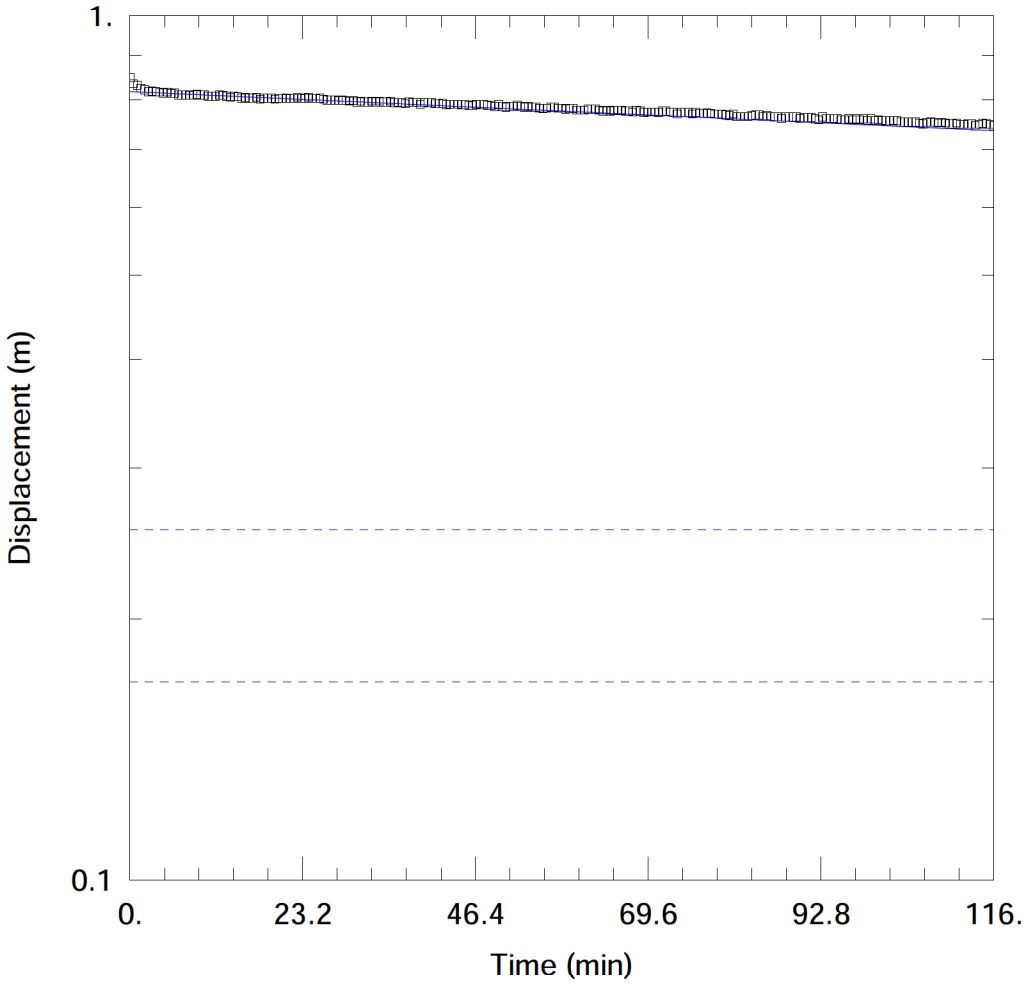
APPENDIX E

Water Level Measurements

05-Apr-21		08, 09, 12-Apr-21		14-Apr-21		07-Oct-22	
th to dwater gs)	Groundwater Elevation (masl)	Depth to Groundwater (mbgs)	Groundwater Elevation (masl)	Depth to Groundwater (mbgs)	Groundwater Elevation (masl)	Depth to Groundwater (mbgs)	Groundwater Elevation (masl)
81	425.52	2.36	423.97	1.56	424.77	1.82	424.51
-	-	-	-	-	-	-	-
59	434.37	0.73	434.23	0.40	434.56	2.99	431.97
-	-	-	-	-	-	-	-
91	427.80	1.01	427.71	0.76	427.95	2.25	426.46
45	426.88	0.57	426.76	0.41	426.92	1.30	426.03
-	-	0.43	428.57	0.74	428.25	2.32	426.68
-	-	1.30	427.69	0.53	428.46	0.69	428.30
06	427.69	0.14	427.61	-0.02	427.77	1.91	425.84
71	430.72	1.85	430.58	1.57	430.86	3.37	429.06
41	431.79	1.05	432.15	0.62	432.58	1.97	431.23
25	427.21	1.30	427.16	1.07	427.39	2.48	425.98
42	431.53	0.11	431.84	0.52	431.43	1.79	430.16
38	427.69	1.30	427.77	1.31	427.76	2.90	426.17
31	430.75	0.29	430.77	0.20	430.86	2.35	428.71
35	431.11	0.34	432.12	-	-	1.53	430.93
-	-	0.65	428.78	0.13	429.30	1.65	427.78
09	429.02	0.74	428.18	0.46	428.47	2.40	426.52
29	425.95	1.29	425.95	1.05	426.19	1.93	425.31
46	428.24	0.43	428.27	0.34	428.36	dry	dry, <427.60
00	427.34	0.07	427.27	0.04	427.30	dry	dry, <426.34
21	425.34	0.32	425.22	0.23	425.31	dry	dry, <424.85
12	427.26	0.05	427.09	-0.19	427.33	dry	dry, <426.31
35	426.86	0.43	426.78	0.13	427.09	dry	dry, <426.23
Depth n)	Stage Elev. (masl)	Water Depth (m)	Stage Elev. (masl)	Water Depth (m)	Stage Elev. (masl)	Water Depth (m)	Stage Elev. (masl)
ry	dry @428.29	dry	dry @428.29	0.05	428.35	dry	dry @428.29
04	427.31	0.02	427.29	0.10	427.37	dry	dry @427.24
09	425.26	dry	dry @425.18	0.07	425.24	dry	dry @425.18
ry	dry @427.10	dry	dry @427.10	0.07	427.20	dry	dry @427.10
ry	dry @427.23	dry	dry @427.23	dry	dry @427.23	dry	dry @427.23

APPENDIX F

Hydraulic Conductivity Testing



WELL TEST ANALYSIS

Data Set: C:\...\BH21-01.aqt
Date: 01/18/22 Time: 15:28:01

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-01
Test Date: 9Apr2021

AQUIFER DATA

Saturated Thickness: 3.74 m Anisotropy Ratio (Kz/Kr): 1.

