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Paterson Group Inc.
Consulting Engineers
154 Colonnade Road
Ottawa (Nepean), Ontario
Canada K2E 7J5

Tel: (613) 226-7381
Fax: (613) 226-6344
www.patersongroup.ca

patersongroup

Supplemental Hydrogeological Study: Emerald Creek Estates - Phase 3

Proposed Residential Development
Tullamore Street
Ottawa, Ontario

Prepared For

Emerald Creek Properties Inc.

June 18, 2020

Report PH3781-REP.01

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1.0 Introduction

This report has been prepared to provide a supplemental hydrogeological assessment on the groundwater quality of the proposed Phase 3 development in Emerald Creek Estates. The scope of review is based on a pre-consultation meeting with the Rideau Valley Conservation Authority (RVCA) on March 7, 2019 and the RVCA Technical Review Memorandum (File Number D07-16-12-0004 dated November 29, 2018) of Paterson Report PH3533-REP.01. The previous reports, identified below, addressed the standard hydrogeological assessment for the full proposed development and the Phase 1 and 2 performance review. However, due to some historical issues, Phase 3 requires a supplemental hydrogeological review related to groundwater quality and RVCA comments related to the Performance Review report for Phase 2 of the development. The RVCA comments have been addressed under separate cover, Paterson Report PH3781 - Memo 1 dated June 18, 2020.

The following reports were previously completed for the subject site and should be read in conjunction with this report:

- ❏ Paterson Report G8329-REP-03 dated May 20, 2003 titled Terrain Analysis and Hydrogeological Study - Proposed Emerald Creek Estates Subdivision
- ❏ Paterson Report PH0968-REP.01 dated October 23, 2009 titled Servicing Review Study: Emerald Creek Estates Subdivision - Phase 1 Review.
- ❏ Paterson Report PH3533-REP.01 dated August 29, 2018 titled Performance Review: Emerald Creek Estates - Phase 1 and 2 Review

In accordance with the RVCA review of Paterson Report PH3533-REP.01, a new test well (TW6) was completed within Phase 3 of the development. Additional testing was completed to review the quality of the groundwater chemistry within Phase 3. Phase 3 of the development consists of 9 lots and are displayed on the attached Paterson drawing PH3781-1 Private Servicing Layout Plan.

The subject site is located in the rural area of the City of Ottawa (City) where the available water supply consists of private water supply wells. Each lot in the proposed development will be serviced by a private water supply well. The wastewater will be treated by individual on-site private sewage systems.

This study was conducted in general accordance with Ontario Ministry of Environment guidance document Procedure D-5-5 - Technical Guideline for Private Wells - Water Supply Assessment.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and recommendations pertaining to the private services for the subject development as it is understood at the time of writing this report.

1.1 RVCA Pre-Consultation

The RVCA clarified that a 6 hour pumping test was not required for Phase 3 of Emerald Creek Estates, however that the new drilled well will be developed until the appropriate quality parameters meet the D-5-5 guidelines. The new drilled well is to be considered as the representative well for Phase 3, and is intended to be used as a private supply well.

1.2 Statement of Qualifications

Erik Ardley performed field co-ordination, field review, technical analysis and reporting. Erik is a junior hydrogeologist. Erik has more than 4 years of experience at Paterson. Erik's experience includes hydrogeological reports/assessments in support of MECP PTTW, MECP EASR, hydrogeological report and terrain analysis, water supply well assessments, and approvals under the City of Ottawa coach house guidelines. Erik has a Bachelor of Science in Geology from Acadia University and is a Geoscientist in training as registered with the Association of Professional Geoscientists of Ontario.

Michael Killam performed technical analysis, reporting and review in support of this report. Michael is an intermediate Geotechnical and Hydrogeological Engineer. Michael has more than 9 years of experience with hydrogeological projects that include hydrogeological reports/assessments in support of MECP PTTW, MECP EASR, hydrogeological report and terrain analysis, water supply well assessments, approvals under the City of Ottawa coach house guidelines, and sewage system designs. Michael has a Bachelor of Engineering in Civil Engineering from Carleton University and is a licensed Professional Engineer in the Province of Ontario. Michael is a member of the professional organizations of the Ottawa Geotechnical Society, International Association of Hydrogeologists, Canadian Water Resources Association, Ontario Onsite Wastewater Association and Professional Engineers of Ontario.

