

Hydrogeological Investigation & Terrain Analysis Proposed Residential Subdivision Emerald Woods Subdivision Greely, Ontario



Submitted to:

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EXECUTIVE SUMMARY

GEMTEC Consulting Engineers and Scientists Limited (GEMTEC) was retained by ARK Engineering and Development Inc. to carry out a Hydrogeological Investigation and Terrain Analysis for a proposed 73 lot residential subdivision on a 35.0-hectare parcel of land in Greely, Ontario.

The main objectives of the study were as follows: characterize the subsurface conditions to assess the suitability of on-site septic systems and their potential impacts of these systems on the receiving aquifer and nearby surface water features; and, investigate the potential quantity and quality of groundwater available from drilled test wells for potential domestic supply and to assess the long-term impacts on other groundwater users.

In March 2021, GEMTEC coordinated and supervised field investigations, which included: the excavation of 18 test pits across the site (well screens installed in three test pits), drilling of four boreholes with monitoring wells installed in three and drilling of five groundwater test wells; groundwater pumping tests, water sample collection and laboratory analysis; soil sample collection and testing; review of available background documents; and, data analysis, compilation and production of a final report.

A complete description of the methodology and approach, results and conclusions are presented in this report. The executive summary should be read in conjunction with the full text of the report.

Key project findings are summarized as follows:

- The subject site is located in an un-serviced rural setting and the majority of site is currently tree covered. Surrounding land use includes undeveloped residential land, a golf course and residential developments.
- Surficial overburden consists of coarse textured glaciomarine deposits of sand with minor clay and silt, underlain by silty sand and/or silty clay on the western portion of the site and silty-sand till on the eastern portion of the site. The overburden thickness ranges from approximately 1.2 to 8.4 metres, with an average thickness of 5.4 metres. No bedrock outcrops were observed on the site.
- The quantity of groundwater available from the proposed bedrock water supply aquifer is more than sufficient for the proposed development and will sustain repeated pumping at the test rate and duration at 24-hour intervals over the long term;
- Interference between drinking water wells is expected to be acceptable under typical usage for residential developments;
- No negative impacts to the bedrock aquifer are anticipated (nitrate dilution calculations demonstrate that offsite impacts are less than 10 mg/L);

- The water quality available from drilled wells on the subject site is safe for consumption based on the absence of health-related exceedances; however, groundwater treatment for aesthetic parameters will likely be required.
- Recommendations on well construction and septic design are provided in the report.

Based on the results of this hydrogeological investigation and terrain analysis, it is recommended that the Emerald Woods residential subdivision be approved for development.



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1.0 INTRODUCTION

GEMTEC Consulting Engineers and Scientists (GEMTEC) was retained by ARK Engineering and Development to conduct a hydrogeological investigation and terrain evaluation for a proposed 35hectare subdivision (hereafter referred to as 'the subject site') in Greely, Ontario. The location of the subject site is shown in the attached Site Plan, Figure 1.

The proposed subdivision is currently part of a 35-hectare (86.5 acre) land parcel, Part of Lots 3 and 4, Concession 3, Geographic Township of Osgoode, now in the City of Ottawa. Residential and commercial properties utilizing private services border the site to the north, south and east. Undeveloped and forest covered land border the site to the west.

The proposed development at the subject site will consist of 73 residential lots serviced with onsite septic disposal systems and water supply wells. The proposed lots will be accessed by an internal roadway system and will have a minimum lot size of 0.4 hectares. The proposed layout of the development is shown on the Detailed Site Plan, Figure 2. A copy of the proposed Conceptual Lot Development Plan prepared by Ark Engineering is provided in Appendix A.

1.1 Objectives of Investigation

The objectives of this investigation are as follows:

- To review available background information to assist in characterization of subsurface conditions in the vicinity of the subject site and develop a hydrogeological conceptual model;
- To identify and characterize the shallow subsurface conditions on the subject site as they relate to the suitability of on-site septic sewage disposal systems;
- To assess the potential for impact on the receiving aquifer(s) and any nearby surface water features from on-site septic disposal systems;
- To investigate the potential quantity and quality of groundwater available from drilled test wells on the subject site for potential domestic supply; and,
- To assess the long-term impacts on groundwater supply from existing developments on drilled water supply wells in the vicinity of the subject site.

Following a review of available background information and analysis of the results of the field investigation, conclusions and recommendations for the proposed residential development of the subject site are provided.



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2.0 REVIEW OF BACKGROUND INFORMATION

2.1 Land Use

The majority of the subject site is currently undeveloped forest covered land. Land use in the vicinity of the site consists of vacant undeveloped land, a golf course and residential properties on private services. Specific land uses near the subject site boundaries are documented in Table 2.1.

Site Boundary	Existing Land Use		
North	Residential propertiesGolf course		
East	Residential properties		
West	 Undeveloped land (future residential subdivision) and forest covered land 		
South	Residential properties		

Potential impacts to groundwater quality from adjacent lands within 500 metres of the subject site boundary are not anticipated based on the present land uses. A privately-run Golf course is situated approximately 100 metres, at its closest point, from the site boundary to the north.

Two large-scale water takings were identified within 500 metres of the subject site boundary. PTTW number 2420-BCVQ2A is listed as recreational use for the Ottawa-Carleton Ultimate Association. The water taking includes surface and groundwater up to a maximum of 177,692 litres per day. PTTW number 2017-9KTQ6D is listed as commercial use for Greely Glen Golf Course Limited. The water taking includes surface and groundwater up to a maximum of 818,280 litres per day.

2.2 Topography and Drainage

Topographic mapping data indicates that elevations across the site range from about 100 to 105 metres above sea level (Figure 3). A topographic high is located along the southeastern boundary of the subject site and the terrain slopes gently downwards towards the north, west and east. The drainage of the subject site is expected to follow topography and is anticipated to be towards the northwest (Figure 3).



2.3 Regional Surficial and Bedrock Geology

Surficial geology maps (Ontario Geologic Survey, 2010) indicate that the site is primarily underlain by coarse-textured glaciomarine deposits consisting of sand with minor silt and clay, stone-poor silty sand till and organic deposits to the northeast (Figure 4). Drift thickness mapping (Gao, 2006) indicate the overburden soil deposits range from 1 to 15 metres in thickness (Figure 5).

Paleozoic bedrock geology maps (Armstrong and Dodge, 2007) indicate the bedrock geology beneath the subject site consists of a limestone unit that is interpreted to be part of the Oxford and March Formations, which are collectively referred to as the Beekmantown Group. The uppermost formation beneath the Site is the Oxford Formation, which is described as a dolostone with shaly and sandy interbeds that are up to 30 cm thick (Williams, 1991). The formation is characterized by light to medium brownish to greenish grey dolostone.

The Oxford Formation is underlain by the March Formation, an interbedded grey quartz sandstone, dolomitic quartz sandstone, and blue-grey sandy dolostone and dolostone. The unit represents a transition zone between the Oxford Formation dolostones above, and the Nepean Formation sandstone below. Dolostones of the March Formation are lithologically similar to the overlying Oxford Formation, making them difficult to distinguish using drill cuttings.

The underlying Nepean Formation is a quartz sandstone that is thinly bedded to massive and well sorted. The sandstone is variable in colour and can be white to light grey, brown, reddish brown and green. It underlies the March Formation beneath the subject site, and the upper Nepean Formation contact is marked by the lowermost unit of (sandy) dolostone.

Available karst mapping (Brunton and Dodge, 2008), does not indicate any areas of any inferred or potential karstic features.

2.4 Ontario Ministry of Environment, Conservation and Parks Water Well Records

The Ministry of Environment, Conservation and Parks (MECP) Water Well Records for existing private wells in the surrounding development were obtained to determine the characteristics of existing private wells in the vicinity of the subject site (500 metre radius). A total of 141 well records were reviewed from the MECP online water well record mapping resource (Appendix B). All of the drinking water well records were for wells completed in bedrock.

Table 2.2 provides a summary of the well characteristics for 141 water well records for depth to water found, static water levels, depth to bedrock, depth into bedrock and total well depth.

Parameter	10 th Percentile	90 th Percentile	Average / Geometric Mean
Depth Water Found ¹ (m)	11.0	56.1	28.3 / 23.1
Static Water Level (m)	1.2	10.6	5.1 / 3.7
Depth to Bedrock ² (m)	0.8	12.8	6.1 / 3.2
Total Well Depth (m)	12.7	60.4	33.5/28.1

Table 2.2 – Summary of Water Well Records Search Results

Notes:

1. Depth water found as reported on MECP water well records, representing water bearing fractures encountered at the time of drilling.

2. Zero readings set to 0.01 in order to calculate geometric mean.

The MECP Water Well Records for drinking water wells surrounding the subject site indicate that the total well depth in existing private wells is 28.1 metres bgs (geometric mean) and the geometric mean overburden thickness above the proposed water supply aquifer is 6.1 metres. The water found depths generally range from 11 to 56 metres (10th and 90th percentiles), suggesting that the depth of water bearing fractures encountered at the time of drilling are variable.

2.5 Neighbouring Subdivisions

The report titled: Hydrogeology, Terrain Analysis and Impact Assessment Report, Emerald Links Phase III, Part of Lot 3, Concession 3, Formerly Township of Osgoode, City of Ottawa (Greely), Ontario (2009), prepared by Trow Associates Inc., was reviewed as part of this investigation. The Emerald Links Phase 3 residential subdivision is located west of the subject site.

Shallow groundwater flow in the proposed Emerald Links Phase III Subdivision was reported as being southeast towards Grey's Creek municipal drain that cuts through the western third of the site. The bedrock groundwater flow in the Emerald Links Phase III Subdivision was reported as northward.

Wells draw water from a limestone aquifer (Oxford Formation) or the March/Nepean formation which consists of limestone and sandstone beds. Test well depths ranged from 19.8 to 79 metres and all five test wells were noted to satisfy D-5-5 with respect to water quantity. The bedrock aquifer met all health-related criteria of the ODWQS, except for sodium levels in one test well, which exceed the warning level for persons on sodium restricted diets. Trow (2009) reported aesthetic objective exceedances of the ODWQS for hydrogen sulphide, iron, hardness and colour. Well construction recommendations included complying with Ontario Regulation 903 and extending well casings at least 3 m into competent bedrock.



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2.6 Preliminary Site Servicing Report

A preliminary site servicing report for the western portion of the subject site was prepared by the Paterson Group, titled "Preliminary Private Services, Site Suitability Study, Proposed Residential Development, Part of Lot 3, Concession 3, Former Township of Osgoode, Now City of Ottawa, Ontario" and dated November 1, 2011. Based on the presence of overburden sands identified up to 1.7 metres below ground surface, on-site septic systems are suitable for the proposed residential development. Shallow groundwater was encountered in all 15 test pits advanced on September 8, 2011 at depths ranging from 0.6 to 1.5 metres below ground surface.

3.0 TERRAIN EVALUATION

3.1 Field Procedure

The field work for the terrain evaluation was completed as part of the GEMTEC geotechnical investigation, titled "DRAFT Geotechnical Investigation, Emerald Woods Subdivision, Jack Pine Crescent, Ottawa, Ontario" dated April 27, 2021. A total of 18 test pits (numbered 21-01 to 21-18, inclusive) and four boreholes (numbered 21-101, 21-103, 21-104, and 21-105) were advanced at the site by GEMTEC. Two additional test pits numbered 19 and 20 were advanced at the site by ARK Engineering. The test pits were advanced to depths ranging from about 1.6 to 4.6 metres below the existing ground surface and the boreholes were advanced to depths of about 4.2 to 6.7 metres below the existing ground surface. Well screens were sealed in the overburden at boreholes 21-101, 21-105, to measure the groundwater levels and facilitate groundwater quality sampling.

Descriptions of the subsurface conditions logged in the test pits and boreholes are provided in Appendix C. Selected samples were submitted for grain size distribution testing; the results of the laboratory classification tests on the soil samples are also provided in Appendix C. The locations of the test pits and boreholes are shown on the Detailed Site Plan, Figure 2.

3.2 Soil and Groundwater Conditions

3.2.1 General

The following presents an overview of the subsurface conditions encountered in the test pits and boreholes advanced as part of the geotechnical investigation (GEMTEC, 2021).

3.2.2 Topsoil

A layer of topsoil was encountered at the ground surface at all test hole locations, except borehole 21-103. The thickness of the topsoil ranges from about 50 to 150 millimetres.

3.2.3 Silty Sand to Sand

Native deposits of silty sand to sand with some silt and trace gravel was encountered below the topsoil in all test hole locations. The silty sand to sand deposit was not fully penetrated in all the test holes, but was proven to depths ranging from about 0.2 to 4.6 metres below ground surface.

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Two grain size distribution tests were undertaken on samples of the sand from test pits 21-03 and 21-10. The results are provided in Appendix C and are summarized in Table 3.1.

Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
21-03	2	0.9 – 1.0	0	93	6	1
21-10	2	1.2 – 1.4	0	96	2	2

Table 3.1 – Summary of Grain Size Distribution Test (Sand)

3.2.4 Silty Clay

Native deposits of silty clay were encountered in test pits 21-04 to 21-12 and 21-18, and all of the boreholes.

The full depth of the silty clay in the test holes is grey in colour. The silty clay was not fully penetrated in the test pits, but was proven to depths ranging from about 4.0 to 4.6 metres below ground surface. The silty clay deposits encountered in the boreholes have a thickness ranging from about 0.6 to 1.4 metres and extend to depths ranging from about 3.1 to 4.6 metres below existing ground surface.

3.2.5 Clayey Silt

Native deposits of clayey silt were encountered below the silty clay in the boreholes. The clayey silt has a thickness ranging from about 0.9 to 1.2 metres and extends to depths ranging from about 4.2 to 5.5 metres below ground surface.

3.2.6 Glacial Till

Native deposits of glacial till were encountered below the silty sand and silty clay, where encountered in test pits 21-09, and 21-12 to 21-17 and boreholes 21-101, 21-103, 21-104, and 21-105. The glacial till was not fully penetrated in all the test holes but was proven to depths ranging from about 1.6 to 6.7 metres below ground surface. The glacial till is a heterogeneous mixture of all grain sizes, which at this site, can be described as grey silty sand with trace to some gravel with cobbles and boulders.

One grain size distribution test was undertaken on a select sample of the glacial till from test pit 21-17. The results are provided in Appendix C and are summarized in Table 3.2.



Location	Sample Number	Sample Depth (metres)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
21-17	2	1.0 – 1.2	12	50	33	5

Table 3.2 – Summary of Grain Size Distribution Test (Glacial Till)

The test pits advanced by Ark Engineering, TP19 and TP20 encountered native deposits of till, with thicknesses of 3.3 and 2.0 metres respectively.

3.2.7 Bedrock

Refusal to excavator advancement was encountered in test pits 21-12, 21-13, 21-14, 21-16, and 21-17 at depths of about 1.6 to 3.4 metres below the existing ground surface. The refusal likely represents the presence of cobbles or boulders within the glacial till deposit or the bedrock surface.

Two additional test pits, numbered 19 and 20, advanced by ARK Engineering on the southeastern portion of the Site, encountered refusal at depths of about 3.5 and 2.2 metres, respectively.

A summary of the excavator refusal depths and elevations are provided in Table 3.3 below.

Borehole/Test Pit Number	Ground Surface Elevation (metres)	Depth to Auger / Excavator Refusal (metres)	Auger / Excavator Refusal Elevation (metres)
21-12	102.7	3.2	99.5
21-13	102.7	3.0	99.7
21-14	102.8	1.6	101.2
21-16	105.0	3.4	101.6
21-17	103.7	3.0	100.7
19	102.7	3.5	99.2
20	102.7	2.2	100.5

Table 3.3 – Summary of Excavator Refusal Depth and Elevation

3.2.8 Groundwater Conditions

Well screens were installed in the overburden at test pits 21-02, 21-08, and 21-18 and boreholes 21-101, 21-104, and 21-105. The groundwater level in the open test pits were measured at the time of the geotechnical field investigation (GEMTEC, 2021) on March 8 and 9, 2021.

The groundwater levels were measured in the well screens on March 12, March 29 and September 1, 2021 and are summarized in Table 3.4.

Test Hole No.	Groundwater Depth Below Existing Ground Surface (metres)	Groundwater Elevation (metres, geodetic datum)	Date of Reading
21-01	1.1	101.2	March 9, 2021
21-02	1.0	101.5	March 12, 2021
21-03	2.3	100.1	March 8, 2021
21-04	1.4	101.1	March 8, 2021
21-05	Dry (>4.50)	< 98.1	March 8, 2021
21-06	Dry (>4.57)	< 98.3	March 8, 2021
21-07	1.8	100.2	March 8, 2021
21-08	1.9	101.1	March 12, 2021
21-09	Dry (>4.50)	< 98.3	March 8, 2021
21-10	Dry (>4.50)	< 98.4	March 8, 2021
21-11	1.3	101.4	March 8, 2021
21-12	1.5	101.2	March 8, 2021
21-13	Dry (>3.00)	< 99.7	March 8, 2021
21-14	1.4	101.4	March 9, 2021
21-15	Dry (>3.00)	< 100.1	March 9, 2021
21-16	Dry (>3.40)	< 101.6	March 9, 2021
21-17	Dry (>3.00)	< 100.7	March 9, 2021
21-18	0.0	102.3	March 12, 2021
21-101	0.2	102.2	March 29, 2021
21-101	1.6	100.8	September 1, 2021

Table 3.4 – Groundwater Depth and Elevation



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Test Hole No.	Groundwater Depth Below Existing Ground Surface (metres)	Groundwater Elevation (metres, geodetic datum)	Date of Reading
21-104	0.0	102.3	March 29, 2021
21-104	1.2	101.1	September 1, 2021
21-105	0.3	101.9	March 29, 2021
21-105	2.1	100.1	September 1, 2021

The groundwater levels may be higher during wet periods of the year such as the early spring or following periods of precipitation.

4.0 HYDROGEOLOGICAL CONCEPTUAL MODEL

4.1 Site Specific Geology

Based on the results of the review of MECP water well records, land use observations and available geology maps, the local hydrogeology on the subject site and adjacent lands are characterized by coarse-textured glaciomarine deposits consisting of sand with minor clay and silt, underlain by silty sand and/or silty clay and silty-sand to sandy-silt till. The subject site overburden thickness varies between 1.2 to 8.8 metres, with an average depth to bedrock of 3.9 metres. Based on the Ontario Geologic Survey (OGS) mapping and test wells advanced on-site, the bedrock is characterized as limestone/dolostone of the Oxford and/or March Formation which is underlain by sandstone of the Nepean Formation. The site-specific geology findings are consistent with the findings of the available background information.

4.2 Hydrogeological Conceptual Model

The framework for the hydrogeological conceptual model for the subject site is summarized in Table 4.1 below.

A northwest-southeast hydrogeological cross-section (Figure 6) across the subject site was prepared based information from onsite test wells. Please note that the boundaries between zones indicated on the cross-section have been interpreted based on available information and may differ somewhat from that indicated. Ground surface elevations for each of the test wells were measured by GEMTEC staff using a Trimble R10 global positioning system. The elevations are referenced to geodetic datum.



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Stratigraphic Unit	Generalized Composition	Thickness (m)
Overburden	 Topsoil; Sand and Till Underlain by silty sand and/or silty clay 	1.2 to 8.8 metres (average of 5.4 metres ¹)
Bedrock	 Limestone (Oxford and/or March Formation) Sandstone (Nepean Formation) 	 34.2 to 40.0 metres > 12 metres

Table 4.1 – Framework of Hydrogeological Conceptual Model

Notes: 1. Average overburden thickness based on five on-site water well records.

The test well bedrock elevation ranges from about 101.25 to 103.00 metres Above Mean Sea Level (AMSL) and the base of the well casings range from 101.7 to 103.4 metres AMSL. The elevation of the water bearing zones (depth water found) ranges from 54.2 to 73.6 metres ASL and the elevation of the bottom of test wells ranged from 48.8 to 71.2 metres AMSL. The cross-section, based on the onsite test well water well records, indicates that the total thickness of the overburden ranges from approximately 1.2 to 8.8 metres and generally consists of sand with gravel, clay and/or boulders.

It is our assessment that the hydrogeological cross section is consistent with available background information and the site-specific geology from the field investigation on the subject site. In general, the site is not considered to be hydrogeologically sensitive based on the absence of significant areas of thin soils, highly permeable soils or karst terrain.

Thin soils, taken to be less than 2.0 metres in thickness were encountered towards the back end of two lots located on the southeastern portion of the Site (refer to Conceptual lot Development Plan in Appendix A and Figure 7). The Conceptual lot Development Plan (Appendix A) indicates septic systems will be located in the front of the lots, where the overburden thickness increases to depths greater than 2.0 metres based on site investigation and not likely to be located in a hydrogeologically sensitive area.

5.0 IMPACT ASSESSMENT

The impact on groundwater and surface water resources due to wastewater treatment and disposal by individual onsite sewage disposal systems on the subject site are assessed in the following sections.



5.1 Sewage Disposal Systems

This section discusses the results of the terrain evaluation as they relate to the feasibility of installing sewage disposal systems on the subject site for onsite wastewater treatment and disposal.

It should be noted that the following information is provided for general guidance purposes only and that all septic systems installed on the subject site should be designed on a lot by lot basis using a lot specific investigation involving test holes to determine the actual subsurface conditions at the location of the proposed septic system. In all cases, the septic system design must conform to the Ontario Building Code (OBC) requirements.

5.1.1 Class IV Septic Sewage Disposal Systems

This section discusses the results of the terrain evaluation as they relate to the feasibility of installing Class IV septic sewage disposal systems on the subject site.

The septic system envelope area (septic envelope) represents the area on a lot set aside for the construction of the leaching bed and is for the leaching bed only. It does not include that area required for the septic tank or the isolation/separation distances required by the Ontario Building Code (OBC). The size of the septic system envelope is a function of the percolation rate of the native soil in the vicinity of the septic envelope (or the fill used for the construction of a septic bed) and the daily effluent loading to the septic bed.

The maximum expected septic system envelope required to service a single-family dwelling at this site is calculated to be 875 m², assuming a conservative design flow of 3,500 litres/day and a loading rate of 4 $L/m^2/day$ (high water table).

A 875 m² septic envelope corresponds to 21% area cover based on a 4,000 m² (0.4 hectare) lot. Typical septic envelope dimensions ions would be 35 metres in length by 25 metres width. The septic system envelope should be readily accommodated on the lot sizes that are proposed. Prior to establishing the actual septic envelope (leaching bed) location on any particular lot, test holes should be excavated to determine the actual subsurface conditions in the area of the proposed leaching bed.

The septic leaching bed design must ensure that the bottom of the absorption trenches is at least 0.9 metres above low permeability soils (such as silty clay), bedrock, and the seasonally high groundwater table. Based on the groundwater levels measured in test pits and boreholes, it is expected that the majority of the septic leaching beds at this site will be partially or fully raised.

5.1.2 Tertiary Septic Systems

Approved septic disposal systems that meet the OBC requirements for tertiary treatment could also be considered for this development in place of conventional Class IV septic systems. The disposal beds for tertiary treatment systems require a smaller area than conventional Class IV

septic systems. Furthermore, the required separation distance between the underside of the crushed stone layer in the disposal bed and low permeability soils, bedrock, or the seasonally high groundwater table is less than the required 0.9 metres for conventional septic systems. Some tertiary treatment systems are also effective in reducing contaminants, such as nitrate, prior to disposal to the leaching bed.

5.2 Groundwater Impacts

The potential risk to groundwater resources on and off the subject site was assessed in accordance with Ministry of Environment Procedure D-5-4: Technical Guideline for Individual On-Site Sewage Systems: Water Quality Impact Risk Assessment. To evaluate the groundwater impacts, the Three-Step Assessment Process outlining in MECP D-5-4 was followed.

5.2.1 Three-Step Assessment: Step 1 - Lot Size Considerations

Lot sizes of 1.0 hectares or larger are assumed to be sufficient for attenuative processes to reduce nitrate-nitrogen to acceptable concentrations in groundwater below adjacent properties. The proposed lot sizes of 0.4 hectares (minimum) do not meet this consideration.

5.2.2 Three-Step Assessment: Step 2 – Isolation

Where proposed lot sizes are less than 1.0 hectares, the risk of sewage effluent contamination must be assessed for the proposed subdivision. As per Procedure D-5-4, it is required to:

- Evaluate the most probable groundwater receiver for sewage effluent; and,
- Define the most probable lower hydraulic or physical boundary of the groundwater receiving the sewage effluent.

Based on the hydrogeological conceptual model and as per the isolation requirements of MECP Procedure D-5-4, the groundwater receiver for the septic effluent is the overburden sands and the upper limestone bedrock aquifer. The result of the hydrogeological conceptual model indicates that the overburden sands and till deposits across the site generally do not meet the above requirements for isolation.

5.2.3 Three-Step Assessment: Step 3 - Nitrate Dilution Calculations

Where it cannot be demonstrated that the effluent is hydrogeologically isolated from the water supply aquifer and the proposed lot sizes are less than 1.0 hectares, the risk of individual on-site septic systems will be assessed using nitrate-nitrogen contaminant loading. The maximum allowable concentration of nitrate in the groundwater at the boundaries of the subject property is 10 mg/L as per the Ministry of the Environment and Climate Change's guideline D-5-4, dated August 1996.

The nitrate concentration at the site boundaries was calculated using the information in Table 5.1, below.

Table 5.1 Nitrate Dilution Assumptions

Parameters	Site Descriptions		
Site Area	350,053.1 m² (86.5 acres)		
Infiltration Area for 73 lots ^(1, 2) Site area – internal roadway (11,900m²) house & driveway footprint (300m² per lot	_ 316,253.1 m ²		
Water Holding Capacity ⁽³⁾	75 mm Sandy Loam (representative of fine sand, silty sand and silty-sand till encountered on-site)		
Annual Water Surplus ⁽⁴⁾	Sandy Loam = 380 mm/year Representative of fine sand, silty-sand till encountered on- site		
Topography Factor (TF)	0.23 Undeveloped site topography is relatively flat, with topography between flat land – 0.2 and rolling land – 0.3, average of 0.25 (65% lot coverage). Post-development lot area (35% lot coverage) may include raised septic beds and landscaping with topography represented by rolling lands (0.2). Weighted average topography factor of 0.23.		
Soil Factor (SF)	0.4 Open Sandy Loam		
Cover Factor (CF) ⁽²⁾	0.165 Urban Lawns 0.1 (35%) and Woodland 0.2 (65%). Weighted average cover factor of 0.165.		
Site Average Infiltration Factor ⁽⁵⁾ (TF + SF + CF)	0.795		
 Internal roadway, house and driveway at It is expected that the infiltration potentia residence time to infiltrate and that its infiltrate 	reas provided in the Conceptual Lot Development Plan (Appendix A). al (i.e. water available for dilution) from the SWMPs will have sufficient filtration will be greater than the infiltration potential from forested lands		
3. Water holding capacity of soils (WHC) by Servicing Study (Patterson, 2011) and h	(i.e. water surplus from soils). Water holding capacity of soils (WHC) based on soil types, which is consistent with the Preliminary Site Servicing Study (Patterson, 2011) and hydrogeological investigations completed for nearby residential subdivisions in the Greely area (Paterson, 2010; Paterson, 2011; Paterson, 2014).		

subdivisions in the Greely area (Paterson, 2010; Paterson, 2011; Paterson, 2014).
Annual water surplus based on Environment Canada Water Surplus Datasheets (Appendix D) for Ottawa International Airport (1984-2006) weather station.

5. Infiltration factors based on information provided in MOEE, 1995.

The predictive assessment is conducted using a mass balance calculation to determine the sewage loading for nitrate at the property boundary (see equation below).

$$C_{Nitrate} = \frac{Mass}{Volume} = \frac{Annual Nitrate Loading(grams/year)}{Annual Dilution Volume(cubic metres/year)} = \frac{grams}{cubic metre} = \frac{mg}{L}$$

The nitrate dilution calculations are provided in Appendix D and summarized in Table 5.2 below.

Table 5.2 Nitrate Dilution Cal	culations
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Parameters	Site Descriptions	
Number of Lots	73	
Annual Nitrate Loading	1,065,800 grams/year	
Annual Nitrate Loading	(73 lots x 40 grams/lot/day *365 days/year)	
	122,185 m³/year	
Annual Dilution Volume	[(surplus 0.380 m/year * infiltration factor 0.795 * infiltration area 316,253.1 m²-)+ (septic flows of 1 m³/lot/day * 73 lots * 365 days/year)	
Nitrate Concentration at Property Boundary	8.72 mg/L	

Based on the above information, the weighted average nitrate concentration at the site boundaries was calculated to be 8.72 mg/L (refer to the calculation in Appendix D). The nitrate impact assessment meets the acceptable nitrate impact requirement of 10 mg/L established by the MECP. For reference, the subject site is able to support up to 86 lots, which would have a calculated nitrate concentration of 9.98 mg/L at the site boundary.

5.2.4 Background Overburden Nitrate Concentrations

Groundwater samples were collected from overburden test pits and boreholes advanced as part of the geotechnical investigation (GEMTEC, 2021). Piezometers were installed within the overburden sands, silty sand and silty clay (refer to test pit and borehole logs in Appendix C). Groundwater samples were submitted to an accredited laboratory for analysis of nitrate and nitrite all of which reported non-detectable nitrate and nitrite concentrations (Table 5.3). The Laboratory Certificates of Analyses are provided in Appendix E.

Table 5.3: Overburden Nitrate Sampling

	Test Pit / Monitoring Well Depth (m)	Sampling Date	Nitrate (mg/L)	Nitrite (mg/L)
Test Pit TP21-02	3.0	Mar 9/21	<0.10	<0.05
Test Pit TP21-04	4.5	Mar 8/21	<0.10	<0.05
Test Pit TP21-07	4.0	Mar 8/21	<0.10	<0.05
Test Pit TP21-12	3.2	Mar 8/21	<0.10	<0.05

	Test Pit / Monitoring Well Depth (m)	Sampling Date	Nitrate (mg/L)	Nitrite (mg/L)
Test Pit TP21-18	4.0	Mar 9/21	<0.10	<0.05
Monitoring Well BH21-101	5.0	Apr 27/21	<0.10	<0.05
Monitoring Well BH21-104	4.5	Apr 27/21	<0.10	<0.05
Monitoring Well BH21-105	4.5	Apr 27/21	<0.10	<0.05

5.3 Stormwater Management Ponds (SWMP)

The specific design details regarding the construction of the proposed stormwater managements ponds (SWMPs) are not known at this time. It is the intention to retain stormwater on site, and the ponds are expected to be constructed in a manner typical of the many SWMPs already constructed and previously approved by both the City and MECP in the Greely area. The designs will be required to meet the requirements of the Shields Creek Subwatershed study and treatment and volume detention criteria.

No negative impacts to the bedrock water supply aquifer are expected from SWMP constructed in accordance with MECP requirements. The proposed residential development is surrounded by residential properties and is not located along any major roadways. As such, there is minimal risk for contamination from agricultural fertilizers (e.g. nitrates), road salts or other sources (e.g. commercial or industrial properties).

6.0 GROUNDWATER SUPPLY

A groundwater supply investigation was carried out in accordance with the MECP August 1996 document "Procedure D-5-5, Technical Guideline for Private Wells: Water Supply Assessment", to determine the quantity and quality of groundwater available for domestic water supply. The results of the groundwater supply investigation are summarized in the following sections.

6.1 Test Well Construction

The MECP Procedure D-5-5 document indicates that a minimum of five test wells are required for sites more than 25 hectares and up to 40 hectares. The total area of the proposed subdivision is 35.0 hectares. A total of five test wells were drilled by Air Rock Drilling Co. Ltd. under Well Contractor License No. 1119. The wells were completed in March 2021; copies of the MECP Water Well Records are provided in Appendix F.

The locations of the new test wells were chosen to provide maximum coverage of the site and with the intent for future use as water supply wells on individual lots (Figure 2).

Well grouting inspections were carried out by GEMTEC staff during the sealing of the well casings in all test wells. The test wells were constructed using a nominal 159 millimetre inside diameter steel casing. The construction details of the test wells are summarized in Table 6.1.

Test Well	Depth to Bedrock (m BGS ¹)	Depth of Well Casing (m BGS)	Depth Water Found (m BGS)	Total Well Depth (m BGS)	Aquifer ² (lower vs upper)
TW 1	8.8	12.2	28.7	30.5	Upper
TW 2	5.2	12.2	41.1	43.0	Upper
TW 3	5.8	12.2	48.8	50.6	Lower
TW4	1.2	12.2	43.9, 45.7	47.5	Lower
TW5	5.8	12.2	41.1	43.0	Lower

Table 6.1 – Summary of Test Well Construction Details

Notes:

1.m BGS - Metres Below Ground Surface

2. Depth water found as reported by well driller on the MECP water well record.

3. Upper aquifer = Delineated by total well depths / depth water found and differences in water quality

(TDS < 500 mg/L and chloride <100 mg/L; lower aquifer = TDS >500 mg/L and chloride >100 mg/L).

6.2 Pumping Tests Field Procedure

The pumping tests for the onsite test wells were conducted between March 16 and 19, 2021. The pumping tests for test wells TW2 / TW4 and TW1 / TW3 were carried out concurrently on March 18 and March 19 respectively. A six-hour duration constant discharge rate pumping test was conducted in each test well. The pump discharge was directed to the ground surface at a distance ranging from 5 to 10 metres from the test wells and in a manner such that the flow of water on the ground surface was directed away from the test wells.

6.2.1 Water Level Measurements

During the pumping tests, water level measurements were taken at regular intervals in the well being pumped using an electric water level tape and on a continuous basis using electronic data loggers. After the pump was shut off, water level data was collected until a minimum of 95 percent of the drawdown in water level had recovered in the test wells. The water level measurements for the drawdown and recovery data for the pumping tests are provided in Appendix G.

Water level measurements were also taken from other onsite test wells (observation wells) prior to, during and after the pumping of each of the test wells to determine potential interference effects, water level fluctuations and influence from precipitation. Continuous water level measurements were recorded at 30 to 60 second intervals in all test wells from March 16, 2021

to March 30, 2021. Water level measurements taken in the observation wells are provided in Appendix H.

Minimal daily water level fluctuations of less than 0.1 metres were observed in all five test wells. Precipitation data from a nearby weather station (Ottawa Int. Airport, approximately 15 km from site) was compared to the test well water levels during the monitoring period, and the major rainfall events did not appear to have direct impacts on the test well water levels (Appendix H). A gradual increase in water levels, up to approximately 0.5 metres was observed in all test wells during the two-week water level monitoring period but after the pump tests, is attributed to aquifer recharge from the spring freshet.

6.2.2 Flow Rate Measurements

The wells were pumped using an electric submersible pump and portable generator supplied by Air Rock Drilling Ltd. The flow rate of the pump discharge hose was constantly monitored using a timed-volume method. Multiple flow measurements were taken within the first hour of the pumping test and then at 60-minute intervals throughout the remainder of the pumping test to ensure that the discharge rate maintained a constant flow rate (i.e. within 5%). The test wells were pumped at a rate of approximately 68 litres per minute.

6.2.3 Groundwater Sampling

Total chlorine tests were conducted in the field to ensure that chlorine levels were at nondetectable concentrations prior to bacteriological testing. The temperature, conductivity, total dissolved solids, pH, turbidity, colour and total chlorine levels of the groundwater were measured at periodic intervals during the pumping tests and are summarized in Appendix I. The field equipment used during the pumping test is calibrated monthly by GEMTEC and the details of field equipment are provided in Table 6.2.

Field Parameters	Manufacturer	Model No.
Total and Free Chlorine	Hach	DR 900
pH, temperature, Conductivity	Hanna / Horiba ¹	HI 98129 / Horiba U-52 ¹
Turbidity	Hanna	HI 98703
Colour	Hach	DR 900

Table 6.2 – Field Equipment Overview

Notes: 1. Rental equipment from Maxim Environmental and Safety Inc.

Groundwater samples for laboratory analysis were collected from the test wells after three and six hours of pumping.

The groundwater samples were collected in laboratory supplied bottles and prepared/preserved in the field in accordance with the industry standard sampling, handling and preservation procedures required by the laboratory. All water samples, including samples for metal analysis, were unfiltered. The groundwater samples were subsequently submitted to Paracel laboratories in Ottawa, Ontario for chemical, physical and bacteriological analyses.

6.3 Test Well Water Quality

The results of the chemical, physical and bacteriological analyses on the water samples from the five test wells are summarized in Appendix I and the laboratory results from Paracel are provided in Appendix J.

6.3.1 Bacteriological Parameters

Total and free chlorine measurements confirmed that total and free chlorine concentrations in the well water was non-detectable (<0.02 mg/L) at the time of bacteriological sampling during the pumping tests (refer to Appendix I).

Based on water samples collected from the on-site test wells, total coliform counts exceeded the Ontario Drinking Water Quality Standards (ODWQS) maximum acceptable concentration of zero in TW 1, TW 2 and TW 4. Low levels of total coliform were detected in the initial 3-hr samples from TW 2 and TW 4, with reported total coliform counts of 1 and 3 CFU/100mL respectively. The samples collected at the end of the six-hour pumping test for TW 2 and TW 4 reported non-detectable total coliform concentrations.