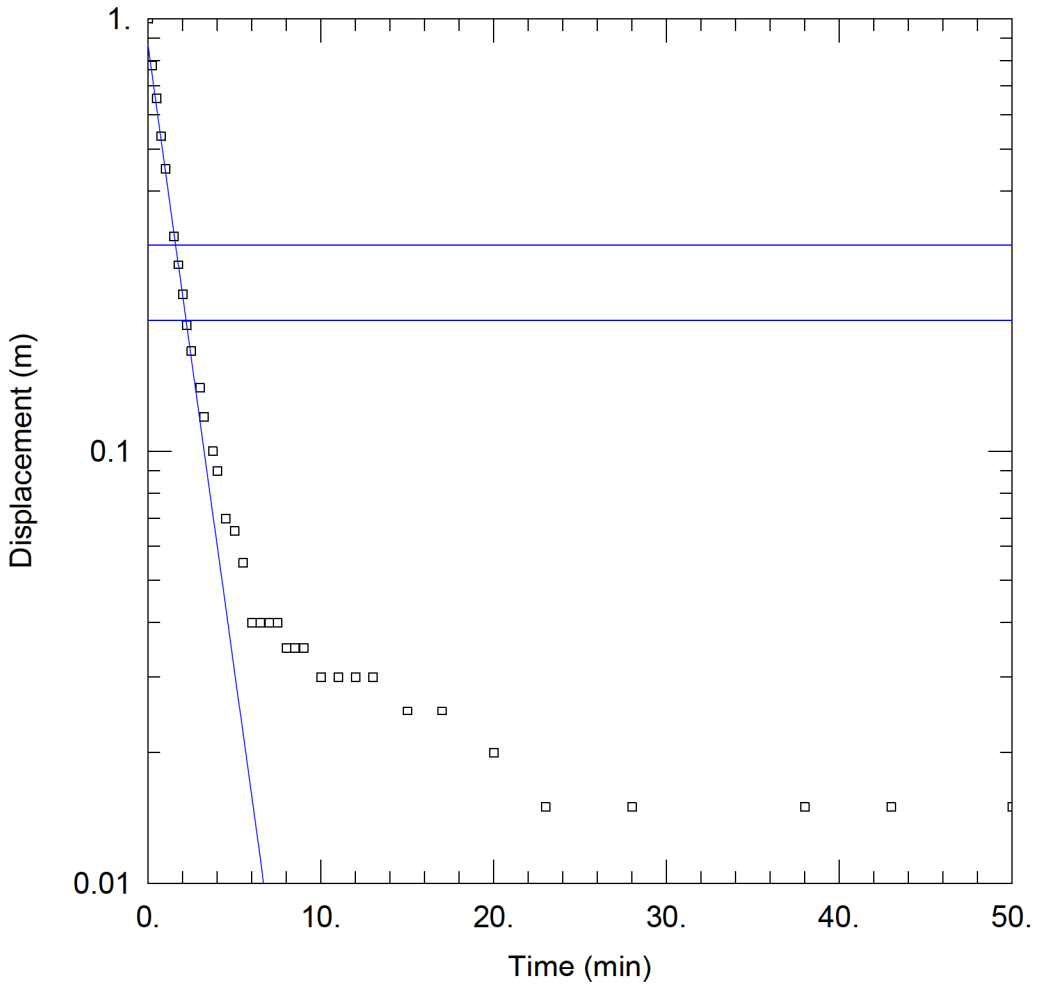
WELL DATA (BH21-01)

Initial Displacement: 0.848 m
Total Well Penetration Depth: 3.74 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.74 m
Screen Length: 1.83 m
Well Radius: 0.051 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 8.395E-9 m/sec y0 = 0.8172 m



WELL TEST ANALYSIS

Data Set:
Date: 04/26/21 Time: 15:54:58

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-03
Test Date: 8Apr2021

AQUIFER DATA

Saturated Thickness: 4.08 m Anisotropy Ratio (Kz/Kr): 1.

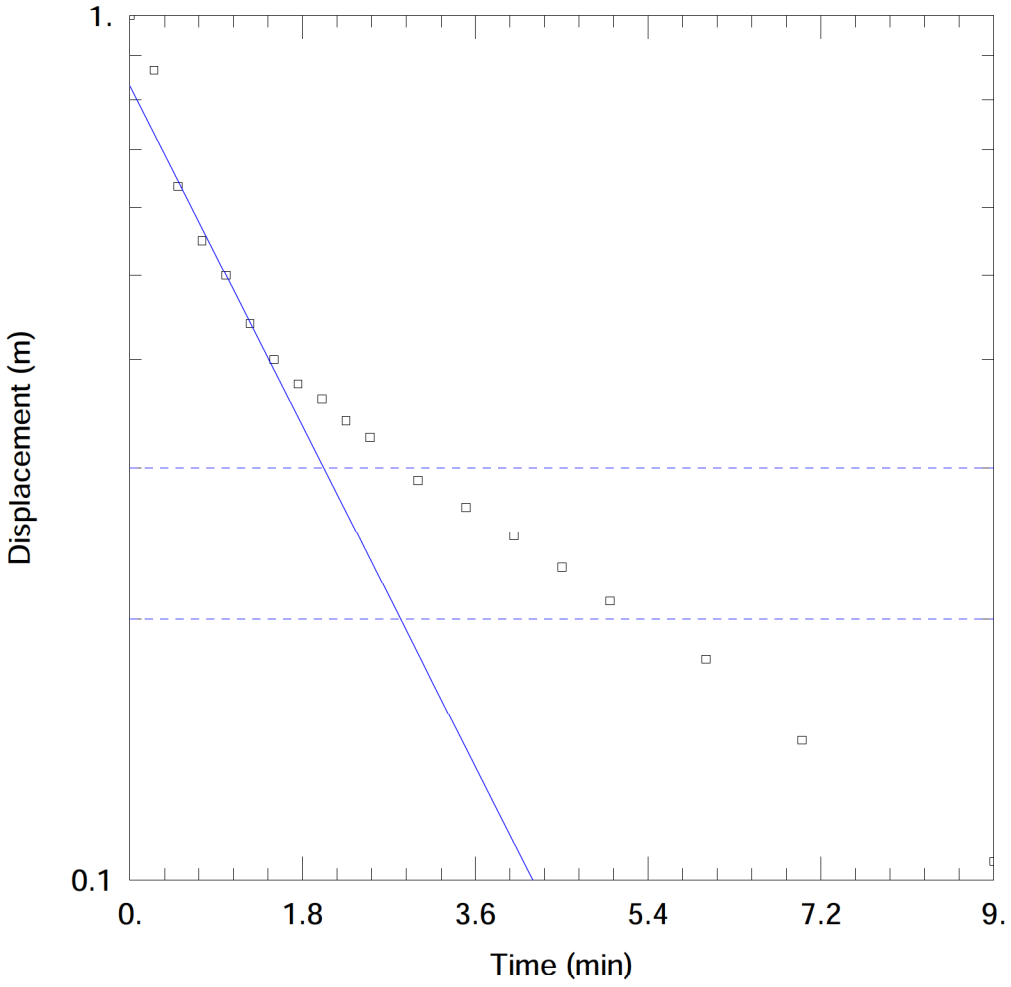
WELL DATA (BH21-03)

Initial Displacement: 1. m
Total Well Penetration Depth: 4.08 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.08 m
Screen Length: 3.66 m
Well Radius: 0.051 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 6.269E-6 m/sec y0 = 0.8716 m



WELL TEST ANALYSIS

Data Set: C:\...\BH21-05.aqt
Date: 01/18/22 Time: 15:36:33

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-05
Test Date: 8Apr2021

AQUIFER DATA

Saturated Thickness: 3.57 m Anisotropy Ratio (Kz/Kr): 1.