2.0 Background

2.1 Surficial Geology

The surficial geology was previously mapped for the development under Paterson Report G8329-REP.03 with a general identification of topsoil over silty sand. Silty clay was found to underlie the silty sand in some areas within the depth of review. Published surficial geology mapping indicates a coarse textured glaciomarine deposit consisting of a sand, gravel minor silt and clay overlying the subject site.

2.2 Bedrock Geology

Published bedrock geology consists of Dolostone and Sandstone of the Beekmantown Group. The Beekmantown Group consists of the March Formation and Oxford Formation. The bedrock geology within the proposed Phase 3 is consistent with the formations encountered in the initial phases of the development.

2.3 Regional Hydrogeology

Published Ministry of the Environment, Conservation and Parks water well records (WWR) in the area indicate that the primary source for a potable water supply is the limestone and sandstone of the Beekmantown Group. Well yields are generally considered to be moderate in the area (suitable for residential development) with no significant indication of any quantitative or qualitative problems noted in our previous review or during the homeowner interviews for the latest performance review completed by Paterson for Phase 1 and 2.

2.4 Conceptual Lot Development Plan

Building plans and design details are custom designed for this area and were not available at the time of report preparation. As such, a 4 bedroom residential dwelling has been assigned to each of the proposed lots for the purpose of completing the study. This results in a maximum total daily design sewage flow for the proposed lots of 2,500 L/day based on Part 8 of the Ontario Building Code (2012). The daily volume required from the water supply is inferred to be equivalent at 2,500 L/day.

As Phase 3 is not considered hydrogeologically sensitive (in accordance with surficial geology and bedrock depth observations recorded in the TW6 WWR), the recommendation from Paterson Report G-8329- REP.03. indicating that on-site

sewage disposal can be handled with partially or fully-raised Class 4 septic systems as per Part 8 of the Ontario Building Code is re-iterated here.

3.0 Water Quality and Test Well Construction

A new test well (TW6) was constructed on a lot within Phase 3 of the Emerald Creek development and is identified as having WWR ID A252914. The well was placed in a manner to re-use the well for future development and was constructed as a representative well. The well was developed to ensure the groundwater geochemistry had stabilized prior to sampling.

3.1 TW6 Construction Details

TW6 was drilled in support of this report on February 19, 2020. The WWR and test results from TW6 has been attached to this report. Paterson Personnel completed the grouting inspection on TW6 at the time of construction.

The new drilled well is located in the central to south portion of Phase 3. Refer to attached Paterson Drawing PH3781 - 1 - Private Servicing Layout Plan for the approximate well location. The new drilled well is fully accessible with the 150 mm diameter steel casing extending 0.63 m above the existing ground surface. The well stick-up meets the minimum height requirement as per Ontario Regulation 903.

The details of the well construction for TW6, from the WWR, is summarized in Table 1, below:

TABLE 1: SUMMARY OF WELL CHARACTERISTICS

Item	TW6
WWR ID	A252914
Depth of Overburden (m)	4.3
Depth of Well (m)	30.5
Depth of Casing (m)	7.3
Depth to Aquifers (m)	28.4
Static Water Level (m)	5.5
Recorded Pumping Rate (L/min)	75.6

The WWR for TW6 reports that a clay with boulders extends to 4.3 m below the ground surface and that a grey and black limestone bedrock was encountered at 4.3 m below ground surface, at the time of the well construction, which coincides with available surficial and bedrock geological information.

3.2 TW6 Physical Analysis

As a means to evaluate the groundwater chemistry of the water supply aquifer intercepted by the well, the well was subjected to a 6 hour constant rate well development period. The duration was based upon the onsite field parameters. Once the field parameters were found to have stabilized, a groundwater sample was taken. The well development was conducted on March 3, 2020 under the full-time supervision of Paterson personnel.

A submersible pump was provided by Air Rock Drilling for the 6 hour well development. A licensed water well technician (Air Rock Drilling) was retained to complete the necessary plumbing related activities. A discharge hose assembly with a gate valve was connected to the rented pump. The discharge line was placed at a sufficient distance to ensure that the discharge water was being directed away from the well. Upon completion of the test, the pump was removed and the well was disinfected by Air Rock Drilling.

The total volume of water pumped during the 6 hour well development event of TW6 was approximately 13,627 L. This is approximately 5.5 times the maximum total daily design volume of water required to support the proposed lot developments (maximum 2,500 L/day).

The suitability of the aquifer to supply the proposed lot developments was assessed using the methodology provided in MECP Procedure D-5-5 (MOEE, 1996).

