Hydrogeological Assessment for Subdivision Development, Village of Ida

Cambium Reference No.: 3751-001

January 7, 2015

Prepared for: Mr. Ian Cameron
EXECUTIVE SUMMARY

Cambium Inc. (Cambium) was retained by Ian Cameron to undertake a hydrogeological assessment for a proposed development located at 1844 Peterborough County Road 10, in the Village of Ida, Township of Cavan-Monaghan, Ontario. The assessment includes a hydrogeological investigation and terrain analysis / impact assessment to support private servicing of potable water and wastewater for a proposed residential subdivision with 15 lots.

There are no municipal services for water or wastewater near the property; therefore, the Site will require to be serviced on-site. A hydrogeological assessment was undertaken for potable water supply and wastewater, in accordance to Ministry of the Environment (MOE) Guidelines D-5-4 and D-5-5. The water supply assessment included the installation of three (3) test wells and water quality assessment to assess the adequacy and potability of the Deep Groundwater aquifer for the development. The capacity of the native soils for wastewater attenuation was completed through a shallow soil investigation and analysis program, groundwater sampling from shallow on-site and neighbouring wells, and a mass balance equation to calculate nitrate concentrations at the property boundary from the addition of 15 residential lots.

A geological investigation was completed with the excavation of 12 test pits across the property to characterize the shallow soils. Test pit results indicated that the Site is primarily overlain by a sandy silt till, with some clay and gravel. Near the existing barn, a layer of coarse sand and gravel, with cobbles was observed and the test pit located near the man-made pond in the southwest portion of the Site exhibited a well-graded sandy silt. Water seepage was noted in all of the test pits, except those located in the southeastern potion of the Site, which is located at a higher elevation than the remaining portion.

Three aquifer systems are observed at the property and surrounding area based on Ministry of the Environment and Climate Change water well records; a Shallow Overburden, a Deep Overburden and a Bedrock aquifer system. The target aquifer system for the development is the Deep Overburden system, approximately 60 m below ground surface.

Three (3) test wells were drilled on the property and completed into the Deep Overburden aquifer system. Preliminary testing of the on-site test wells indicated that they would have ample well yields to supply water for the development with minimal interference between wells or surrounding neighbouring wells. Longer term (6 hour) testing of the on-site wells will be completed in the next phase of the study. Water quality analysis from neighbouring drilled wells indicated that the water quality is generally good, only a few exceedances of the Ontario Drinking Water Quality Standards; on-site water quality sampling and analysis will be completed for the test wells during the next phase of the study. It is anticipated that the water supply systems for the residences will require treatment for hardness and potentially iron.
In accordance with Procedure D-5-4, a mass balance calculation was used to determine the nitrate loading from the addition of 15 residential lots. The calculations determined that the Site cannot support the addition of 15 lots using conventional sewage systems; however the Site can support the lots if tertiary treatment is incorporated in the sewage systems. Tertiary treatment systems have demonstrated effectiveness in reducing total nitrogen by more than 50% compared to pre-treatment results.

Considering the shallow groundwater seepage noted in most of the test pits, raised area beds and associated mantles will be required due to the presence of a high water table. A conceptual footprint of the raised area beds and locations of the sewage systems are provided on the Draft Plan of Subdivision to illustrate that the systems can be adequately situated on each of the building lots.

This study has determined that it is feasible for the development of 15 residential lots, using private drilled wells and on-site sewage systems, provided that tertiary treatment is incorporated in the sewage system designs.

Respectfully submitted,

Cambium Inc.

Bernie Taylor, P.Eng.
Project Specialist

Kevin D. Warner, M.Sc. P.Geo (Lrd)
Senior Project Manager, Senior Hydrogeologist
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1.0 INTRODUCTION

Cambium Inc. (Cambium) was retained by Mr. Ian Cameron (Client) to undertake a hydrogeological assessment for a proposed development located at 1844 Peterborough County Road 10, in the Village of Ida, Township of Cavan-Monaghan, Ontario (referred to herein as the Site and shown on Figure 1). The assessment includes a hydrogeological investigation and terrain analysis / impact assessment to support private servicing of potable water and wastewater for a proposed residential subdivision of 15 lots.