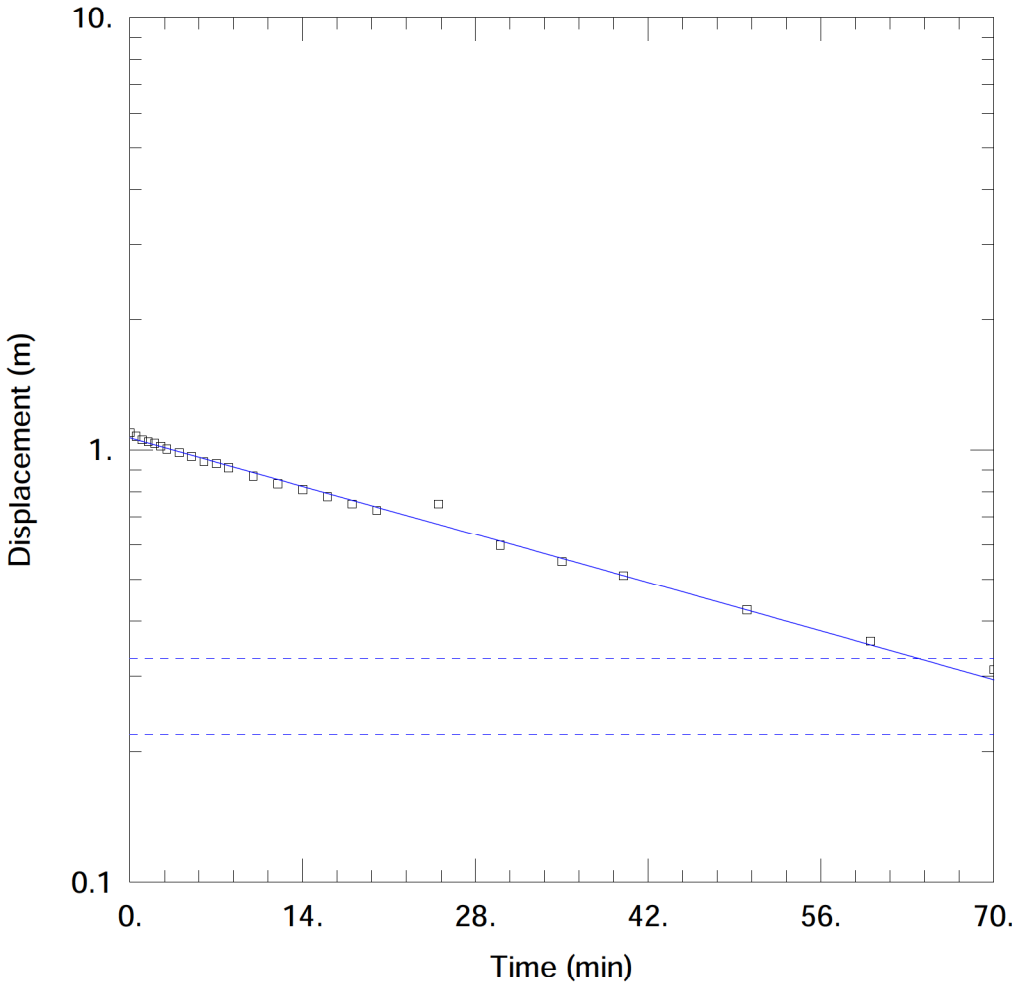
WELL DATA (BH21-05)

Initial Displacement: 1. m
Total Well Penetration Depth: 3.57 m
Casing Radius: 0.0254 m
Static Water Column Height: 3.57 m
Screen Length: 3.57 m
Well Radius: 0.035 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.431E-6 m/sec y0 = 0.8293 m



WELL TEST ANALYSIS

Data Set: C:\...\BH21-06.aqt
Date: 01/13/22 Time: 22:26:36

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-06
Test Date: 8Apr2021

AQUIFER DATA

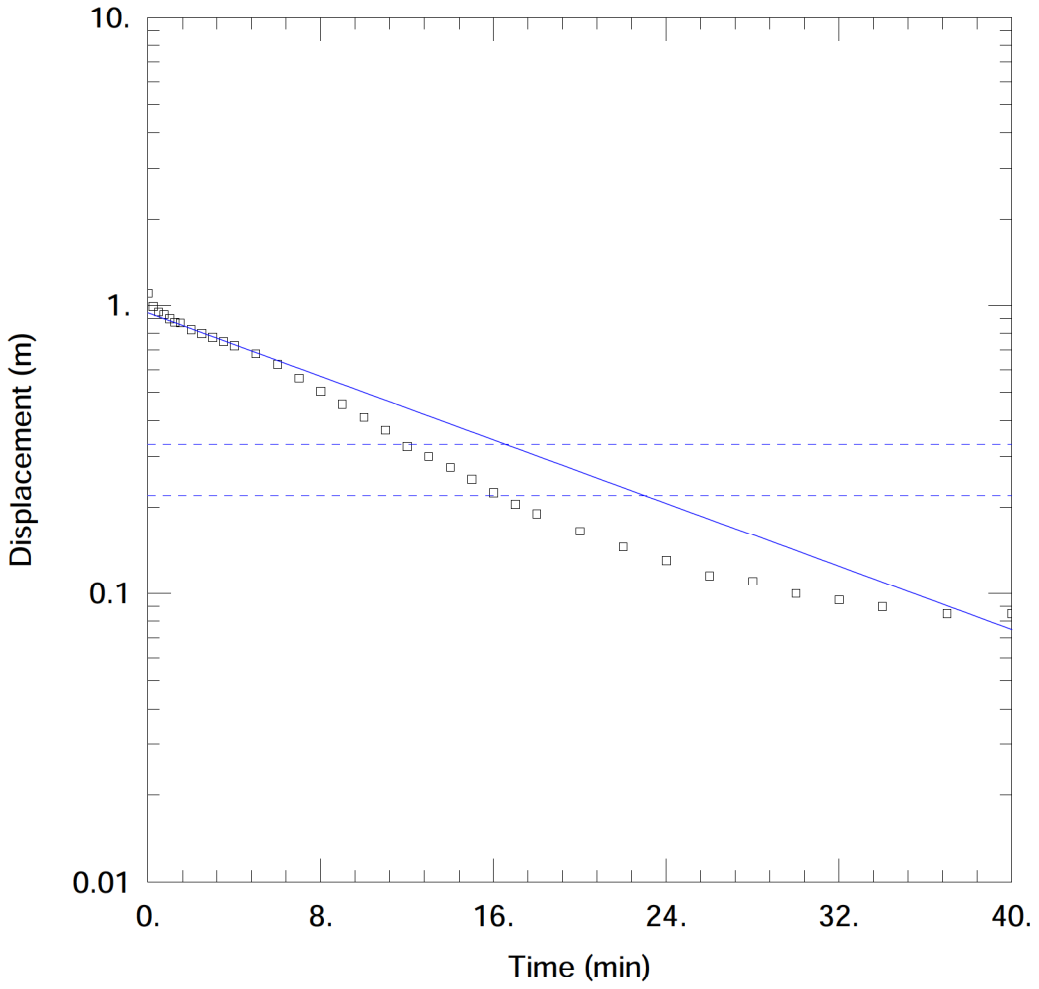
Saturated Thickness: 4.025 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-06)

Initial Displacement: 1.095 m
Total Well Penetration Depth: 4.025 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.025 m
Screen Length: 1.9 m
Well Radius: 0.051 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.675E-7 m/sec
y0 = 1.066 m