Based on the information summarized in Table 2 below, it is readily apparent that the water supply wells have intercepted an adequately strong water supply aquifer which has sufficient quantity to service the proposed lot developments under typical usage.

TABLE 2: AQUIFER TEST RESULTS

Item	TW6
Pumping Rate (litres/sec)	0.6
Depth of Well (m)	30.5
Static Water Level (m)	5.4
Available Drawdown (m)	25.1
Maximum Drawdown (m)	0.2
% Drawdown Observed	0.4

Given the analyses presented and summarized above, it is our opinion that there is an adequate supply of water to service the proposed lot developments in Phase 3 of Emerald Creek Estates, in addition to the neighboring lots whose wells may intercept a similar aquifer. The well construction is considered to be representative of the wells for the development and similar construction should be maintained for future wells within the proposed phase.

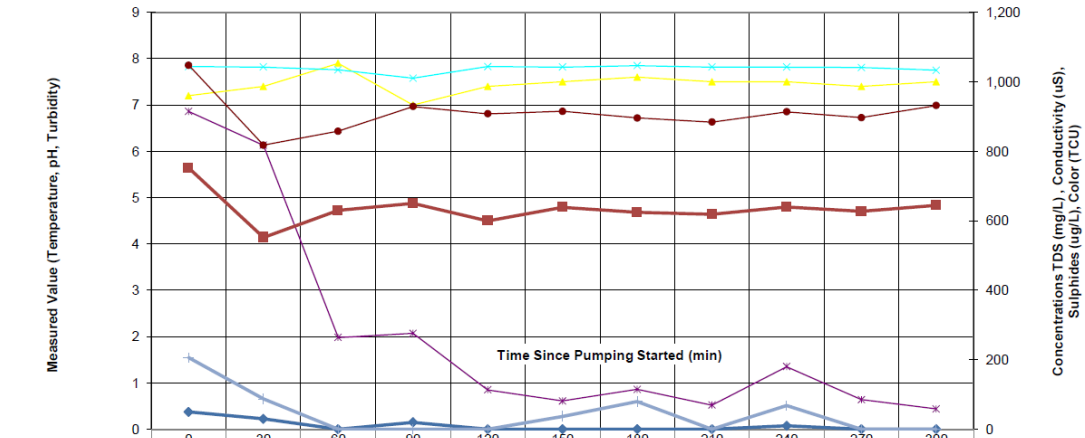
3.3 TW6 Groundwater Geochemistry

A Groundwater sample was collected at 6 hours after the start of well development pumping, once field parameters had stabilized. Prior to collection of the groundwater sample, the free chlorine residual was verified to be non-detectable. The water sample was submitted for comprehensive testing of bacteriological, chemical and physical water quality parameters consistent with the standard 'Subdivision Supply' suite of parameters.

The sample was collected unfiltered and unchlorinated, and placed directly into clean bottles supplied by the analytical laboratory. The sample was placed immediately into a cooler with ice and were transported directly to the Eurofins laboratory in Ottawa. The sample was received by the laboratory within 24 hours of collection.

A series of field tests of the pumped water were carried out at the well head during the 6 hour well development. The parameters tested at the well head included: pH, total dissolved solids, conductivity, turbidity, temperature, sulphides, and colour. The measurements for each of the field parameters are summarized on the graphical representation in Table 3 below.

Table 3: Field Measurements During Constant Rate Development of TW6



	0	30	60	90	120	150	180	210	240	270	300
Turbidty (NTU)	6.86	6.13	1.98	2.07	0.85	0.61	0.86	0.52	1.35	0.64	0.44
Temp (°C)	7.2	7.4	7.9	7.0	7.4	7.5	7.6	7.5	7.5	7.4	7.5
pH	7.83	7.82	7.76	7.58	7.83	7.82	7.85	7.82	7.82	7.81	7.75
Conductivity (uS)	1,048	818	858	929	908	915	896	884	914	897	932
TDS (mg/L)	752	552	630	650	600	639	624	619	640	627	644
Sulphides (ug/L)	50	30	0	20	0	0	0	0	10	0	0
Color (TCU)	206	87	0	0	0	37	80	0	68	0	0

Laboratory Data

The laboratory water quality obtained from the pumping test all test wells is provided in Table 4 below and the laboratory analyses reports can be found attached.