There are no municipal services for water or wastewater near the property; therefore, the Site will require to be serviced on-site. As such, a hydrogeological assessment was undertaken for potable water supply and wastewater, in accordance to Ministry of the Environment (MOE) Guidelines D-5-4 and D-5-5. The water supply assessment included the installation of three (3) test wells along with water quality testing of the aquifer system to identify on-site groundwater resources, determine the areal extent of the aquifer system, and assess the potability of the deep groundwater aquifer.

In order to determine on-site wastewater disposal capacity, the assessment also included the following: characterizing the native soils on the property and identifying the position of the shallow water table; identification of surficial slopes across the property; and an assessment of the wastewater attenuation capacity of Site, particularly for nitrate contamination.

1.1 SITE DESCRIPTION

The Site is situated approximately 2.5 kilometres north of Highway 7A in Ida, Ontario, on Part of Lot 10, Concession 10, in the Township of Cavan Monaghan, as shown on Figure 1. The Site includes a vacant residence, a barn, several small farm-related structures, and an agricultural area, which occupies the majority of the property. Vehicular access to the Site is via a gravel driveway near the residence.

The total Site area is approximately 5.8 hectares (14.4 acres), with each of the proposed 15 lots ranging in size from 0.3 to 0.5 hectares (0.8 acres to 1.2 acres). The surrounding area primarily includes residential and agricultural land.

The Site topography consists of a gently rolling topography with an increasing slope towards the southeast portion of the property. Generally, drainage on the property is towards a wet area near the centre of the on-site agricultural field.
2.0 METHODOLOGY

2.1 BACKGROUND INFORMATION

A thorough review of the available relevant background information was undertaken for this study, which included the following:


2.2 TOPOGRAPHIC SURVEY

A topographical survey was completed J. B. Fleguel Surveyors (J. B. Fleguel Surveyors, 2014) to interpret the Site grade, as well as property features such as large trees, water features, and supply well locations.

2.3 SITE INVESTIGATION

2.3.1 TEST PITTING

On December 17, 2014 a test pitting investigation was completed by Cambium to determine the subsurface conditions across the property. The test pits were excavated using a rubber tired backhoe under the supervision of a Cambium engineer. A total of 12 test pits, designated as TP101-14 through TP112-14 were advanced throughout the Site. Due to wet conditions, the centre portion of the agricultural field could not be accessed. Each soil sample was handled only by the engineer using dedicated nitrile gloves to minimize the potential for cross contamination. Soil samples were logged for soil type, moisture content, and odour. Open test pits were
backfilled with the excavated soils and compacted with the backhoe bucket. Test pit logs are provided in Appendix A.

2.3.2 GROUNDWATER SAMPLING

As described in Section 3.4, groundwater samples were collected from one (1) existing on-site water supply well and six (6) neighbouring water supply wells. All field work was completed by Cambium field personnel. Groundwater samples were collected using standard field sampling protocol. All collected samples were stored in coolers with freezer packs after collection and during transport to the SGS Environmental Analytical Laboratory in Lakefield, Ontario (SGS). SGS is accredited by the Canadian Associations for Laboratory Accreditation Inc. (CALA) for specific environmental tests listed in the scope of accreditation approved by the CALA.