WELL TEST ANALYSIS

Data Set: C:\...\BH21-07.aqt
Date: 01/18/22 Time: 15:35:10

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-07
Test Date: 8Apr2021

AQUIFER DATA

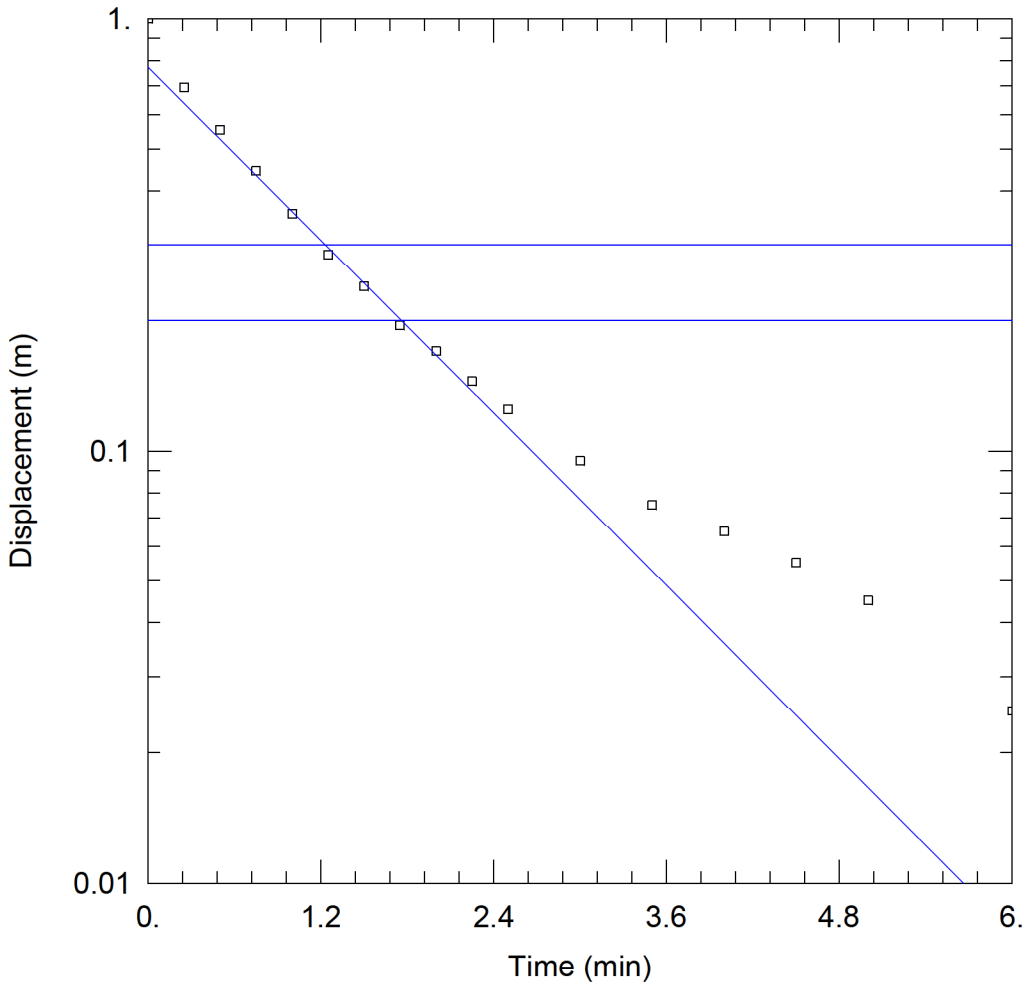
Saturated Thickness: 2.315 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-07S)

Initial Displacement: 1.1 m
Total Well Penetration Depth: 2.315 m
Casing Radius: 0.0254 m
Static Water Column Height: 2.315 m
Screen Length: 1.83 m
Well Radius: 0.0351 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 5.913E-7 m/sec
y0 = 0.9436 m



WELL TEST ANALYSIS

Data Set: C:\Users\CElliott\OneDrive - Golder Associates\Desktop\BH21-08.aqt
Date: 04/26/21 Time: 17:07:00

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-08
Test Date: 8Apr2021

AQUIFER DATA

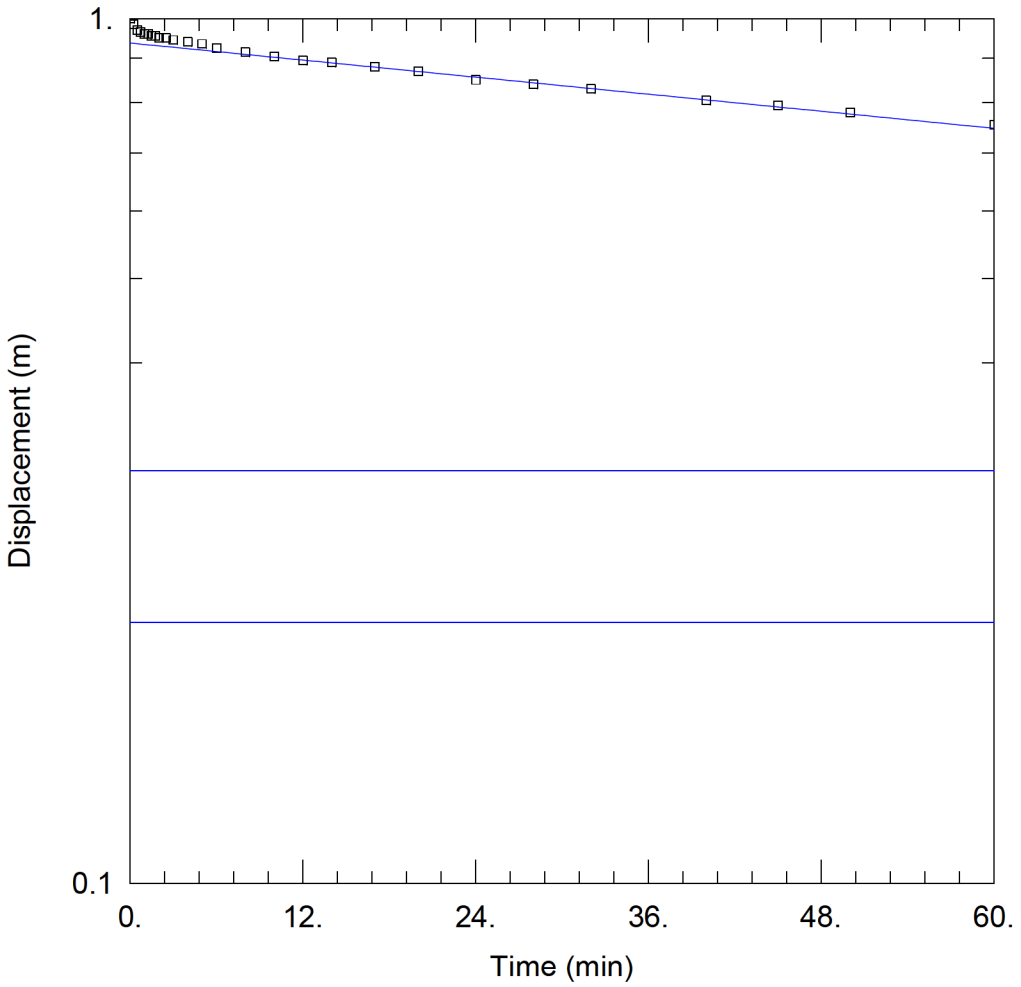
Saturated Thickness: 4.455 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-08)

Initial Displacement: 1. m
Total Well Penetration Depth: 4.455 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.455 m
Screen Length: 3.7 m
Well Radius: 0.051 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 3.803E-6 m/sec
y0 = 0.7743 m