TABLE 4: TW6 GROUNDWATER GEOCHEMISTRY

PARAMETER	UNITS	ODWS		TW6
		LIMIT	TYPE	03-Mar-20
MICROBIOLOGICAL				
Escherichia Coli (E.Coli)	ct/100mL	0	MAC	0
Total Coliforms	ct/100mL	0	MAC	0
GENERAL CHEMICAL - HEALTH RELATED				
Fluoride	mg/L	1.5 (2.4)	MAC	0.13
N-NO2 (Nitrite)	mg/L	1	MAC	<0.10
N-NO3 (Nitrate)	mg/L	10	MAC	<0.10
Turbidity (Laboratory)	NTU	1.0 (5.0)	MAC/AO	3
Turbidity (Field)	NTU	1.0 (5.0)	MAC/AO	0.4
N-NH3 (Ammonia)	mg/L	-	-	0.08
Total Kjeldahl Nitrogen	mg/L	-	-	0.341
GENERAL CHEMICAL - AESTHETIC RELATED				
Hardness (as CaCO3)	mg/L	100	OG	425
Ion Balance	unitless	-	-	1.02
Total Dissolved Solids	mg/L	500	AO	640
Alkalinity (as CaCO3)	mg/L	500	OG	425
Chloride	mg/L	250	AO	93
Colour	TCU	5	AO	4
Conductivity	uS/cm	-	-	917
pH	unitless	6.5-8.5	AO	8.1
Sulphide	mg/L	0.05	AO	nd
Sulphate	mg/L	500	AO	77
Calcium	mg/L	-	-	101
Iron	mg/L	0.3	AO	0.63
Potassium	mg/L	-	-	5
Magnesium	mg/L	-	-	42
Manganese	mg/L	0.05	AO	0.1
Sodium	mg/L	200	AO	40
Phenols	mg/L	-	-	nd
Tannin & Lignin	mg/L	-	-	0.1
Dissolved Organic Carbon	mg/L	5	AO	2.6

1. ODWS identifies the following types of parameters:
   MAC=Maximum Allowable Concentration
   AO = Aesthetic Objective
   OG= Operational Guideline
2. Shaded Concentration Indicates an Exceedance of the ODWS Objective

The bacteriological test results indicate that the test samples at the 6 hour interval were non-detect (0 ct/100 mL) for E.Coli and Total Coliforms.

The water quality of the subject water supply well meets all the Ontario Drinking Water Standards maximum acceptable concentrations (MAC). Furthermore, the water meets all of the aesthetic objectives (AO) and operational guidelines (OG) with the exception of the following:

- ❏ Hardness (As $CaCO_3$)
- ❏ Iron
- ❏ Manganese
- ❏ Total Dissolved solids (TDS)
- ❏ Turbidity

Exceedances of the above parameters are not uncommon of the water supply in the subject aquifer. Each of these groundwater parameters are discussed in detail below.

Hardness as $CaCO_3$

Hardness, expressed as calcium carbonate appears in the ODWSOG as a parameter with an operational guideline of 100 mg/L. The Technical Support Document for ODWS publication states that water with hardness in excess of 500 mg/L may be unacceptable for most domestic purposes, however, there is no maximum treatable value available. It is expected that most hardness concentrations can be treated using conventional water softener technologies. Discharging of wastes from water treatment should be directed away from any septic systems.

Iron

Concentrations of iron above 0.3 mg/L can contribute to staining of fixtures and a metallic taste at higher concentrations. Precipitation of iron can promote the growth of iron bacteria in pipes. The concentration of iron in the groundwater is considered to be reasonably treatable in accordance with Procedure D-5-5. A conventional water softener or iron filter can be used to reduce the levels of iron.

Manganese

The manganese concentration of 0.05 mg/L or greater indicates a exceedance of the aesthetic objectives in the ODWSOG. Concentrations exceeding the aesthetic objective of 0.05 mg/L or greater may contribute to staining of plumbing fixtures and laundry.

Concentrations of Manganese are considered to be acceptable as long as they fall below the allowable aesthetic limit of 1.0 mg/L. A conventional water softener can be used to reduce low levels of manganese. Discharging of wastes from water treatment should be directed away from any septic system.

Sodium

Sodium is an aesthetic parameter, with a ODWSOG aesthetic objective of 200 mg/L. Sodium is a unique water quality parameter in that it has a cautionary limit of 20 mg/L for health related purposes, but can be present in raw water up to 200 mg/L and still be within the aesthetic objective. It is a requirement of the ODWSOG that the Medical Officer of Health be notified of the water quality results where sodium is present in concentrations exceeding 20 mg/L and it is intended for consumption. The purpose of this is such that the information can be disseminated to local physicians for their use in the treatment of individuals requiring reduced sodium dietary needs. A point-of-use RO unit can be used to provide supply to a drinking water tap.