Laboratory results from TW 1 were non-detect for total coliform in the 3-hr sample during the pumping test, but 74 counts/100mL in the 6hr sample. The elevated total coliform was attributed to the elevated turbidity, measured to be 10.3 NTU. Following the pumping test, TW1 was chlorinated and re-pumped on April 6 and 7, 2021. Following additional well development, the turbidity decreased to 0.7 NTU and two samples collected 15 minutes apart had non-detectable total coliform. Upon re-sampling of TW1, the total and free chlorine concentrations were measured to be 0.03 mg/L, just above the method detection limit of 0.02 mg/L. Test well TW1 was pumped for greater than 24 hours at a rate of 68 litres per minute and the residual chlorine detected is likely related to the accuracy of the equipment.

Bacteria indicator species such as e. coli and fecal coliform were not detected in any of the water samples. Based on the bacteriological testing, the water is suitable for consumption.

6.3.2 Other Health Related Parameters

No other maximum acceptable concentration limits of the ODWQS were exceeded (with the exception of total coliforms noted above) in the three- and six-hour water samples collected from the onsite test wells. This includes fluoride, nitrate, nitrite and heavy metals (mercury, aluminum,

antimony, arsenic, barium, boron, cadmium, chromium, copper, lead, manganese, selenium and uranium).

6.3.3 Operational Guideline Exceedances

Operational related exceedances of the ODWQS were noted for hardness (all test well samples) and organic nitrogen (TW 2 and TW 3) and are discussed in the following section:

Hardness

The concentration of hardness in water samples obtained from all five test wells ranged from 164 to 395 mg/L as CaCO₃ and was higher than the operational guideline of 80 to 100 mg/L of CaCO₃ as specified in the ODWQS.

Water having a hardness level above 80 to 100 mg/L as CaCO3 is often softened for domestic use. The MECP Procedure D-5-5 document states that water having a hardness value more than 300 mg/L is considered "very hard". The Ontario Ministry of the Environment publication entitled "Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines", states that water with hardness in excess of 500 mg/L is considered to be unacceptable for most domestic purposes. There is no upper treatable limit for hardness specified in MECP Procedure D-5-5.

The concentrations of hardness in all the test wells are below the reported threshold of 500 mg/L as CaCO3 as specified in the Technical Support Document for the ODWQS. The concentration of hardness observed in the test wells is considered to be reasonably treatable using a conventional water softener. Based on our experience, most water supply wells within rural eastern Ontario are equipped with water softeners.

Water softening by conventional sodium ion exchange may introduce relatively high concentrations of sodium into the drinking water that may be of concern to persons on a sodium restricted diet. The use of potassium chloride in the water softener (which adds potassium to the water instead of sodium); could be considered as a means of keeping sodium concentrations in the water at background levels. Consideration could also be given to providing a bypass of the water softener for drinking water purposes (for example, a bypass of the softener to the cold-water kitchen tap).

Organic Nitrogen

The organic nitrogen concentration (total kjeldahl nitrogen – ammonia) exceeded the operational guideline of 0.15 mg/L for ODWQS in the 6-hr sample from test well TW 2 and TW 5 and in the 3-hr sample from TW 1. Of the five test wells sampled, only TW 2 and TW 5 slightly exceeded the ODWQS at the end of the pumping tests, with concentrations of 0.2 mg/L.

The ODWQS indicates that levels of organic nitrogen in excess of 0.15 mg/L may be caused by septic tank or sewage effluent contamination and is typically associated with dissolved organic carbon (DOC) contribution of 0.6 mg/L. At the concentrations calculated in TW 2 and TW 5, the organic nitrogen is unlikely associated with septic tank or sewage effluent contamination, given the absence of common septic indicator parameters such as nitrate and nitrite, which were non-detectable (less than 0.1 mg/L).

The DOC in TW 2 and TW 5 was reported to be 3.8 and 1.4 mg/L in the 6-hr samples. Organic nitrogen can react with chlorine and severely reduce its disinfectant power; in addition, taste and odour problems may also occur. It is not expected that ongoing chlorination will be utilized by homeowners in the residential subdivision and, as such, no concerns with the operational objective exceedance for organic nitrogen were identified.

Aluminum

The concentration of aluminum collected from TW1 to TW5, inclusive, at the end of each pumping test ranged from < 0.001 to 0.117 mg/L. The concentrations measured in TW1 and TW2 exceeds the ODWQS operational guideline of 0.1 mg/L. Aluminum in untreated water is found in the form of fine particles of alumino-silicate clay, which are effectively removed in coagulation/filtration. The elevated aluminum concentrations in TW1 and TW2 are attributed to the elevated turbidity, measured to be 10.3 and 10.0 NTU respectively. Following additional well development in TW1 and TW2, the turbidity decreased significantly to 1.1 and 0.7 mg/L respectively and aluminum concentrations in excess of the ODWQS operational guideline are not anticipated. The aluminum concentrations are below the maximum acceptable concentration of 2.9 mg/L (Health Canada, 2021).

6.3.4 Aesthetic Objective Exceedances

Aesthetic objective exceedances of the ODWQS included six drinking water parameters (iron, sulphide, manganese, turbidity, total dissolved solids and colour) as follows: iron (TW 1 and TW 2), sulphide (TW 3, TW 4, TW 5), manganese (TW 1, TW 3), turbidity (TW 1, TW 2), total dissolved solids (TW 3, TW 4, TW 5), and colour (TW 1, TW 2). These exceedances are discussed in the following sections:

Iron

The iron levels in samples recovered from the on-site test wells ranged from 0.1 to 0.8 mg/L. Samples recovered from test wells TW 1 and TW 2 exceed the ODWQS aesthetic objective for iron of 0.3 mg/L. Elevated levels of iron may cause staining to plumbing fixtures and laundry. However, the iron level is well within the maximum reasonably treatable limits of 5.0 mg/L provided in Table 3 of the Appendix in the MECP Guideline D-5-5.



Sulphide

Sulphide levels in samples from three of the five test wells exceed the ODWQS aesthetic objective of 0.05 mg/L. Laboratory samples from TW 3, TW 4 and TW 5 reported sulphide levels of 0.18, 0.58 and 0.92 mg/L respectively. Although the sulphide levels in these test wells exceed the ODWQS aesthetic objectives, low levels of sulphide in drinking water can be effectively removed from most wells by aeration treatment.

Manganese

The manganese levels in samples recovered from the on-site test wells ranged from 0.023 to 0.075 mg/L. Samples recovered from test wells TW 1 and TW 3 exceed the ODWQS aesthetic objective for manganese of 0.05 mg/L. Like iron, manganese may cause staining to plumbing fixtures and laundry. However, the manganese level is well within the maximum reasonably treatable limits (1.0 mg/L) provided in Table 3 of the Appendix in the MECP Guideline D-5-5.

Turbidity

Turbidity levels in samples from two of the five test wells exceed the ODWQS aesthetic objective of 5 NTU. Test wells TW1 and TW2 reported turbidity levels of 10.3 and 10.0 NTU following 6-hours of pumping. The field measured turbidity showed good agreement with the lab results, confirming the exceedance of the ODWQS guidelines for turbidity.

Test wells TW1 and TW2 were both resampled for turbidity on April 7th and April 6th respectively, after pumping for up to 24 hours at a rate of approximately 68 litres per minute. The laboratory results returned turbidity of 1.1 NTU and 0.7 NTU for TW1 and TW2 respectively. Following additional well development, all test wells meet the ODWQS aesthetic objective for turbidity.

Total Dissolved Solids (TDS)

TDS levels in samples from three of the five test wells exceed the ODWQS aesthetic objective of 500 mg/L, with TW 3, TW 4, and TW 5 reporting values of 664 mg/L, 742 mg/L and 520 mg/L respectively. Elevated levels of TDS can lead to problems associated with encrustation and corrosion

To determine the corrosive nature of the groundwater, the Langelier Saturation Index (LSI) was calculated for the samples obtained from the test wells. These values are based on the laboratory measured TDS, pH, alkalinity, and calcium following 6-hours of pumping. The LSI was calculated for TW 3, TW 4 and TW 5 to be 0.76, 0.66 and 0.49 respectively, using an estimated groundwater temperature of 10°C (refer to Appendix K). The test wells have LSI values between 0.5 and 2, which indicates the groundwater scale forming, but non-corrosive.



As per the "Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines", TDS levels in excess of 500 mg/L may result in excessive hardness, taste, mineral deposition or corrosion. According to the "Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Total Dissolved Solids (TDS)", published by Health Canada (1991), TDS levels between 600 and 900 mg/L are considered to be 'fair'. At levels above 1,200 mg/L, the palatability of drinking water is 'unacceptable'. The palatability of the drinking water is expected to be acceptable, although some taste problems may occur as the palatability is classified as 'fair'.

Colour

The analytical laboratory results for actual colour (ACU; unfiltered) exceeded the ODWQS aesthetic objective of 5 ACU at all test well locations. The colour in samples from these test wells ranged from 9 - 69 ACU. The true colour (TCU; filtered) was also measured, which ranged from 3 - 38 TCU.

Water having a faint yellow/brown colour can be caused by organic materials and contributed to by iron and manganese. Colour is not generally considered a health issue and the aesthetic objective is set by appearance. The laboratory-measured colour in samples from four of the five test wells exceeded the MECP D-5-5 treatability limit of 7 TCU.

The elevated colour may be the result of high iron concentrations, which can precipitate out of solution and increase the colour levels. Filtered colour (true colour units; TCU) levels were lower than actual colour for all samples. Generally, the test wells with the highest iron concentrations were associated with higher colour.

Given the absence of any elevated organic substances (e.g. dissolved organic carbon, nitrate, nitrite, tannins and lignins and organic nitrogen) exceeding the ODWQS, the colour is likely the result of elevated iron concentrations and can be treated through removal of iron (e.g. manganese greensand treatment systems). As stated in Table 3 of the Appendix in the MECP Guideline D-5-5, higher iron-related colour (exceeding the maximum concentration considered reasonably treatable limit of 7 TCU) may be removed by manganese greensand treatment.

6.4 Offsite Domestic Well Water Quality

The offsite domestic well water quality was assessed through a review of the hydrogeological report completed for the Emerald Links Phase 3 residential subdivision (Trow, 2009) located just adjacent to the west and by collecting four groundwater samples (PW1, PW2, PW3 and PW4) from private homes located to the south and east of the subject site. The approximate private well locations are shown in Figure 2. The water quality results are provided in Appendix I and the ODWQS exceedances are summarized in Table 6.3 below.

Table 6.3: Offsite Domestic ODWQS Exceedances

	On-Site	Emerald Links Phase 3 (Trow, 2009)	Offsite Domestic Wells
ODWQS Health- Related Exceedances	-	-	-
ODWQS Aesthetic Exceedances	Iron, manganese, colour, sulphide, total dissolved solids	lron, manganese, colour, sulphide,	Iron, manganese, colour, sulphide, total dissolved solids
ODWQS Operation Guideline Exceedances	Hardness, organic nitrogen	Hardness	Hardness, organic nitrogen

The groundwater encountered in the on-site test wells is similar to the water quality in off-site test wells (Trow, 2009) and private domestic wells. With the exception of one private well which reported a nitrate concentration of 0.2 mg/L, all other well sampled reported non-detectable (<0.1 mg/L) nitrate concentrations.

6.5 Water Supply Aquifer

The hydrogeological conceptual model completed for the subject site (Table 4.1) identified two distinct water supply aquifers: limestone of the Beekmantown Group (Oxford and March Formations) and sandstone of the Potsdam Group (Nepean Formation). The water well records for the on-site test wells suggest that TW 1 and TW 2 are completed in limestones of the Oxford and/or March Formations and test wells TW 3, TW 4 and TW 5 extend further into the lower March Formation and sandstones of the Nepean Formation (refer to geological cross sections, Figure 6A and 6B). Based on differences in water quality, the aquifer can generally be separated into the 'upper' and 'lower' aquifer (Table 6.4).

Table 6.4: Test Well Water Quality

	TW 1 and TW 2	TW 3, TW 4, TW 5
Well Depths (m BGS)	30.5, 43.0	50.6, 47.5, 43.0



	TW 1 and TW 2	TW 3, TW 4, TW 5
Lithology – Water Well Record	Grey and black limestone	Grey and black limestone underlain by grey and white sandstone
Notable Water Quality Differences ¹	Chloride = $2 - 3 \text{ mg/L}$ TDS = $192 - 336 \text{ mg/L}$ Turbidity = $0.7 - 1.1 \text{ mg/L}^{(2)}$ Hardness = $164 - 192 \text{ mg/L}$ Sulphide = ND (0.02 mg/L) Iron = $0.5 \text{ to } 0.8 \text{ mg/L}$	Chloride = 119 – 148 mg/L TDS = 520 – 742 mg/L Turbidity = 0.4 – 1.6 mg/L Hardness = 331 – 395 mg/L Sulphide = 0.17 – 0.92 mg/L Iron = 0.1 to 0.3 mg/L
Aquifer (lower vs upper) ³	Upper	Lower

Notes:

1. Based on water quality results from 6-hour pumping tests.

Initially elevated turbidity levels of 10.0 to 18.6 mg/L which decreased following additional well development.
 Upper aquifer = Delineated by water quality (TDS < 500 mg/L and chloride <100 mg/L; lower aquifer = TDS >500

3. Opper aquiter = Delineated by water quality (1DS < 500 mg/L and chloride <100 mg/L; lower aquiter = 1DS >500 mg/L and chloride >100 mg/L).

All on-site test wells meet the ODWQS maximum acceptable concentrations and are within treatable limits. The water quality encountered on future lots may vary, depending on the depths of water bearing fractures encountered at the time of drilling.

To further assess the expected water supply aquifer for the proposed residential development (i.e. upper vs lower), the private wells sampled from nearby residential properties and the test wells from the nearby residential subdivision (Trow, 2009) were delineated based on well depth and water quality (refer to tables 6.5 and 6.6). The associated well records are provided in Appendix F.

PW ¹	Well ID	Depth to Bedrock (m)	Depth of Well Casing (m)	Depth of Water Found (m)	Total Well Depth (m)	Aquifer ² (lower vs upper)
PW1	1531219	7.0	10.4	11.3, 14.6, 16.1	18.6	Lower
PW2	1531034	8.5	11.6	23.5, 44.8	46.6	Upper
PW3	1515995	9.1	11.0	18.3	19.2	Upper

PW ¹	Well ID	Depth to Bedrock (m)	Depth of Well Casing (m)	Depth of Water Found (m)	Total Well Depth (m)	Aquifer ² (lower vs upper)
PW4	1533917	4.6	8.2	29.0	31.4	Upper

Notes:

1: No well tags were observed on the private wells at the time of sampling and the well records were obtained from MECP Water Well Record Database.

2. Upper aquifer = Delineated by water quality (TDS < 500 mg/L and chloride <100 mg/L; lower aquifer = TDS >500 mg/L and chloride >100 mg/L).

Trow (2009) Test Wells ¹	Depth to Bedrock (m)	Depth of Well Casing (m)	Depth of Water Found (m)	Total Well Depth (m)	Aquifer ² (lower vs upper)
Well 1	9.6	12.8	41.1	42.7	Upper
Well 2	12.5	16.0	23.5, 25.6	33.5	Upper
Well 3	13.2	16.5	36.0, 74.7	79.2	Upper
Well 4	11.0	14.0	16.5, 17.4	19.8	Upper
Well 5	15.8	18.9	46.3	48.8	Upper

Table 6.6: Trow (2009) Test Well Construction Details

Notes:

1: Well records provided in Appendix F.

2. Upper aquifer = Delineated by water quality (TDS < 500 mg/L and chloride <100 mg/L; lower aquifer = TDS >500 mg/L and chloride >100 mg/L).

The water quality results suggest that there are two distinct water supply aquifers, which can generally be defined as the upper aquifer (approx. 12 metres to 43 metres) and the lower aquifer (43 to 51 metres). However, the water quality results from PW1 is representative of the "lower aquifer" yet is completed at relatively shallow depths – 18.6 metre total depth. This does not necessarily indicate that the lower and upper aquifers cannot be defined by depth, but that aquifer heterogeneity can be expected. Both water supply aquifers meet the ODWQS and are considered suitable for water supply purposes.

6.6 Pumping Test Analysis

6.6.1 Pump Test Analysis Overview

The drawdown and recovery water level data from the five pumping tests conducted on the onsite test wells TW 1 to TW 5, inclusive, are provided in Appendix G. The details of the pumping tests carried out on the test wells are provided in Table 6.7. All depths provided are in metres below ground surface (m BGS).

Table 6.7 – Pumping Tests Details

Parameter	TW 1	TW 2	TW 3	TW 4	TW 5
Duration (minutes)	360	360	360	360	360
Flow Rate (litres per minute)	68	68	68	68	68
Static Water Level (m BGS)	1.6	2.0	5.3	6.2	5.6
Well Depth (m BGS)	31.1	44.2	51.2	50.3	43.9
Available Drawdown (m)	29.5	42.2	45.9	44.1	38.3
Water Level at End of Pumping (m BGS)	6.1	7.4	6.2	8.6	6.6
Observed Drawdown at End of Pumping (m)	4.5	5.4	0.9	2.4	1.0
Percent Drawdown Utilized (%)	15	13	2.0	5.0	3.0
Specific Capacity (L/min/m)	15.1	12.6	75.5	28.3	68.0

As per MECP Procedure D-5-5, each of the test wells was pumped at a flow rate greater than 18.9 litres per minute for 6 hours. The maximum drawdown observed at the end of pumping was 4.5 metres in test well TW 1 which is equivalent to approximately 15 percent of the available drawdown in the test well. The drawdown utilized in the remaining test wells ranged from 2 to 13 percent. Based on these results, all of the onsite test wells are capable of supplying water at a rate significantly greater than 18.9 litres per minute for a period greater than six hours. This is considered more than sufficient for typical domestic use.

6.6.2 Transmissivity and Storativity Analysis

The transmissivity and storativity of the water supply aquifer were estimated from the pump test drawdown data using Aqtesolv version 4.5, a commercially available software program from HydroSOLVE Inc. An analysis of the pumping test data was carried out using the Cooper-Jacob and Theis recovery methods. Drawdown in the observation wells was typically minimal (<0.1 m) and did not produce reasonable transmissivity or storativity values. The results of the Aqtesolv 4.5 analysis are provided in Appendix G.

6.6.2.1 Pumping Test TW 1

Test well TW 1 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 1.5 m following initiation of pumping and then increased to 4.5 m until approximately 360 minutes after pumping started. The water level in the test well fully recovered approximately 60 minutes after the pump was shut off.

Aquifer parameters were evaluated using drawdown and recovery data from the pumping well. The specific capacity of the well at the time of maximum drawdown was 15.1 L/min/m. An aquifer transmissivity of 53 and 77 m²/day was estimated using the drawdown and recovery data, respectively.

6.6.2.2 Pumping Test TW 2

Test well TW 2 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 0.5 m following initiation of pumping and then further increased to 5.4 by the end of the pumping test. The water level in the test well recovered 95% within 4.5 hours after the pump was shut off.

Aquifer parameters were evaluated using drawdown data from the pumping well. The specific capacity of the well at the time of maximum drawdown was 12.6 L/min/m. Aquifer transmissivities of 8.8 m²/day and 7.6 m²/day were estimated using the drawdown and recovery data, respectively.

6.6.2.3 Pumping Test TW 3

Test well TW 3 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 0.6 m following initiation of pumping and then decreased to 0.9 by the end of the pumping test. The water level in the test well recovered 95% 20 minutes after the pump was shut off.

Aquifer parameters were evaluated using drawdown data from the pumping well. The specific capacity of the well at the time of maximum drawdown was 75.5 L/min/m. Aquifer transmissivities of 294 m²/day and 216 m²/day were estimated using the drawdown and recovery data, respectively.

6.6.2.4 Pumping Test TW 4

Test well TW 4 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 1.0 m following initiation of pumping and further increased to 2.4 metres approximately 360 minutes after pumping started. The water level in the test well recovered 95% approximately 30 minutes after the pump was shut off.

Aquifer parameters were evaluated using drawdown and recovery data from the pumping well, and drawdown data in one observation well (TW 3). The specific capacity of the well at the time of maximum drawdown was 28.3 L/min/m. An aquifer transmissivity of 98 and 100 m²/day was

estimated using the drawdown and recovery data, respectively. The data from the observation well produced a transmissivity of 377 m²/day and storativity of 3 x 10^{-5} .

6.6.2.5 Pumping Test TW 5

Test well TW 5 was pumped at a constant rate of 68 L/min for 360 minutes. The drawdown in the pumped well increased to approximately 0.5 m following initiation of pumping and then decreased to 1.1 by the end of the pumping test. The water level in the test well fully recovered 30 minutes after the pump was shut off.

Aquifer parameters were evaluated using drawdown data from the pumping well. The specific capacity of the well at the time of maximum drawdown was 68.0 L/min/m. Aquifer transmissivities of 156 m²/day and 129 m²/day were estimated using the drawdown and recovery data, respectively.

6.6.3 Aquifer Parameters – Transmissivity and Storativity

The transmissivity for each test well was calculated and where sufficient drawdown was observed in the observation wells, the transmissivity and storativity of the bedrock aquifer was calculated. A summary of the aquifer properties is provided in Table 6.8.

	Transmissivity – Drawdown						
		TW 1	TW 2	TW 3	TW 4	TW 5	
c	TW 1	53		-	-	-	
atior s	TW 2	-	8.8	-	-	-	
Observation Wells	TW 3	-	-	294	-	-	
obs/	TW 4	-	-	-	98	-	
_	TW 5	-	-	-		156	
	Transmissivity – Recovery						
		TW 1	TW 2	TW 3	TW 4	TW 5	
-	TW 1	77	-	-	-	-	
atior s	TW 2	-	7.6	-	-	-	
servat Wells	TW 3	-	-	216	-	-	
Observation Wells	TW 4	-	-	-	100	-	
_	TW 5	-	-	-	-	129	
Geo	Geometric Mean Transmissivity		71 m²/d				

Table 6.8 – Summary of Aquifer Parameters

6.7 Hydraulic Interference Effects

During the pumping of the onsite test wells, water level measurements were recorded at the remaining four bedrock observation wells using electric data loggers, recording every 30 seconds to one-minute intervals. The water level measurements in the observation wells are reported in Appendix G and discussed below.

6.7.1 Bedrock Observation Wells

During the pumping tests for test wells TW 1 to TW 5, inclusive, water levels were measured in bedrock observation wells (test wells not being pumped) which are located 250 to 850 metres apart (Figure 2). The observed water level decrease in bedrock observations wells was less than 0.1 metres, including during the pumping tests for TW1 / TW3 on March 19, 2021 and TW2 / TW4 on March 18, 2021 which were carried out concurrently.

Based on the test well pumping rates (68 litres per minute), which are greater than typical domestic use, little to no hydraulic interference effects are anticipated at the subject site. This is supported by long-term water level monitoring of the test wells between March 16 to 30, 2021. The test wells located on proposed lots adjacent to the existing residential development (Figure 2) did not display any significant (less than 0.1 metres) daily water level fluctuations over the 15 day monitoring period.

6.7.2 Computer Model Simulations

A well interference simulation was developed using Aqtesolv version 4.5. One scenario was developed and the well simulation output is provided in Appendix K for discussion purposes. Storativity estimates were not calculated from the pumping test data due to minimal water level drawdowns in the observations wells. Literature values of storativity for confined aquifers typically range from 5 x 10^{-5} to 5 x 10^{-3} (Todd, 1980).

6.7.2.1 Scenario 1

Scenario 1 is provided to illustrate the maximum drawdown using the geometric mean aquifer parameters identified in Table 6.8. The following parameter values were utilized in the model:

- Number of pumping wells = 74 wells (well locations approximated by taking the central point on each proposed land parcel);
 - It is noted that the current conceptual development plan includes 73 lots. The previous conceptual development plan included 74 lots. The well interference simulation is considered to be more conservative with the modelled 74 lots than the proposed 73 lots.
- Individual well pumping rate = 18.75 litres per minute (minimum peak flow estimate as per MECP Procedure D-5-5);
- Duration of pumping = 120 minutes;
- Analysis model = Theis

- Aquifer thickness = 24.4 m (average of TW 1 to TW 5);
- Aquifer transmissivity, Theis = 71 m²/day (geometric mean; refer to Table 6.8); and,
- Storativity coefficient = 5 x 10⁻⁵ (conservative estimate of storativity based on literature values; Todd, 1980).

The results of Scenario 1 simulation indicate that the maximum drawdown within the site is approximately 4.5 metres and is localized to the pumping well, representing 11% of available drawdown in the wells (calculated using the geometric mean available drawdown in the test wells). Drawdown at the property boundary is conservatively estimated to be less than 4 metres and less than 3 metres at existing neighbouring properties (Figure 8). Based geometric mean available drawdown of offsite wells within 500 m of site, a conservative drawdown of 4 metres would represent approximately 16% of the total available drawdown. The results of the well interference simulation and the average available drawdown in the on-site and neighbouring water wells indicates the interference between drinking water wells is considered acceptable.

7.0 CONCLUSIONS

Based on the results of the hydrogeological investigation, the following conclusions and professional opinions are provided:

- The surficial geology at the subject site generally consists of coarse-textured glaciomarine deposits of sand with minor clay and silt, underlain by silty sand and/or silty clay on the western portion of the site and silty-sand to sandy-silt till on the eastern portion of the site. The subject site overburden thickness ranges from approximately 1.2 to 8.8 metres, with an average thickness of 5.4 metres.
 - The subject site is not considered to be hydrogeologically sensitive based on the absence of significant areas of thin soils, highly permeable soils or karst features. It is noted that thin soils (1.2 to 1.6 metres) were encountered at the southeastern portion of the subject site; however, based on the Conceptual Lot Development Plan (Appendix A), the proposed location of the septic systems is the front yards where overburden thickness generally increases to greater than 2.0 metres.
- The water supply aquifer encountered at the subject site includes limestone of the Oxford and March Formations as well as sandstones of the Nepean Formation.
 - The upper aquifer is the preferred water supply aquifer and water well drillers should attempt to keep wells as shallow as possible. Drilling to deeper depths may be required to obtain sufficient groundwater quantity and aesthetically 'fair' groundwater quality may be encountered as depths.

- The testing depth of on-site test wells ranges from 30.5 to 50.6 metres below ground surface.
- The water quality available from drilled wells on the subject site is safe for consumption based on the absence of health-related exceedances; however, groundwater treatment for aesthetic parameters will be required.
 - Variability in groundwater quality was encountered in the five on-site test wells and aesthetic exceedances and treatment options may vary (all exceedances and treatment options discussed below).
 - To note, at the end of the six-hour pumping tests total coliform exceeded the ODWQS in TW 1; however, following well chlorination and additional well development to reduce turbidity levels, the total coliform decreased to nondetectable concentrations.
 - The levels of hardness, colour, iron and manganese are considered to be reasonably treatable using a conventional water softener and/or manganese greensand filters.
 - Total Dissolved Solids levels are in excess of 500 mg/L in three of the five test wells, but are considered "fair", according to the "Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Total Dissolved Solids (TDS)", published by Health Canada (1991), and are well below levels of 1,200 mg/L, above which the palatability of drinking water is considered 'unacceptable'. LSI values indicate the water is considered scale forming, but non-corrosive.
- The water quality from nearby residential subdivisions (Trow, 2009) and private domestic wells sampled are similar to the water quality found in the proposed subdivision. No significant impacts have been identified from the available background reports and water quality sampling.
- The water quality determined in the course of this investigation is representative of longterm water quality from which future lot owners are likely to obtain from their wells constructed in accordance with the well construction recommendations.
- The quantity of groundwater available from the proposed water supply aquifer is more than sufficient for the proposed development and will sustain repeated pumping at the test rate and duration at 24-hour intervals over the long term.

- Interference between drinking water wells is expected to be acceptable under typical usage for residential developments.
 - Drawdown at the site boundary is conservatively estimated to be less than 4.0 metres, which represents 16% available drawdown of average existing domestic water supply wells.
 - Negligible well interference (>0.1 metres) observed during test well pumping tests and long-term test well water level monitoring.
- No negative impacts to the bedrock aquifer are anticipated from the use of on-site septic systems (based on nitrate dilution calculations which demonstrate that offsite nitrate impacts are less than 10 mg/L).
 - Development can support up to 86 lots with a calculated nitrate concentration of 9.98 mg/L at the Site boundary.
 - Development Plan (Appendix A) indicates 73 lots, which has a calculated nitrate concentration of 8.72 mg/L at the Site boundary.
- No negative impacts to the bedrock aquifer are anticipated from on-site stormwater management ponds constructed in accordance with MECP requirements.
- The test well construction is typical of wells which will be used in the development in the future.

8.0 **RECOMMENDATIONS**

The following provides recommendations regarding well construction specifications, water quality and septic systems:

8.1 Well Construction Recommendations

- All wells that are drilled in the subdivision should be constructed in accordance with local and MECP regulations, including, but not limited to, Ontario Reg. 903.
- Well casings should be extended at least 12.2 metres (40 feet) below ground surface and a minimum of 3 metres into competent bedrock. The entire annular space between the steel casing and the overburden/ bedrock should be filled with a suitable cement or bentonite grout;
- A well grouting certification inspection should be conducted during the installation and grouting of the well casing for all future wells installed on the subject site. The well grouting certification inspection should be conducted under the supervision of a professional engineer or professional geoscientist.

- It should be noted that the water bearing fractures in the limestone and sandstone bedrock were encountered at depths ranging from 28.6 to 48.8 metres below ground surface in test wells TW 1 to TW5, inclusive. Water quality below 48.8 metres has not been tested.
- Drinking water wells should be located so that they meet and preferably exceed the minimum setback distances from septic systems, property lines and any other sources of contamination, as required in the Ontario Building Code and/or Ontario Reg. 903. In addition, the well should be situated in a location that allows for future site access for cleaning, treatment, repair, testing or maintenance. Information regarding well access should be included in the subdivision agreement and/or purchase agreement.
 - A minimum 3.5 metre side yard setback is recommended to accommodate accessibility for well service rigs.
 - A minimum of 15 metres separation from water wells and on-site stormwater management ponds.
- Drinking water wells should be located in general accordance with the Conceptual Lot Development Plan prepared by ARK Engineering (Appendix A).
 - Septic systems to be located in the front yards and water supply wells located in the rear yards.
- It is recommended that newly drilled water wells be developed by the well driller for a minimum of one hour of pumping following completion of the well drilling. This well development can be carried in conjunction with the one hour pumping test that is required for the MECP Water Well Record.
 - Some newly drilled water wells may require extended well development, up to 24 hours in order to decrease turbidity levels.
- It is recommended that newly drilled water wells be chlorinated by the well driller following completion of the well drilling and pumping.
- It should be noted that this study does not address the construction of earth energy systems, which may require approval from the MECP.

8.2 Well Ownership Recommendations

• It is recommended that the property owners construct, maintain and test their drinking water well in accordance with the Ministry of the Environment and Climate Change

document "Water Supply Wells - Requirements and Best Management Practices, Revised April 2015".

- For all newly drilled wells, it is recommended that a raw water sample be collected and analyzed for potability requirements (E. Coli. and total coliform bacteria).
 - If any bacteriological exceedances of the Ontario Drinking Water Quality Standards (ODWQS) are noted in the sampling, then it is recommended that the homeowner take remedial actions (such as chlorination of the well to eliminate bacteria) and retest a raw water sample to confirm that the remedial actions were effective.
- It is recommended that homeowners be informed that some wells may exhibit elevated aesthetic parameters (hardness, iron, manganese, total dissolved solids, sodium, sulphide and/or organic nitrogen) and incrustation, taste, odour and colour can be expected.
 - Organic nitrogen compounds frequently contain amine groups which can react with chlorine and severely reduce its disinfectant power.
- It is recommended that homeowners be informed that hardness levels may exceed the ODWQS operational guideline for hardness. Conventional water softeners may be desired by homeowners to treat minor aesthetic objective and operational guideline exceedances of the ODWS such as hardness. On heating, hard water has a tendency to form scale deposits and can form excessive scum with regular soaps. Conversely, soft water may result in accelerated corrosion of water pipes.
- It is recommended that homeowners and the Local Medical Officer of Health be informed that sodium concentrations exceed 20 mg/L and exceed the warning level for persons on sodium restricted diets.
- It is recommended that homeowners be informed that water softening by conventional sodium ion exchange may introduce relatively high concentrations of sodium into the drinking water which may be of concern to persons on a sodium restricted diet. The use of potassium chloride in the water softener (which adds potassium to the water instead of sodium) could be considered as a means of keeping sodium concentrations in the water at background levels. Consideration could also be given to providing a bypass of the water softener for drinking water purposes.



8.3 Site Phasing and Performance Reviews

- Performance reviews should be conducted in accordance with MECP Procedure D-5-5 Private Wells: Water Supply Assessment, section 4.7 Phased Developments;
- The results of the proposed performance evaluation would be reported prior to the registration of the subsequent phases. The report would include the MECP Water Well Records for the private wells sampled and a site plan showing the sampled well locations as well as any other wells drilled in the subdivision.
- In accordance with the MECP guideline D-5-5, the recommendations and requirements provided in the hydrogeological report and terrain evaluation will be assessed and updated, if required, based on the findings of the investigations for the performance reports and/or a change in the surrounding land use.

8.4 Septic System Construction Recommendations

- Septic systems should be located in general accordance with the Lot Development Plan prepared by ARK Engineering (Appendix A).
- The proposed lots will be serviced by conventional septic sewage disposal systems designed according to the Ontario Building Code. A site-specific investigation should be conducted on each lot for the design of the septic system;
 - Due to the presence of shallow groundwater, septic beds will likely be partially or fully raised.
- Tertiary septic systems could be considered for the proposed development and/or individual property owners. Any tertiary systems should be designed according to the Ontario Building Code. A site-specific investigation should be conducted on each lot for the design of the septic system; and,
- It is recommended that if property owners choose to install tertiary treatment septic systems, then it will be required to enter a maintenance agreement with authorized agents of the system manufacturer for the service life of the system.

8.5 Septic Ownership Recommendations

• It is recommended that the property owners construct, maintain and check their onsite septic system in accordance with the Ontario Building Code.



9.0 LIMITATIONS OF REPORT

This report was prepared for ARK Engineering and Development and is intended for the exclusive use of ARK Engineering and Development. This report may not be relied upon by any other person or entity without the express written consent of GEMTEC and ARK Engineering and Development Nothing in this report is intended to provide a legal opinion.

The investigation undertaken by GEMTEC with respect to this report and any conclusions or recommendations made in this report reflect the best judgments of GEMTEC based on the site conditions observed during the investigations undertaken at the date(s) identified in the report and on the information available at the time the report was prepared. This report has been prepared for the application noted and it is based, in part, on visual observations made at the site, subsurface investigations at discrete locations and depths and laboratory analyses of specific chemical parameters and material during a specific time interval, all as described in the report. Unless otherwise stated, the findings contained in this report cannot be extrapolated or extended to previous or future site conditions, portions of the site that were unavailable for direct investigation, subsurface locations on the site that were not investigated directly, or chemical parameters, materials or analysis which were not addressed.

Should new information become available during future work, including excavations, borings or other studies, GEMTEC should be requested to review the information and, if necessary, reassess the conclusions presented herein.

We trust that this report is sufficient for your requirements. If you have any questions concerning this information or if we can be of further assistance to you on this project, please call.