WELL TEST ANALYSIS

Data Set: C:\...\BH21-10.aqt
Date: 04/28/21 Time: 16:49:14

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-10
Test Date: 09Apr2021

AQUIFER DATA

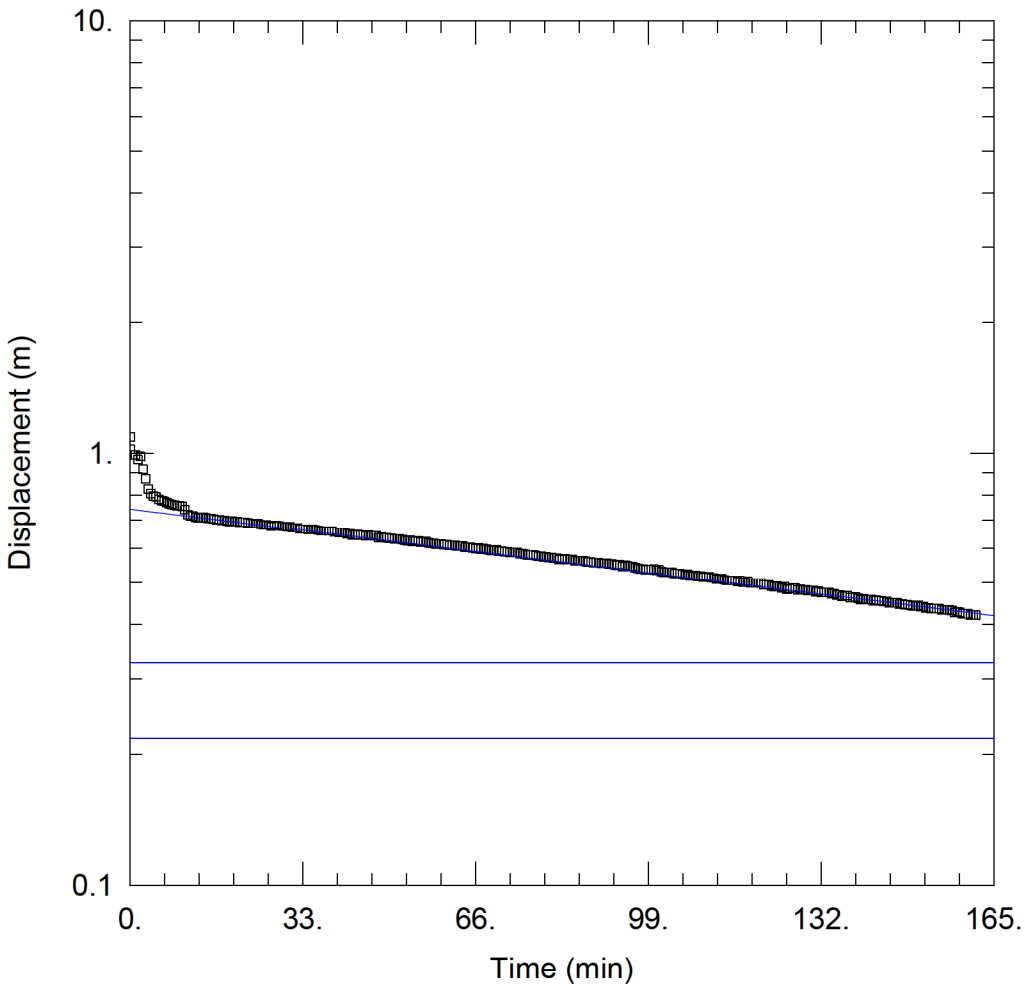
Saturated Thickness: 5.05 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-10)

Initial Displacement: 1. m
Total Well Penetration Depth: 5.05 m
Casing Radius: 0.0254 m
Static Water Column Height: 5.05 m
Screen Length: 3.4 m
Well Radius: 0.051 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 2.069E-8 m/sec
y0 = 0.9375 m



WELL TEST ANALYSIS

Data Set: C:\Users\CElliott\OneDrive - Golder Associates\Desktop\BH21-16.aqt
Date: 04/27/21 Time: 08:18:33

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-16
Test Date: 9Apr2021

AQUIFER DATA

Saturated Thickness: 2.12 m Anisotropy Ratio (Kz/Kr): 1.

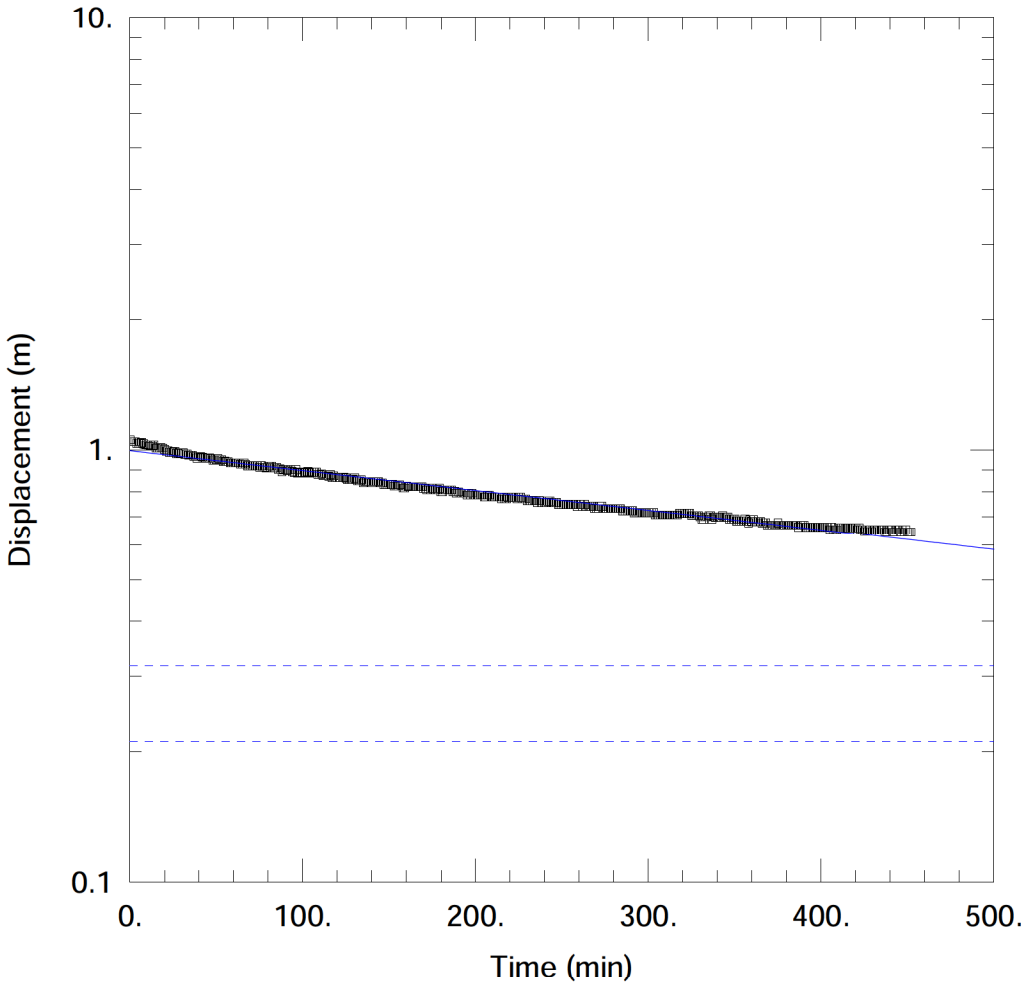
WELL DATA (BH21-16)