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) refers to the concentration of inorganic substances dissolved in water. The main constituents are typically chloride, sulphates, calcium, magnesium and bicarbonates. Water with a TDS concentration above 500 mg/L of TDS may not be palatable for some users. A readily available reverse osmosis unit can adequately reduce the elevated TDS, should it be desired. Procedure D-5-5 does not provide a 'treatability limit' for TDS, but it does require written rationale that corrosion, encrustation, or taste problems will not occur.

The Langelier Saturation Index (Langelier, 1936) is used to predict the calcium carbonate stability of water. It indicates whether the water will precipitate, dissolve, or be in equilibrium with calcium carbonate. The results of the Langelier calculation (LSI = 1.0) indicate the water is super saturated and tends to precipitate a scale layer of calcium carbonate (scale forming but non-corrosive). See Langelier Saturation Index Calculation attached for calculation details.

Turbidity

Turbidity, which is generally an aesthetic parameter, was detected in the laboratory test samples at 3 NTU. Final field test values of turbidity were 0.4 NTU.

The ODWS maximum acceptable concentration for turbidity in drinking water entering

the distribution system is 1 NTU. The Aesthetic Objective for turbidity in drinking water reaching the consumer is 5 NTU. It is expected that continued use would tend to provide lower turbidity values. Continued development of the well, prior to occupancy, is recommended until the measured turbidity values meet the ODWSOG standards. The installation of a water softener will help to reduce the turbidity level with the reduction of hardness, iron and manganese.

4.0 Development Recommendations

The following sections outline the recommendations for Phase 3 of Emerald Creek Estates Development which have been formulated from the data collected in this investigation.

4.1 Site Development

Based on the results of our investigation, this site is considered to be suitable for development of the lots consistent with the previous Phase 1 and 2. The on-site sewage systems can consist of partially or fully-raised Class 4 Septic Systems (as per Part 8 of the Ontario Building Code (OBC)) and an adequate water supply can be obtained with private water wells.

Lot Development Plans

The previous review of Phase 1 and 2 have indicated that the previous lot development layout has successfully achieved minimizing negative effects on the surrounding environment. In accordance with Part 8 of the OBC, a minimum separation of 15 m (18 m for fully-raised systems) is required between a well and sewage system, whether they are servicing a single lot, or are on neighbouring lots. Please see attached Paterson Drawing PH3781 - 1 - Private Servicing Layout Plan for proposed lot layouts. The purpose of this drawing is to show that a typical home and services will fit onto the proposed lot, and can meet all pertinent regulations without causing environmental constraints. Actual locations may differ based on site specific conditions. The house footprint shown in this drawing covers a plan area of 120 m^2 , assuming a two-storey 240 m^2 (2600 ft^2) home, with a garage of 50 m^2, and is serviced by a sewage system with the capacity of 2,500 L/day. In actuality, the daily sewage flows will likely be significantly lower than this figure.

It is not the intent of the drawing to restrict placement of the home on each lot. While the position of the home may change, the relative position of the home, sewage system and well should be maintained. In all cases, the separation criteria for the immediate and neighbouring lots should be followed.

Well Design

Drilled wells, completed in the bedrock aquifer, should be used for the water supply in this development. The wells should be drilled by a licensed well driller experienced in

the study area. A minimum well yield of 0.23 litres/sec is recommended for an average residence.

A rotary drill has been proven to provide satisfactory water supply results in the test wells and previous phases. Drilling should continue down into the bedrock so that the casing is seated firmly into the bedrock. The space between the casing and hole should be cement grouted using a method recommended by the MECP.

After allowing the cement to set (24 hours for quick-set cement, 72 hours for regular cement), drilling should continue at a diameter of 150 mm until the necessary water yield is intercepted. The well should be developed by surging or pumping until the water is clear.

The well should be completed with a submersible pump, pitless adaptor and well cap. The casing should project for approximately 0.40 m above the final lot grade. The grading around the well casing should be slightly elevated to direct surface runoff away from the well.

The well design for TW6 can be used as a representative well design for Phase 3 of Emerald Creek Estates.