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Shaun Pelkey, M.Sc.E., P.Eng. Principal, Environmental Engineer



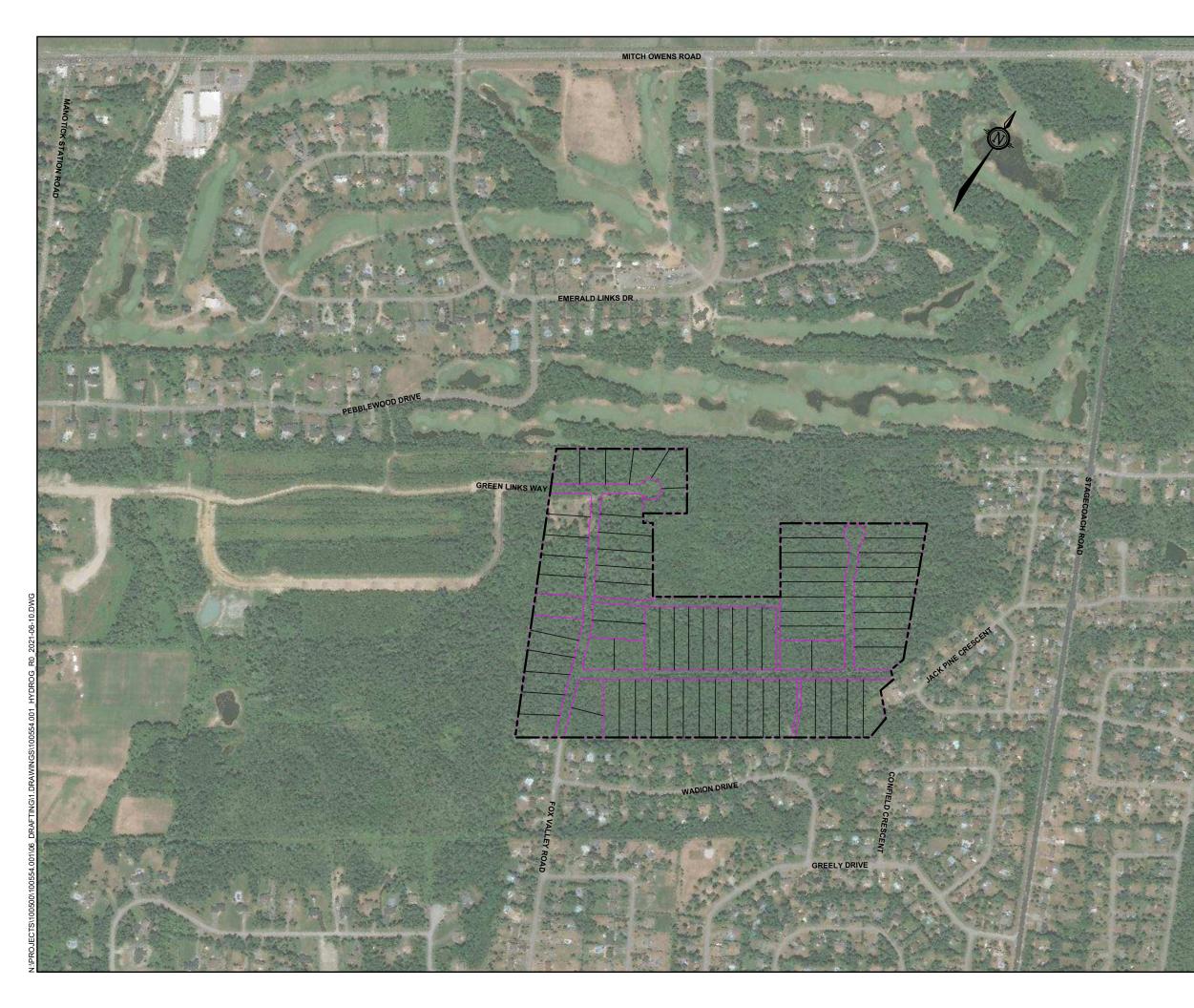
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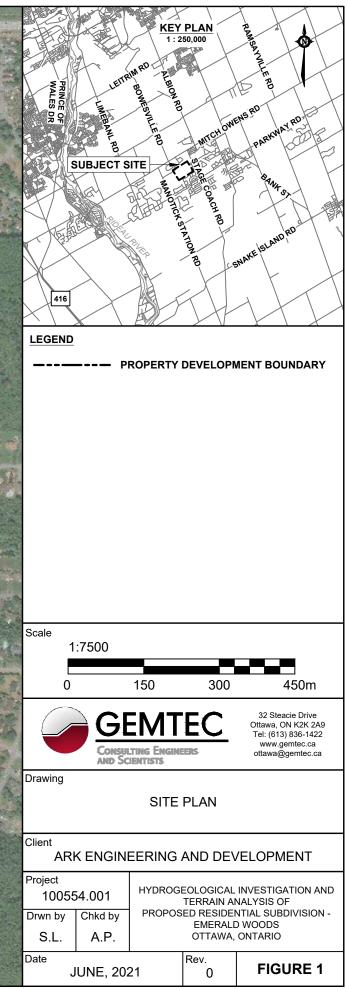
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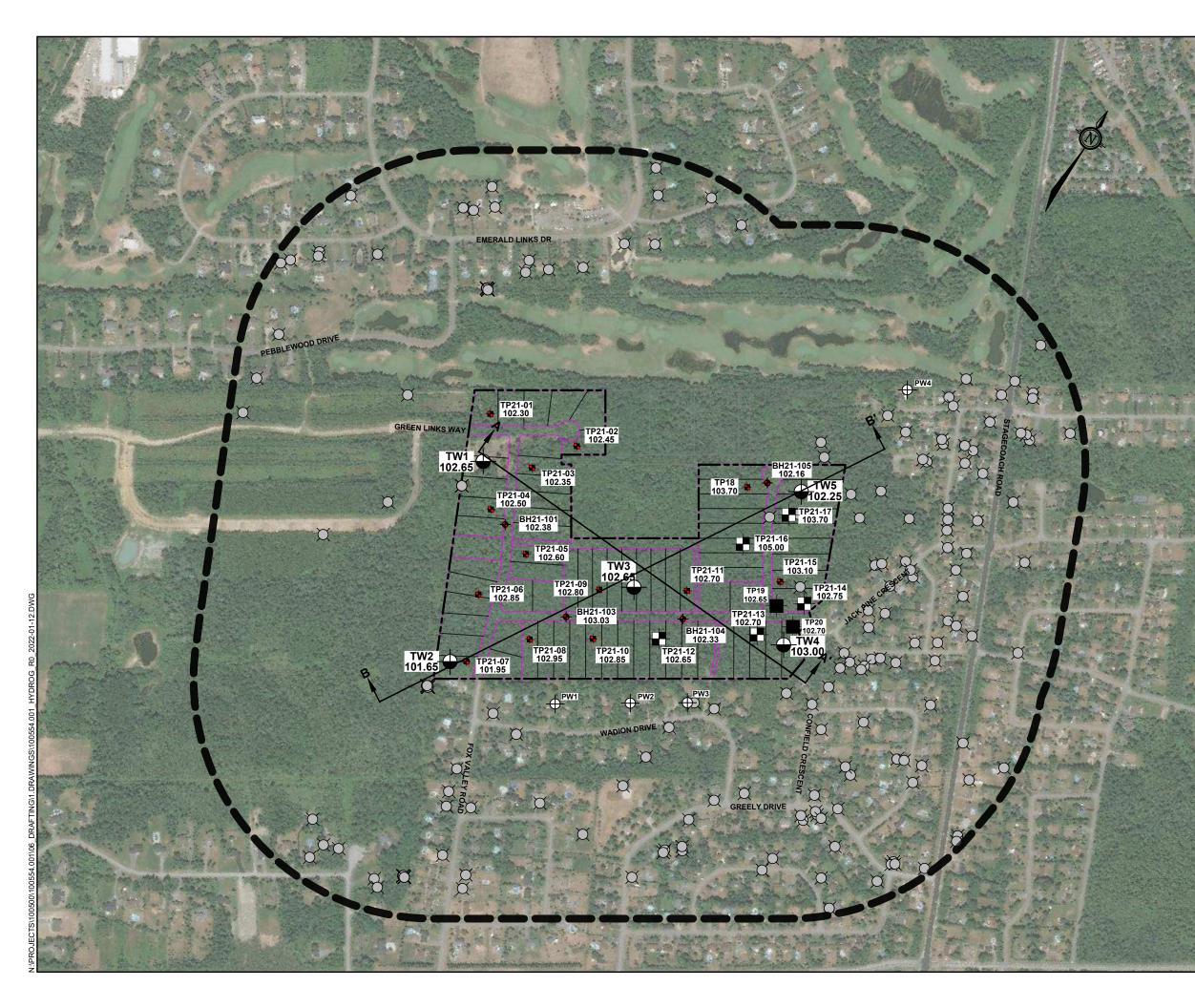
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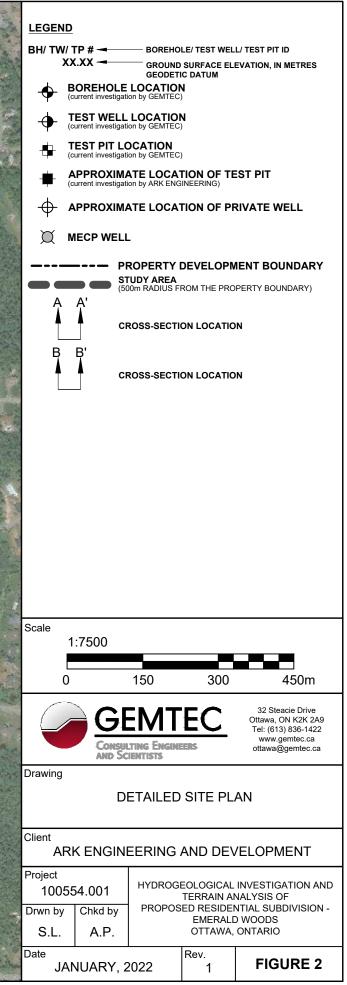


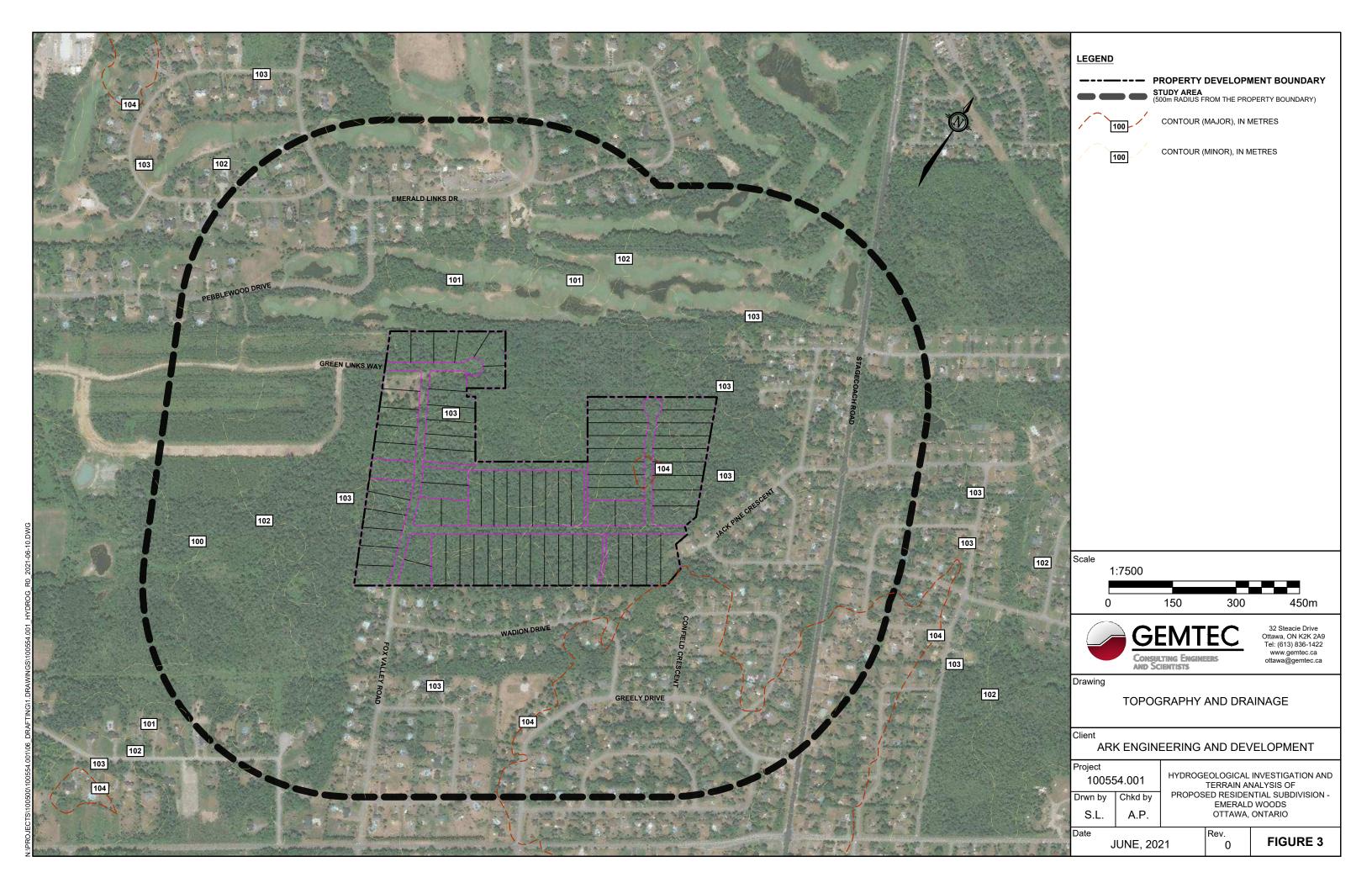
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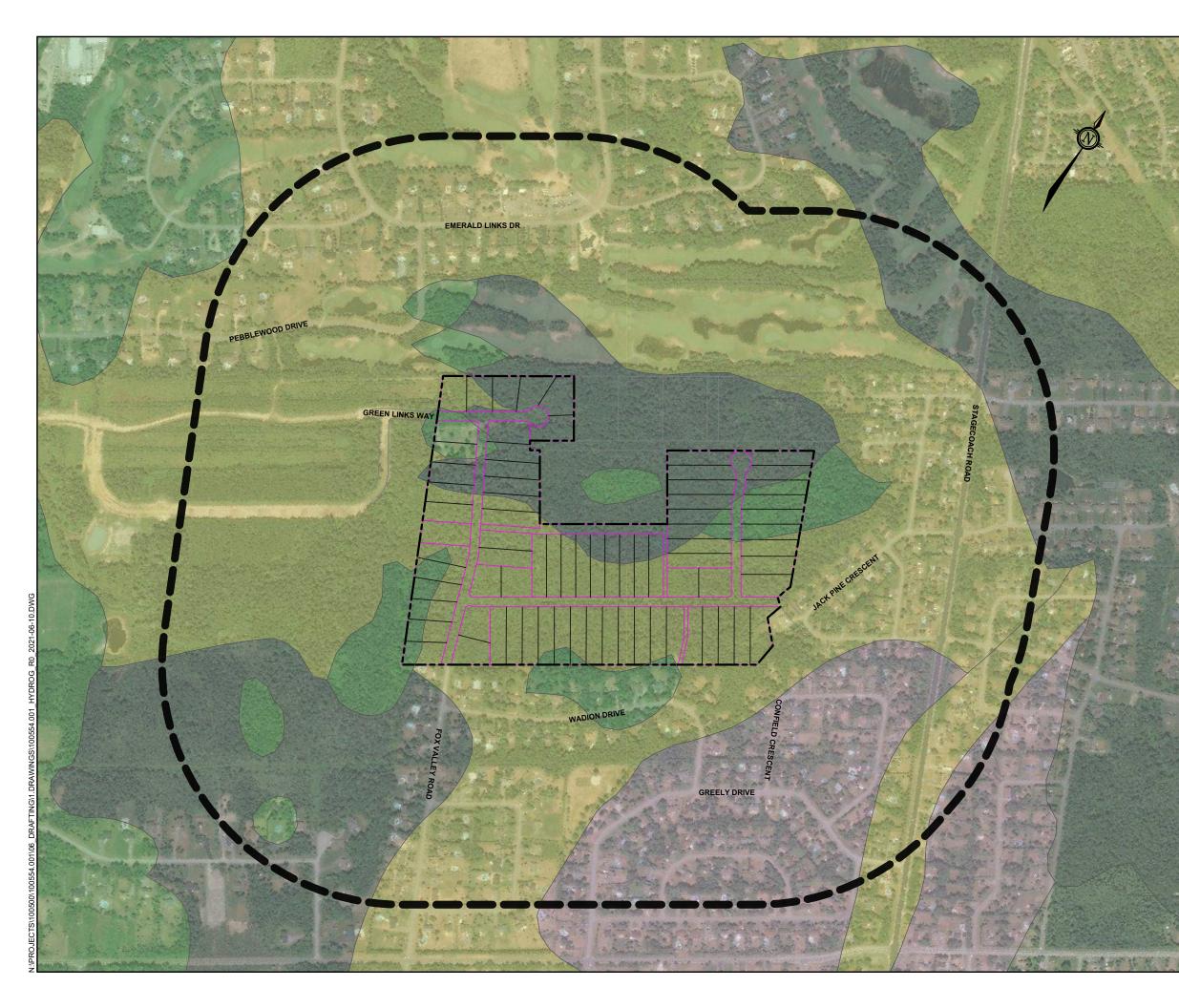




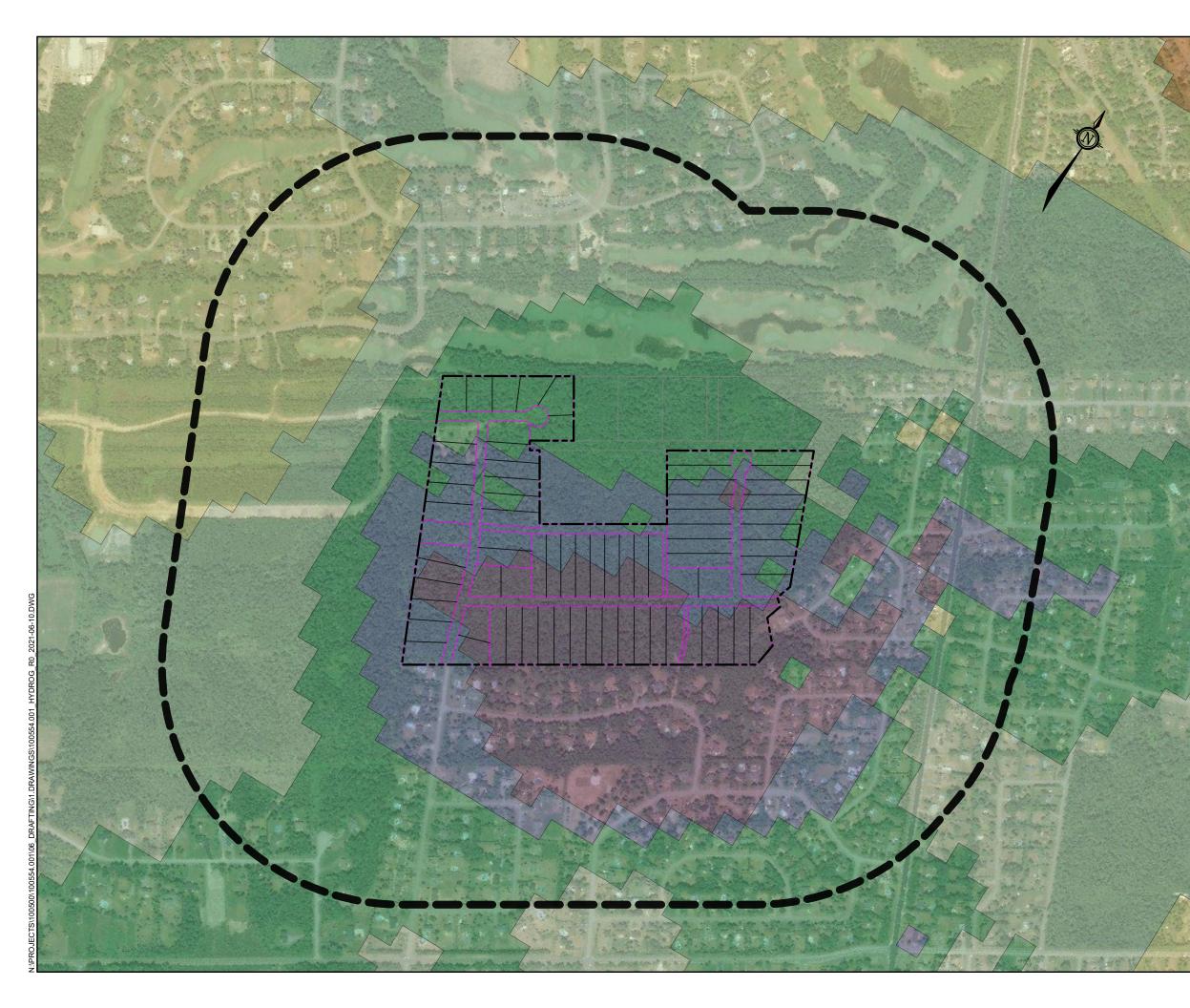


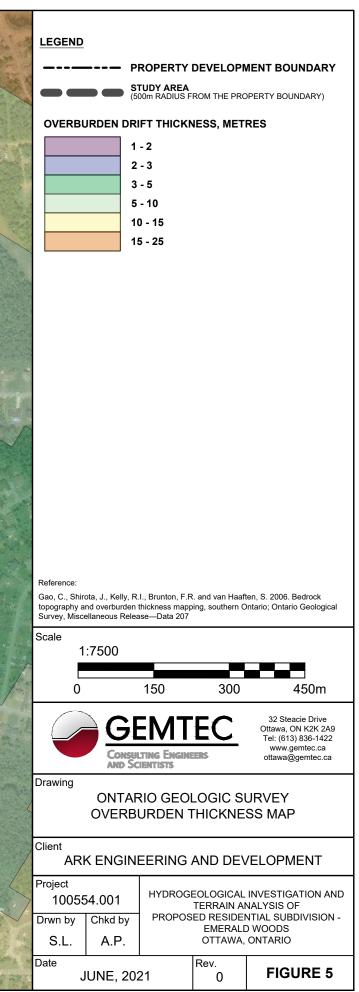


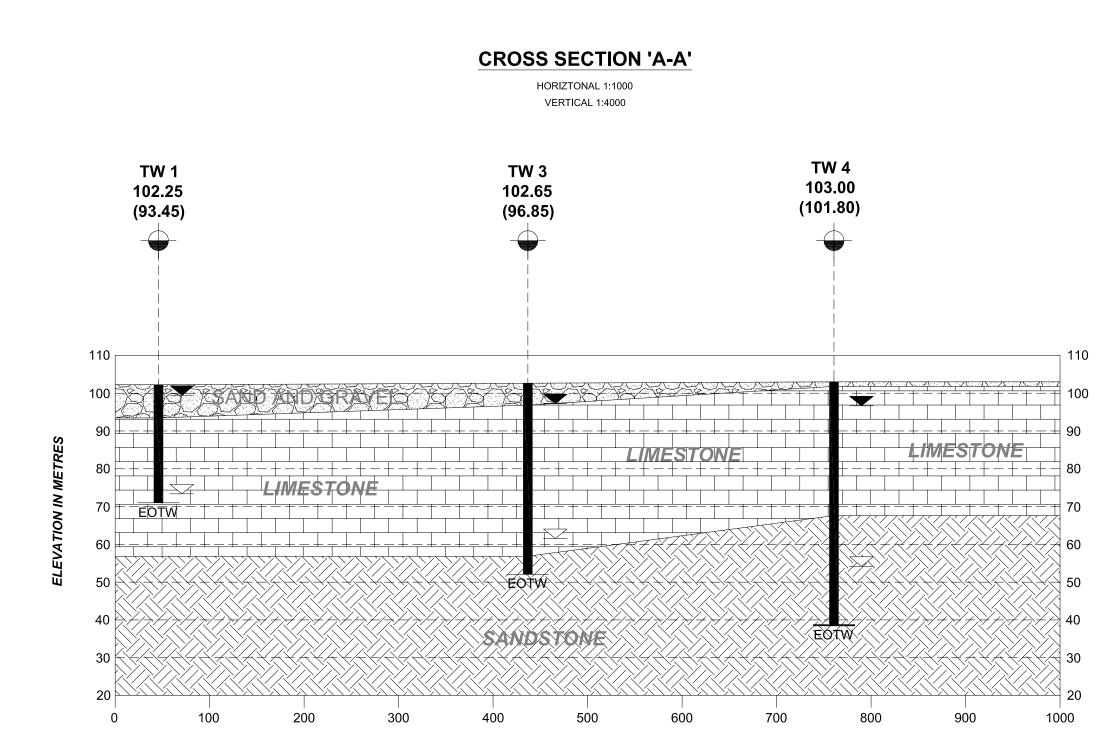




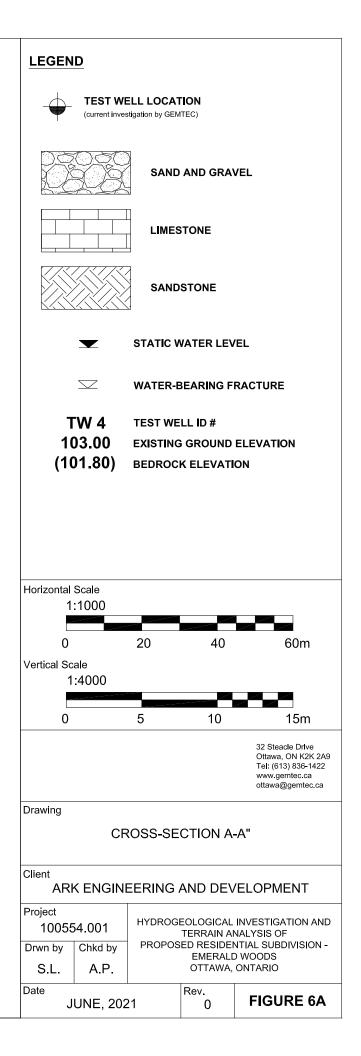
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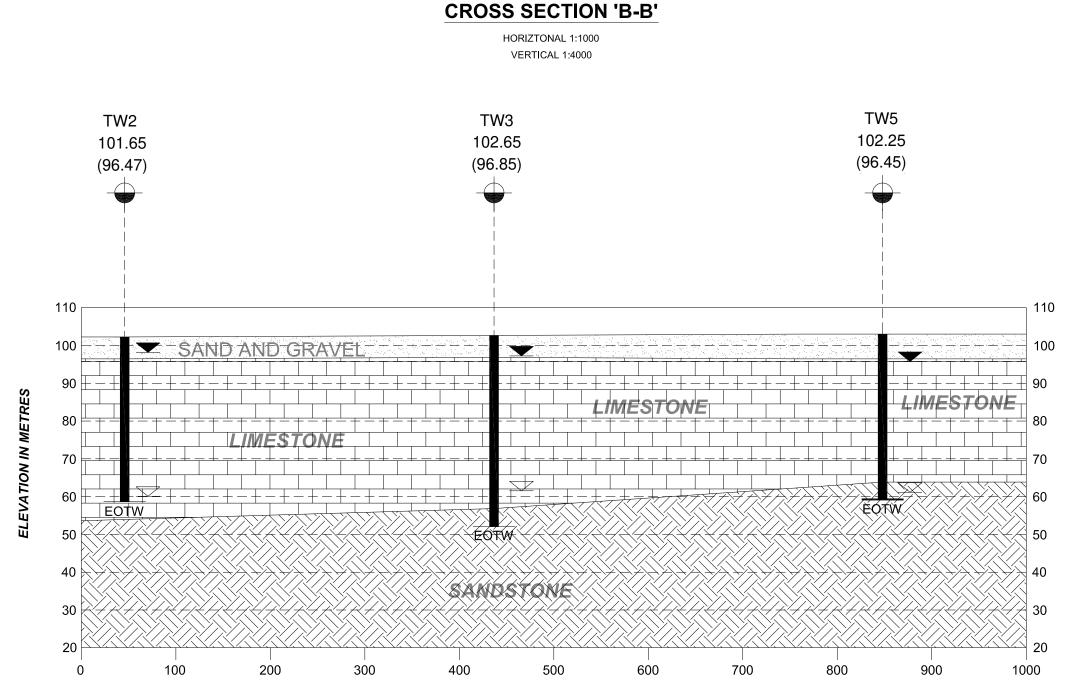






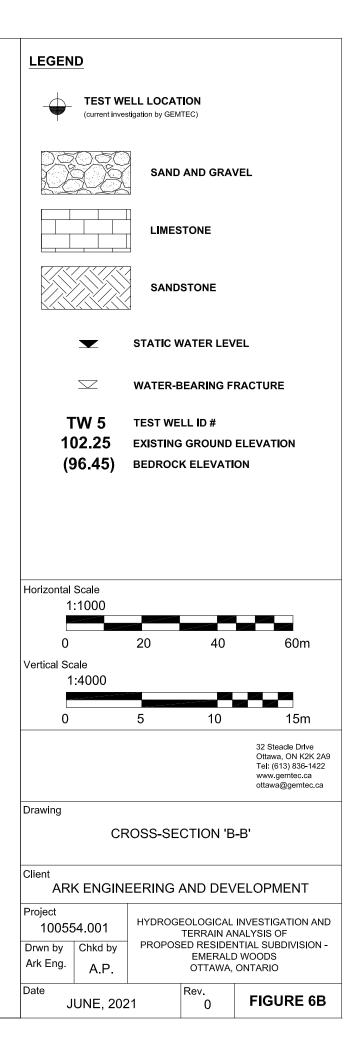
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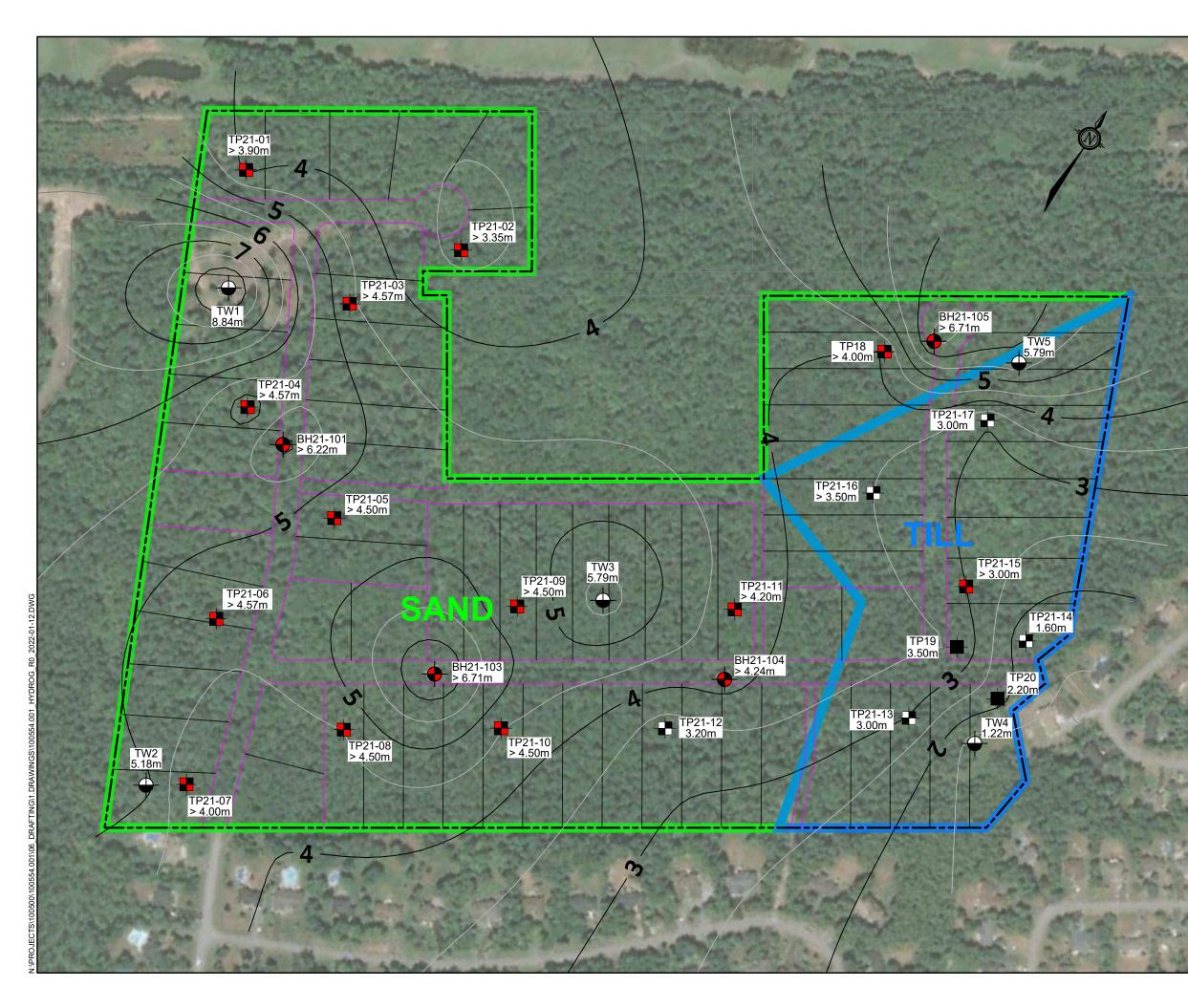




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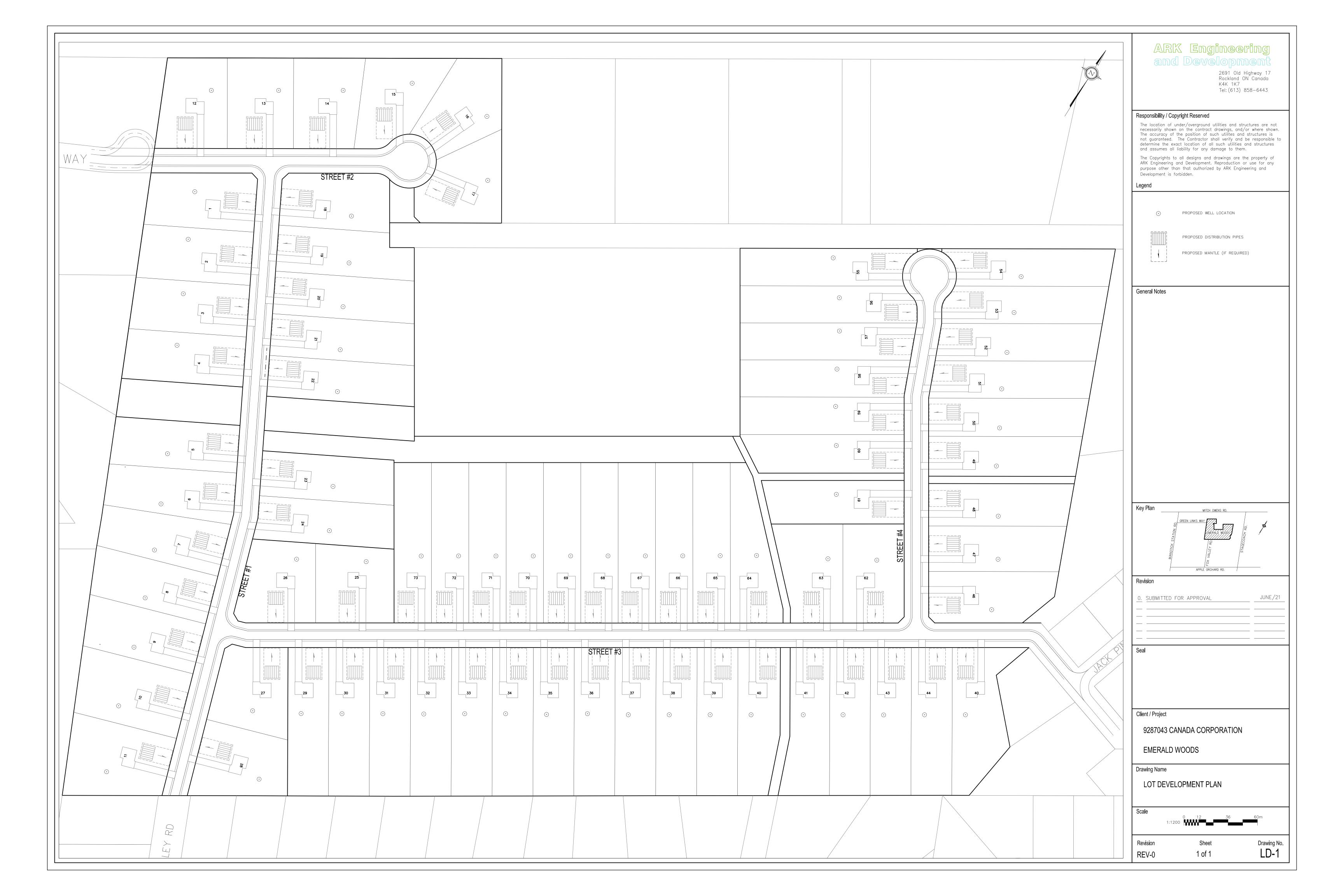


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A DE LE	1.0		ATER TABLE	DRAWDOWI	N, METRES
	÷	- 74	WELLS IN S	MULATION	
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San Providence					
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					32 Steacie Drive
			<u>EMT</u>		Ottawa, ON K2K 2A9 Tel: (613) 836-1422 www.gemtec.ca
		CONSUL AND SC	ting Engine ientists	ERS	ottawa@gemtec.ca
a man	Drawing	/[=] =	-06606		
Sum / m			-KFEKEI	NCES SI	MULATION
	Client			אח טבי	/ELOPMENT
and the second	Project				
	10055	54.001		TERRAIN AI	INVESTIGATION AND NALYSIS OF
	Drwn by S.L.	Chkd by A.P.	PROPOS	EMERALD	NTIAL SUBDIVISION - D WOODS ONTARIO
1	S.L. Date	А.Г.		Rev.	
AN I		UNE, 202	21	0	FIGURE 8

APPENDIX A

Conceptual Lot Development Plan

Report to: ARK Engineering and Development Project: 100554.001 (January 18, 2022)



APPENDIX B

Background MECP Water Well Records

Background MECP Water Well Records (500 m) Proposed Emerald Woods Residential Subdivision