Initial Displacement: 1.09 m
Total Well Penetration Depth: 1.87 m
Casing Radius: 0.0254 m
Static Water Column Height: 2.12 m
Screen Length: 1.6 m
Well Radius: 0.051 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 5.485E-8 m/sec y0 = 0.7427 m



WELL TEST ANALYSIS

Data Set: C:\...\BH21-17.aqt
Date: 01/13/22 Time: 22:49:57

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-17
Test Date: 14Apr2021

AQUIFER DATA

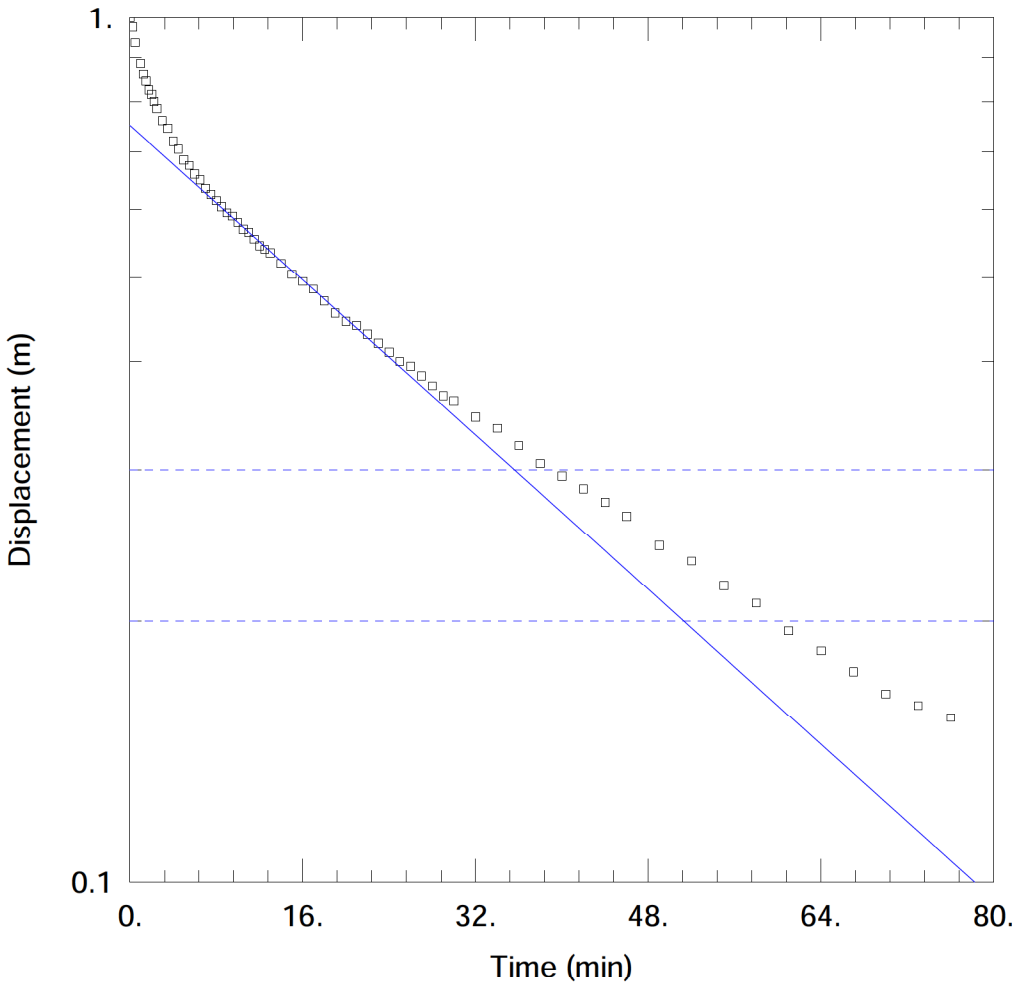
Saturated Thickness: 4.445 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-17)

Initial Displacement: 1.055 m
Total Well Penetration Depth: 4.445 m
Casing Radius: 0.0254 m
Static Water Column Height: 4.445 m
Screen Length: 1.85 m
Well Radius: 0.051 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 1.002E-8 m/sec
y0 = 0.996 m



WELL TEST ANALYSIS

Data Set: C:\...\BH21-18.aqt
Date: 01/18/22 Time: 15:30:59

PROJECT INFORMATION

Company: Golder Associates
Client: Fergus Golf Course
Project: 21456909
Test Well: BH21-18
Test Date: 8Apr2021

AQUIFER DATA

Saturated Thickness: 2.705 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BH21-18)

Initial Displacement: 1. m
Total Well Penetration Depth: 2.705 m
Casing Radius: 0.0254 m
Static Water Column Height: 2.705 m
Screen Length: 2.705 m
Well Radius: 0.035 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 2.172E-7 m/sec y0 = 0.7508 m

APPENDIX G

Water Balance Results

Table G-1: Environment Canada Precipitation, Surplus Data Fergus Shand Dam, Ontario

Fergus Shand Dam Water Budget Means for the period 1965-2020 6142400

Water Holding Capacity	75	mm
Heat Index	34.84	
Lower Zone	45	mm
A	1.052	
Date Range	1965	2020

Date	Temperature	Precipitation	Rain	Melt	Potential Evapo-transpiration	Actual Evapo-transpiration	Deficit	Surplus	Snow	So
	(°C)	mm	mm	mm	mm	mm	mm	mm	mm	m
January	-7.6	75	21	19	1	1	0	39	69	7
February	-7.1	60	18	25	1	1	0	42	85	7
March	-2.2	66	38	71	7	7	0	102	43	7
April	5.2	80	73	50	30	30	0	92	0	7
May	12.2	82	82	0	76	76	0	19	0	6
June	17.4	93	93	0	110	103	-7	11	0	4
July	19.9	82	82	0	128	104	-24	2	0	1
August	19.0	89	89	0	114	88	-26	4	0	1
September	15.0	88	88	0	77	67	-10	7	0	2
October	8.3	85	85	0	38	37	-1	20	0	5
November	2.0	87	75	8	12	12	0	54	4	7
December	-4.2	79	32	16	2	2	0	44	34	7
Average	6.4									
Total		966	776	189	596	528	-68	436		

Table G-1: Environment Canada Precipitation, Surplus Data Fergus Shand Dam, Ontario

Fergus Shand Dam Water Budget Means for the period 1965-2020 6142400

Water Holding Capacity	100	mm
Heat Index	34.84	
Lower Zone	60	mm
A	1.052	
Date Range	1965	2020

Date	Temperature	Precipitation	Rain	Melt	Potential Evapo-transpiration	Actual Evapo-transpiration	Deficit	Surplus	Snow	So
	(°C)	mm	mm	mm	mm	mm	mm	mm	mm	m
January	-7.6	75	21	19	1	1	0	38	69	10
February	-7.1	60	18	25	1	1	0	42	85	10
March	-2.2	66	38	71	7	7	0	101	43	10
April	5.2	80	73	50	30	30	0	92	0	10
May	12.2	82	82	0	76	76	0	19	0	8
June	17.4	93	93	0	110	107	-3	11	0	6
July	19.9	82	82	0	128	113	-15	2	0	3
August	19.0	89	89	0	114	91	-22	4	0	2
September	15.0	88	88	0	77	68	-9	7	0	3
October	8.3	85	85	0	38	37	-1	16	0	6
November	2.0	87	75	8	12	12	0	46	4	9
December	-4.2	79	32	16	2	2	0	41	34	9
Average	6.4									
Total		966	776	189	596	545	-50	419		