5.0 CONCLUSIONS

A terrain analysis and hydrogeological investigation were previously completed in support of the, now existing, Emerald Creek Estates Subdivision located at Ballycastle Crescent and Tullamore Street, in the City of Ottawa, Ontario. The development consists of lot sizes averaging 0.3 hectares with similar sized lots in the proposed Phase 3. This Supplemental Hydrogeological Study has reviewed the proposed Phase 3 groundwater supply aquifer quality to supplement the original hydrogeological investigation in regards to the proposed development.

Based on the information contained within the body of this report, the following conclusions can be drawn:

- ❏ The water supply aquifer intercepted by TW6 is consistent with the quality observed in the previous phases. It is considered to be more than adequate to support the demands for the proposed Phase 3 residential development in regards to groundwater quality.
- ❏ The preferred water supply aquifer intercepted by TW6 contains a water supply that is potable, and contains only elevated concentrations of hardness, iron, manganese, TDS and Turbidity. The concentrations are within the maximum concentration considered reasonably treatable outlined by the ODWS. The hardness can be treated with current readily available water conditioning equipment, and the elevated TDS can be reduced with a readily available reverse osmosis unit, if desired.
- ❏ The sodium concentrations were measured to be above the 20 mg/L reporting limit and, as such, the Medical Officer of Health for the City of Ottawa should be informed to assist area physicians in the treatment of local residents on sodium reduced diets.
- ❏ It is anticipated that TW6 will be used as a potable well supply for a lot in Phase 3 of the proposed development, and will be maintained in accordance with O.Reg 903.
- ❏ The results of this supplemental water supply assessment suggests that the water supply aquifer underlying the subject site can support the proposed Phase 3 residential development from a quality perspective.

It is our opinion that Phase 3 is consistent in quantity and quality with the previous phases of the development and is recommended to be approved for development. The hydrogeological recommendations of the original and supplemental report, if followed, will ensure that the development takes place in an effective manner, with minimal

impact on the environment.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Cavanagh Construction Limited, or their agents, is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

We trust that this report satisfies your present requirements. Should you have any questions regarding this report, do not hesitate to contact us.

Yours truly,

PATERSON GROUP INC.

Erik Ardley, BSc. Geology
Junior Hydrogeologist

Michael S. Killam, P.Eng.
Hydrogeologist

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APPENDIX 1

MECP Water Well Record - TW6

Ontario | Ministry of the Environment and Climate Change

Well Tag No. Tag#:A252914
A252914

Well Record

Regulation 903 Ontario Water Resources Act

Page ____ of ____

Measurements recorded in: ☐ Metric ☒ Imperial

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
Emerald Creek Properties Inc. c/o Thomas Cavanagh			

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
Construction Limited, 9094 Cavanagh Road	Ashton	Ont	K0A 1B0	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
(No Civic) TULLAMORE STREET	Gloucester	P/L29	3

County/District/Municipality	City/Town/Village	Province	Postal Code
OTTAWA-CARLETON	Gloucester	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	18	452355	5013222	Test well #1 / PHASE III	S/L25

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	To
	Clay & Boulders			0'	14'
(Hard) Grey & Black	Limestone			14'	82'
Grey	Sandstone			82'	100'

* Phase III - TW#1 *

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
24'	0'	Neat Cement Slurry	9.36

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, specify

If pumping discontinued, give reason: X

Pump intake set at (m/ft): 90

Pumping rate (l/min / GPM): 20

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping (m/ft): 19' 2"

If flowing give rate (l/min / GPM): X

Recommended pump depth (m/ft): 80'

Recommended pump rate (l/min / GPM): 20

Well production (l/min / GPM): 20

Disinfected? ☒ Yes ☐ No

Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level	18'1"		19'2"
1	18'9"	1	18'6"
2	18'9"	2	18'1"
3	19'	3	18'1"
4	19.1	4	18'1"
5	19.1	5	↓
10	19.2	10	
15	19'2"	15	
20	19'2"	20	
25	↓	25	
30		30	
40		40	
50		50	
60		60	

Method of Construction

☐ Cable Tool ☐ Rotary (Conventional) ☐ Rotary (Reverse) ☐ Boring ☒ Air percussion ☐ Other, specify ☐ Diamond ☐ Jetting ☐ Driving ☐ Digging

Well Use

☐ Public ☒ Domestic ☐ Livestock ☐ Irrigation ☐ Industrial ☐ Other, specify ☐ Commercial ☐ Municipal ☐ Test Hole ☐ Cooling & Air Conditioning ☐ Not used ☐ Dewatering ☐ Monitoring