		Douth	Depth to	Static Water	Water	Matar	14/011
WELL_ID	Completed	Depth (m)	Bedrock (m)	Level (m BGS ¹)	Found (m BGS)	Water Detail	Well Use
1531226	05-06-00	48.8	5.5	6.1	45.1, 47.5	FR	DO
1507174	07-06-66	12.2	0.0	2.1	12.2	FR	DO
1514264	28-08-74	14.6	2.4	1.5	9.1, 13.4	FR	DO
1532953	20-06-02	59.4	1.5	7.9	57.3	UK	DO
1509590	02-07-68	14.6	5.2	0.9	14.6	FR	DO
1527155	29-06-93	29.9	11.6	0.0	21, 27.4	UK	DO
7189207	24-09-12	20.0	11.0		21, 27.1	UT	DO
1512180	06-09-72	12.2	0.3	1.2	11.6	FR	DO
1532442	18-09-01	54.9	0.1	4.9	51.5, 53	FR	DO
1528294	16-11-94	42.7	2.7	3	39.6	FR	DO
1535016	05-08-04	18.9	10.7	2.7	16.8		DO
1532600	30-10-01	53.3	0.1	11.6	50, 51.8	UK	DO
1534799	12-07-04	21.3	11.9	4.3	18, 19.8		DO
1532919	26-06-02	22.9	13.1	1.5	18.9	UK	DO
1526593	22-09-92	18.6	4.6	2.7	8.8, 13.4, 16.2	FR	DO
7272943	17-08-16						
1529630	16-09-97	53	7.6	7.9	50	UK	DO
1510959	16-10-70	16.8	7	2.1	16.2	FR	DO
1526464	29-06-92	62.5	0.1	14	59.4	FR	DO
1530360	12-11-98	47.2	8.8	7	47.2	UK	ST
1524519	13-05-90	13.7	11.3	1.8	12.8	UK	DO
1511675	19-11-71	20.1	2.1	0.9	20.1	FR	DO
1511312	20-07-71	12.2	2.1	2.4	11.6	UK	DO
1534774	15-06-04	67.7	1.8	12.4	61, 64.6		DO
1534781	04-06-04	49.4	10.4	8.7	47.2		DO
1532152	27-07-01	22.9	12.2	4.9	18.9	UK	DO
1530359	11-11-98	38.1	7.3	2.1	13.4, 33.8	UK	DO
1517031	05-07-79	11.9	6.4	4	11.3	FR	DO
1534784	21-06-04	19.2	12.5	4.7	16.2, 16.8		DO
1514040	27121	18	1.8	0.6	18	FR	DO
1531342	05-08-00	22.9	12.2	2.7	18.6	UK	DO
1513377	04-06-73	12.5	3	1.2	8.2, 11.9	FR	DO
1531143	04-05-00	22.9	15.2	3.4	19.2	UK	DO
1533041	08-07-02	55.5	12.2	11	53.3	UK	DO
7218233	09-07-13	01.0			04.0		
1514477	22-11-74	21.3		6.1	21.3	FR	DO
1526544	31-08-92	19.2	0.1	4.6	17.4	FR	DO

			Depth to	Static Water	Water		
		Depth	Bedrock	Level	Found	Water	Well
WELL_ID	Completed	(m)	(m)	(m BGS ¹)	(m BGS)	Detail	Use
7145838	09-04-10	18.9		3.1	15.8, 16.8, 18	UT	DO
1535181	18-10-04	67	4.6	12.3	64.6		DO
1520088	24-09-85	19.2	7.3	2.4	12.2, 17.7	FR	DO
1533917	17-06-03	31.4	4.6	7.3	29	UK	DO
1511673	17-11-71	17.7	8.2	0.6	17.7	FR	DO
1531440	28-08-00	18.9	6.1	1.8	13.7, 15.5, 16.2	FR	DO
1525808	10-09-91	64	3.7	12.2	54.3, 62.8	FR	DO
1513438	12-07-73	7.6	6.1	0.9	6.7, 7.6	FR	DO
1535313	06-12-04	57.9	1.2	9.1	56.1	UK	DO
1529087	06-07-96	22.9	2.4	4	19.8	UK	DO
1519474	15-10-84	19.2	0.9	3	17.4	FR	DO
1526168	05-05-92	49.7	1.8	3.7	15.2, 48.8	FR	DO
1530312	09-07-98	48.8	8.5	5.5	46.6	FR	DO
1532153	27-07-01	36.6	12.8	5.2	33.8	UK	DO
1535662	23-06-05	52.4	13.7	7.4	50.9		DO
1509836	20-11-68	12.5	8.2	2.1	12.2	FR	DO
1530956	28-09-99	18.3	11.9	0.9	15.2	UK	DO
1525435	10-04-91	15.2	12.2	1.5	14	UK	DO
1517699	27-08-81	29	5.2	6.7	25.9	FR	DO
1534775	17-06-04	49.1	1.8	10.4			DO
7187705	31-07-12	62.8		13.5	60.7	UT	DO
1507176	08-10-65	17.1	0.9	0.6	17.1	FR	DO
1518551	21-02-83	21.3	7.3	3	19.8	UK	DO
7046768	09-05-05						
1530361	12-11-98	18.3	3.4	2.4	10.7, 14.9	UK	ST
1528178	11-08-94	36.9	1.2	6.1	16.2, 31.1	FR	DO
1518847	23-09-83	12.2	1.8	2.1	11	FR	DO
1531973	02-04-01	24.4	13.7	2.1	16.2, 18.3, 22.6	FR	DO
1534905	03-09-04	25	13.7	4.6			DO
1529730	17-10-97	30.5	15.2	2.4	24.4	UK	DO
1511387	18-08-71	9.4	3	1.8	9.4	FR	DO
1533115	13-08-02	64	13.1	7.3	56.7, 62.2	UK	DO
7113132	39717	18.3		0.8	9.1, 14.6, 15.8	UT	DO
1530184	35961	48.8	9.1	7.9	46.6	FR	DO
7187423	41086	82.9		13.4	82.6	UT	DO
1532534	37223	18.3	3.7	2.1	14	UK	DO
1532952	37424	36.6	2.4	15.2	25.9, 34.1	UK	DO
1511946	26413	18.3	2.7	1.5	17.7	FR	DO
1511013	25914	7		0.6	6.1	FR	DO
1531225	36682	24.4	4.6	6.1	14.9, 17.4, 20.4, 21.6	FR	DO

			Depth	Static			
			to	Water	Water		
		Depth	Bedrock	Level	Found	Water	Well
WELL_ID	Completed	(m)	(m)	(m BGS¹)	(m BGS)	Detail	Use
1514589	27451	48.8	9.1	6.1	48.2	FR	DO
1513842	26823	19.8	5.2	2.4	19.8	FR	DO
1507172	23156	15.5	7	2.1	14.9	FR	DO
1518682	30533	68.6	3.4	6.1	67.1	FR	DO
1514272	27269	14.6	1.8	1.5	13.4	SU	DO
1515730	28061	16.8	9.4	1.2	14.9	FR	DO
1507223	23538	22.6	5.5	5.2	22.6	FR	DO
1529380	35514	62.5	3.7	6.1	59.4	FR	DO
7053821	39385	24.4		2	14.9, 18, 21.3	UK	DO
7134336	40100	79.3		46.9	36, 74.7	UT	DO
1512214	26616	42.7	5.5	4.6	42.4	FR	DO
1507173	23916	11.3	8.2	2.1	10.7	FR	DO
1510099	25366	20.4	2.1	0.3	19.8	FR	DO
1515467	27933	13.4	3	1.8	10.7, 12.5	FR	DO
1534479	37978	55.5	14.6	6.9	51.8	UK	DO
1532090	37041	54.9	1.8	8.2	52.4	FR	DO
1530953	36437	38.1	4.6	5.5	21, 34.7	UK	DO
1534782	38142	55.5	10.4	7.2	48.8, 52.4		DO
7049236	39267	30.5		4.8	#VALUE!		DO
1527700	34344	83.8	61	1.5	76.2, 76.8	UK	
1516711	28759	17.7	1.2	2.1	16.8	FR	DO
1518686	30533	56.4	3.4	6.1	54.9	FR	DO
1531052	36564	25	15.5	7.9	21, 22.3	UK	DO
1535175	38266	54.9	2.4	7.1			DO
1528083	34526	18.3	12.2	2.1	14, 17.1	UK	DO
1507178	24320	15.2	0.1	3	13.7	FR	DO
1531034	36501	46.6	8.5	4.3	23.5, 44.8	UK	DO
1515176	27732	8.5	4.6	1.8	7.3	FR	DO
1533901	37777	38.1	9.1	2.7	37.2	UK	DO
1533613	37660	41.1	4	4.6	37.2, 38.1	UK	NU
1512459	26728	10.7	1.8	0.6	10.1	FR	DO
4500000	05750	10.0	0.4	0.7	11.9, 14.3,		50
1529960	35753	18.3	0.1	2.7	16.2	FR	DO
1535270	38314	19.2	11.9	4.2	16.2		DO
7272966	42598	62.2	<u> </u>	13.6	59.7	UT	DO
1525054	33151	57.9	0.1	7.9	31.4, 56.1	FR	DO
1527160	34136	29.9	9.8	2.7	23.8	UK	DO
1533006	37447	16.8	11.9	3.4	14.9	UK	DO
1530533	36300	22.9	12.8	2.4	21	UK	ST
1533360	37566	49.4	0.9	9.1	32.3, 47.5	UK	DO
7218241	41463	82.3		11.4	82	UT	DO
1535666	38537	18.9	5.5	2.8	14.9, 18.3		DO
1510622	25724	17.1	2.7	1.2	17.1	FR	DO

			Depth	Static			
			to	Water	Water		
		Depth	Bedrock	Level	Found	Water	Well
WELL_ID	Completed	(m)	(m)	(m BGS ¹)	(m BGS)	Detail	Use
1515677	27976	12.2	1.8	2.4	9.8, 11.6	FR	DO
1528295	34655	18.3	1.5	3	11.9, 14, 15.8	UK	DO
1510523	25591	15.2	5.5	1.5	14.3	FR	DO
1527109	34078	53.3	3.4	6.1	7.6, 51.8	FR	DO
7230310	41884	30.5		1.9	11.6, 21, 28.7	UT	DO
1533528	37586	19.2	13.4	2.4	15.2, 16.2	UK	DO
1535908	38623	36.6	14.6	4.3	35.1	FR	DO
1518213	30370	44.2	9.1	3	25.9, 42.7	FR	DO
1533371	37561	25	0.9	7.6	21.9	UK	DO
1510100	25350	19.8		0.6	19.2	FR	DO
1532582	37229	62.5	1.2	7.3	60	UK	DO
1512222	26617	10.7	2.7	2.7	10.1	FR	DO
1514273	27269	14.6	1.5	1.5	13.4	SU	DO
1510802	25781	16.5	0.9	1.5	16.5	FR	DO
1528291	34654	18.3	1.8	3	11, 11.9, 15.8	UK	DO
7134334	40099	42.7		5.4	41.1	UT	DO
1528510	34831	22.9	12.8	4	20.1	UK	DO
					19.2, 24.1,		
1530737	36342	30.5	4.3	2.4	27.7	FR	DO
1527441	34201	54.9	0.9	11.3	28.7, 52.1	SU	DO
1533372	37564	63.4	2.7	8.5	58.2, 61.9	UK	DO
1532339	37146	61	8.8	10.1	52.1	UK	DO
1511505	26233	18.3	5.5	3	16.8	FR	DO
1526130	33568	13.7	11.6	1.5	12.8	UK	DO
1510468	25511	20.4	5.8	2.1	19.8	FR	DO
7324269	43384		10.1				
7042546	39150	57.9	10.4	7.1	53.3		DO
1527194	34149	43.6	0.1	3.4	41.8	FR	DO
1527985	34500	16.5	12.2	1.8	15.2	UK	DO
1507180	24381	12.2	1.5	2.4	7.6, 9.1, 11.6	FR	DO
1509930	25146	18.3	0.1	2.1	18.3	FR	DO
1533427	37587	59.1	0.1	7.9	57.6	UK	DO
1534779	38139	55.5	2.7	7.6			DO
1534903	38232	49.7	8.5	9.7	46.6		DO
7126966	40022	19.2		1	14, 16.2, 16.5	UT	DO
7132022	40085					UT	DO
1531439	36766	51.2	8.2	5.5	48.8, 49.4	FR	DO
7272971	42598	59.4		13.9	57.6	UT	DO
7151405	40422	54.9		9.6	25, 52.7	UT	DO
1529959	35751	18.3	8.2	2.7	11.9, 16.8	FR	DO
1531219	36682	18.6	7	5.2	11.3, 14.6, 16.2	FR	DO
1529514	35584	30.5	9.8	2.1	12.8, 29.3	FR	DO

			Depth to	Static Water	Water		
		Depth	Bedrock	Level	Found	Water	Well
WELL ID	Completed	(m)	(m)	(m BGS ¹)	(m BGS)	Detail	Use
1507177	24310	15.5	0.1	2.1	15.5	FR	DO
7157195	40457	18.9		4			DO
1534722	38127	61.3	0.3	10.3	8.5, 48.8, 57	UK	DO
1526463	33785	62.5	0.1	14	59.1	FR	DO
1534481	37965	49.1	14.6	6.1	46.9	UK	DO
1507179	24328	20.7	0.1	2.1	20.7	FR	CO
1525053	33156	54.9	0.1	8.8	32, 52.1	FR	DO
1516113	28317	13.4	3	1.8	9.1, 12.2	FR	DO
1512205	26638	14.6	2.1	0.9	14	FR	DO
1532094	37027	24.4	8.5	5.8	18.3, 21.6	FR	DO
1525431	33338	13.1		1.8	13.1	UK	DO
1535185	38287	57.9	0.9	9.6			DO
1533135	37490	44.2	15.2	4.9	39.6	FR	DO
1533352	37526	57.9	1.8	14.6	55.5	UK	DO
1534780	38142	45.7	10.4	7.2			DO
1525388	33289	17.4	8.8	4.6	10.7, 15.2	UK	DO
7187704	41121	61		14.6	58.5	UT	DO
1535973	38614	21.9	12.2	4	18.9		DO
7324275	43375	18.9		3.1	14.6, 15.5, 16.2		#N/A
1518212	30249	12.2	2.1	1.2	11	FR	DO
1512223	26617	12.2	1.5	3	11.6	FR	DO
1531929	37036	61	16.8	6.7	43.6, 57.6	UK	DO
1515123	27673	9.1	0.9	1.2	7.9	FR	DO
1530738	36346	57.3	8.5	8.5	46.3	FR	DO
1533365	37560	49.1	0.9	6.1	46.6	UK	DO
1536034	38644	57.3	3	7.2			MN
1533438	37545	53.3	4.3	11.3	25.9, 51.5	UK	DO
1533364	37557	61.6	1.5	10.7	57.9, 59.7	UK	DO
7132591	40086	18.3		3	16.2	UT	DO
1529744	35678	24.7	2.1	12.5	23.2	FR	DO
7132137	40011	10.7		2.3	8.2	MN	DO
1532592	37203	25	16.1	6.7	18, 21.3, 22.3	UK	DO
1533784	37740	55.2	2.7	5.5	45.7, 53.3	UK	DO
1532581	37228	49.1	9.8	5.5	42.1, 46	UK	DO
1518089	30280	30.5	4	3	29	FR	DO
7272944	42599						
1509833	24950	14.9	1.8	1.2	13.4	FR	DO
1533289	37531	29.9	12.8	4.3	26.2	UK	DO
1532603	37246	55.5	1.8	7.9	53	FR	DO
1525386	33289	24.4	1.2	1.5	9.1, 22.3	UK	DO
1526104	33650	54.9	2.7	4.3	10.4, 46.9	FR	DO
1534991	38147	29.9	14.3	3.1			DO

WELL_ID	Completed	Depth (m)	Depth to Bedrock (m)	Static Water Level (m BGS ¹)	Water Found (m BGS)	Water Detail	Well Use
7324283	43378	42.7		6.8	12.8, 20.1, 39.3		
1529740	35639	33.5	6.1	7.3	31.4	FR	DO
1020740	00000	00.0	0.1	7.0	7.9, 10.1, 14.9,	111	00
1528931	35150	18.3	4.6	1.5	15.8	UK	DO
					36.3, 39.6,		
1531821	36896	43.3	7.6	4.9	40.8	FR	DO
1512181	26548	12.2	1.5	2.4	10.7	FR	DO
1534154	37896	42.7	1.2	3	39.6	UK	DO
1531596	36652	54.9	0.1	8.5	29.6, 51.2	FR	DO
1515995	28238	19.2	9.1	0.6	18.3	FR	DO
1533095	37480	45.1	1.5	11.6	41.8	UK	DO
1512099	26416	20.7	0.1		20.7	FR	DO

Notes. BGS: below ground surface

"Well Use"

DO Domestic

ST Livestock

- IR Irrigation
- IN Industrial
- CO Commercial
- MN Municipal
- PS Public
- AC Cooling and A/C
- NU Not Used
- OT Other
- TH Test Hole
- DE Dewatering
- MO Monitoring
- MT Monitoring Test

"Water Detail"

- FR Fresh
- SA Salty
- SU Sulphur
- MN Mineral
- UK Unknown
- GS Gas
- IR Iron

APPENDIX C

Test Pit and Borehole Logs, Grain Size Analyses

C	SOIL PROFILE				SAN	IPLES		● PE RE	NETR.	ATION NCE (N), BLOV	VS/0.3r	SH	EAR S	TRENG	TH (C	u), kPA JLDED	ں،	
	O SOIL PROFILE	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	ТҮРЕ	RECOVERY, mm	BLOWS/0.3m	▲ DY RE	NAMIO SISTA	C PENE NCE, BI	TRATIC LOWS/(N).3m	W	WATE	R CON W	TENT,		ADDITIONAL LAB. TESTING	PIEZOME OR STANDPI INSTALLA
	Ground Surface TOPSOIL Loose, brown SAND, with rootlets		102.38 102.25 0.13	1	SS	150	5	•										-	Bentonite
				2	SS	305	7											-	Backfill
	Compact, grey SAND some silt		. 1.52	3	SS	380	10												Backfill
uger	HOLLOW STEE			4	SS	610	26			٠									
Power A	Pirm, grey SILTY CLAY																		Bentonite Sand
	Firm, grey SILTY CLAY		98.57 3.81	5	SS	305	wн												Screen
	Stiff, grey CLAYEY SILT		9 <u>7.81</u> 4.57	6	SS	610	1	•											
	Very dense, grey SILTY SAND, so gravel, with cobbles and boulders (GLACIAL TILL)	me o V	96.94 5.44																
	End of Borehole		6.22	7	SS	100	>50 f	or 125	nin										
																		-	
																			GROUNDWA OBSERVATI DATE DEPTH (m) 21/03/29 0.2 5

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B	# :	 Geotechnical Investigation, Proposed Er 100554.001 N: See Test Hole Location Plan, Figure 1 		ioas Resia	ential	Develo	pment										BO		ATE: Ma	GVD28 ar 19 2021
	DOH-	SOIL PROFILE		1		SAN	IPLES		● PE RE	NETR/	ATION NCE (N	I), BLOV	VS/0.3I	HR 1 + ⊓				Cu), kPA OULDED	R ^A R	
	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	ТҮРЕ	RECOVERY, mm	BLOWS/0.3m				TRATIC LOWS/		W ₁ 50 6		0 0		T, % W _L 90	ADDITIONAL LAB. TESTING	PIEZOMET OR STANDPII INSTALLAT
l		Ground Surface	ν. ·	103.03			-								50 : : : :			90	:	
		Very dense, brown SILTY SAND, some gravel (FILL MATERIAL)		102.62	1	SS	455	33				•							· · · · · · · · · · · · · · · · · · ·	
																				R. S. A.
					2	SS	455	12		•									· · · · · · · · · · · · · · · · · · ·	
		Compact to dense, grey SILTY SAND, with shells	Ē	10 <u>1.51</u> 1.52	3	SS	405	15												
						00	-00												· ·	A COM
																				t de la companya de la company De la companya de la c
	w Stem			- - - - -	4	SS	455	33				•								
	200mm Diameter Hollow Stem	Grey SILTY CLAY		<u>99.78</u> 3.25	5	SS	510	1	•											Native Backfill
	200mm Di	Stiff, grey CLAYEY SILT		9 <u>9.07</u> 3.96						Ð								+		
										Ð							+			
					6	SS	305	9											•	
		Compact to loose, grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		97.85 5.18																
					7	SS	355	21			•									
					8	SS	305	10		•										
ŀ		End of Borehole	^_⊮∖⊀	96.32 6.71																K.
ĺ																				
																			· · · · · · · · · · · · · · · · · · ·	

_		N: See Test Hole Location Plan, Figure 1 SOIL PROFILE			I	SVI	/PLES			PENET		ON			5	HEAR	STF	RENG	TH (C	ı), kPA		<u> </u>	
	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	3AN BAYT	RECOVERY,			PENETF RESIST DYNAM RESIST 10			RATIC OWS/0	N).3m	3m +	NATU	JRAL		REMOU TENT,	JLDED	TIONAL	s	EZOMET OR TANDPI STALLAT
		Ground Surface		102.33							: :											Be	enton ite
		TOPSOIL Very loose to compact, grey brown SAND	<u>, 17 , 1</u>	0.08	1	SS	75	3	•		· · · · · · · · · · · · · · · · · · ·											De	Backfill
1					2	ss	380	3	•													I	Backfill
2					3	SS	610	12		•													
																						Be	entonite
3		Firm, grey SILTY CLAY		<u>99.84</u> 2.49	4	SS	610	2	•													Silic	a Sand
		Stiff, grey CLAYEY SILT		<u>99.28</u> 3.05	5	SS	250	12		•	· · · · · · · · · · · · · · · · · · ·												- - - - - - - - - - - - -
					6	SS	250	>50	før 12	5 mm :												:	Screen
		Grey, SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL) End of Borehole		<u>98.14</u> 4:24																			-
;																							
5												· · · ·											
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)																						GF OE DATE	ROUNDWA SERVATIO DEPTH (m)
																						21/03/29	0.0 💆

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		N: See Test Hole Location Plan, Figure 1 SOIL PROFILE				SAN	IPLES		PI	NETR	ATIC	ON		S	HEAR S	STREN	IGTH	(Cu)), kPA			
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	RECOVERY,	BLOWS/0.3m	▲ ^{D'} Ri	YNAMIO ESISTA			RATIO OWS/	v	wati / _P	STRENGTH (Cu), kP/ IRAL ⊕ REMOULDED TER CONTENT, % ₩ 			% ⊣w_	ADDITIONAL LAB. TESTING	S	EZOMET OR TANDPII STALLAT
t		Ground Surface		102.16													: :					
		TOPSOIL Very loose to loose, grey brown SAND	.11	0.08	1	SS	230	3	•													⊥ Ţ
				· · · · · · · · · · · · · · · · · · ·	2	SS	355	5									· · · · · · · · · · · · · · · · · · ·			-		- - - - -
		Compact, grey SAND, some silt		100.64 1.52	3	SS	405	14		•										-		- - -
	Stem	Grey SILTY CLAY		<u>99.87</u> 2.29	4	SS	305	2	•													ntonite
Power Auger	200mm Diameter Hollow Stem			98,50	5	ST	610	PM												-	Silica	a Sand
	200mm D	Stiff, grey CLAYEY SILT		9 <u>8.50</u> 3.66	6	SS	305	wн												-		Screen
		Compact, grey SILTY SAND, some gravel with cobbles and boulders (GLACIAL TILL)		<u>97.44</u> 4.72	7	SS	203	11		•										-		-
					8	SS	75	11		•											Silica	a Sand
				95.45 6.71	9	SS	203	13		•												
		End of Borehole		0.71													· · · · · · · · · · · · · · · · · · ·			-		
																		· · · · · · · · · · · · · · · · · · ·			GF	OUNDWA
																		· · · · · · · · · · · · · · · · · · ·			DATE 21/03/29	DEPTH (m)

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SOIL PROFILE	LOT	LOT		SAMPLE TYPE	EAR S				WATER CONTENT, %					WATER LEV OPEN TEST	
DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLI	IATUR 0 2		ULDED 40		P'		80	w _∟ 90	ADDITIONAL LAB. TESTING	ST INST	or Andpif Fallati
Ground Surface		102.30												Native	b)
TOPSOIL Dark brown SAND, with rootlets		0.05												backfill	
Brown SAND	- /		1	GS											R
Grey SAND		10 <u>1.60</u> 0.70													
GIEV SAND			2	GS									: : :		
															¥
													•		
													:		
		100.30											• • •		Ř
Grey SILTY SAND, with shells		2.00													
													:		R
								· · · · ·							
													:		
End of Test Pit		<u>98.40</u> 3.90												Ground	
Sidewalls caving in														level at 1.1 mbg upon	s
														complet	ion
					 			<u> </u>				· · · · ·			
													:		
													:		
														OBS	DUNDWAT
														DATE	(m)
														21-03-09	1.1 💆
		1				::::	: : : : :	: : : :	: : : : :	: [: : :]	: : : : :	: [: : : :	:		ļ

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT (W) (M)		SAMPLE NUMBER	SAMPLE TYPE		SHEAR STRENGTH (Cu), kPA WAT + NATURAL ⊕ REMOULDED W _P						TER	CONTE W		, ⊣w_	ADDITIONAL LAB. TESTING	WATER LEVEL I OPEN TEST PI OR STANDPIPE INSTALLATION		
2		STRAT	DEPTH (m)	EPTH dws (m) s	SAN	1	0 2	20 3	30 ·	40	50	60	70	80	9	0	ADD LAB.	INST	TALLATION	
)	Ground Surface		102.45															Native	nus i	
	TOPSOIL Dark brown SAND, with rootlets	<u></u>	0.10															backfill		
	Brown SAND		0.30	1	GS														janakanananana Intananananana	
	Grey SAND		10 <u>1.45</u> 1.00	2	GS														∑ A A A A A A A A A A A A A A A A A A A	
			10 <u>0.45</u> 2.00															32mm Diamete Screen		
	Grey SAND, with shells		2.00																	
	End of Test Pit		<u>99.10</u> 3.35	-														Native backfill		
	Sidewalls caving in																			
							- -					· · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · · ·								
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																	-		DUNDWATER SERVATIONS	
																		DATE 21-03-12	DEPTH (m) EL (1 1.0 ⊻ 10	

	SOIL PROFILE															25 ZF	WATE		
MEIRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	1+	NATUR	TRENG AL⊕F 20 3	REMOL	JLDED	W				% w _∟ 90	ADDITIONAL LAB. TESTING	OPE ST INST	ER LEVE N TEST OR ANDPIF TALLATI	PI E ON
	Ground Surface		102.35				: : : :												_
	TOPSOIL	1	0.05	1	GS			0									Native backfill	Ř	ž
	Dark brown SAND, with rootlets		10 <u>1.75</u> 0.60		00														NON NON
				2	GS		C									мн			
																		∑	S S S S
	Grey SILTY SAND, with shells		99.61 2.74	3	GS			0											
																		ACARDAN A	きじそして
																-			
	End of Test Pit Sidewalls caving in		97.78 4.57														Groundv level at 2.25 mb		
																	upon completi		
																-		DUNDWAT ERVATIO DEPTH	E
																	21-03-08	(m) 2.3	
			1									1:55	: : : :	: : : : :	: : : : :	1			F

SOIL PROFILE		i	BER	ЪЕ							 				μų	WAT		
DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	1+	NATUR	TRENG AL⊕F 20 :	REMOU	JLDED		70		ENT, 9	% ⊣w_ 90	ADDITIONAL LAB. TESTING	OPE ST INS	ER LEVI N TEST OR ANDPIF FALLAT	E PIT E ON
Ground Surface TOPSOIL	<u></u>	102.50 102.37 0.13										· · · ·	· · · · ·		-	Native backfill	ACR -	ģ
Brown SAND, with rootlets			1	GS		0											2020	X X X X X X
		<u>101.75</u> 0.75	2	GS			0								-			
		00.50													-			
Grey SILTY CLAY		<u>99.50</u> 3.00	3	GS						C					-			
		97.93 4.57																
End of Test Pit Sidewalls caving in		4.57										· · · · · · · · · · · · · · · · · · ·				Ground level at 1.4 mbg upon	s	
													· ·			complet	ion	
															-			
															-			
					· · · · · · · · · · · · · · · · · · ·													
																GRO OBS DATE 21-03-08	DUNDWAT SERVATIC DEPTH (m) 1.4	E

METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV.	SAMPLE NUMBER	SAMPLE TYPE				GTH (Cu REMOL		w w _P H	/ATER		ΓENT, '	% ⊣w_	ADDITIONAL LAB. TESTING	WATER OPEN (STAM	JR NDPIPE
≥	DEGONI HON	STRAT	DEPTH (m)	SAMPI	SAM	1	0 2	20 3	30 4	40 5	50 60	70	8	80	90	ADI LAB.	INSTA	LLATION
	Ground Surface		102.60														Native	N.A.
	TOPSOIL Dark brown SAND, with rootlets		0.05	1	GS												backfill	R
	Grey brown SAND		102.20 0.40															R
				2	GS													Ŕ
																		E.
																		- E
																		- E
																		Þ
			100 50															Ŕ
	Grey SILTY SAND, with shells		100.50 2.10	1														R
																		Ŕ
																		Ŕ
																		- E
			• •	3	GS													
																		- A
																		R
			98.60	4														Ŕ
	Grey SILTY CLAY		4.00	4	GS													R
			98.10 4.50															Ŕ
	End of Test Pit Sidewalls caving in		4.50														Test Pit dry upon completion	
													· · · · ·			-	completion	1
			1															
			1															
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	DESCRIPTION Ground Surface TOPSOIL	STRATA PLOT	ELEV.		- ⊢	SH	IEAR S	STREN	GTH ((Cu), k	PA		WATE		FENT,	%	INAL	OPEN	LEVEL
		5	DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	+	NATUF	RAL ⊕ 20				W _P		₩ ₩ 8 0'	30	⊣w _L 90	ADDITIONAL LAB. TESTING	STAN INSTA	OR NDPIPE LLATIO
	TOPSOIL		102.85																
			0.05										· · · · ·					Native backfill	1 2 2
	Dark brown SAND, with rootlets	_1	0.25	1	GS														- De
_	Red brown SAND																		
-																			25
			10 <u>1.95</u> 0.90						: : :				::::						
			1	2	GS														E.
																			R
																			Ŕ
									: :										R
			100 75						: : :			<u></u>					4		R
	Grey SILTY SAND, with shells		100.75 2.10	1					: : :										R
	•			3	GS														R
									: : :										Ŕ
]																Þ
																	-		段
																			B
			99.35						: : :										29
(Grey SILTY CLAY		99.35 3.50						: : :										
			1	4	GS														ES.
			1														-		
			1			1													Ŕ
			00.00																Ŕ
	End of Test Pit		<u>98.28</u> 4.57	1														Test Pit	60
1	Sidewalls caving in																	dry upon completion	ı
									: : :								1		
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S	SOIL PROFILE	1 ⊢	<u> </u>	MBER	YPE							14/4 1		TENT	0/	AL ING	WATE	ER LEVEL N TEST PI
METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	1+	IATUR	al ⊕∣	REMO	u), kPA JLDED 40	W	/ _P	70 FR CON		% w_ 90	ADDITIONAL LAB. TESTING	OPEI ST. INST	n test pi or Andpipe Tallation
	Ground Surface TOPSOIL Dark brown SAND, with rootlets		101.95 0.05 0.20		GS												Native backfill	Ŕ
	Brown SAND	/	0.40	1	GS													
				2	GS											-		
	Grey SILTY SAND, with shells		100.15 1.80	3	GS											-		Z C
	Grey SILTY CLAY		<u>99.45</u> 2.50															
	End of Test Pit		<u>97.95</u> 4.00	4	GS											-		
	Sidewalls caving in																Groundv level at 1.8 mbg: upon completi	s
																-		
																-		
																	OBS	DUNDWATER ERVATIONS DEPTH E (m) 1.8

	SOIL PROFILE			ER	ш											. (7)		
MEIKES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	+ ٢	IATUR/	al ⊕ I	REMOU	u), kPA JLDED 40	W	′ _₽ ├──	TR CON	TENT 80	, % w _L 90	ADDITIONAL LAB. TESTING	ST	R LEVEL II N TEST PIT OR ANDPIPE ALLATION
	Ground Surface TOPSOIL		102.95 0.05 0.20														Native backfill	
	Dark brown SAND, with rootlets Red brown SAND	. / . _	0.20 102.35 0.60	1	GS		0											
				2	GS											_		
	Grey SILTY SAND, with shells		100.95 2.00	3	GS					0						-	32mm	
			99.95														Diamete Screen	
	Grey SILTY CLAY		3.00														Native	
	End of Test Pit		<u>98.45</u> 4.50	4	GS											-	backfill	
	Sidewalls caving in																	
																-		
																	OBS	UNDWATER ERVATIONS DEPTH E (m) 1.9 <u>V</u> 1

S	SOIL PROFILE	5	<u> </u>	JMBER	түре	S⊢	IEAR S	TRENG	STH (C	u), kPA		WATE		ITENT,	%	NAL TING	WATER OPEN 1	LEVEL I
METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	1+	NATUR.	AL ⊕ F	REMO	JLDED	W	F	70		w _L 90	ADDITIONAL LAB. TESTING	STAN INSTAL	DPIPE
	Ground Surface		102.80 0.05														Native backfill	bàt
	Dark brown SAND, with rootlets			1	GS												Dackilli	
	Brown SAND		<u>102.10</u> 0.70															ġ
			101.70	2	GS											-		i i i i i i i i i i i i i i i i i i i
	Grey SILTY SAND, with shells		1.10															
	 Grey SILTY SAND		10 <u>0.50</u> 2.30	3	GS													
	Grey SILTY CLAY		99.50 3.30	4	GS													
	Grev SILTY SAND, some gravel, with cobbles and		<u>98.80</u> 4.00															
	Grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		9 <u>8.30</u> 4.50															
	End of Test Pit Sidewalls caving in		4.50														Test Pit dry upon completion	
																_		
																-		
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	SOIL PROFILE			3ER	й											ري ري		
	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	+ ٢	IATUR.	TRENG AL⊕F 20 :	REMO	JLDED		₩АТ / _Р 60	ER COI M C		т, % —— w _L 90	ADDITIONAL LAB. TESTING	WATER OPEN (STAN INSTAI	or Ndpipe
	Ground Surface	0,	102.85								: : : :	: : : :	: :::	: : :		:		
	TOPSOIL		0.05			· · · · · · · · · · · · · · · · · · ·	· · · · ·							: :			Native backfill	Ŕ
	Dark brown SAND, with rootlets		102.45 0.40								:			: ::				- F
	Brown SAND		0.40	1	GS	C												X
																		×
			101 75								<u> </u>			: : :				
ľ			<u>101.75</u> 1.10		00													2
				2	GS			0								MH		Q
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			100.55 2.30								:			: :				Ŕ
	Grey SILTY SAND, with shells		2.30	3	GS			0										R
																		R
			1													:		R
			00.65										-					Ŕ
	Grey SILTY CLAY		<u>99.65</u> 3.20	1												:		R
				4	GS						:					:		R
				4	65						:			: :		:		R
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			1											: : :				
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	End of Test Pit	_puud	98.35 4.50	1														KO(
	Sidewalls caving in																Test Pit dry upon	
				1													dry upon completion	ı
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	FION: See Test Hole Location Plan, Figure 1 SOIL PROFILE			BER	щ					 	 	 	0		
MEIRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	+ 1	NATUR	AL ⊕ F	STH (Cu REMOU 30 4	W _P		 % ⊣w∟ 90	ADDITIONAL LAB. TESTING	ST	ER LEVEL I N TEST PIT OR ANDPIPE TALLATION
	Ground Surface		102.70											Native	
	TOPSOIL Dark brown SAND, with rootlets Brown SAND		0.05											backfill	
			<u>101.40</u> 1.30												Z
	Grey SILTY SAND, some gravel, with shells		<u>101.00</u> 1.70												
				1	GS										
	Grey SILTY CLAY		99.90 2.80	2	GS										
			<u>98.20</u> 4.50										-		
	End of Test Pit Sidewalls caving in		4.50										-	Groundv level at 1.3 mbg upon completi	
													-		
														GRC OBS DATE	DUNDWATER ERVATIONS DEPTH E (m)
														21-03-08	(m) 1.3 <u>V</u> 1

0	SOIL PROFILE		i	MBER	ΥΡΕ										AL	WATE	ER LEVEL I
MEIKES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	1+	IATUR.	TRENG AL⊕F 20 3	REMO		v W _P 60		80	, % ₩_ 90	ADDITIONAL LAB. TESTING	ST	N TEST PI OR ANDPIPE TALLATION
	Ground Surface	0	102.65							: : :							
			0.05							: ::			:::			Native backfill	
	Dark brown SAND, with rootlets Brown SAND		10 <u>2.35</u> 0.30	1	GS												
			<u>101.55</u> 1.10														
				2	GS												∑ Q Q Q Q Q Q Q Q
	Grey SILTY SAND, with shells		<u>100.45</u> 2.20	3	GS												
			<u>99.85</u> 2.80	4	GS												
	Grey SILTY CLAY Grey SILTY SAND, some gravel with cobbles and		99.85 2.80 99.65 3.00 99.45 3.20	+	33										-		Ř
	boulders (GLACIAL TILL) End of Test Pit Refusal on boulders in GLACIAL TILL	J-A-A-Z	<u>99.45</u> 3.20													Groundv level at 1.5 mbg	
																upon complet	
															1		
															1	GRC OBS DATE	DUNDWATER ERVATIONS DEPTH E
																DATE 21-03-08	(m) 1.5 <u>V</u> 1