Table G-1: Environment Canada Precipitation, Surplus Data Fergus Shand Dam, Ontario

Fergus Shand Dam Water Budget Means for the period 1965-2020 6142400

Water Holding Capacity	125	mm
Heat Index	34.84	
Lower Zone	75	mm
A	1.052	
Date Range	1965	2020

Date	Temperature	Precipitation	Rain	Melt	Potential Evapo-transpiration	Actual Evapo-transpiration	Deficit	Surplus	Snow	So
	(°C)	mm	mm	mm	mm	mm	mm	mm	mm	m
January	-7.6	75	21	19	1	1	0	36	69	12
February	-7.1	60	18	25	1	1	0	42	85	12
March	-2.2	66	38	71	7	7	0	101	43	12
April	5.2	80	73	50	30	30	0	92	0	12
May	12.2	82	82	0	76	76	0	19	0	11
June	17.4	93	93	0	110	109	-1	11	0	8
July	19.9	82	82	0	128	119	-10	2	0	4
August	19.0	89	89	0	114	96	-18	4	0	3
September	15.0	88	88	0	77	69	-8	7	0	4
October	8.3	85	85	0	38	37	-1	13	0	8
November	2.0	87	75	8	12	12	0	38	4	11
December	-4.2	79	32	16	2	2	0	40	34	12
Average	6.4									
Total		966	776	189	596	559	-38	405		

Table G-1: Environment Canada Precipitation, Surplus Data Fergus Shand Dam, Ontario

Fergus Shand Dam Water Budget Means for the period 1965-2020 6142400

Water Holding Capacity	150	mm
Heat Index	34.84	
Lower Zone	90	mm
A	1.052	
Date Range	1965	2020

Date	Temperature	Precipitation	Rain	Melt	Potential Evapo-transpiration	Actual Evapo-transpiration	Deficit	Surplus	Snow	So
	(°C)	mm	mm	mm	mm	mm	mm	mm	mm	m
January	-7.6	75	21	19	1	1	0	35	69	14
February	-7.1	60	18	25	1	1	0	42	85	14
March	-2.2	66	38	71	7	7	0	101	43	15
April	5.2	80	73	50	30	30	0	92	0	15
May	12.2	82	82	0	76	76	0	19	0	13
June	17.4	93	93	0	110	110	0	11	0	10
July	19.9	82	82	0	128	122	-6	2	0	6
August	19.0	89	89	0	114	100	-13	4	0	5
September	15.0	88	88	0	77	70	-7	7	0	6
October	8.3	85	85	0	38	37	-1	12	0	9
November	2.0	87	75	8	12	12	0	34	4	13
December	-4.2	79	32	16	2	2	0	37	34	14
Average	6.4									
Total		966	776	189	596	568	-27	396		

Table G-1: Environment Canada Precipitation, Surplus Data Fergus Shand Dam, Ontario

Fergus Shand Dam Water Budget Means for the period 1965-2020 6142400

Water Holding Capacity	250	mm
Heat Index	34.84	
Lower Zone	150	mm
A	1.052	
Date Range	1965	2020

Date	Temperature	Precipitation	Rain	Melt	Potential Evapo-transpiration	Actual Evapo-transpiration	Deficit	Surplus	Snow	So
	(°C)	mm	mm	mm	mm	mm	mm	mm	mm	m
January	-7.6	75	21	19	1	1	0	29	69	24
February	-7.1	60	18	25	1	1	0	40	85	24
March	-2.2	66	38	71	7	7	0	99	43	24
April	5.2	80	73	50	30	30	0	90	0	25
May	12.2	82	82	0	76	76	0	19	0	23
June	17.4	93	93	0	110	110	0	11	0	20
July	19.9	82	82	0	128	127	-1	2	0	16
August	19.0	89	89	0	114	110	-4	4	0	13
September	15.0	88	88	0	77	73	-4	7	0	14
October	8.3	85	85	0	38	38	0	11	0	18
November	2.0	87	75	8	12	12	0	31	4	22
December	-4.2	79	32	16	2	2	0	33	34	23
Average	6.4									
Total		966	776	189	596	587	-9	376		

Table G-1: Environment Canada Precipitation, Surplus Data Fergus Shand Dam, Ontario

Fergus Shand Dam Water Budget Means for the period 1965-2020 6142400

Water Holding Capacity	300	mm
Heat Index	34.84	
Lower Zone	180	mm
A	1.052	
Date Range	1965	2020

Date	Temperature	Precipitation	Rain	Melt	Potential Evapo-transpiration	Actual Evapo-transpiration	Deficit	Surplus	Snow	So
	(°C)	mm	mm	mm	mm	mm	mm	mm	mm	m
January	-7.6	75	21	19	1	1	0	28	69	29
February	-7.1	60	18	25	1	1	0	40	85	29
March	-2.2	66	38	71	7	7	0	99	43	29
April	5.2	80	73	50	30	30	0	90	0	30
May	12.2	82	82	0	76	76	0	19	0	28
June	17.4	93	93	0	110	110	0	11	0	25
July	19.9	82	82	0	128	128	0	2	0	21
August	19.0	89	89	0	114	111	-2	4	0	18
September	15.0	88	88	0	77	74	-3	7	0	19
October	8.3	85	85	0	38	38	0	11	0	22
November	2.0	87	75	8	12	12	0	31	4	26
December	-4.2	79	32	16	2	2	0	33	34	28
Average	6.4									
Total		966	776	189	596	590	-5	375		

Table G-1: Environment Canada Precipitation, Surplus Data Fergus Shand Dam, Ontario

Fergus Shand Dam Water Budget Means for the period 1965-2020 6142400

Water Holding Capacity	400	mm
Heat Index	34.84	
Lower Zone	240	mm
A	1.052	
Date Range	1965	2020

Date	Temperature	Precipitation	Rain	Melt	Potential Evapo-transpiration	Actual Evapo-transpiration	Deficit	Surplus	Snow	So
	(°C)	mm	mm	mm	mm	mm	mm	mm	mm	m
January	-7.6	75	21	19	1	1	0	27	69	39
February	-7.1	60	18	25	1	1	0	39	85	39
March	-2.2	66	38	71	7	7	0	98	43	39
April	5.2	80	73	50	30	30	0	89	0	40
May	12.2	82	82	0	76	76	0	19	0	38
June	17.4	93	93	0	110	110	0	11	0	35
July	19.9	82	82	0	128	128	0	2	0	31
August	19.0	89	89	0	114	113	-1	4	0	28
September	15.0	88	88	0	77	76	-1	7	0	28
October	8.3	85	85	0	38	38	0	11	0	32
November	2.0	87	75	8	12	12	0	30	4	36
December	-4.2	79	32	16	2	2	0	32	34	38
Average	6.4									
Total		966	776	189	596	594	-2	369		