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
6 1/4"	Steel	.188"	+2'	24'
6 1/8"	Open Hole		24'	100'

Status of Well

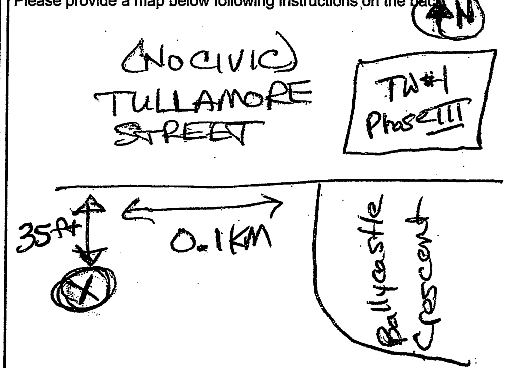
☒ Water Supply ☐ Replacement Well ☐ Test Hole ☐ Recharge Well ☐ Dewatering Well ☐ Observation and/or Monitoring Hole ☐ Alteration (Construction) ☐ Abandoned, Insufficient Supply ☐ Abandoned, Poor Water Quality ☐ Abandoned, other, specify ☐ Other, specify

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To

Map of Well Location

Please provide a map below following instructions on the back.



Water Details

Water found at Depth	Kind of Water
93 (m/ft) ☐ Gas	☐ Fresh ☒ Untested ☐ Other, specify
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify
(m/ft) ☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0'	24'	9 3/4"
24'	100'	6 1/8"

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
AIR ROCK DRILLING Co LTD	C7681

Business Address (Street Number/Name)	Municipality
6659 Franktown Road	Richmond

Province	Postal Code	Business E-mail Address
Ont	K0A 2Z0	

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
6138382170	HANNA, JEREMY

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
T3632	[signature]	20200228

Comments: 1/2 HP - 10 GPM Set @ 80 FT

Well owner's information package delivered: ☒ Yes ☐ No

Date Package Delivered: 20200224

Date Work Completed: 20200219

Ministry Use Only
Audit No. Z302535
Received

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APPENDIX 2

Eurofins Certificate of Analysis

Langelier Saturation Index Calculation

eurofins | Environment Testing

Certificate of Analysis

Client: Paterson Group
154 Colonnade Rd. South
Nepean, ON
K2E 7T7
Attention: Mr. Erik Ardley
PO#:
Invoice to: Paterson Group

Report Number: 1926523
Date Submitted: 2020-03-04
Date Reported: 2020-03-05
Project: PH3781
COC #: 855100

				Lab I.D.	1482863
				Sample Matrix	Water
				Sample Type	
				Sampling Date	2020-03-03
				Sample I.D.	TW6-GW1
Group	**Analyte**	**MRL**	**Units**	**Guideline**	
Microbiology	Escherichia Coli	0	ct/100mL	MAC 0	0
	Total Coliforms	0	ct/100mL	MAC 0	0

Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Analytical Method: AMBCOLM1
additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

Certificate of Analysis

eurofins | Environment Testing

Client: Paterson Group
154 Colonnade Rd. South
Nepean, ON
K2E 7T7
Attention: Mr. Erik Ardley
PO#: 29030
Invoice to: Paterson Group

Report Number: 1926516
Date Submitted: 2020-03-04
Date Reported: 2020-03-10
Project: PH3781
COC #: 855100

				Lab I.D.	1482851
				Sample Matrix	Water
				Sample Type	
				Sampling Date	2020-03-03
				Sample I.D.	TW6-GW1
Group	**Analyte**	**MRL**	**Units**	**Guideline**	
Anions	Cl	1	mg/L	AO 250	93
	F	0.10	mg/L	MAC 1.5	0.13
	N-NO2	0.10	mg/L	MAC 1.0	<0.10
	N-NO3	0.10	mg/L	MAC 10.0	<0.10
	SO4	1	mg/L	AO 500	77
General Chemistry	Alkalinity as CaCO3	5	mg/L	OG 500	297
	Colour	2	TCU	AO 5	4
	Conductivity	5	uS/cm		917
	DOC	0.5	mg/L	AO 5	2.6
	pH	1.00		6.5-8.5	8.10
	S2-	0.01	mg/L	AO 0.05	<0.01
	TDS	10	mg/L	AO 500	640*
	Turbidity	0.1	NTU	AO 5.0	3.0
Hardness	Hardness as CaCO3	1	mg/L	OG 100	425*
Indices/Calc	Ion Balance	0.01			1.02
Metals	Ca	1	mg/L		101
	Fe	0.03	mg/L	AO 0.3	0.63*
	K	1	mg/L		5
	Mg	1	mg/L		42
	Mn	0.01	mg/L	AO 0.05	0.10*
	Na	2	mg/L	AO 200	40
Nutrients	N-NH3	0.010	mg/L		0.080
	Total Kjeldahl Nitrogen	0.100	mg/L		0.341
Subcontract-Inorg	Phenols	0.001	mg/L		<0.001
	Tannin & Lignin	0.1	mg/L		0.1