	TION: See Test Hole Location Plan, Figure 1 SOIL PROFILE			۲											1	
METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	1+	IATUR/	AL ⊕ F	GTH (Cu REMOU	LDED	WP		% ⊣w _L	ADDITIONAL LAB. TESTING	WATER OPEN (STAN INSTAI	LEVEL TEST PI OR IDPIPE LLATIOI
)	Ground Surface	11,- 1	102.70												Native	βά
	Dark brown SAND, with rootlets		0.10												backfill	
		× V/X	<u>102.00</u> 0.70													
l	Grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)													-		
2																
;	End of Test Pit		<u>99.70</u> 3.00	1	GS											
	Refusal in GLACIAL TILL														Test Pit dry upon completion	1
Ļ																
5																
6														-		
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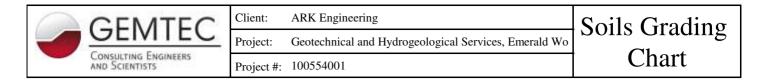
S	SOIL PROFILE	⊢	1	MBER	ΥPE	0		TOPN	0711/0				R CONT	0/_	ING	WATE		
METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	1+	NATUR	AL ⊕	GTH (C REMO 30		W _P 6([∞] ⊣w_ 90	ADDITIONAL LAB. TESTING	ST	N TEST OR ANDPIF ALLAT	Έ
	Ground Surface TOPSOIL Dark brown SAND, with rootlets Brown SAND, trace gravel Grey SILTY SAND, trace gravel, with shells Grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL) End of Test Pit Refusal on bedrock		102.75 0.05 102.45 0.30 0.50 0.65 101.15 1.60	1 2 3	GS GS GS											Native backfill Groundv level at 1.4 mbg upon completi	6	
											· ·	I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I I					UNDWAT ERVATIO DEPTH (m) 1.4 _	EL (

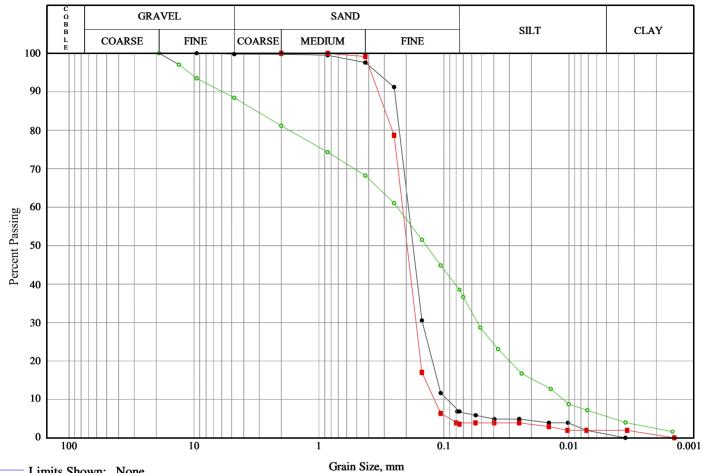
METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH	SAMPLE NUMBER	SAMPLE TYPE				u), kPA ULDED			R CON W	TENT, 9	% ⊣w _L	ADDITIONAL LAB. TESTING	OPEN STAI	LEVEL TEST PI OR NDPIPE LLATION
		STR	(m)	SA	S S	 10 2	20	30	40	50 6	60 ·	70 8	30 9	90 			
)	Ground Surface	1.1.1.1	103.10													Native	24
	Dark brown SAND, with rootlets		0.05 102.86 0.24	-												backfill	Ŕ
	Grey brown SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		0.24	1	GS												
									Image: Section of the sectio								
	Grey SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		100.80 2.30	2	GS				I I I I I I								
;	End of Test Pit		100.10 3.00	-													125
																Test Pit dry upon completior	ı
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	SOIL PROFILE	-	•	BER	Щ										_0		
METRES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	1+	NATUR/	AL ⊕ F	STH (Cu REMOU 30 4	LDED	W _F	,⊢	R CON ⁻ W 	 % ⊣w _L 90	ADDITIONAL LAB. TESTING	STAN	LEVEL TEST PI DR IDPIPE LLATIOI
)	Ground Surface	0	105.00														
,	TOPSOIL Dark brown SAND, with rootlets Red brown SAND		0.05	1	GS											Native backfill	
	Grey brown SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		<u>104.00</u> 1.00		00												
				2	GS												
2																	
3			2														
	End of Test Pit Refusal in GLACIAL TILL		101.60 3.40													Test Pit dry upon	
Ļ																completion	
i																	
6																	
,															-		
3																	
)																	
)																	

1	TION: See Test Hole Location Plan, Figure 1 SOIL PROFILE			Ř									BORI		<u> </u>		
	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	+ ١	IATUR.	al ⊕	GTH (Cu REMOU 30 4	ILDED	Wp			% ⊣w _L 90	ADDITIONAL LAB. TESTING	WATER OPEN STAI INSTA	TEST OR
+	Ground Surface		103.70													Native	Þ,
	TOPSOIL Dark brown SAND, with rootlets Red brown SAND		0.05 10 <u>3.40</u> 0.30	1	GS				0							backfill	
-	Grey brown SILTY SAND, some gravel, with cobbles and boulders (GLACIAL TILL)		103.05 0.65	2	GS	C									мн		
															-		
			100 70														
	End of Test Pit Refusal on boulders with GLACIAL TILL		<u>100.70</u> 3.00													Test Pit dry upon completior	n E
															-		
															1		
															-		

	SOIL PROFILE			ER	ц											10		
MEIKES	DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLE NUMBER	SAMPLE TYPE	+ ٢	IATUR	TRENG AL ⊕ R 20 3	REMOU	LDED		₩ ₩ _P ⊢ 60	ATEF		WL	ADDITIONAL LAB. TESTING	ST	ER LEVEL IN EN TEST PIT OR FANDPIPE TALLATION
	Ground Surface		102.25														Native	V.
	TOPSOIL Dark brown SAND, with rootlets		102.10 0.15														backfill	
	Brown SAND	1	0.30	1	GS													
			10 <u>1.60</u> 0.65	2	GS													
				2	03									: : :				
			1														32mm	
																	Diamete	
			100.25 2.00															
	Grey SILTY SAND, some gravel, with shells		1	3	GS													
	Grey SILTY SAND		9 <u>9.95</u> 2.30															
																	Native	
																	backfill	
				4	GS													
	Field (Test Dit		98.25 4.00										· · · ·	 :::		-		666
	End of Test Pit Sidewalls caving in																	
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																	OB DATE	SERVATIONS DEPTH EL
																	DATE 21-03-12	(m) (i
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— Limits Shown:	None
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Line Symbol	Sample		Boreh Test			nple mber		Depth	9	% Cob.+ Gravel		% Sand		% Sil		% Clay	
•	Sand, trace silt		21-0	03	G	GS-2		0.90-1.05		0.2		92	.9	5.9)	1.0	
	Sand		21-1	10	G	S-2		1.20-1.35		0.0		96	.4	1.6	5	1.9	
o	Glacial Till		21-1	17	C	GS2		1.00-1.15		11.6		49.9		32.	9	5.6	
															₽		
Line Symbol	CanFEM Classification		SCS nbol	D ₁	0	D ₁₅		D ₃₀	D ₅	50	De	60	D	85	% :	5-75µm	
•	Sand , trace gravel, trace silt, trace clay	N	J/A	0.0)9	0.11		0.15		0.18 0.		0.19 (0.24		5.9	
	Sand , trace silt, trace clay	S	SP	0.1	2	0.14	ļ.	0.17	0.2	0.20		21 0.2		0.29		1.6	
o	Silty sand , some gravel , trace clay N/A		I/A	0.0)1	0.02	 ; 	0.05	0.1	14	0.2	24	3.	17		32.9	

APPENDIX D

Nitrate Dilution Calculations

Nitrate Dilution Calculation Worksheet

Nitrate Loading

Residential Septic Systems (assumes 1,000 L/day/lot) Number of lots with untreated septic systems = Nitrate loading from untreated septic system = Total annual nitrate loading from untreated systems =	73 lots 40 grams/lot/day 1065800 grams/year
Total Annual Nitrate Loading from all Systems =	1065800 grams/year
Dilution Volumes	
Infiltration Factors Topography factor = Soil factor = Cover factor =	0.23 0.4 0.165
Combined infiltration factor =	0.795
 Precipitation Infiltration Annual water surplus = Annual infiltration (Water Surplus x Infiltration Factor) = Infiltration Area and Infiltration Volumes Area available for infiltration (Site Area) = Area available for infiltration (Site Area - Hard Surface Area) = (assumes 7 metre wide x 1,700 m long interal roadways and 300m2 for explanation) 	0.380 metres/year 0.3021 metres/year 350053.1 square metres 316253.1 square metres ach lot house+driveway)
Total Annual Volume of Infiltration (Infiltration x Area) = Annual Flow from Residential Lots (assuming 1000 L/day/lot) =	95540 cubic metres/year 26645 cubic metres/year
Total Annual Volume Available for Dilution =	122185 cubic metres/year
Dilution Oplandation	

Dilution Calculation

$C_{Nitrate} = \frac{Mass}{Volume} = \frac{Mass}{A}$	Annual Nitrate Loading(grams		= grams cubic metre	$\frac{1}{e} = \frac{mg}{L}$
C _{nitrate (73 lots)} =	1065800 grams/year 122185 cubic metres/year	=	8.72	mg/L
C _{nitrate (86 lots)} =	1255600 grams/year 125752 cubic metres/year	=	9.98	mg/L



Ottawa	Intl A		WATE	R BUDG	ET MEA	ANS FOR	R THE P	ERIOD	1939-2	020	DC20492
	45.32 G 75.67		TER HO WER ZO				75 MM 45 MM	_	AT IND		
DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-10.6	62	12	14	0	0	0	25	83	74	295
28- 2	-9.0	56	10	17	1	1	0	26	112	74	351
31- 3	-2.8	66	31	78	5	5	0	103	69	75	416
30-4	5.7	73	68	74	31	31	0	111	0	75	490
31- 5	13.1	76	76	0	80	80	0	14	0	56	566
30- 6	18.3	85	85	0	116	107	-9	5	0	30	651
31- 7	20.9	88	88	0	136	103	-33	3	0	11	739
31- 8	19.6	84	84	0	118	84	-34	1	0	11	823
30- 9	14.8	82	82	0	75	65	-10	4	0	24	906
31-10	8.3	77	77	0	37	36	-1	14	0	52	77
30-11	1.3	76	59	8	10	10	0	38	9	71	154
31-12	-6.9	79	27	14	1	1	0	36	47	74	233
AVE	6.0 TTL	904	699	205	610	523	-87	380			

Ottawa	Intl A		STAN	DARD [DEVIATI	ONS FO	OR THE	PERIOD	1939-	2020	DC20492
DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	2.9	26	15	17	1	1	0	29	44	3	59
28- 2	2.6	26	14	26	1	1	0	35	59	3	63
31- 3	2.6	28	22	49	5	5	0	55	87	0	71
30- 4	1.8	32	33	88	9	9	0	89	2	2	80
31- 5	1.8	34	34	2	12	12	0	24	0	22	94
30- 6	1.2	38	38	0	8	18	18	16	0	29	105
31- 7	1.2	45	45	0	8	31	33	16	0	22	117
31- 8	1.3	37	37	0	8	29	31	4	0	21	126
30- 9	1.5	39	39	0	8	16	16	15	0	29	132
31-10	1.5	37	37	1	7	7	2	21	0	27	37
30-11	1.8	27	27	8	4	4	0	32	13	12	45
31-12	3.0	30	22	14	1	1	0	30	34	4	55

APPENDIX E

Test Pit and Monitoring Well Water Quality Laboratory Results

Report to: ARK Engineering and Development Project: 100554.001 (January 18, 2022)



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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive Kanata, ON K2K 2A9 Attn: Andrius Paznekas

Client PO: Project: 100554.001 Custody: 124959

Report Date: 11-Mar-2021 Order Date: 8-Mar-2021

Order #: 2111112

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2111112-01	TP21-04 GW-1
2111112-02	TP21-07 GW-1
2111112-03	TP21-12 GW-1

Approved By:

Mark Foto

Mark Foto, M.Sc. Lab Supervisor

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.



Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	10-Mar-21	10-Mar-21



Certificate of Analysis

Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 11-Mar-2021

Order Date: 8-Mar-2021

Project Description: 100554.001

			-		
	Client ID:	TP21-04 GW-1	TP21-07 GW-1	TP21-12 GW-1	-
	Sample Date:	08-Mar-21 10:00	08-Mar-21 11:15	08-Mar-21 13:00	-
	Sample ID:	2111112-01	2111112-02	2111112-03	-
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	-
Anions					
Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	-



Order #: 2111112

Report Date: 11-Mar-2021

Order Date: 8-Mar-2021

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N Nitrite as N	ND ND	0.1 0.05	mg/L mg/L						



Order #: 2111112

Report Date: 11-Mar-2021

Order Date: 8-Mar-2021

Project Description: 100554.001

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	0.53	0.1	mg/L	0.54			2.0	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	



Report Date: 11-Mar-2021

Order Date: 8-Mar-2021

Project Description: 100554.001

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	1.58	0.1	mg/L	0.54	104	79-120			
Nitrite as N	1.01	0.05	mg/L	ND	101	84-117			



Order #: 2111112

Report Date: 11-Mar-2021 Order Date: 8-Mar-2021 Project Description: 100554.001

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable ND: Not Detected MDL: Method Detection Limit Source Result: Data used as source for matrix and duplicate samples %REC: Percent recovery. RPD: Relative percent difference. NC: Not Calculated



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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive Kanata, ON K2K 2A9 Attn: Andrius Paznekas

Client PO: Project: 100554.001 Custody: 124960

Report Date: 11-Mar-2021 Order Date: 9-Mar-2021

Order #: 2111200

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID **Client ID** 2111200-01 TP21-02 GW-1 2111200-02 TP21-18 GW-1

Approved By:

Mark Foto

Mark Foto, M.Sc. Lab Supervisor

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.



Project Description: 100554.001

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	10-Mar-21	10-Mar-21



Certificate of Analysis

Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 11-Mar-2021

Order Date: 9-Mar-2021

Project Description: 100554.001

	Client ID:	TP21-02 GW-1	TP21-18 GW-1	_	_
	Sample Date:	09-Mar-21 11:00	09-Mar-21 11:00	-	-
	Sample ID:	2111200-01	2111200-02	-	-
	MDL/Units	Drinking Water	Drinking Water	-	-
Anions					
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	-	-



Order #: 2111200

Report Date: 11-Mar-2021

Order Date: 9-Mar-2021

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N Nitrite as N	ND ND	0.1 0.05	mg/L mg/L						



Order #: 2111200

Report Date: 11-Mar-2021

Order Date: 9-Mar-2021

Project Description: 100554.001

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	0.53	0.1	mg/L	0.54			2.0	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	



Report Date: 11-Mar-2021

Order Date: 9-Mar-2021

Project Description: 100554.001

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	1.58	0.1	mg/L	0.54	104	79-120			
Nitrite as N	1.01	0.05	mg/L	ND	101	84-117			



Order #: 2111200

Report Date: 11-Mar-2021 Order Date: 9-Mar-2021 Project Description: 100554.001

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable ND: Not Detected MDL: Method Detection Limit Source Result: Data used as source for matrix and duplicate samples %REC: Percent recovery. RPD: Relative percent difference. NC: Not Calculated



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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive Kanata, ON K2K 2A9 Attn: Andrius Paznekas

Client PO: Project: 100554.001 Custody: 13297

Report Date: 29-Apr-2021 Order Date: 27-Apr-2021

Order #: 2118199

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2118199-01	BH21-101
2118199-02	BH21-104
2118199-03	BH21-105

Approved By:

Mark Foto

Mark Foto, M.Sc. Lab Supervisor

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.



Report Date: 29-Apr-2021 Order Date: 27-Apr-2021

Project Description: 100554.001

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC	28-Apr-21	28-Apr-21



Certificate of Analysis

Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Order #: 2118199

Report Date: 29-Apr-2021 Order Date: 27-Apr-2021

Project Description: 100554.001

	Client ID: Sample Date: Sample ID: MDL/Units	BH21-101 27-Apr-21 12:10 2118199-01 Drinking Water	BH21-104 27-Apr-21 12:50 2118199-02 Drinking Water	BH21-105 27-Apr-21 12:30 2118199-03 Drinking Water	- - - -
Anions					
Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	-



Order #: 2118199

Report Date: 29-Apr-2021

Order Date: 27-Apr-2021

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N Nitrite as N	ND ND	0.1 0.05	mg/L mg/L						



Order #: 2118199

Report Date: 29-Apr-2021

Order Date: 27-Apr-2021

Project Description: 100554.001

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	1.67	0.1	mg/L	1.67			0.1	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	



Report Date: 29-Apr-2021

Order Date: 27-Apr-2021

Project Description: 100554.001

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Nitrate as N	2.66	0.1	mg/L	1.67	98.7	79-120			
Nitrite as N	0.979	0.05	mg/L	ND	97.9	84-117			



Order #: 2118199

Report Date: 29-Apr-2021 Order Date: 27-Apr-2021 Project Description: 100554.001

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable ND: Not Detected MDL: Method Detection Limit Source Result: Data used as source for matrix and duplicate samples %REC: Percent recovery. RPD: Relative percent difference. NC: Not Calculated

APPENDIX F

On-Site Water Well Records

Report to: ARK Engineering and Development Project: 100554.001 (January 18, 2022)

Measurements re	corded in:	Metric Amperia	al	A313160			Pag	ge	of
Well Owner's I First Name		_ast Name/Organiza	ation	s.(B.	E-mail Address				Constructed
Mailing Address (St		928704		ta Corporation (Postal Code	Teleshaa	by W	ell Owner
1705 Old	Prescott F			Greely	ON IN INC.	1	111118		. area code)
Well Location Address of Well Loc	cation (Street Nug	gber/Name)	<u>.</u>	Township		Lot	Concess	ion	
Fox Valle County/District/Mun	y Road	NOCIU	(1c)	Osgoode City/Town/Village	1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 - 1999 -	P/L	4 3	Posta	I Code
Ottawa (Carleton	serie de la		Greely			Ontario		
UTM Coordinates Z NAD 8 3	one Easting	84 Northing	1298	Municipal Plan and Sub	OHL OF \$	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	Other S/L 2		
Overburden and General Colour	0.0.00000000000000000000000000000000000	als/Abandonmen non Material	200-2012/06/26/2020 - 0.000/060	cord (see instructions on t	AN DESCRIPTION OF A DES	ral Descriptior		Dep	oth (mate)
		Sand	aGa		+ Boulder			From	29 1
Grey + B	lack	Limestone				· .		29 (94 /
Grey of B	black	Limestone	•				. <u>,</u> ,	94 1	100 1
							\frown		
PDON	OF SET	T Punt	BE	DW 80 FT	- Blok	EN «	Kack	¥	3
			`						
Depth Set at (mtt		Annular Space Type of Sealant Us	ed	Volume Placed	After test of well yield, w	vater was:	ell Yield Testing Draw Down	Re	ecovery
From To 40 30		(Material and Type) ment		(m)®) The first state of the	Clear and sand fr	ee Not teste i	Time Water Lev (min) (m/ft)	vel Time (min)	Water Level (m/ft)
30 / 0 /	Bentonii	te slúrry	a Alexandra de la com	16.8	If pumping discontinued		Static Level 71.8	U (1998)	62 /
						an an ann an thair an	1 16.	1 1	31
					Pump intake set at (mf	173	2 20.1	3 2	00.0
					80	שי היי היי היי	Second Second Second		20.8
Method of C	CHARLEN CONTRACTOR CONTRACTOR		Well L	and a second	Pumping rate (I/min / E	- MP	3 24.1	83	11.9
Cable Tool	Diamond []] Diamond []] Diamond []] Diamond []] Jetting	Public	Comm	ipal Dewatering	Pumping rate (/min / 20 Duration of pumping	A A A	3 24 (4 27 (63 54	11.9 7.8
Cable Tool Cable Tool Rotary (Convention Rotary (Reverse) Boring	Diamond	Livestock	Comm Munici	ipal Dewatering	Pumping rate (/min / @ 20 Duration of pumping 1 hrs + 0 mi Final water level end of	- 	3 24.1	8 3 54 5	11.9
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Ministry's Copy

Ontario Ministry of the Environment	an a		The Ontario Wate WATER W	er Resources Ac ELL RECORD
Print only in spaces provided. Mark correct box with a checkmark, where applical	ble. 11	153121	9 15999 Plan 4M936 Jub 10	
County or District Ottawa Owner's surname John Getard Hon Zone First Name	Township/Borough/City/To Address Address Address Address Address Northing		Con block tract su Date complete	and OS OC year
		24 25 26	30 31	47
	F OVERBURDEN AND BEDR Other materials	OCK MATERIALS (se	ee instructions) General description	Depth - feet
General colour Most common material				From To
grey linestone				2361
		· · · · · · · · · · · · · · · · · · ·		
			· · · · · · · · · · · · · · · · · · ·	
32 10 14 15 21 41 WATER RECORD 51			54 Sizes of opening 31-33 Diame	ter 34-38 Length 39-40
Water found Kind of water Inside diam inches	Wall Material thickness inches	Depth - feet From To	Image: Solution of the soluti	inches feet Depth at top of screen 30
37 2 Salt 6 To as	1 Concrete	13.16 A 24	S	teet
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53^{2} 1 por Fresh (Double T) 2 Salty 6 Gas ()	2 Galvanized 3 Concrete	0 32	Depth set at - feet From To Material and type	Abandonment (Cement grout, bentonite, etc.)
25-28 1 G Fresh 3 Sulphur 29 2 Galty 6 Gas	5	27-30	2 344 Ceme	intgrout
30-33 1 □ Fresh 2 □ Salty 6 □ Gas 60 60 60 60 60 60 60 60 60 60	2 Galvanized 3 Concrete 4 Seopen hole 5 Plastic	326	18-21 22:25 26-29 30-33 80	1
71 Pumping test method ¹⁰ Pumping rate 311-11 1 Depump ² Bailer GPN	Durauon or pumping		LOCATION OF WELL	
Static level Water level 25 Water levels during 1	Pumping 2 Pecovery		below show distances of well fro	m road and lot line.
SU 19-21 22-24 15 minutes 26-28 26-28 26-28 26-28 26-28 26-28 26-28 17 17	1717	1		~
If flowing give rate 38-41 Pump intake set at	feet feet Water at end of test 42		× /	1
Shallow Deep	¹⁵ Recommended 46-49 pump rate		west	
50-53			w	
1 Torigon Vater supply 5 Abandoned, insufficient 2 Cbservation well 6 Abandoned, poor qualit 3 Test hole 7 Abandoned (Other) 4 Recharge well 8 Dewatering		60	~ 312 ~ ~	-
WATER USE 55-56 1 Subomestic 5 Commercial 2 Stock 6 Municipal 3 Irrigation 7 Public supply 4 Industrial 8 Cooling & air conditioning	9 □ Not use 10 □ Other		· 312m >	85'
METHOD OF CONSTRUCTION 57 1 Cable tool 5 Air percussion 2 Rotary (conventional) 6 Boring 3 Rotary (reverse) 7 Diamond 4 Rotary (air) 8 Jetting	9 Driving 10 Digging 11 Other	Wac	lasn	217007
Name of Well Contractor A Roch DIIL flo Adems R # 2 Japper, 7	Well Contractor's Licence No.	Date of inspection	Contractor 59-62 Date I Inspector	received 63-68 80
Name of Well Technician	Well Technician's Licence No.	A Remarks		CSS.ES0
				0506 (11/98) Front Form

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2 - MINISTRY OF THE ENVIRONMENT COPY

	Ministry of the Environment		ana a sa a sa s	The Ontario Water Resources Act WATER WELL RECORD
Print only in spaces pro Mark correct box with a	ovided. a checkmark, where applica	able. 11	1531034	Municipality 15009 Con. 03 Pla, 4092 V L 1518
County or District Ottouron Owner's surname John (76		asting Northing		Con block tract survey, etc. Lot Date 0 4 Completed 0 7 1/2 RC Basin Code 1 14 14
General colour	LOG O Most common material	F OVERBURDEN AND BEDR Other materials		Depth - feet
grey 2 grey 2	Fasel Timestosp Sandstos	Sand		From To O 28 Z8 141 141 153
	~			
At - Teet Image: Second se	a Sulphur 14 a Minerals b Gas c Sulphur a Sulphur a Sulphur a Sulphur a Minerals b Gas c Gas a Sulphur a Minerals b Gas c Gas c Sulphur c Gas d Minerals d Gas d Minerals d Gas c Gas d Minerals d Gas d Join Minerals d Gas d Join Minerals d Join Minerals d Join Minerals d <td>1 ØSteel 12 2 Galvanized 3 Open hole 4 Open hole 5 Plastic 1 Steel 1 Steel 2 Galvanized 3 Concrete 4 Open hole 5 Plastic 1 Steel 2 Galvanized 3 Concrete 2 Galvanized 3 Concrete 2 Galvanized 3 Concrete 3 Concrete 3 Concrete 4 Duration of pumping 1 Pumping 2 Plastic 1 Pumping 3 45 minutes 3 32:34 60 minutes 35:37 45 minutes 32:34 60 minutes 12 teet 14 teet 15 Clear 16 GPM <!--</td--><td>Depth - feet From To C 38 0 38 0 36 153 161 Depth From 2:.03 0 36 153 (Sk Ma 0 0 161 10 10 16 10 10 16 10 10 10 10 10 10 10 10 10 10</td><td>$\frac{38}{328} \frac{\text{Cement from t}}{\text{Sout}}$</td></td>	1 ØSteel 12 2 Galvanized 3 Open hole 4 Open hole 5 Plastic 1 Steel 1 Steel 2 Galvanized 3 Concrete 4 Open hole 5 Plastic 1 Steel 2 Galvanized 3 Concrete 2 Galvanized 3 Concrete 2 Galvanized 3 Concrete 3 Concrete 3 Concrete 4 Duration of pumping 1 Pumping 2 Plastic 1 Pumping 3 45 minutes 3 32:34 60 minutes 35:37 45 minutes 32:34 60 minutes 12 teet 14 teet 15 Clear 16 GPM </td <td>Depth - feet From To C 38 0 38 0 36 153 161 Depth From 2:.03 0 36 153 (Sk Ma 0 0 161 10 10 16 10 10 16 10 10 10 10 10 10 10 10 10 10</td> <td>$\frac{38}{328} \frac{\text{Cement from t}}{\text{Sout}}$</td>	Depth - feet From To C 38 0 38 0 36 153 161 Depth From 2:.03 0 36 153 (Sk Ma 0 0 161 10 10 16 10 10 16 10 10 10 10 10 10 10 10 10 10	$\frac{38}{328} \frac{\text{Cement from t}}{\text{Sout}}$
WATER USE Gromestic Stock Irrigation Industrial METHOD OF CONS Cable tool Rotary (reverse) Rotary (reverse) Rotary (air)	5 Air percussion	Other	Wadd.	20'1 210543
Name of Well Contractor Address RR# 2 Name of Well Technician Signature of Technictan/Control		Well Contractor's Licence No. HIN9 Well Technician's Licence No. TZ122 Submission date Submission date Submission date Submission date Submission date Submission date	Data 58 Contraction Source Date of inspection Bate Remarks	•

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		SALTY MI	INERAL JLPHUR		STEEL GALVANIZED								
			INERAL	L	CONCRETE								
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	SHALLOW		SETTING	+7	FEET RATE	0	GPM.				. I h		

	L					· 14		
	FINAL STATUS OF WELL	WATER SUPPLY OBSERVATION WELL TEST HOLE RECHARGE WELL	ABANDONED, INSUFFICIENT SUPPLY ABANDONED, POOR QUALITY UNFINISHED	Ę	437'	E 4		31
	, WATER USE	DOMESTIC stock IRRIGATION INDUSTRIAL OTHER	COMMERCIAL COMMERCIAL UNICIPAL UPUBLIC SUPPLY COOLING OR AIR CONDITIONING UNOT USED		X	Chueien		tury at
	METHOD OF DRILLING	CABLE TOOL ROTARY (CONVENTIO ROTARY (REVERSE) ROTARY (AIR) AIR PERCUSSION	BORING NAL) DIAMOND JETTING DRIVING	DRILLER	IS REMARKS:	O TIANIA	CONT	*
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	CONTRACTO						FORM 7 MOE	07-091

CONTRACTOR'S COPY

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Pont:	ario Ministry			The Ontario Water	Resources Act
Print only in space	Environment		15339		
Mark correct box	with a checkmark, where applica		Plan	<u>15009</u> 0 1401855 Suli	0X1 8.
County or District	ve Carleton		own/Village	Con block tract surv	ey, etc. Lot 4
Owner's sumame	Sito (Stud	Address Sceel	in Ont	Date completed	170603
21		Easting Northing		ation RC Basin Code ii	
		OF OVERBURDEN AND BEDR	OCK MATERIALS (s	ee instructions) General description	Depth - feet
General colour	Most common material	Old trees.	tou ed		From To $()$ (5
grey	Inestone		/		15 103
5				· · · · · · · · · · · · · · · · · · ·	
				•	
)					
31					
				Sizes of opening 31-33 Diamet	er ³⁴⁻³⁸ Length ³⁹⁻⁴⁰
Water found at - feet	Kind of water Inside Fresh 3 Sulphur 14 Fresh 4 I Minorals	Material thickness s inches	Depth - feet From To 13-16	X (Slot No.) W Material and type	inches feet Depth at top of screen 30
<u>45</u> ²		2 Galvanized 3 Concrete	x 27	So.	41-44 feet
2	Fresh ³ Sulphur ²⁴	4 Open hole 5 Plastic 8 1 Steel 19 2 Galvanized		61 PLUGGING & SEALIN	Abandonment
2 [Fresh 4 Minerals Salty 6 Gas	3 □ Concrete 4 ➡ Open hole 5 □ Plastic	025	From 10	Cement grout, bentonite, etc.)
2 [4 ☐ Minerals 24.	5 1 ⊡ Steel 26 2 ⊡ Galvanized 3 ⊡ @oncrete	27-30	18-21 22-25	en grow
	Fresh 4 Ginerals	4 Open hole 5 🗆 Plastic	25/03	26-29 30-33 60	
71 Pumping test n Pump 2	🗆 Bailer 🚺 🥇 🤇	Duration of pumping 17-18 PM		LOCATION OF WELL n below show distances of well from	road and lot line
	Water level 25 Water levels during 22·24 15 minutes 30 minute	1 Pumping 2 Recovery 5 45 minutes 60 minutes	Indicate r	north by arrow.	
	$90_{\text{feet}} $ 2%	$f_{\text{feet}} = 2 f_{\text{feet}} = 2 f_{\text{feet}}$			1'N
Recommended p	GPM	Water at end of test 42 feet Clear Cloudy ³³⁻⁴⁵ Recommended 46-49			•
Shallow	Pump setting 90	feet pump rate 15 GPM			
FINAL STATU		nt supply ⁹ 🗌 Unfinished	75'	addon Dr. 6485	
² Observati ³ Test hole ⁴ Recharge	ion well ⁶ Abandoned, poor qua ⁷ Abandoned (Other)		Inl	addua	
WATER USE	55-56 5 🗀 Commercial	9 □ Not use		Dr.	
2 Stock 3 Irrigation 4 Industrial	6 🔲 Municipal 7 🔲 Public supply	10 🗌 Other	14:	6485	Dr.
				6485 Greely west	
 Cable too Rotary (call Rotary (call Rotary (call 	onventional) ⁶ 🗌 Boring	 Driving Digging Other 		6.000	040070
4 🗌 Rotary (a	ir) ⁸ 🗌 Jetting			· · · · · · · · · · · · · · · · · · ·	248378
Name of Well Centre	Sch. Dr. Webl	Well-Contractor's Licence No.	Data source	1119 JI	eceived 63-68 80
RP#1	Richnian	d. Ont		Inspector	
Name of Well Tech	nnonfucer	Well Technician's Licence No.	Remarks NUL NUN		CSS.ES3
Signature of Techn	iician/Contractor				0506 (07/00) Front Form 9
O MAINUC	TRY OF THE ENVIRON	MENT CODY			(07/00/ FIORE FORM 9

ENVIRONMENT C SIRY UP INC

09/28/2009 13:44 6138383277	AIR R	DCK Trow (2009)	TW1 PAGE 02/11
Ministry of		tow)	ell Record
Ontario the Environment	A. 09 471	Regulation 903 Ontario Wi Page	
Measurements recorded in: Metric Amperial			
First Kane	E-104	TAINSTO IN ATT	Well Constructed
Malling Address (Street Number/Name)	1 Carlebed Sp	Ince Postal Code Telephone	No. (Inc. area 0006)
	Township	Concession	<u>~~</u>
Content wer Loparitien (Street Number/Name)	Dave offer	PIL3	Postal Code
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	· · · · · · · · · · · · · · · · · · ·		
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32 0 Nost barton	Jestimp 16-84		<u>(1)7'7"</u> (2)85'5 <u>"</u>
		207 3271 ping rang (kmin / 6 ^{FM}) 3271	3 56' 8''
Cable Tool Diamond Public		<u> ^ ^ ^ ^ </u>	4 4 26'
Cable Tool Diamond Public Rotary (Conventional) Jening Comcette Rotary (Revente) Diriving Liverbock	Murricipal Dewstering Test Hole Monitoring		$\frac{9''}{2} \frac{5}{25'4}$
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		in GPM)	<u>6" 30 7 77"</u>
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	- Frank V
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(mmt) [Ges] Other, spechy	and the second second second
Business Name of Well Confractor and Well Technikaan Intocreations	ACT 3
Bubiness Address (Street Number/Name) // Municipality Comm	remain and the later is the second se
Province Postal Code Business E-mail Address	I Cost Well # A
Bus, Telephone No. (ing. area code) Name of Web Technician (Last Name, Figst Name) packs	ation Dry Palohly Augustino 102001
Well Technicary Useries (%) (Signapore of Technician and/or Contractor/Data Submitted	Date Work Completed
	10 Curry 1's Printer for Ontario. 2007