Table G-2: Estimated Infiltration Factors and Annual Infiltration Rates

Land Use		Water Holding Capacity (mm)	Infiltration Factor	Percipitation (mm)	Evapotranspiration (mm)	Surplus (mm)	Runoff (mm)
Forested Area	Sand Loam	300	0.75	966	590	375	94
	Silt Loam	400	0.60	966	594	369	148
	Clay Loam	400	0.50	966	594	369	185
Undeveloped Area (Pasture Shurbs)	Sand Loam	150	0.65	966	568	396	139
	Silt Loam	250	0.50	966	587	376	188
	Clay Loam	250	0.40	966	587	376	226
Golf Lawns, Residential Lawns and Landscaping (Urban Lawn)	Sand Loam	75	0.65	966	528	436	153
	Silt Loam	125	0.50	966	559	405	203
	Clay Loam	100	0.40	966	545	419	251
Wetland, Ponds, and SWM Ponds		Precip - PET	0.00	966	596	370	370
Impervious Areas		90% Precip	0.00	966	97	869	869

Table 1: Pre-development Scenario Water Balance Results

Catchment	Area (m^2)	Precipitation	Evapo-transpiration	Surplus	Infiltration	Runoff
		(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)
Fairview Golf & Country Club Clubhouse / Golf Sheds / Storage	508	(966) 490	(97) 50	(869) 440	(0) 0	(869) 440
Entrance Roadways	1,224	(966) 1,180	(97) 120	(869) 1,060	(0) 0	(869) 1,060
Lawn - Sand Loam	70,345	(966) 67,950	(528) 37,140	(436) 30,670	(283) 19,940	(153) 10,730
Lawn - Silt Loam	74,306	(966) 71,780	(559) 41,540	(405) 30,090	(203) 15,050	(203) 15,050
Forested Area - Sand Loam	40,509	(966) 39,130	(590) 23,900	(375) 15,190	(281) 11,390	(94) 3,800
Forested Area - Silt Loam	69,151	(966) 66,800	(594) 41,080	(369) 25,520	(221) 15,310	(148) 10,210
Forested Area - Clay Loam	632	(966) 610	(594) 380	(369) 240	(185) 120	(185) 120
Ponds	1,847	(966) 1,790	(596) 1,100	(370) 680	(0) 0	(370) 680
Wetland	22,342	(966) 21,580	(596) 13,320	(370) 8,270	(0) 0	(370) 8,270
Undeveloped Area - Sand Loam	56,551	(966) 54,630	(568) 32,120	(396) 22,400	(257) 14,560	(139) 7,840
Undeveloped Area - Silt Loam	42,566	(966) 41,120	(587) 24,990	(376) 16,000	(188) 8,000	(188) 8,000
Undeveloped Area - Clay Loam	18,518	(966) 17,890	(587) 10,870	(376) 6,960	(150) 2,780	(226) 4,180
Total	**398,500**	**384,950**	**226,610**	**157,520**	**87,150**	**70,380**

Table 2: Proposed Development Scenario Water Balance Results - Without Mitigation

Catchment	Area	Precipitation	Evapo-transpiration	Surplus	Infiltration	Runoff
	(m^2)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)
Residential Lawns - Sand Loam	126,567	(966) 122,260	(528) 66,830	(436) 55,180	(283) 35,870	(153) 19,310
Residential Lawns - Clay Loam	15,293	(966) 14,770	(545) 8,330	(419) 6,410	(168) 2,560	(251) 3,850
Residential Lawns - Silt Loam	88,650	(966) 85,640	(559) 49,560	(405) 35,900	(203) 17,950	(203) 17,950
Wetland	34,568	(966) 33,390	(596) 20,600	(370) 12,790	(0) 0	(370) 12,790
Roads & Paths	27,470	(966) 26,540	(97) 2,650	(869) 23,880	(0) 0	(869) 23,880
House - Driveway	10,540	(966) 10,180	(97) 1,020	(869) 9,170	(0) 0	(869) 9,170
House - Roof	42,780	(966) 41,320	(97) 4,130	(869) 37,190	(0) 0	(869) 37,190
SWM Pond	12,900	(966) 12,460	(596) 7,690	(370) 4,770	(0) 0	(370) 4,770
Open Space / Landscaping - Silt Loam	32,132	(966) 31,040	(559) 17,960	(405) 13,020	(203) 6,510	(203) 6,510
Landscape Strip - Sand Loam	2,843	(966) 2,750	(528) 1,500	(436) 1,240	(283) 810	(153) 430
Landscape Strip - Silt Loam	2,837	(966) 2,740	(559) 1,590	(405) 1,140	(203) 570	(203) 570
Landscape Strip - Clay Loam	1,520	(966) 1,470	(545) 830	(419) 640	(168) 260	(251) 380
Sanitary Pumping Station	400	(966) 390	(97) 40	(869) 350	(0) 0	(869) 350
Total	**398,500**	**384,950**	**182,730**	**201,680**	**64,530**	**137,150**

Table 3: Proposed Development Scenario Water Balance Results - With Mitigation

Catchment	Area	Precipitation	Evapo-transpiration	Surplus	Infiltration	Runoff
	(m^2)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)	(mm/yr) (m^3/yr)
Residential Lawns - Sand Loam	126,567	(966) 122,260	(528) 66,830	(436) 55,180	(283) 35,870	(153) 19,310
Residential Lawns - Clay Loam	15,293	(966) 14,770	(545) 8,330	(419) 6,410	(168) 2,560	(251) 3,850
Residential Lawns - Silt Loam	88,650	(966) 85,640	(559) 49,560	(405) 35,900	(203) 17,950	(203) 17,950
Wetland	34,568	(966) 33,390	(596) 20,600	(370) 12,790	(0) 0	(370) 12,790
Roads & Paths	27,470	(966) 26,540	(97) 2,650	(869) 23,880	(0) 0	(869) 23,880
Roof (to Downspout Disconnect) - Silt Loam	10,350	(966) 10,000	(97) 1,000	(869) 9,000	(217) 2,250	(652) 6,750
Roof (to Downspout Disconnect) - Clay Loam	1,035	(966) 1,000	(97) 100	(869) 900	(217) 230	(652) 670
House - Driveway	10,540	(966) 10,180	(97) 1,020	(869) 9,170	(0) 0	(869) 9,170
SWM Pond	12,900	(966) 12,460	(596) 7,690	(370) 4,770	(0) 0	(370) 4,770
Open Space / Landscaping - Silt Loam	32,132	(966) 31,040	(559) 17,960	(405) 13,020	(203) 6,510	(203) 6,510
Landscape Strip - Sand Loam	2,843	(966) 2,750	(528) 1,500	(436) 1,240	(283) 810	(153) 430
Landscape Strip - Silt Loam	2,837	(966) 2,740	(559) 1,590	(405) 1,140	(203) 570	(203) 570
Landscape Strip - Clay Loam	1,520	(966) 1,470	(545) 830	(419) 640	(168) 260	(251) 380
Roof to Infiltration Trench - Sand Loam	22,425	(966) 21,660	(97) 2,160	(869) 19,490	(669) 15,010	(200) 4,480
Roof to Infiltration Trench - Silt Loam	7,935	(966) 7,660	(97) 770	(869) 6,900	(626) 4,970	(243) 1,930
Roof to Infiltration Trench - Clay Loam	1,035	(966) 1,000	(97) 100	(869) 900	(478) 500	(391) 400
Sanitary Pumping Station	400	(966) 390	(97) 40	(869) 350	(0) 0	(869) 350
Total	**398,500**	**384,950**	**182,730**	**201,680**	**87,490**	**114,190**

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