Guideline = ODWSOG *** = Guideline Exceedence**

Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

MRL = Method Reporting Limit, AO = Aesthetic Objective, OG = Operational Guideline, MAC = Maximum Acceptable Concentration, IMAC = Interim Maximum Acceptable Concentration, STD = Standard, PWQO = Provincial Water Quality Guideline, IPWQO = Interim Provincial Water Quality Objective, TDR = Typical Desired Range

patersongroup

Emerald Creek Estates - Phase 3
PH3781

TW1 inputs

pH	8.1	A	0.18
TDS	640	B	2.43
Hardness	425	C	2.23
Alkalinity	425	D	2.63
Temp.	7.5		
		pHs =	7.056960941

Langelier Saturation Index (LSI) Calculation (Langelier, 1936)

LSI = pH - pHs

pHs = (9.3 + A + B) - (C + D)

Where:

A = (Log10 [TDS] - 1) / 10

B = -13.12 x Log10 (oC + 273) + 34.55

C = Log10 [Ca2+ as CaCO3] - 0.4

D = Log10 [alkalinity as CaCO3]

LSI = 1.0

LSI	Effect
0.5 to 2	**Water is super saturated and tends to precipitate a scale layer of calcium carbonate (scale forming but non-corrosive)**
0 to 0.5	Water is super saturated and tends to precipitate a scale layer of calcium carbonate (slightly scale forming and corrosive).
0	Water is saturated (in equilibrium) with calcium carbonate. A scale layer of calcium carbonate is neither precipitated nor dissolved.
0 to -0.5	Water is under saturated and tends to dissolve solid calcium carbonate (slightly corrosivebut non-scale forming).
-0.5 to -2	Water is under saturated and tends to dissolve solid calcium carbonate (seriously corrosive).

APPENDIX 3

PH3781 - 1 - Private Servicing Layout Plan

WEST

EAST

15m RADIUS FROM PROPOSED WELL

PHASE 3

3.0m WIDE ACCESS

PHASE 1

485

489

LOCATION

LOCATION

19 [40]

18 [39]

24

23

22

21

20

3.0m WIDE

PROP. CULVERT 19.0m 600ø CSP 2.8th

PROP. CULVERT 15.0m 600ø CSP 2.8th

CB

HBC

P1

D1

102.11 100 YR. HGL

TW 6 (LOCATED BY HANDHELD GPS)

DUCT BANK 6-HYDRO 1-BELL 1-CABLE

TULLAMORE STREET

25

26

27

28

29 [36]

488

FILL BACK SLOPE TO CREATE DITCH AS PER DETAIL ON DWG. D1

PROP. DITCH 75.0m @ 0.50%

10.0m DRAINAGE EASEMENT

15m RADIUS FROM WELL

15m RADIUS FROM PROPOSED WELL

CMB LAYBY SEE DETAIL ON DWG-D1

TRANSNORTHERN PIPELINE EASEMENT

PROPOSED RECREATIONAL PATHWAY

PHASE 2

62 [35]

DUCT BANK 12-HYDRO

SCALE: 1:1000

0 10 20 30 40 50m 75m

DD/MM/YY	DESCRIPTION	REV.

Consultant:

patersongroup
consulting engineers

Client:

CAVANAGH CONSTRUCTION LIMITED

Project:

EMERALD CREEK – PHASE 3 HYDROGEOLOGICAL UPDATE
TULLAMORE ROAD / BALLYCASTLE CRESCENT OTTAWA (METCALFE), ONTARIO

Drawing:

PRIVATE SERVICING LAYOUT PLAN

Scale:	Drawn by:
1-1000	RCG
Date: 03/2020	Checked by: MK

Drawing No.:

PH3781-1

p:\autocad drawings\hydrogeology\ph35xx\ph3533 - cavanagh - emerald creek\ph3533-2.dwg