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K	A	\ U89433	elow)	Well Record	00/11
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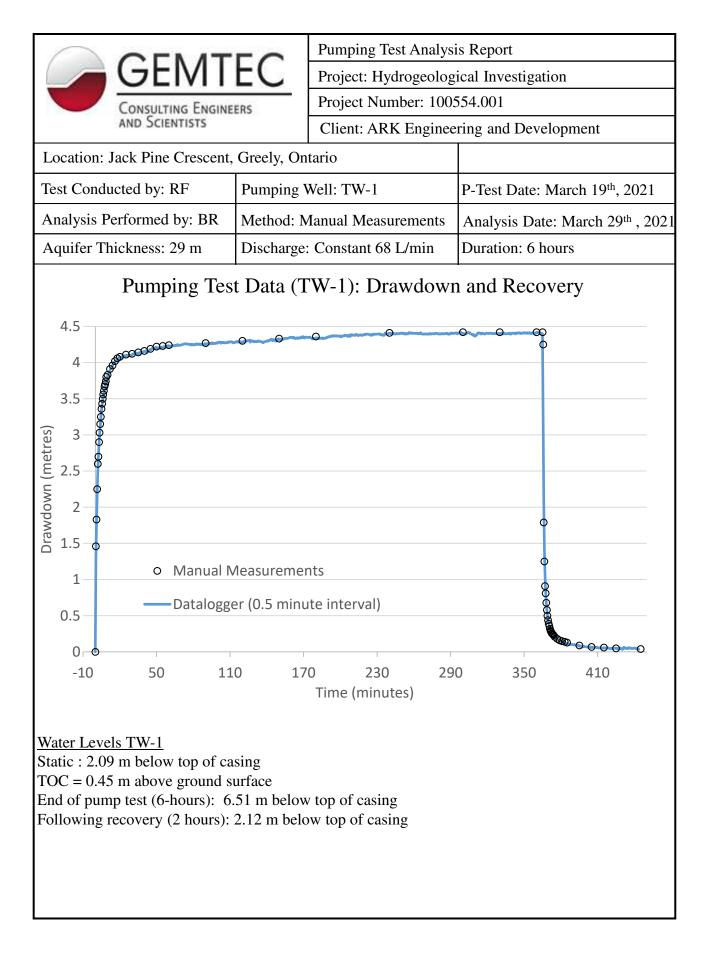
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The State of the Details and the State of th	
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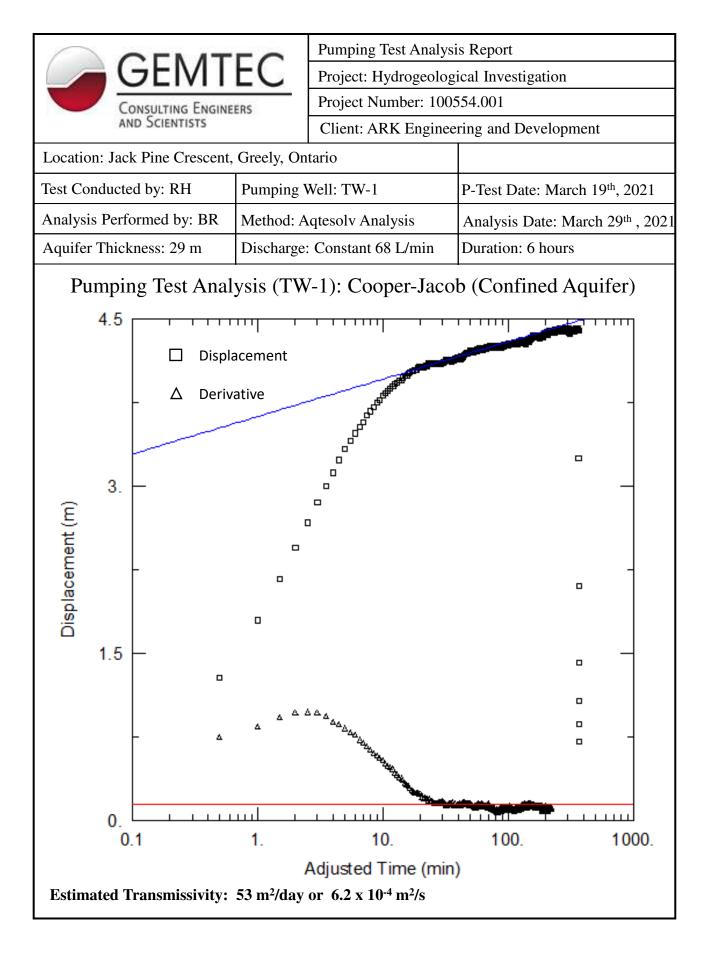
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Zat - al No Flags tel co - 19	🗌 🗌 ಭೇಗತ್ಸ್ ಸಂ-೭		(min) (m/ft)	
ED So Nest Bentante Sluty 25.0	# pumping deta		1 92 94	
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			1 · 72	
Matilities of construction	7 5	4 54	4 66'	
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Rotary (Revense) Driving Uvestock Drestron Cooling & Air Constitioning Descring	Final water level	end of pumping (m/t) 10 60 6	<u>" 10 52'3'</u>	
Other, specify	If flowing give n		15 <u>39'6"</u>	
Inside Open Hole DEt Material Visa Depth (m/H) SUMerer Supply	Recommended	point dapin (n(n))	<u><u><u></u></u>²⁰<u>27</u>′<u>1</u>(</u>	
Constrile, Plastic, Steel) (cm/n) From To Test Role	Recommendated	259712 pump rate 30 977 /	25 2 1 7 7" 30 D	
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ONT KAA220	Wyd owner's information pyckage	S ALL I HAUGH	ⁿ z 102681	
Bus Telephone No. find area code) [Name of Weil Technicon (Last Name. FlettyName) (6138332170_514470		Date Work Completed	C TO CO T	
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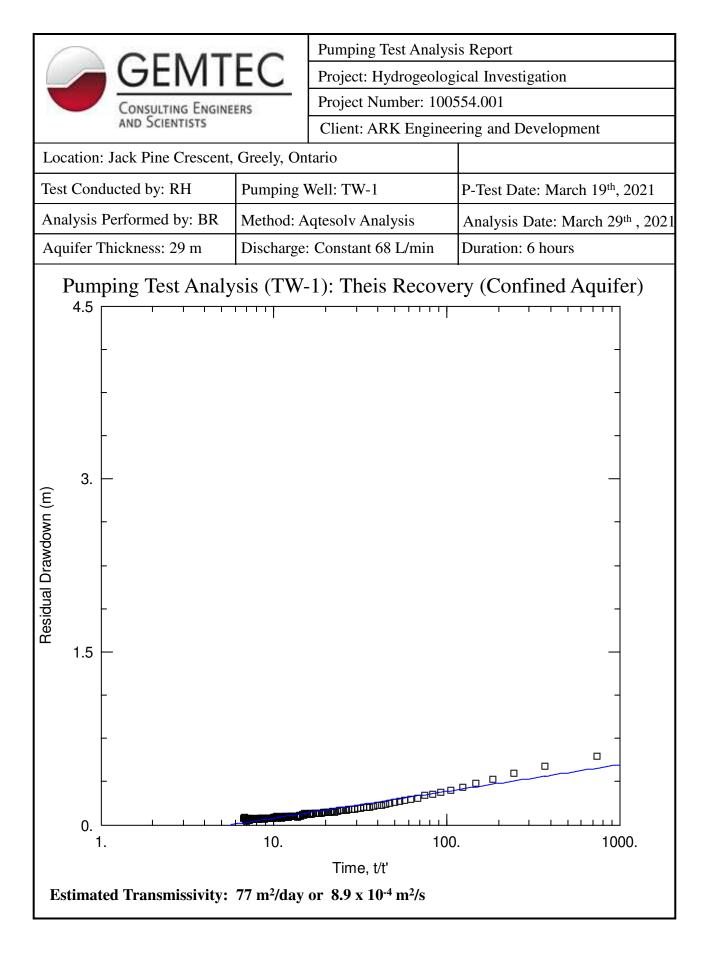
APPENDIX G

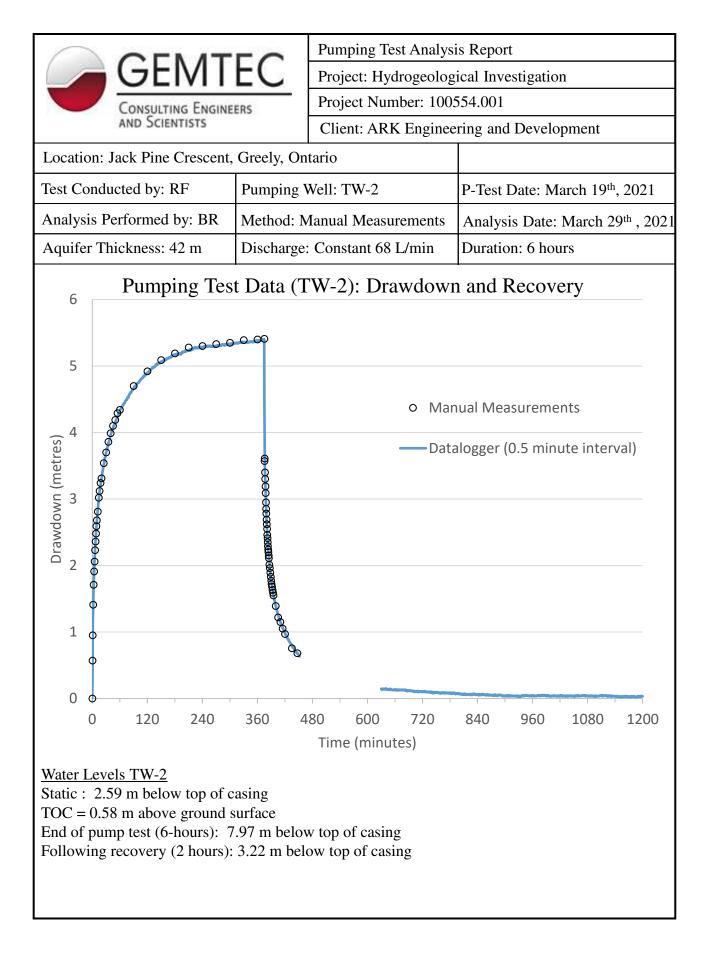
Pumping Test Data and Analyses

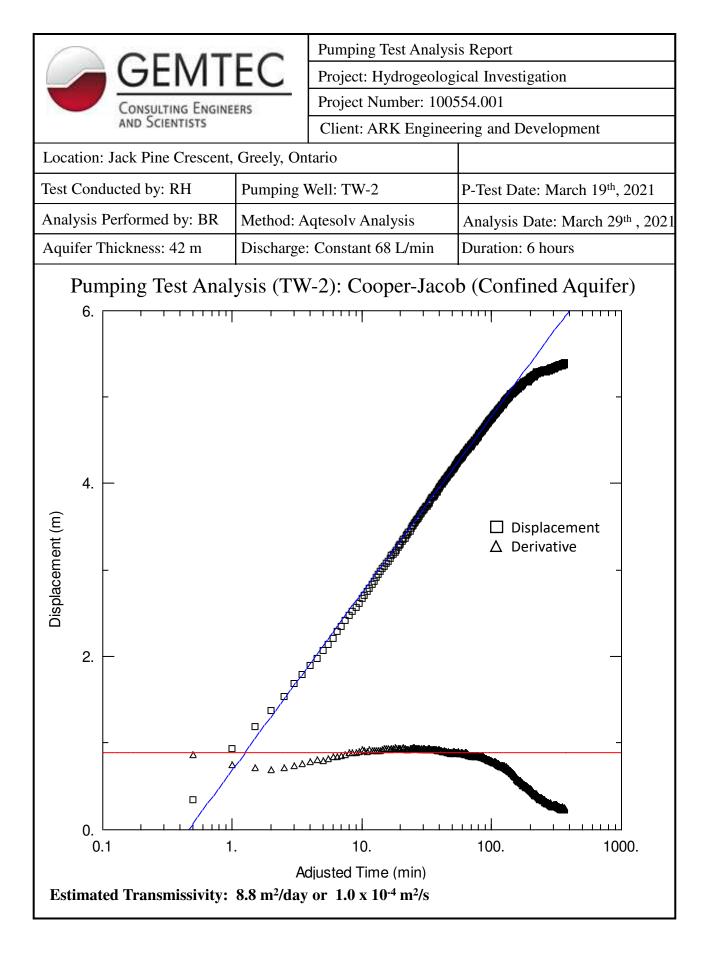
Report to: ARK Engineering and Development Project: 100554.001 (January 18, 2022)

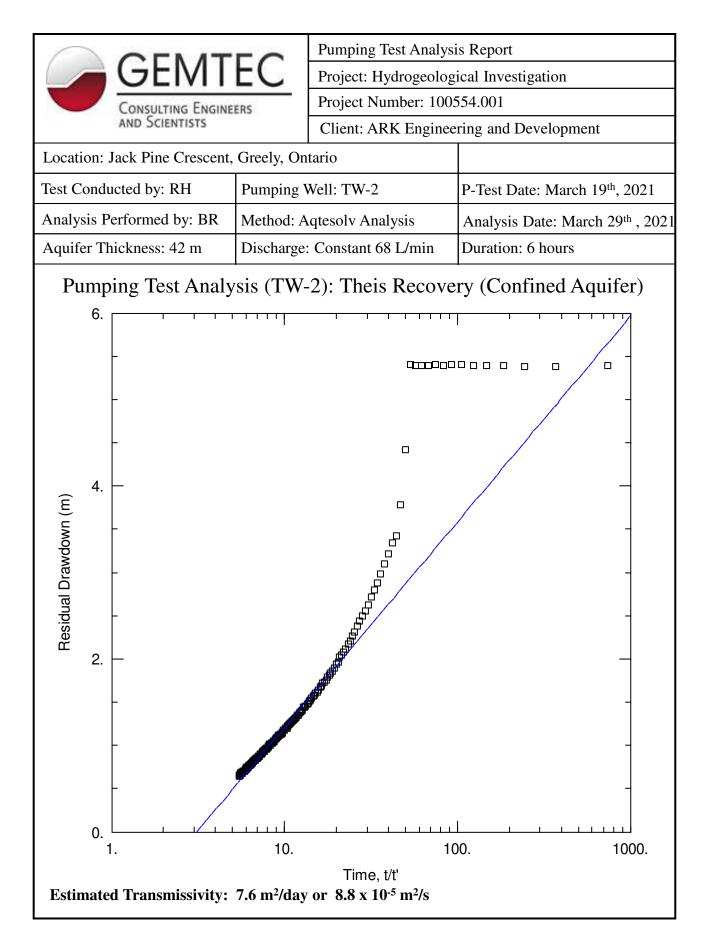


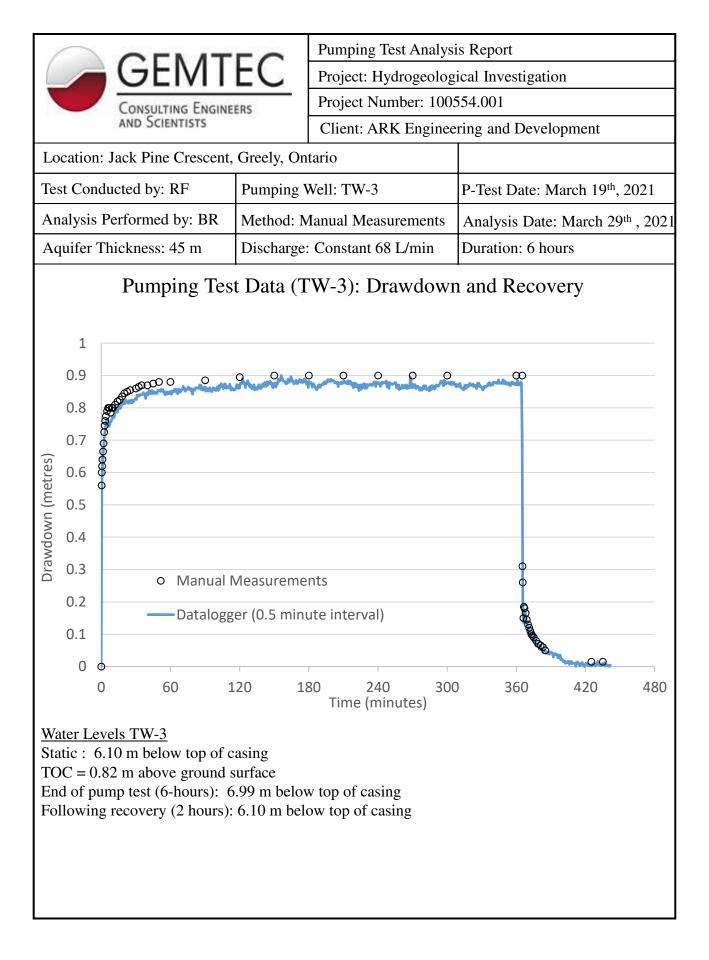


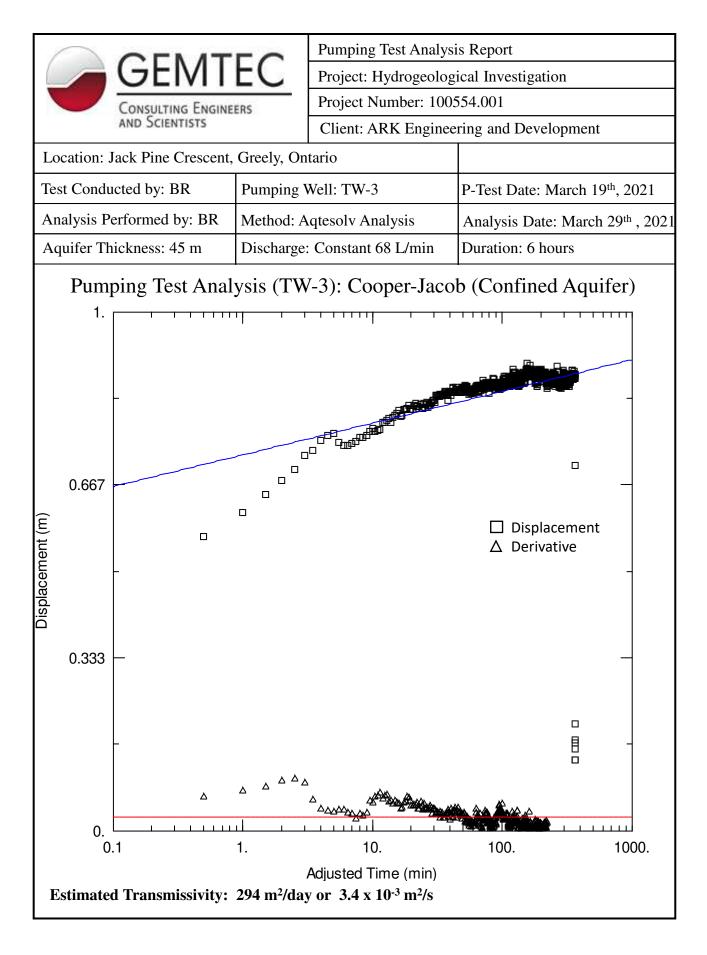


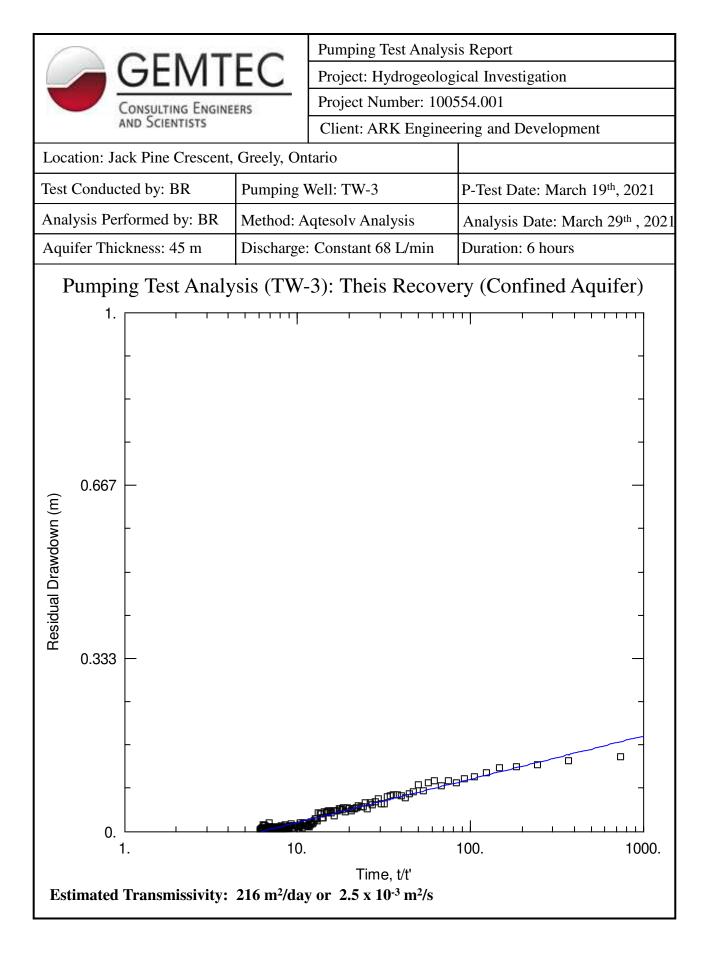


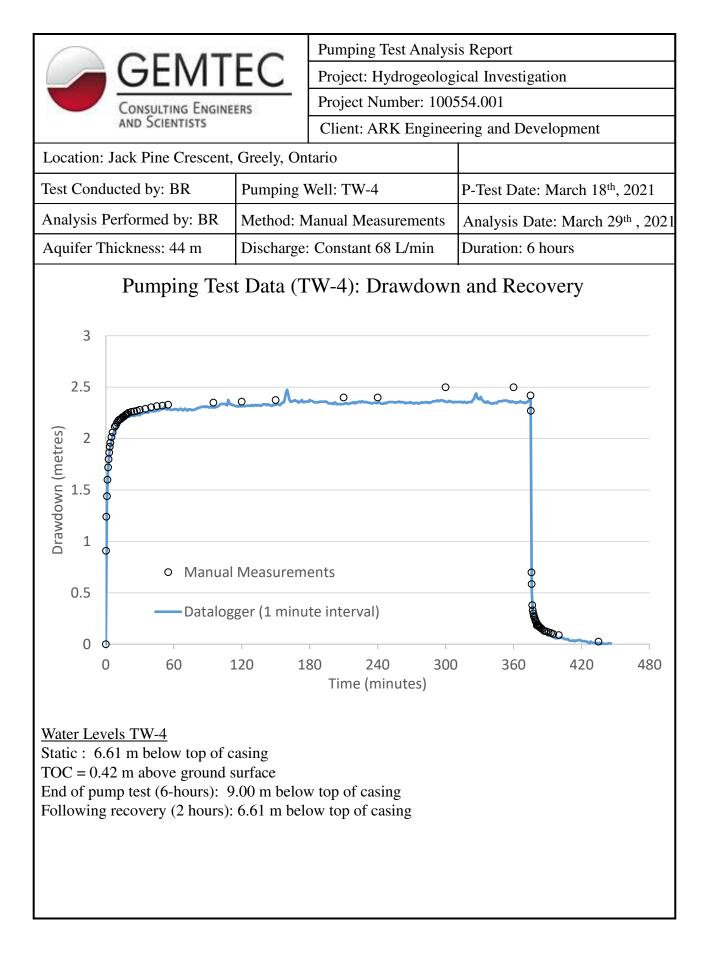


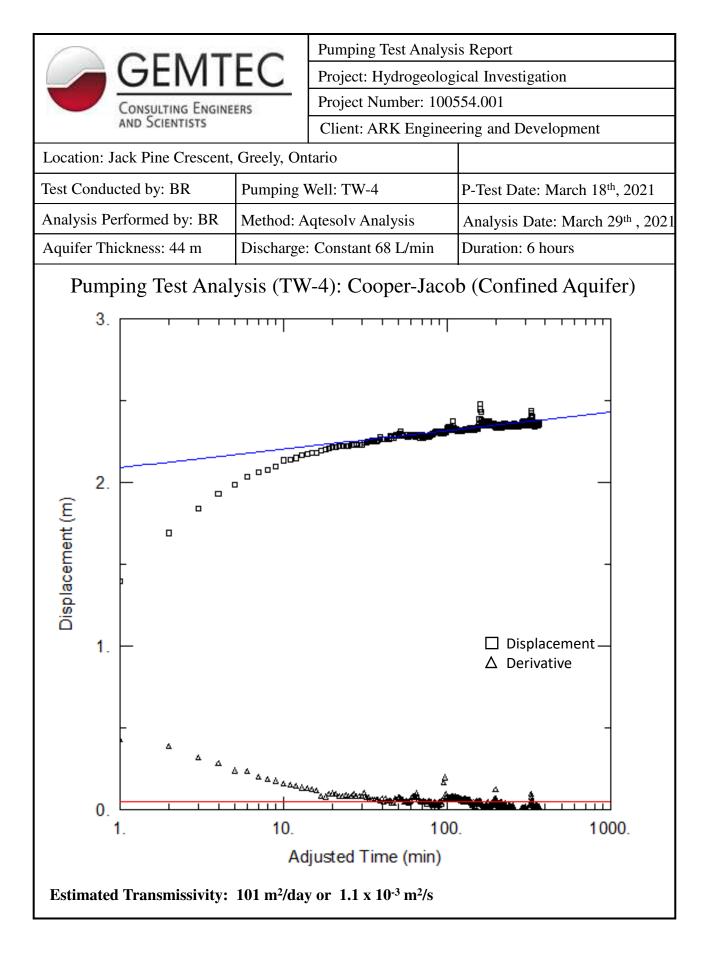


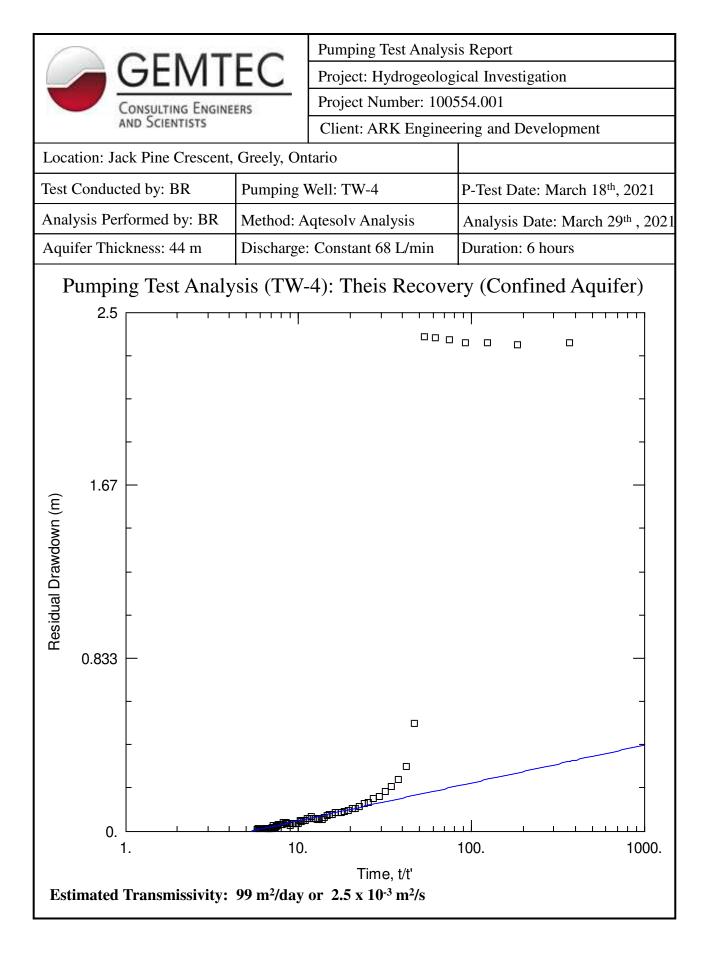


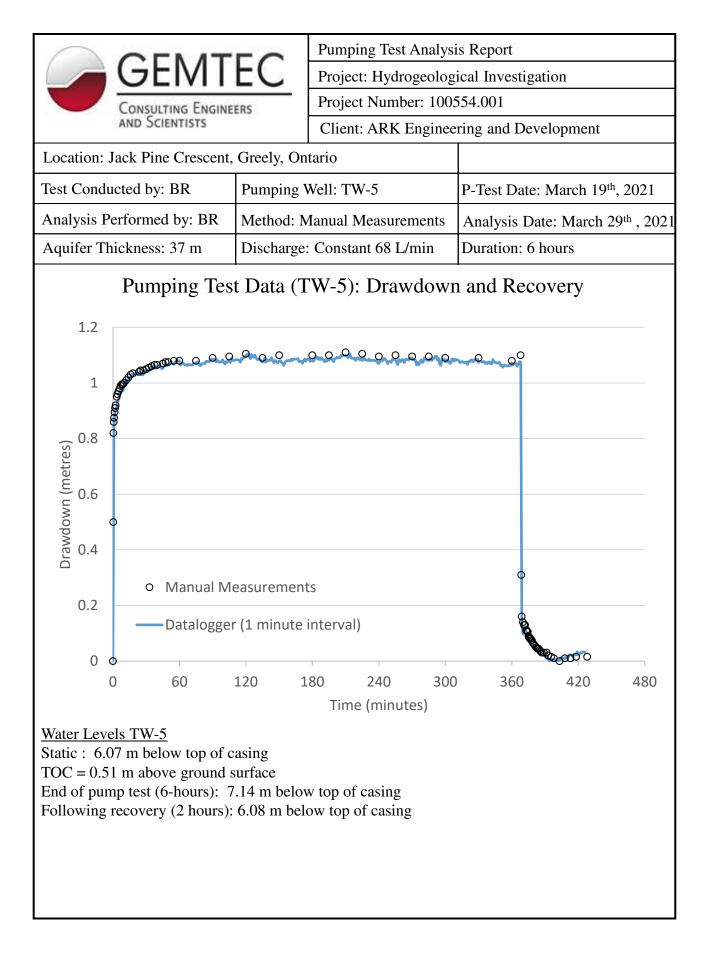


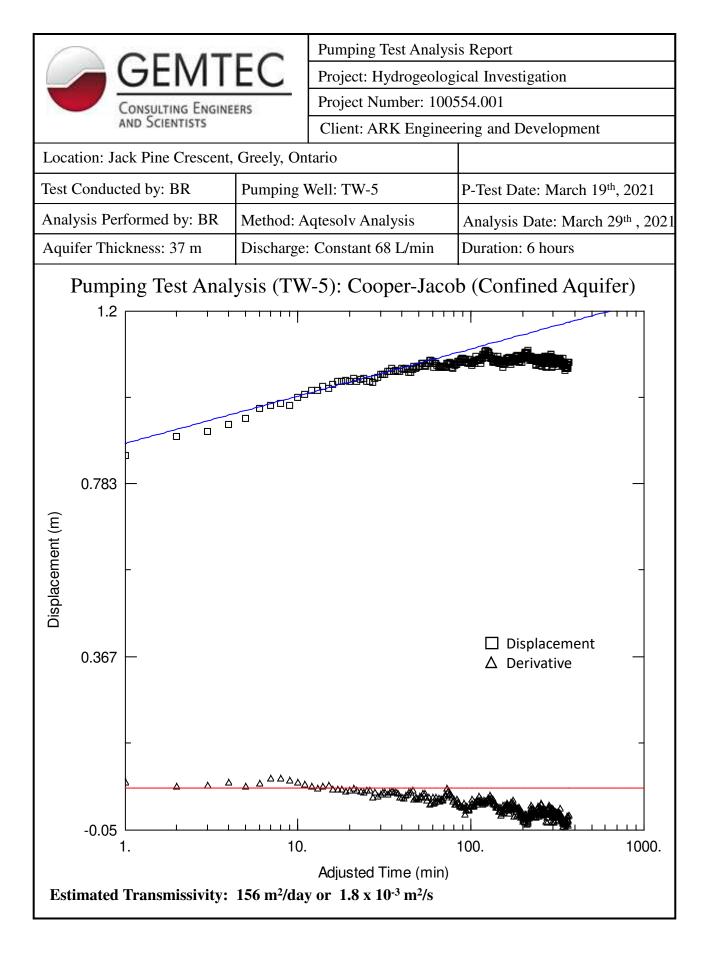


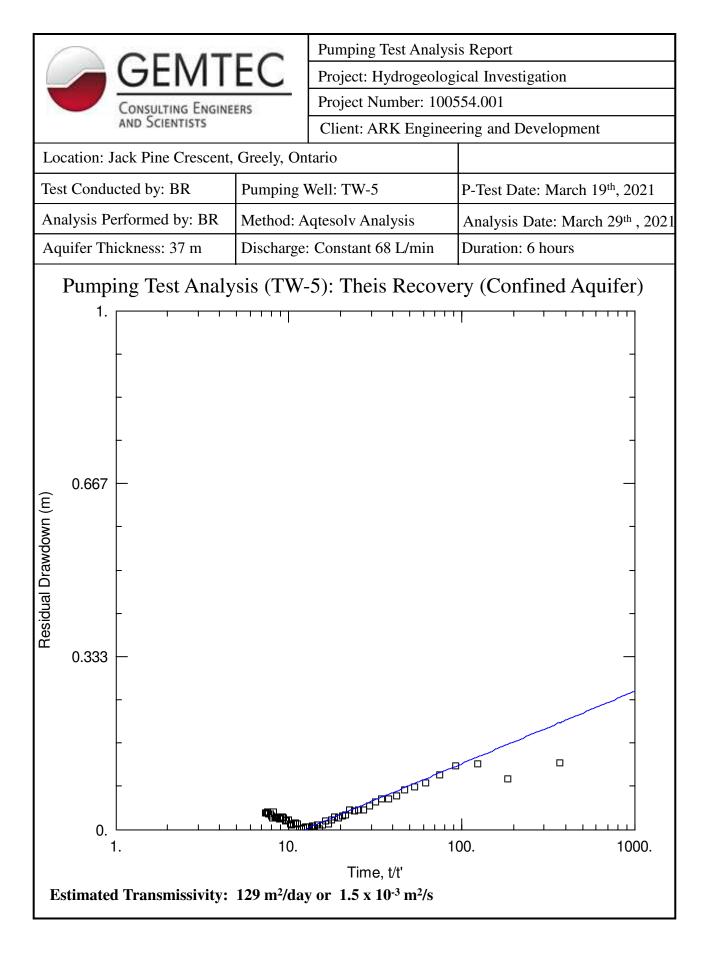








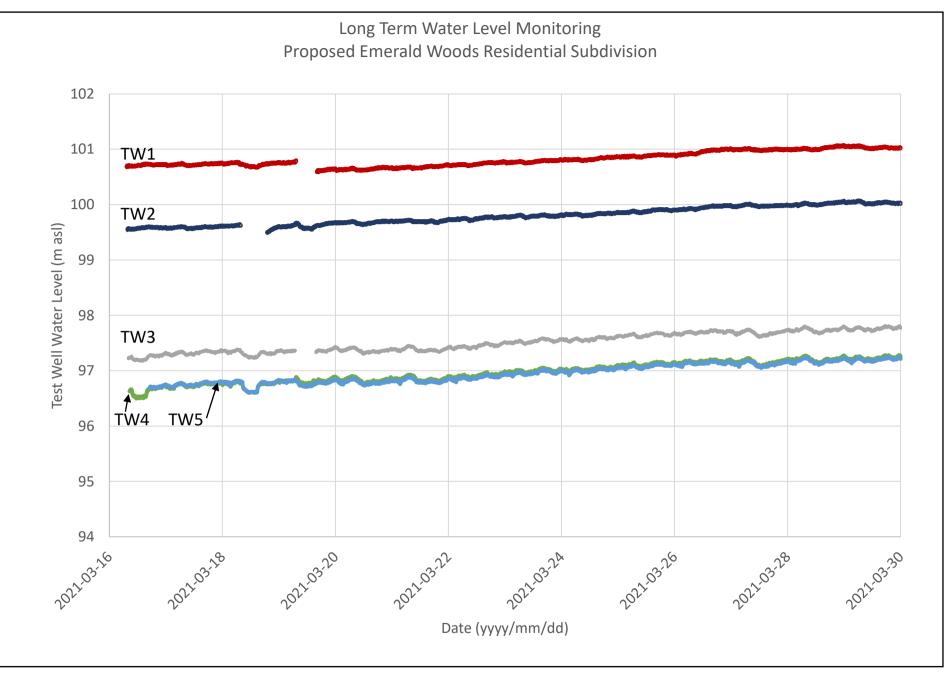




APPENDIX H

Long Term Water Level Monitoring

Report to: ARK Engineering and Development Project: 100554.001 (January 18, 2022)





Project: 100554.001 Date: June 2021

APPENDIX I

Water Quality Field Measurements and Laboratory Summary

Report to: ARK Engineering and Development Project: 100554.001 (January 18, 2022)

Test Wells

Well	Time Since Pump Start (Hours)	Temp (°C)	EC¹ (μS/cm)	рН (-)	Turbidity ² (NTU)	TDS ³ (ppm)	Free Chlorine (mg/litre)	Total Chlorine (mg/litre)	Colour (ACU⁴)	Colour (TCU⁵)
TW 1	1	7.7	331	8.14	13.8	162	-	-	-	-
	2	7.9	318	7.92	21.2	139	-	-	-	-
	3	7.5	320	8.05	12.4	160	<0.02	<0.02	89	42
	4	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-
	6	8.7	327	7.99	12.6	163	<0.02	<0.02	94	<5
TW1 ⁶ (Resample)	-	10.2	323	7.57	1.11	162	0.03	0.03	11	<5
TW 2	1	8.2	380	7.91	11.4	190	-	-	-	-
	2	8.2	381	7.99	26.1	189	-	-	-	-
	3	8.3	380	8	16.7	190	<0.02	<0.02	117	41
	4	8.4	380	7.92	14.4	184	-	-	-	-
	5	8.5	377	7.95	10.2	189	-	-	-	-
	6	8.4	379	7.99	8.98	189	<0.02	<0.02	82	12
TW2 ⁶ (Resample)	-	-	-	-	0.70	-	<0.02	<0.02	<5	<5



Project: 100554.001 Date: June 2021

Test Wells

Well	Time Since Pump Start (Hours)	Temp (°C)	EC¹ (μS/cm)	рН (-)	Turbidity ² (NTU)	TDS ³ (ppm)	Free Chlorine (mg/litre)	Total Chlorine (mg/litre)	Colour (ACU⁴)	Colour (TCU⁵)
TW3	1	7.4	627	7.78	2.4	317	-	-	-	-
	2	7.6	873	7.92	2.1	317	-	-	-	-
	3	7.6	1006	7.75	2.5	506	<0.02	<0.02	14	8
	4	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-
	6	8.4	1126	7.58	2.16	566	<0.02	<0.02	<5	<5
TW4	1	8.3	1140	7.35	2.06	572	-	-	-	-
	2	8.1	1125	7.57	1.80	565	-	-	-	-
	3	8.6	1118	7.83	1.84	563	<0.02	<0.02	24	18
	4	-	-	-	-	-	-	-	-	-
	5	8.6	1120	7.86	1.95	561	-	-	-	-
	6	8.7	1088	7.60	1.61	541	<0.02	<0.02	<5	<5



Test Wells

Well	Time Since Pump Start (Hours)	Temp (°C)	EC¹ (μS/cm)	рН (-)	Turbidity ² (NTU)	TDS ³ (ppm)	Free Chlorine (mg/litre)	Total Chlorine (mg/litre)	Colour (ACU⁴)	Colour (TCU⁵)
TW5	1	7.8	1050	7.64	9.13	520	-	-	-	-
	2	7.8	1040	7.78	1.94	519	-	-	-	-
	3	7.6	1052	8.05	2.10	533	<0.02	<0.02	50	40
	4	8.2	1066	7.85	1.46	534	-	-	-	-
	5	7.8	1050	7.76	2.32	528	-	-	-	-
	6	7.9	1060	7.90	2.13	531	<0.02	<0.02	34	<5

Notes:

- 1. EC: Electrical Conductivity
- 2. Turbidity is taken to be the average of three consecutive measurements.
- 3. TDS: Total Dissolved Solids
- 4. ACU: Actual Colour Units (unfiltered)
- 5. TCU: True Colour Units (field-filtered using 0.45-micron filter
- 6. Test well TW1 and TW2 were resampled after an extended pumping duration due to initial high levels of turbidity.



Private Wells

Well	Temp (°C)	EC¹ (μS/cm)	рН (-)	Turbidity ² (NTU)	TDS³ (ppm)	Free Chlorine (mg/L)	Total Chlorine (mg/L)	Colour (ACU⁴)	Colour (TCU⁵)
PW1	9.7	1435	7.45	2.1	714	-	<0.02	0	0
PW2	10.7	633	7.46	1.06	315	-	<0.02	34	31
PW3	10.2	766	7.47	0.96	385	-	<0.02	0	0
PW4	11.0	817	7.42	0.69	411	-	<0.02	8	0



Water Quality Summary Test Wells

Parameter	Units	MDL						San	nple					
			TW1- 3hr	TW1-6hr	TW1-R1a / TW1-	TW2- 3hr	TW2- 6hr	TW2-R1	TW3- 3hr	TW3- 6hr	TW4- 3hr	TW4- 6hr	TW5 - 3hr	TW5 - 6hr
Sample Date (m/d/y)			03/19/2021	03/19/2021	R1b 04/07/2021	03/18/2021	03/18/2021	04/05/2021	03/19/2021	03/19/2021	03/18/2021	03/18/2021	03/16/2021	03/16/2021
Microbiological Parameters			00/15/2021	00/10/2021	04/07/2022	00/10/2021	00/10/2021	04/05/2022	00/10/2021	00/10/2021	00/10/2021	00/10/2021	00/10/2021	00/10/2021
E. Coli	CFU/100 mL	1	ND (1)	ND (1)	ND (1) / ND (1)	ND (1)	ND (1)	-	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Fecal Coliforms	CFU/100 mL	1	ND (1)	ND (1)	ND (1) / ND(1)	ND (1)	ND (1)	-	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Total Coliforms	CFU/100 mL	1	ND (1)	74	ND (1) / ND (1)	1	ND (1)	-	ND (1)	ND (1)	3	ND (1)	ND (1)	ND (1)
Heterotrophic Plate Count	CFU/mL	10	-	-	ND (10) / ND (10)	ND (10)	ND (10)	-	-	-	ND (10)	ND (10)	ND (10)	ND (10)
General Inorganics						()	(,					(,	()	()
Alkalinity, total	mg/L	5	149	147		170	171	-	276	300	293	293	284	286
Ammonia as N	mg/L	0.01	0.09	0.38		0.06	0.15	-	0.14	0.17	0.25	0.23	0.25	0.25
Dissolved Organic Carbon	mg/L	0.5	5.6	4.9		3.3	3.8	-	3.3	2.5	4.1	3.9	1.5	1.4
Colour	TCU	2	30	35	18	35	38	16	10	8	8	7	2	3
Colour, apparent	ACU	2	67	69	25	99	64	24	17	16	10	11	5	9
Conductivity	uS/cm	5	344	321		359	368	-	1010	1170	1120	1100	1050	1060
Hardness	mg/L		-	164		-	192	-		373		395	331	339
pH	pH Units	0.1	8.3	8.3		8.3	8.3	-	8.2	8.2	8.1	8.1	7.9	8.0
Phenolics	mg/L	0.001	ND (0.001)	ND (0.001)		ND (0.001)	ND (0.001)	-	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Total Dissolved Solids	mg/L	10	196	192		336	336	-	572	664	716	742	528	520
Sulphide	mg/L	0.02	ND (0.02)	ND (0.02)		ND (0.02)	ND (0.02)	-	0.17	0.18	0.56	0.58	0.90	0.92
Tannin & Lignin	mg/L	0.1	0.5	0.5		0.3	0.3	-	0.1	ND (0.1)	0.2	0.2	ND (0.1)	ND (0.1)
Total Kjeldahl Nitrogen	mg/L	0.1	0.3	0.5		0.1	0.3	-	0.1	0.2	0.2	0.3	0.3	0.4
Organic Nitrogen	mg/L		0.2	0.1		0.0	0.2		-	0.0	-	0.1	0.1	0.2
Turbidity	NTU	0.1	10.2	10.3	1.1	18.6	10.0	0.7	1.2	1.0	0.9	1.0	0.4	1.6
Anions		0.1	1012	2010		1010	1010			2.0	0.5	1.0	0.4	1.0
Chloride	mg/L	1	2	2	-	3	3	-	119	148	141	135	125	127
Fluoride	mg/L	0.1	ND (0.1)	0.1	-	ND (0.1)	ND (0.1)	-	0.2	0.2	0.3	0.3	0.1	0.1
Nitrate as N	mg/L	0.1	ND (0.1)	ND (0.1)	-	ND (0.1)	ND (0.1)	-	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)
Nitrite as N	mg/L	0.05	ND (0.05)	ND (0.05)		ND (0.05)	ND (0.05)	-	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)
Sulphate	mg/L	1	16	16	-	18	18	-	66	78	76	74	63	65
Metals		-	10	10		10	10		00	70	,,,		00	00
Mercury	mg/L	0.0001	-	ND (0.0001)	-	-	ND (0.0001)	-	-	ND (0.0001)	-	ND (0.0001)	-	ND (0.0001)
Aluminum	mg/L	0.001	-	0.117	-	-	0.103	-	-	0.002	-	0.002	-	0.001
Antimony	mg/L	0.0005	-	ND (0.0005)	-	-	ND (0.0005)	-	-	ND (0.0005)	-	ND (0.0005)	-	ND (0.0005)
Arsenic	mg/L	0.001	-	ND (0.001)	-	-	ND (0.001)	-	-	ND (0.001)	-	ND (0.001)	-	ND (0.001)
Barium	mg/L	0.001	-	0.170		-	0.215	-	-	0.309	-	0.288	-	0.247
Boron	mg/L	0.01	-	0.01	-	-	0.01	-	-	0.09	-	0.15	-	0.23
Cadmium	mg/L	0.0001	-	ND (0.0001)	-	-	ND (0.0001)	-	-	ND (0.0001)	-	ND (0.0001)	-	ND (0.0001)
Calcium	mg/L	0.1	-	44.6	-	49.9	50.0	-	-	89.3	95	91.2	75.0	77.1
Chromium (VI)	mg/L	0.010	-	ND (0.010)	-	-	ND (0.010)	-	-	ND (0.010)	-	ND (0.010)	-	ND (0.010)
Chromium	mg/L	0.001	-	ND (0.001)	-	-	ND (0.001)	-	-	ND (0.001)	-	ND (0.001)	-	ND (0.001)
Copper	mg/L	0.0005	-	0.0006	-	-	0.0005	-	-	0.0013	-	0.0031	-	ND (0.0005)
Iron	mg/L	0.1	-	0.7	0.5	0.8	0.8	0.529	-	0.3	0.2	0.2	ND (0.1)	0.1
Lead	mg/L	0.0001	-	0.0007	-	-	0.0007	-	-	ND (0.0001)	-	0.0003	-	ND (0.0001)
Magnesium	mg/L	0.2	-	12.7	-	16.1	16.3	-	-	36.5	41.2	40.7	34.9	35.7
Manganese	mg/L	0.005	-	0.075	-	0.051	0.048	-	-	0.051	0.023	0.023	0.023	0.025
Potassium	mg/L	0.005	-	1.1	-	1.4	1.4	_	_	5.1	9.0	8.5	8.0	7.9
Selenium	mg/L	0.001	-	ND (0.001)	-	-	ND (0.001)	-	_	ND (0.001)	-	ND (0.001)	-	ND (0.001)
Sodium	mg/L	0.2	-	2.7	-	3.4	3.2	-	-	75.3	64.8	66.9	78.4	78.9
Uranium	mg/L	0.0001	-	0.0002	-	-	0.0002	_		0.0001	-	0.0003	-	ND (0.0001)
Zinc	mg/L	0.005	_	ND (0.005)	_	_	ND (0.005)	_		0.008		0.007	_	ND (0.005)
ZIIIC	IIIB/L	0.005	-	(כטט.ט) שא	-	-	(כטט.ט) עא	-	-	0.000	-	0.007	-	(כטט.ט) עא

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Exceeds the Ontario Drinking Water Quality Standards



Water Quality Summary Private Well Sampling

Parameter	Units	MDL		Sam	ple	
			PW1	PW2	PW3	PW4
Sample Date (m/d/y)			04/28/2021	04/28/2021	04/28/2021	04/28/2021
Microbiological Parameters						
E. Coli	CFU/100 mL	1	ND (1)	ND (1)	ND (1)	ND (1)
Fecal Coliforms	CFU/100 mL	1	ND (1)	ND (1)	ND (1)	ND (1)
Total Coliforms	CFU/100 mL	1	ND (1)	ND (1)	ND (1)	ND (1)
Heterotrophic Plate Count	CFU/mL	10	ND (10)	ND (10)	ND (10)	ND (10)
General Inorganics						
Alkalinity, total	mg/L	5	305	229	250	282
Ammonia as N	mg/L	0.01	0.07	0.10	0.20	0.07
Dissolved Organic Carbon	mg/L	0.5	3.0	3.2	4.5	5.0
Colour	TCU	2	2	12	8	12
Colour, apparent	ACU	2	22	13	47	15
Conductivity	uS/cm	5	1470	614	733	773
Hardness	mg/L		488	263	280	320
рН	pH Units	0.1	7.8	8.0	8.0	7.8
Phenolics	mg/L	0.001	ND (0.001)	ND (0.001)	ND (0.001)	ND (0.001)
Total Dissolved Solids	mg/L	10	810	336	434	412
Sulphide	mg/L	0.02	ND (0.02)	0.10	0.04	ND (0.02)
Tannin & Lignin	mg/L	0.1	ND (0.1)	ND (0.1)	ND (0.1)	ND (0.1)
Total Kjeldahl Nitrogen	mg/L	0.1	0.2	0.2	0.4	0.2
Organic Nitrogen	mg/L	0.1	0.1	0.1	0.2	0.1
Turbidity	NTU	0.1	3.6	0.5	2.6	0.2
Anions						
Chloride	mg/L	1	187	33	64	47
Fluoride	mg/L	0.1	ND (0.1)	0.2	ND (0.1)	ND (0.1)
Nitrate as N	mg/L	0.1	0.2	ND (0.1)	ND (0.1)	ND (0.1)
Nitrite as N	mg/L	0.05	ND (0.05)	ND (0.05)	ND (0.05)	ND (0.05)
Sulphate	mg/L	1	124	38	37	59
Metals						
Calcium	mg/L	0.1	115	62.6	70.6	82.3
Iron	mg/L	0.1	0.5	0.2	0.9	ND (0.1)
Magnesium	mg/L	0.2	48.6	25.8	25.3	27.8
Manganese	mg/L	0.005	0.119	0.035	0.102	0.110
Potassium	mg/L	0.1	1.9	3.2	1.6	1.4
Sodium	mg/L	0.2	88.6	22.2	36.4	33.4

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Exceeds the Ontario Drinking Water Quality Standards



APPENDIX J

Laboratory Certificates of Analyses



RELIABLE.

300 - 2319 St. Laurent Blvd Ottawa, ON, K1G 4J8 1-800-749-1947 www.paracellabs.com

Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive Kanata, ON K2K 2A9 Attn: Andrius Paznekas

Client PO: Project: 100554.001 Custody: 143484

Report Date: 25-Mar-2021 Order Date: 19-Mar-2021

Order #: 2112634

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2112634-01	TW1- 3hr
2112634-02	TW1- 6hr
2112634-03	TW3- 3hr
2112634-04	TW3- 6hr

Approved By:

Mark Foto

Mark Foto, M.Sc. Lab Supervisor

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.



Analysis Summary Table

Report Date: 25-Mar-2021 Order Date: 19-Mar-2021

Project Description: 100554.001

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	22-Mar-21	23-Mar-21
Ammonia, as N	EPA 351.2 - Auto Colour	22-Mar-21	23-Mar-21
Anions	EPA 300.1 - IC	22-Mar-21	23-Mar-21
Chromium, hexavalent - water	MOE E3056 - colourimetric	23-Mar-21	23-Mar-21
Colour	SM2120 - Spectrophotometric	19-Mar-21	19-Mar-21
Colour, apparent	SM2120 - Spectrophotometric	19-Mar-21	19-Mar-21
Conductivity	EPA 9050A- probe @25 °C	22-Mar-21	23-Mar-21
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	23-Mar-21	23-Mar-21
E. coli	MOE E3407	19-Mar-21	19-Mar-21
Fecal Coliform	SM 9222D	19-Mar-21	19-Mar-21
Mercury by CVAA	EPA 245.2 - Cold Vapour AA	23-Mar-21	24-Mar-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	22-Mar-21	22-Mar-21
рН	EPA 150.1 - pH probe @25 °C	22-Mar-21	23-Mar-21
Phenolics	EPA 420.2 - Auto Colour, 4AAP	22-Mar-21	22-Mar-21
Hardness	Hardness as CaCO3	22-Mar-21	22-Mar-21
Sulphide	SM 4500SE - Colourimetric	23-Mar-21	23-Mar-21
Tannin/Lignin	SM 5550B - Colourimetric	22-Mar-21	22-Mar-21
Total Coliform	MOE E3407	19-Mar-21	19-Mar-21
Total Dissolved Solids	SM 2540C - gravimetric, filtration	24-Mar-21	24-Mar-21
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	22-Mar-21	23-Mar-21
Turbidity	SM 2130B - Turbidity meter	19-Mar-21	19-Mar-21

PARACEL LABORATORIES LTD.

Certificate of Analysis

Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Order #: 2112634

Report Date: 25-Mar-2021 Order Date: 19-Mar-2021

Project Description: 100554.001

	Client ID: Sample Date: Sample ID:	TW1- 3hr 19-Mar-21 11:00 2112634-01	TW1- 6hr 19-Mar-21 13:30 2112634-02	TW3- 3hr 19-Mar-21 11:00 2112634-03	TW3- 6hr 19-Mar-21 13:30 2112634-04
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	Drinking Water
Microbiological Parameters			i		
E. coli	1 CFU/100 mL	ND	ND [1]	ND	ND
Fecal Coliforms	1 CFU/100 mL	ND	ND	ND	ND
Total Coliforms	1 CFU/100 mL	ND	74 [1]	ND	ND
General Inorganics			1		
Alkalinity, total	5 mg/L	149	147	276	300
Ammonia as N	0.01 mg/L	0.09	0.38	0.14	0.17
Dissolved Organic Carbon	0.5 mg/L	5.6	4.9	3.3	2.5
Colour	2 TCU	30	35	10	8
Colour, apparent	2 ACU	67	69	17	16
Conductivity	5 uS/cm	344	321	1010	1170
Hardness	mg/L	-	164	-	373
рН	0.1 pH Units	8.3	8.3	8.2	8.2
Phenolics	0.001 mg/L	<0.001	<0.001	<0.001	<0.001
Total Dissolved Solids	10 mg/L	196	192	572	664
Sulphide	0.02 mg/L	<0.02	<0.02	0.17	0.18
Tannin & Lignin	0.1 mg/L	0.5	0.5	0.1	<0.1
Total Kjeldahl Nitrogen	0.1 mg/L	0.3	0.5	0.1	0.2
Turbidity	0.1 NTU	10.2	10.3	1.2	1.0
Anions					
Chloride	1 mg/L	2	2	119	148
Fluoride	0.1 mg/L	<0.1	0.1	0.2	0.2
Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	<0.1
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	<0.05
Sulphate	1 mg/L	16	16	66	78
Metals					
Mercury	0.0001 mg/L	-	<0.0001	-	<0.0001
Aluminum	0.001 mg/L	-	0.117	-	0.002
Antimony	0.0005 mg/L	-	<0.0005	-	<0.0005
Arsenic	0.001 mg/L	-	<0.001	-	<0.001
Barium	0.001 mg/L	-	0.170	-	0.309
Boron	0.01 mg/L	-	0.01	-	0.09
Cadmium	0.0001 mg/L	-	<0.0001	-	<0.0001
Calcium	0.1 mg/L	-	44.6	-	89.3
Chromium	0.001 mg/L	-	<0.001	-	<0.001
Chromium (VI)	0.010 mg/L	-	<0.010	-	<0.010



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 25-Mar-2021 Order Date: 19-Mar-2021

Project Description: 100554.001

	r		T 14/4 O		
	Client ID:	TW1- 3hr	TW1- 6hr	TW3- 3hr	TW3- 6hr
	Sample Date:	19-Mar-21 11:00	19-Mar-21 13:30	19-Mar-21 11:00	19-Mar-21 13:30
	Sample ID:	2112634-01	2112634-02	2112634-03	2112634-04
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	Drinking Water
Copper	0.0005 mg/L	-	0.0006	-	0.0013
Iron	0.1 mg/L	-	0.7	-	0.3
Lead	0.0001 mg/L	-	0.0007	-	<0.0001
Magnesium	0.2 mg/L	-	12.7	-	36.5
Manganese	0.005 mg/L	-	0.075	-	0.051
Potassium	0.1 mg/L	1.1	1.1	5.0	5.1
Selenium	0.001 mg/L	-	<0.001	-	<0.001
Sodium	0.2 mg/L	-	2.7	-	75.3
Uranium	0.0001 mg/L	-	0.0002	-	0.0001
Zinc	0.005 mg/L	-	<0.005	-	0.008



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 25-Mar-2021

Order Date: 19-Mar-2021

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	тсu						
Colour, apparent	ND	2	ACU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NŤU						
Metals									
Mercury	ND	0.0001	mg/L						
Aluminum	ND	0.001	mg/L						
Antimony	ND	0.0005	mg/L						
Arsenic	ND	0.001	mg/L						
Barium	ND	0.001	mg/L						
Boron	ND	0.01	mg/L						
Cadmium	ND	0.0001	mg/L						
Calcium	ND	0.1	mg/L						
Chromium (VI)	ND	0.010	mg/L						
Chromium	ND	0.001	mg/L						
Copper	ND	0.0005	mg/L						
Iron	ND	0.1	mg/L						
Lead	ND	0.0001	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese	ND	0.005	mg/L						
Potassium	ND	0.1	mg/L						
Selenium	ND	0.001	mg/L						
Sodium	ND	0.2	mg/L						
Uranium	ND	0.0001	mg/L						
Zinc	ND	0.005	mg/L						
Microbiological Parameters		0.000	g, L						
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						
	שא	I							



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 25-Mar-2021

Order Date: 19-Mar-2021

Project Description: 100554.001

Method Quality Control: Duplicate

A se a la dia		Reporting		Source		%REC		RPD	
Analyte	Result	Limit	Units	Result	%REC	Limit	RPD	Limit	Notes
nions									
Chloride	7.02	1	mg/L	7.12			1.4	10	
Fluoride	0.71	0.1	mg/L	0.73			2.9	10	
Nitrate as N	0.59	0.1	mg/L	0.60			1.6	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	
Sulphate	24.6	1	mg/L	24.8			0.9	10	
eneral Inorganics			5						
Alkalinity, total	282	5	mg/L	287			1.9	14	
Ammonia as N	0.166	0.01	mg/L	0.168			1.2	17.7	
Dissolved Organic Carbon	4.0	0.5	mg/L	3.3			19.6	37	
Colour	32	2	TCU	30			6.5	12	
Colour, apparent	72	2	ACU	69			4.3	12	
Conductivity	850	5	uS/cm	876			3.0	5	
bH	8.0	0.1	pH Units	8.0			0.5	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
otal Dissolved Solids	94.0	10	mg/L	98.0			4.2	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
annin & Lignin	ND	0.02	mg/L	ND			NC	10	
otal Kjeldahl Nitrogen	0.18	0.1	mg/L	0.27			NC	16	
urbidity	10.3	0.1	NTU	10.27			1.0	10	
	10.5	0.1	NIU	10.2			1.0	10	
etals									
<i>M</i> ercury	ND	0.0001	mg/L	ND			NC	20	
luminum	0.086	0.001	mg/L	0.117			29.9	20	QR-05
Intimony	ND	0.0005	mg/L	ND			NC	20	
Arsenic	ND	0.001	mg/L	ND			NC	20	
Barium	0.168	0.001	mg/L	0.170			1.6	20	
Boron	0.01	0.01	mg/L	0.01			0.6	20	
Cadmium	ND	0.0001	mg/L	ND			NC	20	
Calcium	42.5	0.1	mg/L	44.6			4.9	20	
Chromium (VI)	ND	0.010	mg/L	ND			NC	20	
Chromium	ND	0.001	mg/L	ND			NC	20	
Copper	0.0005	0.0005	mg/L	0.0006			3.8	20	
on	0.6	0.1	mg/L	0.7			7.7	20	
ead	0.0007	0.0001	mg/L	0.0007			6.0	20	
/agnesium	12.4	0.2	mg/L	12.7			2.1	20	
langanese	0.075	0.005	mg/L	0.075			0.5	20	
Potassium	1.1	0.1	mg/L	1.1			0.8	20	
Selenium	ND	0.001	mg/L	ND			NC	20	
Sodium	2.5	0.2	mg/L	2.7			7.0	20	
Jranium	0.0002	0.0001	mg/L	0.0002			1.7	20	
linc	0.0002 ND	0.0001	mg/L	0.0002 ND			NC	20	
icrobiological Parameters	UN	0.005	IIIg/L	NU			NO	20	
•		4	CFU/100 mL				NO	20	
	ND	1		ND			NC	30	
Fecal Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100 mL	ND			NC	30	



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 25-Mar-2021

Order Date: 19-Mar-2021

Project Description: 100554.001

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	16.7	1	mg/L	7.12	95.6	77-123			
Fluoride	1.54	0.1	mg/L	0.73	80.7	79-121			
Nitrate as N	1.60	0.1	mg/L	0.60	100	79-120			
Nitrite as N	0.914	0.05	mg/L	ND	91.4	84-117			
Sulphate	33.2	1	mg/L	24.8	84.1	74-126			
General Inorganics									
Ammonia as N	0.421	0.01	mg/L	0.168	101	81-124			
Dissolved Organic Carbon	13.9	0.5	mg/L	3.3	107	60-133			
Phenolics	0.023	0.001	mg/L	ND	92.5	69-132			
Total Dissolved Solids	100	10	mg/L	ND	100	75-125			
Sulphide	0.52	0.02	mg/L	ND	104	79-115			
Tannin & Lignin	1.1	0.1	mg/L	ND	106	71-113			
Total Kjeldahl Nitrogen	2.16	0.1	mg/L	0.27	94.5	81-126			
Metals									
Mercury	0.0031	0.0001	mg/L	ND	104	70-130			
Aluminum	44.5	0.001	mg/L	ND	89.1	80-120			
Antimony	45.1	0.0005	mg/L	0.225	89.7	80-120			
Arsenic	50.1	0.001	mg/L	0.480	99.3	80-120			
Barium	210	0.001	mg/L	170	79.1	80-120		(QM-07
Boron	55.7	0.01	mg/L	13.0	85.3	80-120			
Cadmium	50.1	0.0001	mg/L	0.0146	100	80-120			
Calcium	11600	0.1	mg/L	ND	116	80-120			
Chromium (VI)	0.205	0.010	mg/L	ND	102	70-130			
Chromium	53.3	0.001	mg/L	0.539	106	80-120			
Copper	48.0	0.0005	mg/L	0.561	94.8	80-120			
Iron	2870	0.1	mg/L	652	88.7	80-120			
Lead	42.8	0.0001	mg/L	0.666	84.2	80-120			
Magnesium	23400	0.2	mg/L	12700	108	80-120			
Manganese	123	0.005	mg/L	74.8	95.6	80-120			
Potassium	12500	0.1	mg/L	1140	113	80-120			
Selenium	48.2	0.001	mg/L	0.128	96.1	80-120			
Sodium	13800	0.2	mg/L	2690	111	80-120			
Uranium	43.9	0.0001	mg/L	0.221	87.3	80-120			
Zinc	48.3	0.005	mg/L	1.17	94.3	80-120			



Login Qualifiers :

Container(s) - Labeled improperly/insufficient information - sample time reads 14:00

Applies to samples: TW1- 3hr, TW1- 6hr, TW3- 3hr, TW3- 6hr

Sample Qualifiers :

1: A2C - Background counts greater than 200

QC Qualifiers :

- QM-07 : The spike recovery was outside acceptance limits for the MS and/or MSD. The batch was accepted based on other acceptable QC.
- QR-05 : Duplicate RPDs higher than normally accepted. Remaining batch QA\QC was acceptable. May be sample effect.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable ND: Not Detected MDL: Method Detection Limit Source Result: Data used as source for matrix and duplicate samples %REC: Percent recovery. RPD: Relative percent difference. NC: Not Calculated



RELIABLE.

300 - 2319 St. Laurent Blvd Ottawa, ON, K1G 4J8 1-800-749-1947 www.paracellabs.com

Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive Kanata, ON K2K 2A9 Attn: Andrius Paznekas

Client PO: Project: 100554.001 Custody: 13285

Report Date: 24-Mar-2021 Order Date: 18-Mar-2021

Order #: 2112540

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2112540-01	TW2- 3hr
2112540-02	TW2- 6hr
2112540-03	TW4- 3hr
2112540-04	TW4- 6hr

Approved By:

Mark Foto

Mark Foto, M.Sc. Lab Supervisor

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.



Analysis Summary Table

Report Date: 24-Mar-2021 Order Date: 18-Mar-2021

Project Description: 100554.001

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	22-Mar-21	23-Mar-21
Ammonia, as N	EPA 351.2 - Auto Colour	22-Mar-21	23-Mar-21
Anions	EPA 300.1 - IC	22-Mar-21	22-Mar-21
Chromium, hexavalent - water	MOE E3056 - colourimetric	19-Mar-21	19-Mar-21
Colour	SM2120 - Spectrophotometric	19-Mar-21	19-Mar-21
Colour, apparent	SM2120 - Spectrophotometric	19-Mar-21	19-Mar-21
Conductivity	EPA 9050A- probe @25 °C	22-Mar-21	23-Mar-21
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	23-Mar-21	23-Mar-21
E. coli	MOE E3407	19-Mar-21	19-Mar-21
Fecal Coliform	SM 9222D	19-Mar-21	19-Mar-21
Heterotrophic Plate Count	SM 9215C	20-Mar-21	22-Mar-21
Mercury by CVAA	EPA 245.2 - Cold Vapour AA	19-Mar-21	23-Mar-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	19-Mar-21	19-Mar-21
рН	EPA 150.1 - pH probe @25 °C	22-Mar-21	23-Mar-21
Phenolics	EPA 420.2 - Auto Colour, 4AAP	19-Mar-21	19-Mar-21
Hardness	Hardness as CaCO3	19-Mar-21	19-Mar-21
Sulphide	SM 4500SE - Colourimetric	23-Mar-21	23-Mar-21
Tannin/Lignin	SM 5550B - Colourimetric	22-Mar-21	22-Mar-21
Total Coliform	MOE E3407	19-Mar-21	19-Mar-21
Total Dissolved Solids	SM 2540C - gravimetric, filtration	23-Mar-21	24-Mar-21
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	19-Mar-21	22-Mar-21
Turbidity	SM 2130B - Turbidity meter	19-Mar-21	19-Mar-21



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Barium

Boron

Cadmium

Calcium

Chromium

Order #: 2112540

Report Date: 24-Mar-2021

Order Date: 18-Mar-2021
Project Description: 100554.001

	Client ID: Sample Date: Sample ID:	TW2- 3hr 18-Mar-21 11:30 2112540-01 Drinking Water	TW2- 6hr 18-Mar-21 14:30 2112540-02 Drinking Water	TW4- 3hr 18-Mar-21 11:30 2112540-03 Drinking Water	TW4- 6hr 18-Mar-21 14:30 2112540-04 Drinking Water
Microbiological Parameters	MDL/Units	Drinking water	Diffiking water	Diffiking water	Drinking Water
E. coli	1 CFU/100 mL	ND	ND	ND	ND
Fecal Coliforms	1 CFU/100 mL	ND	ND	ND	ND
Total Coliforms	1 CFU/100 mL	1 [1]	ND	3	ND
Heterotrophic Plate Count	10 CFU/mL	<10	<10	<10	<10
General Inorganics	ł			ļ	ļ
Alkalinity, total	5 mg/L	170	171	293	293
Ammonia as N	0.01 mg/L	0.06	0.15	0.25	0.23
Dissolved Organic Carbon	0.5 mg/L	3.3	3.8	4.1	3.9
Colour	2 TCU	35	38	8	7
Colour, apparent	2 ACU	99	64	10	11
Conductivity	5 uS/cm	359	368	1120	1100
Hardness	mg/L	-	192	-	395
рН	0.1 pH Units	8.3	8.3	8.1	8.1
Phenolics	0.001 mg/L	<0.001	<0.001	<0.001	<0.001
Total Dissolved Solids	10 mg/L	336	336	716	742
Sulphide	0.02 mg/L	<0.02	<0.02	0.56	0.58
Tannin & Lignin	0.1 mg/L	0.3	0.3	0.2	0.2
Total Kjeldahl Nitrogen	0.1 mg/L	0.1	0.3	0.2	0.3
Turbidity	0.1 NTU	18.6	10.0	0.9	1.0
Anions			•		
Chloride	1 mg/L	3	3	141	135
Fluoride	0.1 mg/L	<0.1	<0.1	0.3	0.3
Nitrate as N	0.1 mg/L	<0.1	<0.1	<0.1	<0.1
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	<0.05
Sulphate	1 mg/L	18	18	76	74
letals					
Mercury	0.0001 mg/L	-	<0.0001	-	<0.0001
Aluminum	0.001 mg/L	-	0.103	-	0.002
Antimony	0.0005 mg/L	-	<0.0005	-	<0.0005
Arsenic	0.001 mg/L	-	<0.001	-	<0.001

-

-

-

-

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0.215

0.01

< 0.0001

50.0

<0.001

-

-

-

-

-

0.001 mg/L

0.01 mg/L

0.0001 mg/L

0.1 mg/L

0.001 mg/L

0.288

0.15

< 0.0001

91.2

<0.001



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 24-Mar-2021 Order Date: 18-Mar-2021

Project Description: 100554.001

	Client ID:	TW2- 3hr	TW2- 6hr	TW4- 3hr	TW4- 6hr
	Sample Date:	18-Mar-21 11:30	18-Mar-21 14:30	18-Mar-21 11:30	18-Mar-21 14:30
	Sample ID:	2112540-01	2112540-02	2112540-03	2112540-04
	MDL/Units	Drinking Water	Drinking Water	Drinking Water	Drinking Water
Chromium (VI)	0.010 mg/L	-	<0.010	-	<0.010
Copper	0.0005 mg/L	-	0.0005	-	0.0031
Iron	0.1 mg/L	-	0.8	-	0.2
Lead	0.0001 mg/L	-	0.0007	-	0.0003
Magnesium	0.2 mg/L	-	16.3	-	40.7
Manganese	0.005 mg/L	-	0.048	-	0.023
Potassium	0.1 mg/L	1.4	1.4	9.0	8.5
Selenium	0.001 mg/L	-	<0.001	-	<0.001
Sodium	0.2 mg/L	-	3.2	-	66.9
Uranium	0.0001 mg/L	-	0.0002	-	0.0003
Zinc	0.005 mg/L	-	<0.005	-	0.007



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 24-Mar-2021

Order Date: 18-Mar-2021

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics			0						
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	тču						
Colour, apparent	ND	2	ACU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals		0.1							
Mercury	ND	0.0001	mg/L						
Aluminum	ND	0.001	mg/L						
Antimony	ND	0.0005	mg/L						
Arsenic	ND	0.000	mg/L						
Barium	ND	0.001	mg/L						
Boron	ND	0.01	mg/L						
Cadmium	ND	0.0001	mg/L						
Calcium	ND	0.1	mg/L						
Chromium (VI)	ND	0.010	mg/L						
Chromium	ND	0.010	mg/L						
Copper	ND	0.0005	mg/L						
Iron	ND	0.0005	mg/L						
Lead	ND	0.0001							
	ND	0.0001	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese Potassium	ND		mg/L						
		0.1	mg/L						
Selenium	ND	0.001	mg/L						
Sodium	ND	0.2	mg/L						
Uranium	ND	0.0001	mg/L						
Zinc Missobiological Parameters	ND	0.005	mg/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						
Heterotrophic Plate Count	ND	10	CFU/mL						



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 24-Mar-2021

Order Date: 18-Mar-2021

Project Description: 100554.001

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
				result	,01120				
Anions									
Chloride	7.02	1	mg/L	7.12			1.4	10	
Fluoride	0.71	0.1	mg/L	0.73			2.9	10	
Nitrate as N	0.59	0.1	mg/L	0.60			1.6	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	
Sulphate	24.6	1	mg/L	24.8			0.9	10	
General Inorganics									
Alkalinity, total	282	5	mg/L	287			1.9	14	
Ammonia as N	0.166	0.01	mg/L	0.168			1.2	17.7	
Dissolved Organic Carbon	4.0	0.5	mg/L	3.3			19.6	37	
Colour	8	2	тсu	8			0.0	12	
Colour, apparent	19	2	ACU	19			0.0	12	
Conductivity	850	5	uS/cm	876			3.0	5	
pH	8.0	0.1	pH Units	8.0			0.5	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	306	10	mg/L	336			9.4	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	ND	0.1	mg/L	ND			NC	11	
Total Kjeldahl Nitrogen	0.28	0.1	mg/L	0.30			6.8	16	
Turbidity	18.7	0.1	NTU	18.6			0.5	10	
Metals									
Mercury	ND	0.0001	mg/L	ND			NC	20	
Aluminum	ND	0.001	mg/L	ND			NC	20	
Antimony	ND	0.0005	mg/L	ND			NC	20	
Arsenic	ND	0.001	mg/L	ND			NC	20	
Barium	0.023	0.001	mg/L	0.022			3.2	20	
Boron	0.06	0.01	mg/L	0.06			0.8	20	
Cadmium	ND	0.0001	mg/L	ND			NC	20	
Calcium	94.1	0.1	mg/L	93.3			0.9	20	
Chromium (VI)	ND	0.010	mg/L	ND			NC	20	
Chromium	ND	0.001	mg/L	ND			NC	20	
Copper	0.0052	0.0005	mg/L	0.0054			3.7	20	
Iron	ND	0.1	mg/L	ND			NC	20	
Lead	0.0004	0.0001	mg/L	0.0005			16.6	20	
Magnesium	26.3	0.2	mg/L	25.9			1.4	20	
Manganese	ND	0.005	mg/L	ND			NC	20	
Potassium	3.2	0.1	mg/L	3.1			2.0	20	
Selenium	ND	0.001	mg/L	ND			NC	20	
Sodium	10.7	0.2	mg/L	11.0			3.5	20	
Uranium	ND	0.0001	mg/L	0.0001			NC	20	
Zinc	0.005	0.005	mg/L	0.005			1.1	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100 mL	1			NC	30	
Heterotrophic Plate Count	ND	10	CFU/mL	ND			NC	30	



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 24-Mar-2021

Order Date: 18-Mar-2021

Project Description: 100554.001

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	16.7	1	mg/L	7.12	95.6	77-123			
Fluoride	1.54	0.1	mg/L	0.73	80.7	79-121			
Nitrate as N	1.60	0.1	mg/L	0.60	100	79-120			
Nitrite as N	0.914	0.05	mg/L	ND	91.4	84-117			
Sulphate	33.2	1	mg/L	24.8	84.1	74-126			
General Inorganics									
Ammonia as N	0.421	0.01	mg/L	0.168	101	81-124			
Dissolved Organic Carbon	13.9	0.5	mg/L	3.3	107	60-133			
Phenolics	0.025	0.001	mg/L	ND	99.7	69-132			
Total Dissolved Solids	110	10	mg/L	ND	110	75-125			
Sulphide	0.52	0.02	mg/L	ND	104	79-115			
Tannin & Lignin	1.1	0.1	mg/L	ND	106	71-113			
Total Kjeldahl Nitrogen	2.00	0.1	mg/L	0.37	81.8	81-126			
Metals									
Mercury	0.0032	0.0001	mg/L	ND	108	70-130			
Aluminum	42.2	0.001	mg/L	ND	84.4	80-120			
Antimony	42.6	0.0005	mg/L	ND	85.1	80-120			
Arsenic	49.9	0.001	mg/L	0.135	99.5	80-120			
Barium	68.3	0.001	mg/L	22.5	91.7	80-120			
Boron	55.4	0.01	mg/L	9.16	92.6	80-120			
Cadmium	45.3	0.0001	mg/L	0.0603	90.5	80-120			
Calcium	20800	0.1	mg/L	9130	117	80-120			
Chromium (VI)	0.209	0.010	mg/L	ND	104	70-130			
Chromium	52.8	0.001	mg/L	0.084	105	80-120			
Copper	51.6	0.0005	mg/L	5.42	92.3	80-120			
Iron	2410	0.1	mg/L	8.3	96.1	80-120			
Lead	42.5	0.0001	mg/L	0.473	84.0	80-120			
Magnesium	36200	0.2	mg/L	25900	103	80-120			
Manganese	55.3	0.005	mg/L	3.83	103	80-120			
Potassium	12500	0.1	mg/L	732	117	80-120			
Selenium	47.7	0.001	mg/L	0.124	95.1	80-120			
Sodium	21700	0.2	mg/L	11000	107	80-120			
Uranium	46.9	0.0001	mg/L	0.128	93.6	80-120			
Zinc	50.3	0.005	mg/L	5.19	90.3	80-120			



Sample Qualifiers :

1: Duplicate result for this sample analysis was determined to be ND.

QC Qualifiers :

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable ND: Not Detected MDL: Method Detection Limit Source Result: Data used as source for matrix and duplicate samples %REC: Percent recovery. RPD: Relative percent difference. NC: Not Calculated Report Date: 24-Mar-2021 Order Date: 18-Mar-2021 Project Description: 100554.001



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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive Kanata, ON K2K 2A9 Attn: Andrius Paznekas

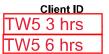
Client PO: Project: 100554.001 Custody:

Report Date: 23-Mar-2021 Order Date: 17-Mar-2021

Order #: 2112298

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID 2112298-01 2112298-02



Approved By:

Juck

Mark Foto, M.Sc. Lab Supervisor

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.

Page 1 of 8



Analysis Summary Table

Report Date: 23-Mar-2021 Order Date: 17-Mar-2021 Project Description: 100554.001

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	17-Mar-21	17-Mar-21
Ammonia, as N	EPA 351.2 - Auto Colour	18-Mar-21	18-Mar-21
Anions	EPA 300.1 - IC	18-Mar-21	18-Mar-21
Chromium, hexavalent - water	MOE E3056 - colourimetric	17-Mar-21	18-Mar-21
Colour	SM2120 - Spectrophotometric	17-Mar-21	17-Mar-21
Colour, apparent	SM2120 - Spectrophotometric	17-Mar-21	17-Mar-21
Conductivity	EPA 9050A- probe @25 °C	17-Mar-21	17-Mar-21
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	18-Mar-21	18-Mar-21
E. coli	MOE E3407	17-Mar-21	17-Mar-21
Fecal Coliform	SM 9222D	17-Mar-21	17-Mar-21
Heterotrophic Plate Count	SM 9215C	17-Mar-21	17 - Mar-21
Mercury by CVAA	EPA 245.2 - Cold Vapour AA	18-Mar-21	18-Mar-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	17-Mar-21	17-Mar-21
рН	EPA 150.1 - pH probe @25 °C	17-Mar-21	17-Mar-21
Phenolics	EPA 420.2 - Auto Colour, 4AAP	17-Mar-21	17-Mar-21
Hardness	Hardness as CaCO3	17-Mar-21	17-Mar-21
Sulphide	SM 4500SE - Colourimetric	18-Mar-21	18-Mar-21
Tannin/Lignin	SM 5550B - Colourimetric	22-Mar-21	22 - Mar-21
Total Coliform	MOE E3407	17-Mar-21	17-Mar-21
Total Dissolved Solids	SM 2540C - gravimetric, filtration	22-Mar-21	22-Mar-21
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	19-Mar-21	22-Mar-21
Turbidity	SM 2130B - Turbidity meter	17-Mar-21	17-Mar-21



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Order #: 2112298

Report Date: 23-Mar-2021 Order Date: 17-Mar-2021 Project Description: 100554.001

	_				
	Client ID:	TW5 3 hrs	TW5 6 hrs	-	-
	Sample Date:	16-Mar-21 09:00	16-Mar-21 00:00	-	-
	Sample ID:	2112298-01 Drinking Water	2112298-02 Drinking Water	-	-
Microbiological Parameters	MDL/Units	Dilliking Water	Diliking water		
	1 CFU/100 mL	ND	ND	_	_
	1 CFU/100 mL		1		
Fecal Coliforms	+	ND	ND	-	-
Total Coliforms	1 CFU/100 mL	ND	ND	-	-
Heterotrophic Plate Count	10 CFU/mL	<10	<10	-	-
General Inorganics	· · · ·				
Alkalinity, total	5 mg/L	284	286	-	-
Ammonia as N	0.01 mg/L	0.25	0.25	-	-
Dissolved Organic Carbon	0.5 mg/L	1.5	1.4	-	-
Colour	2 TCU	2	3	-	-
Colour, apparent	2 ACU	5	9	-	_
Conductivity	5 uS/cm	1050	1060	-	-
Hardness	mg/L	331	339	-	-
рН	0.1 pH Units	7.9	8.0	-	-
Phenolics	0.001 mg/L	<0.001	<0.001	-	-
Total Dissolved Solids	10 mg/L	528	520	-	-
Sulphide	0.02 mg/L	0.90	0.92	-	-
Tannin & Lignin	0.1 mg/L	<0.1	<0.1	-	-
Total Kjeldahl Nitrogen	0.1 mg/L	0.3	0.4	-	-
Turbidity	0.1 NTU	0.4	1.6	-	-
Anions					
Chloride	1 mg/L	125	127	-	-
Fluoride	0.1 mg/L	0.1	0.1	-	-
Nitrate as N	0.1 mg/L	<0.1	<0.1	-	-
Nitrite as N	0.05 mg/L	<0.05	<0.05	-	-
Sulphate	1 mg/L	63	65	-	-
Metals			-	-	
Mercury	0.0001 mg/L	-	<0.0001	-	-
Aluminum	0.001 mg/L	-	0.001	-	-
Antimony	0.0005 mg/L	-	<0.0005	-	-
Arsenic	0.001 mg/L	-	<0.001	_	-
Barium	0.001 mg/L	-	0.247	-	_
Boron	0.01 mg/L	-	0.23	-	_
Cadmium	0.0001 mg/L	-	<0.0001	-	-
Calcium	0.1 mg/L	75.0	77.1	-	-
Chromium	0.001 mg/L	-	<0.001	-	-



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Order #: 2112298

Report Date: 23-Mar-2021 Order Date: 17-Mar-2021 Project Description: 100554.001

	,			i	
	Client ID:	TW21-04 3hrs	TW21-04 6hrs	-	-
	Sample Date:	16-Mar-21 09:00	16-Mar-21 00:00	-	-
	Sample ID:	2112298-01	2112298-02	-	-
	MDL/Units	Drinking Water	Drinking Water	-	-
Chromium (VI)	0.010 mg/L	-	<0.010	-	-
Copper	0.0005 mg/L	-	<0.0005	-	_
Iron	0.1 mg/L	<0.1	0.1	_	_
Lead	0.0001 mg/L	-	<0.0001	-	_
Magnesium	0.2 mg/L	34.9	35.7	-	_
Manganese	0.005 mg/L	0.023	0.025	-	_
Potassium	0.1 mg/L	8.0	7.9	-	_
Selenium	0.001 mg/L	-	<0.001	-	_
Sodium	0.2 mg/L	78.4	78.9	-	_
Uranium	0.0001 mg/L	-	<0.0001	-	-
Zinc	0.005 mg/L	_	<0.005	-	_

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Order #: 2112298

Report Date: 23-Mar-2021 Order Date: 17-Mar-2021

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	тси						
Colour, apparent	ND	2	ACU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals		0.1							
Mercury	ND	0.0001	mg/L						
Aluminum	ND	0.0001	mg/L						
Antimony	ND	0.0005	mg/L						
Anumony Arsenic	ND	0.0005	mg/L						
Barium	ND	0.001	mg/L						
Boron	ND	0.001							
Cadmium	ND	0.0001	mg/L						
			mg/L						
	ND	0.1	mg/L						
Chromium (VI)	ND	0.010	mg/L						
Chromium	ND	0.001	mg/L						
Copper	ND ND	0.0005	mg/L						
Iron		0.1	mg/L						
Lead	ND	0.0001	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese	ND	0.005	mg/L						
Potassium	ND	0.1	mg/L						
Selenium	ND	0.001	mg/L						
Sodium	ND	0.2	mg/L						
Uranium Zinc	ND ND	0.0001 0.005	mg/L mg/L						
Aince Microbiological Parameters	ND	0.005	mg/L						
-		4	0511/400						
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						
Heterotrophic Plate Count	ND	10	CFU/mL						

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Zinc

E. coli

Fecal Coliforms

Total Coliforms

Microbiological Parameters

Heterotrophic Plate Count

Certificate of Analysis Client: GEMTEC Consulting Engineers and Scientists Limited Client PO:

Report Date: 23-Mar-2021 Order Date: 17-Mar-2021

Notes

Project Description: 100554.001

		Reporting		Source		%REC		RPD
Analyte	Result	Limit	Units	Result	%REC	Limit	RPD	Limit
Anions								
Chloride	94.8	1	mg/L	94.2			0.6	10
Fluoride	0.22	0.1	mg/L	0.22			0.8	10
Nitrate as N	ND	0.1	mg/L	ND			NC	10
Nitrite as N	ND	0.05	mg/L	ND			NC	10
Sulphate	38.6	1	mg/L	38.3			0.8	10
General Inorganics			•					
Alkalinity, total	280	5	mg/L	284			1.4	14
Ammonia as N	0.258	0.01	mg/L	0.251			2.5	17.7
Dissolved Organic Carbon	14.7	0.5	mg/L	13.3			9.8	37
Colour	15	2	TCU	15			0.0	12
Colour, apparent	9	2	ACU	9			0.0	12
Conductivity	1030	5	uS/cm	1050			1.5	5
pH	8.0	0.1	pH Units	7.9			0.9	3.3
Phenolics	ND	0.001	mg/L	ND			NC	10
Total Dissolved Solids	544	10	mg/L	528			3.0	10
Sulphide	ND	0.02	mg/L	ND			NC	10
Tannin & Lignin	ND	0.1	mg/L	ND			NC	11
Total Kjeldahl Nitrogen	0.28	0.1	mg/L	0.30			6.8	16
Turbidity	1.7	0.1	NTU	1.6			7.2	10
Vetals								
Mercury	ND	0.0001	mg/L	ND			NC	20
Aluminum	0.003	0.001	mg/L	0.003			0.6	20
Antimony	0.0008	0.0005	mg/L	ND			NC	20
Arsenic	ND	0.001	mg/L	ND			NC	20
Barium	0.023	0.001	mg/L	0.022			3.3	20
Boron	0.02	0.01	mg/L	0.02			3.2	20
Cadmium	ND	0.0001	mg/L	ND			NC	20
Calcium	38.4	0.1	mg/L	38.5			0.1	20
Chromium (VI)	ND	0.010	mg/L	ND			NC	20
Chromium	ND	0.001	mg/L	ND			NC	20
Copper	0.0077	0.0005	mg/L	0.0079			2.5	20
Iron	ND	0.1	mg/L	ND			NC	20
Lead	0.0008	0.0001	mg/L	0.0008			4.1	20
Magnesium	8.8	0.2	mg/L	9.4			6.8	20
Manganese	ND	0.005	mg/L	ND			NC	20
Potassium	2.0	0.1	mg/L	2.0			1.7	20
Selenium	ND	0.001	mg/L	ND			NC	20
Sodium	18.8	0.2	mg/L	19.5			3.4	20
Uranium	0.0003	0.0001	mg/L	0.0003			3.7	20
Zinc	0.039	0.005	mg/L	0.0000			0.5	20

0.039

ND

ND

ND

ND

0.005

1

1

1

10

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mg/L

CFU/100 mL

CFU/100 mL

CFU/100 mL

CFU/mL

0.039

ND

ND

ND

ND

0.5

NC

NC

NC

NC

20

30

30

30

30



Method Quality Control: Spike

Report Date: 23-Mar-2021 Order Date: 17-Mar-2021

Project Description: 100554.001

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	9.74	1	mg/L	ND	97.4	85-115			
Fluoride	1.17	0.1	mg/L	0.22	94.7	79 - 121			
Nitrate as N	1.06	0.1	mg/L	ND	106	79-120			
Nitrite as N	1.03	0.05	mg/L	ND	103	84-117			
Sulphate	47.0	1	mg/L	38.3	86.7	74-126			
General Inorganics									
Ammonia as N	0.503	0.01	mg/L	0.251	101	81-124			
Dissolved Organic Carbon	20.6	0.5	mg/L	13.3	73.3	60-133			
Phenolics	0.028	0.001	mg/L	ND	111	69-132			
Total Dissolved Solids	96.0	10	mg/L	ND	96.0	75-125			
Sulphide	0.51	0.02	mg/L	ND	102	79-115			
Tannin & Lignin	1.1	0.1	mg/L	ND	106	71-113			
Total Kjeldahl Nitrogen	2.00	0.1	mg/L	0.37	81.8	81-126			
Metals									
Mercury	0.0033	0.0001	mg/L	ND	108	70-130			
Aluminum	46.1	0.001	mg/L	3.42	85.4	80-120			
Antimony	49.2	0.0005	mg/L	0.175	98.1	80-120			
Arsenic	49.2	0.001	mg/L	0.788	96.8	80-120			
Barium	69.7	0.001	mg/L	22.4	94.6	80-120			
Boron	64.9	0.01	mg/L	23.8	82.2	80-120			
Cadmium	46.7	0.0001	mg/L	0.0378	93.3	80-120			
Calcium	47400	0.1	mg/L	38500	89.8	80-120			
Chromium (VI)	0.209	0.010	mg/L	ND	104	70-130			
Chromium	51.5	0.001	mg/L	0.296	102	80-120			
Copper	54.0	0.0005	mg/L	7.90	92.3	80-120			
Iron	2370	0.1	mg/L	28.0	93.7	80-120			
Lead	40.0	0.0001	mg/L	0.833	78.4	80-120		C	S-02
Magnesium	19500	0.2	mg/L	9380	101	80 - 120			
Manganese	50.7	0.005	mg/L	0.652	100	80-120			
Potassium	13700	0.1	mg/L	2000	117	80-120			
Selenium	46.0	0.001	mg/L	0.151	91.8	80-120			
Sodium	29600	0.2	mg/L	19500	101	80-120			
Uranium	41.8	0.0001	mg/L	0.330	83.0	80-120			
Zinc	82.1	0.005	mg/L	39.0	86.1	80-120			



Qualifier Notes:

Login Qualifiers :

Container and COC sample IDs don't match - Containers labelled as TW21-04 (6hrs), chain of custody is missing sample ID. Applies to samples: TW21-04 3hrs, TW21-04 6hrs

Sample Qualifiers :

QC Qualifiers :

QS-02: Spike level outside of control limits. Analysis batch accepted based on other QC included in the batch.

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable ND: Not Detected MDL: Method Detection Limit Source Result: Data used as source for matrix and duplicate samples %REC: Percent recovery. RPD: Relative percent difference. NC: Not Calculated

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Project Description: 100554.001

Order #: 2112298



RELIABLE.

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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive Kanata, ON K2K 2A9 Attn: Andrius Paznekas

Client PO: Project: 100554.001 Custody: 58639

Report Date: 12-Apr-2021 Order Date: 7-Apr-2021

Order #: 2115359

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID **Client ID** 2115359-01 TW1-R1a 2115359-02 TW1-R1b

Approved By:

Dale Robertson, BSc Laboratory Director

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.



Report Date: 12-Apr-2021

Order #: 2115359

Order Date: 7-Apr-2021

Project Description: 100554.001

Analysis Summary Table

Analysis	Method Reference/Description		Analysis Date
Colour	SM2120 - Spectrophotometric	8-Apr-21	8-Apr-21
Colour, apparent	SM2120 - Spectrophotometric	8-Apr-21	8-Apr-21
E. coli	MOE E3407	8-Apr-21	8-Apr-21
Fecal Coliform	SM 9222D	8-Apr-21	8-Apr-21
Heterotrophic Plate Count	SM 9215C	8-Apr-21	8-Apr-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	8-Apr-21	8-Apr-21
Total Coliform	MOE E3407	8-Apr-21	8-Apr-21
Turbidity	SM 2130B - Turbidity meter	8-Apr-21	8-Apr-21



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Order #: 2115359

Report Date: 12-Apr-2021

Order Date: 7-Apr-2021

Project Description: 100554.001

	-				
	Client ID:	TW1-R1a	TW1-R1b	-	-
	Sample Date:	07-Apr-21 09:15	07-Apr-21 09:15	-	-
	Sample ID:	2115359-01	2115359-02	-	-
	MDL/Units	Water	Water	-	-
Microbiological Parameters			-		
E. coli	1 CFU/100 mL	ND	ND	-	-
Fecal Coliforms	1 CFU/100 mL	ND	ND	-	-
Total Coliforms	1 CFU/100 mL	ND	ND	-	-
Heterotrophic Plate Count	10 CFU/mL	<10	<10	-	-
General Inorganics			•		
Colour	2 TCU	18	-	-	-
Colour, apparent	2 ACU	25	-	-	-
Turbidity	0.1 NTU	1.1	-	-	-
Metals			•		
Iron	100 ug/L	550	-	-	-



Client: GEMTEC Consulting Engineers and Scientists Limited Client PO: Report Date: 12-Apr-2021

Order Date: 7-Apr-2021

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Colour	ND	2	TCU						
Colour, apparent	ND	2	ACU						
Turbidity	ND	0.1	NTU						
Metals									
Iron	ND	100	ug/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						
Heterotrophic Plate Count	ND	10	CFU/mL						



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 12-Apr-2021

Order Date: 7-Apr-2021

Project Description: 100554.001

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Colour	18	2	TCU	18			0.0	12	
Colour, apparent	25	2	ACU	25			0.0	12	
Turbidity	1.1	0.1	NTU	1.1			3.6	10	
Metals									
Iron	ND	100	ug/L	ND			NC	20	
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Heterotrophic Plate Count	ND	10	CFU/mL	ND			NC	30	



Report Date: 12-Apr-2021 Order Date: 7-Apr-2021

Project Description: 100554.001

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Metals									
Iron	2760	100	ug/L	ND	110	80-120			



Login Qualifiers :

Container(s) - Labeled improperly/insufficient information - Metals Bottle is not labelled Applies to samples: TW1-R1a

Container and COC sample IDs don't match - Bacteria bottles labelled as TW-R1a, chain of custody reads TW1 9:30

Applies to samples: TW1-R1b

Container and COC sample IDs don't match - General bottle labelled as TW2-R1, bacteria bottles labelled as TW-R1b chain of custody reads TW1 9:15 Applies to samples: TW1-R1a

Sample Qualifiers :

QC Qualifiers :

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable ND: Not Detected MDL: Method Detection Limit Source Result: Data used as source for matrix and duplicate samples %REC: Percent recovery. RPD: Relative percent difference. NC: Not Calculated Report Date: 12-Apr-2021 Order Date: 7-Apr-2021 Project Description: 100554.001



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Report Date: 7-Apr-2021

Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive Kanata, ON K2K 2A9 Attn: Andrius Paznekas

Client PO: Project: 100554.001 Custody: 128966

Order Date: 6-Apr-2021 **Revised Report**

Order #: 2115227

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID **Client ID** 2115227-01 TW2

Approved By:

Mark Foto

Mark Foto, M.Sc. Lab Supervisor

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.



Report Date: 07-Apr-2021 Order Date: 6-Apr-2021

Project Description: 100554.001

Order #: 2115227

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Colour	SM2120 - Spectrophotometric	7-Apr-21	7-Apr-21
Colour, apparent	SM2120 - Spectrophotometric	7-Apr-21	7-Apr-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	7-Apr-21	7-Apr-21
Turbidity	SM 2130B - Turbidity meter	7-Apr-21	7-Apr-21



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Report Date: 07-Apr-2021

Order Date: 6-Apr-2021

Project Description: 100554.001

	Client ID:	TW2	-	-	-
	Sample Date:	05-Apr-21 09:30	-	-	-
	Sample ID:	2115227-01	-	-	-
	MDL/Units	Water	-	-	-
General Inorganics			•		
Colour	2 TCU	16	-	-	-
Colour, apparent	2 ACU	24	-	-	-
Turbidity	0.1 NTU	0.7	-	-	-
Metals					
Iron	100 ug/L	529	-	-	-



Report Date: 07-Apr-2021

Order Date: 6-Apr-2021

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Colour	ND	2	TCU						
Colour, apparent	ND	2	ACU						
Metals									
Iron	ND	100	ug/L						



Client PO:

Report Date: 07-Apr-2021 Order Date: 6-Apr-2021

Project Description: 100554.001

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
General Inorganics									
Colour	16	2	TCU	16			0.0	12	
Colour, apparent	24	2	ACU	24			0.0	12	
Metals									
Iron	313	100	ug/L	316			0.8	20	



Report Date: 07-Apr-2021 Order Date: 6-Apr-2021

Project Description: 100554.001

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Metals									
Iron	2520	100	ug/L	ND	101	80-120			



Qualifier Notes:

Login Qualifiers :

Container and COC sample IDs don't match - metals bottle missing and ID. Generals bottle read TW2-R1 Applies to samples: TW2

Sample Data Revisions

None

Work Order Revisions / Comments:

REVISION 1: This version contains an amended project number.

Other Report Notes:

n/a: not applicable ND: Not Detected MDL: Method Detection Limit Source Result: Data used as source for matrix and duplicate samples %REC: Percent recovery. RPD: Relative percent difference. NC: Not Calculated



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Certificate of Analysis

GEMTEC Consulting Engineers and Scientists Limited

32 Steacie Drive Kanata, ON K2K 2A9 Attn: Andrius Paznekas

Client PO: Project: 100554.001 Custody: 11954

Report Date: 3-May-2021 Order Date: 28-Apr-2021

Order #: 2118321

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID

Paracel ID	Client ID	
2118321-01		Relabelled PW1
2118321-02		Relabelled PW2
2118321-03		Relabelled PW3
2118321-04		Relabelled PW4

Approved By:

lack

Mark Foto, M.Sc. Lab Supervisor

Any use of these results implies your agreement that our total liability in connection with this work, however arising, shall be limited to the amount paid by you for this work, and that our employees or agents shall not under any circumstances be liable to you in connection with this work.

Page 1 of 7



Analysis Summary Table

Report Date: 03-May-2021 Order Date: 28-Apr-2021 Project Description: 100554.001

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Alkalinity, total to pH 4.5	EPA 310.1 - Titration to pH 4.5	29-Apr-21	29-Apr-21
Ammonia, as N	EPA 351.2 - Auto Colour	29-Apr-21	29-Apr-21
Anions	EPA 300.1 - IC	29-Apr-21	29-Apr-21
Colour	SM2120 - Spectrophotometric	29 - Apr-21	29-Apr-21
Co l our, apparent	SM2120 - Spectrophotometric	29 - Apr-21	29-Apr-21
Conductivity	EPA 9050A- probe @25 °C	29-Apr-21	29-Apr-21
Dissolved Organic Carbon	MOE E3247B - Combustion IR, filtration	29 - Apr-21	29-Apr-21
E. coli	MOE E3407	29 - Apr-21	29-Apr-21
Fecal Coliform	SM 9222D	29-Apr-21	29-Apr-21
Heterotrophic Plate Count	SM 9215C	29 - Apr-21	29-Apr-21
Metals, ICP-MS	EPA 200.8 - ICP-MS	29 - Apr-21	29-Apr-21
рН	EPA 150.1 - pH probe @25 °C	29-Apr-21	29-Apr-21
Phenolics	EPA 420.2 - Auto Colour, 4AAP	30-Apr-21	30-Apr-21
Hardness	Hardness as CaCO3	29 - Apr-21	29-Apr-21
Sulphide	SM 4500SE - Colourimetric	29 - Apr-21	29-Apr-21
Tannin/Lignin	SM 5550B - Colourimetric	29-Apr-21	30-Apr-21
Total Coliform	MOE E3407	29 - Apr-21	29-Apr-21
Total Dissolved Solids	SM 2540C - gravimetric, filtration	29-Apr-21	30-Apr-21
Total Kjeldahl Nitrogen	EPA 351.2 - Auto Colour, digestion	29-Apr-21	30-Apr-21
Turbidity	SM 2130B - Turbidity meter	29-Apr-21	29-Apr-21



Client: GEMTEC Consulting Engineers and Scientists Limited

Client PO:

Order #: 2118321

Report Date: 03-May-2021 Order Date: 28-Apr-2021

Project Description: 100554.001

	Client ID:	PW1	PW2	PW3	PW4
	Sample Date:	28-Apr-21 16:10 2118321-01	28-Apr-21 12:15 2118321-02	28-Apr-21 13:15 2118321-03	28-Apr-21 14:50 2118321-04
	Sample ID: MDL/Units	Drinking Water	Drinking Water	Drinking Water	Drinking Water
Microbiological Parameters		Dimining trattor	Drinking Water	Dimining Match	Drinking Water
E. coli	1 CFU/100 mL	ND	ND	ND	ND
Fecal Coliforms	1 CFU/100 mL	ND	ND	ND	ND
Total Coliforms	1 CFU/100 mL	ND	ND	ND	ND
Heterotrophic Plate Count	10 CFU/mL	<10	<10	<10	<10
General Inorganics			-	•	•
Alkalinity, total	5 mg/L	305	229	250	282
Ammonia as N	0.01 mg/L	0.07	0.10	0.20	0.07
Dissolved Organic Carbon	0.5 mg/L	3.0	3.2	4.5	5.0
Colour	2 TCU	2	12	8	12
Colour, apparent	2 ACU	22	13	47	15
Conductivity	5 uS/cm	1470	614	733	773
Hardness	mg/L	488	263	280	320
рН	0.1 pH Units	7.8	8.0	8.0	7.8
Phenolics	0.001 mg/L	<0.001	<0.001	<0.001	<0.001
Total Dissolved Solids	10 mg/L	810	336	434	412
Sulphide	0.02 mg/L	<0.02	0.10	0.04	<0.02
Tannin & Lignin	0.1 mg/L	<0.1	<0.1	<0.1	<0.1
Total Kjeldahl Nitrogen	0.1 mg/L	0.2	0.2	0.4	0.2
Turbidity	0.1 NTU	3.6	0.5	2.6	0.2
Anions					
Chloride	1 mg/L	187	33	64	47
Fluoride	0.1 mg/L	<0.1	0.2	<0.1	<0.1
Nitrate as N	0.1 mg/L	0.2	<0.1	<0.1	<0.1
Nitrite as N	0.05 mg/L	<0.05	<0.05	<0.05	<0.05
Sulphate	1 mg/L	124	38	37	59
Metals					
Calcium	0.1 mg/L	115	62.6	70.6	82.3
Iron	0.1 mg/L	0.5	0.2	0.9	<0.1
Magnesium	0.2 mg/L	48.6	25.8	25.3	27.8
Manganese	0.005 mg/L	0.119	0.035	0.102	0.110
Potassium	0.1 mg/L	1.9	3.2	1.6	1.4
Sodium	0.2 mg/L	88.6	22.2	36.4	33.4
			-		l



Order #: 2118321

Report Date: 03-May-2021 Order Date: 28-Apr-2021

Project Description: 100554.001

Method Quality Control: Blank

Analyte	Result	Reporting	1.1	Source	% DE Q	%REC		RPD	Notes
, individ	Result	Limit	Units	Result	%REC	Limit	RPD	Limit	Notes
Anions									
Chloride	ND	1	mg/L						
Fluoride	ND	0.1	mg/L						
Nitrate as N	ND	0.1	mg/L						
Nitrite as N	ND	0.05	mg/L						
Sulphate	ND	1	mg/L						
General Inorganics									
Alkalinity, total	ND	5	mg/L						
Ammonia as N	ND	0.01	mg/L						
Dissolved Organic Carbon	ND	0.5	mg/L						
Colour	ND	2	TCU						
Colour, apparent	ND	2	ACU						
Conductivity	ND	5	uS/cm						
Phenolics	ND	0.001	mg/L						
Total Dissolved Solids	ND	10	mg/L						
Sulphide	ND	0.02	mg/L						
Tannin & Lignin	ND	0.1	mg/L						
Total Kjeldahl Nitrogen	ND	0.1	mg/L						
Turbidity	ND	0.1	NTU						
Metals									
Calcium	ND	0.1	mg/L						
Iron	ND	0.1	mg/L						
Magnesium	ND	0.2	mg/L						
Manganese	ND	0.005	mg/L						
Potassium	ND	0.1	mg/L						
Sodium	ND	0.2	mg/L						
Microbiological Parameters									
E. coli	ND	1	CFU/100 mL						
Fecal Coliforms	ND	1	CFU/100 mL						
Total Coliforms	ND	1	CFU/100 mL						
Heterotrophic Plate Count	ND	10	CFU/mL						



Order #: 2118321

Report Date: 03-May-2021 Order Date: 28-Apr-2021

Project Description: 100554.001

Method Quality Control: Duplicate

		Reporting				%REC		RPD	
Analyte	Result	Limit	Units	Source Result	%REC	Limit	RPD	Limit	Notes
Anions									
Chloride	185	1	mg/L	187			1.4	10	
Fluoride	ND	0.1	mg/L	ND			NC	10	
Nitrate as N	0.18	0.1	mg/L	0.18			1.3	10	
Nitrite as N	ND	0.05	mg/L	ND			NC	10	
Sulphate	121	1	mg/L	124			1.8	10	
General Inorganics			-						
Alkalinity, total	140	5	mg/L	138			1.3	14	
Ammonia as N	3.40	0.10	mg/L	3.31			2.7	17.7	
Dissolved Organic Carbon	0.5	0.5	mg/L	0.6			18.8	37	
Colour	12	2	ΤČU	12			0.0	12	
Colour, apparent	15	2	ACU	15			0.0	12	
Conductivity	5580	5	uS/cm	5650			1.2	5	
pН	7.6	0.1	pH Units	7.6			0.1	3.3	
Phenolics	ND	0.001	mg/L	ND			NC	10	
Total Dissolved Solids	748	10	mg/L	810			8.0	10	
Sulphide	ND	0.02	mg/L	ND			NC	10	
Tannin & Lignin	ND	0.1	mg/L	ND			NC	11	
Total Kjeldahl Nitrogen	0.11	0.1	mg/L	0.17			NC	16	
Turbidity	3.8	0.1	NTU	3.6			4.1	10	
Vetals									
Calcium	449	0.1	mg/L	453			1.0	20	
Iron	0.3	0.1	mg/L	0.3			2.1	20	
Magnesium	144	0.2	mg/L	147			2.2	20	
Manganese	0.176	0.005	mg/L	0.180			2.3	20	
Potassium	53.2	0.1	mg/L	53.6			0.8	20	
Sodium	667	0.2	mg/L	704			5.3	20	
Microbiological Parameters			-						
E. coli	ND	1	CFU/100 mL	ND			NC	30	
Fecal Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Total Coliforms	ND	1	CFU/100 mL	ND			NC	30	
Heterotrophic Plate Count	ND	10	CFU/mL	ND			NC	30	



Method Quality Control: Spike

Report Date: 03-May-2021 Order Date: 28-Apr-2021

Project Description: 100554.001

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	196	1	mg/L	187	93.6	77-123			
Fluoride	0.92	0.1	mg/L	ND	92.3	79 - 121			
Nitrate as N	1.27	0.1	mg/L	0.18	109	79-120			
Nitrite as N	0.916	0.05	mg/L	ND	91.6	84-117			
Sulphate	132	1	mg/L	124	82.7	74-126			
General Inorganics									
Ammonia as N	0.216	0.01	mg/L	ND	86.2	81-124			
Dissolved Organic Carbon	12.2	0.5	mg/L	0.6	116	60-133			
Phenolics	0.024	0.001	mg/L	ND	94.2	69-132			
Total Dissolved Solids	94.0	10	mg/L	ND	94.0	75-125			
Sulphide	0.52	0.02	mg/L	ND	105	79-115			
Tannin & Lignin	ND	0.1	mg/L	ND		71-113			
Total Kjeldahl Nitrogen	2.11	0.1	mg/L	0.17	96.9	81-126			
Metals									
Calcium	9770	0.1	mg/L	ND	97.7	80-120			
Iron	2950	0.1	mg/L	280	107	80-120			
Magnesium	9980	0.2	mg/L	ND	99.8	80-120			
Manganese	227	0.005	mg/L	180	94.8	80-120			
Potassium	62000	0.1	mg/L	53600	84.2	80-120			
Sodium	9760	0.2	mg/L	ND	97.6	80-120			



Order #: 2118321

Report Date: 03-May-2021 Order Date: 28-Apr-2021 Project Description: 100554.001

Qualifier Notes:

Sample Qualifiers :

QC Qualifiers :

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable ND: Not Detected MDL: Method Detection Limit Source Result: Data used as source for matrix and duplicate samples %REC: Percent recovery. RPD: Relative percent difference. NC: Not Calculated

APPENDIX K

Langelier Saturation Index

Langelier Saturation Index Calculation

Project: 100554.001 Location: Proposed Emerald Woods Residential Subdivision Sample ID: **TW3 - 6hr** Well Tag: A313200

<u>Inputs</u>

Inputo		
pH =	8.2	
Total Dissolved Solids =	664	
Calcium (as $CaCO_3$) =	223	Note: Ca (as CaCO3) = 2.5 x Ca
Alkalinity (as $CaCO_3$) =	300	
Temperature $(^{\circ}C) =$	10	Assumed average groundwater temperature

Where Langelier Saturation Index (LSI) is defined as: $LSI = pH - pH_s$

Where: $pH_s = (9.3 + A + B) - (C + D)$

And:

$$A = \frac{(\log_{10}[TDS] - 1)}{10}$$

$$B = -13.12 \cdot \log_{10}[Temp + 273] + 34.55$$

$$C = \log_{10}[Calcium] - 0.4$$

$$D = \log_{10}[Alkalinity]$$

Output:

LSI =	0.76
pH _s =	7.44
D =	2.48
C =	1.95
B =	2.38
A =	0.18

LSI Value	Indication
-2.0 to -0.5	Serious corrosion
-0.5 to 0.0	Slight corrosion but non-scale forming
LSI = 0	Balanced but corrosion possible
0.0 to 0.5	Slightly scale forming and corrosive
0.5 to 2	Scale forming but non corrosive



Langelier Saturation Index Calculation

Project: 100554.001 Location: Proposed Emerald Woods Residential Subdivision Sample ID: **TW4 - 6hr** Well Tag: A305116

<u>Inputs</u>

inputo		
pH =	8.1	
Total Dissolved Solids =	742	
Calcium (as $CaCO_3$) =	228	Note: Ca (as CaCO3) = 2.5 x Ca
Alkalinity (as $CaCO_3$) =	293	
Temperature (°C) =	10	Assumed average groundwater temperature

Where Langelier Saturation Index (LSI) is defined as: $LSI = pH - pH_s$

Where: $pH_s = (9.3 + A + B) - (C + D)$

And:

$$A = \frac{(\log_{10}[TDS] - 1)}{10}$$

$$B = -13.12 \cdot \log_{10}[Temp + 273] + 34.55$$

$$C = \log_{10}[Calcium] - 0.4$$

$$D = \log_{10}[Alkalinity]$$

Output:

LSI =	0.66
pH _s =	7.44
D =	2.47
C =	1.96
B =	2.38
A =	0.19

LSI Value	Indication
-2.0 to -0.5	Serious corrosion
-0.5 to 0.0	Slight corrosion but non-scale forming
LSI = 0	Balanced but corrosion possible
0.0 to 0.5	Slightly scale forming and corrosive
0.5 to 2	Scale forming but non corrosive



Langelier Saturation Index Calculation

Project: 100554.001 Location: Proposed Emerald Woods Residential Subdivision Sample ID: **TW5 - 6hr** Well Tag: A313201

<u>Inputs</u>

Inputo		
pH =	8	
Total Dissolved Solids =	520	
Calcium (as $CaCO_3$) =	193	Note: Ca (as CaCO3) = 2.5 x Ca
Alkalinity (as $CaCO_3$) =	286	
Temperature (°C) =	10	Assumed average groundwater temperature

Where Langelier Saturation Index (LSI) is defined as: $LSI = pH - pH_s$

Where: $pH_s = (9.3 + A + B) - (C + D)$

And:

$$A = \frac{(\log_{10}[TDS] - 1)}{10}$$

$$B = -13.12 \cdot \log_{10}[Temp + 273] + 34.55$$

$$C = \log_{10}[Calcium] - 0.4$$

$$D = \log_{10}[Alkalinity]$$

Output:

LSI =	0.49
pH _s =	7.51
D =	2.46
C =	1.88
B =	2.38
A =	0.17

LSI Value	Indication
-2.0 to -0.5	Serious corrosion
-0.5 to 0.0	Slight corrosion but non-scale forming
LSI = 0	Balanced but corrosion possible
0.0 to 0.5	Slightly scale forming and corrosive
0.5 to 2	Scale forming but non corrosive





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