The laboratory Certificates of Analysis are provided as Appendix B. The results of the groundwater sampling program are detailed in Section 4.0.
3.0 GEOLOGICAL AND HYDROGEOLOGICAL CONTEXT

3.1 TOPOGRAPHY AND DRAINAGE

During the preliminary evaluation, particular attention was paid to the topography and drainage as they play important roles in determining the design and location of the on-site wastewater treatment system. Aside from the relatively steep slope in the southwest portion of the property, the Site has a gentle rolling topography. From available geological mapping (Ontario Geological Survey, 2010), it appears that the southeast portion of the Site (where the residence and barn are located) is situated on a northeast to southwest trending drumlin, and this was confirmed by Site observations. From this portion of the property, the slope is in a general northwest direction towards an area of standing water near the centre of the agricultural field. Similarly, from the northwest portion of the Site, the slope is in a general southeast direction towards the same wet area. Near the residence and the most eastern portion of the agricultural field, there is a general east slope towards County Road 10. Geodetic elevations range from approximately 280 metres above sea level (masl) to 287 masl across the Site. An assumed man-made pond is located in the southwest portion of the property. The local topography and drainage are illustrated on Figure 1, Figure 3, Figure 4 and Figure 5.

3.2 GEOLOGICAL AND HYDROGEOLOGICAL CONDITIONS

The Site and surrounding area are characterized by one bedrock region composed of Middle Ordovician limestone, dolostone, shale, arkose, and sandstone of the Ottawa Group, Simcoe Group, and Shadow Lake Formation (Ontario Geological Survey, 1991). Based on well records from surrounding properties obtained from the MOE database, the bedrock is assumed to be greater than 85 m below grade (mbg); however, limestone bedrock was identified in one (1) well at 36.6 m, located over 300 m south of the Site. According to available mapping (Ontario Geological Survey, 2010), the southeast portion of the Site, which is assumed to be situated on a drumlin, is composed of stone-poor, sandy silt to silty sand textured till, and the northwest portion of the Site is composed of coarse-textured glaciolacustrine deposits consisting of sand, gravel, and minor silt and clay (considered foreshore and basinal deposits). The regional quaternary geology consists of predominantly sandy silt to silt till, which is commonly rich in clasts and often high in total carbonate content (Ministry of Northern Development and Mines, 1991).

During the test pitting program, the overburden characteristics were recorded. Of the 12 test pits completed at the Site, 10 exhibited a similar stratigraphy of topsoil (ranging from 0.00 to 0.70 mbg) overlying sandy silt till, with some clay and gravel, and with cobbles found throughout most of these test pit locations. Test pit TP102-14, located near the barn structure, exhibited a surficial layer of topsoil to 0.46 mbg overlying a layer of coarse sand and gravel, with cobbles found throughout. Test pit TP111-14, located near the man-made pond in the
southwest portion of the Site, exhibited a surficial layer of topsoil to 0.38 mbg overlying a layer of well-graded sandy silt.

In total, four (4) soil samples were collected for grain size analysis: two (2) samples of the sandy silt till from test pits TP103-2 (depth of 0.51 to 2.00 mbg) and TP108-14 (depth of 0.50 to 2.00 mbg); one (1) sample of the coarse sand and gravel from test pit TP102-14 (depth of 0.46 to 2.00 mbg); and one (1) sample of the sandy silt from test pit TP111-14 (depth of 0.38 to 1.00 mbg). The analyses provided the following results:

**TP102-14**
- Classified the soil as S.W. with a percolation rate of 2 – 12 min/cm with 24% gravel, 73% sand, and 2% silt and clay; as such a percolation rate of 7 min/cm was selected for design purposes.

**TP103-14**
- Classified the soil as S.M. with a percolation rate of 8 – 20 min/cm with 8% gravel, 39% sand, and 53% silt and clay; as such a percolation rate of 18 min/cm was selected for design purposes.

**TP108-14**
- Classified the soil as S.M. with a percolation rate of 8 – 20 min/cm with 15% gravel, 40% sand, and 45% silt and clay; as such a percolation rate of 18 min/cm was selected for design purposes.

**TP111-14**
- Classified the soil as M.L. with a percolation rate of 20 – 50 min/cm with 0% gravel, 32% sand, and 68% silt and clay; as such a percolation rate of 35 min/cm was selected.

Laboratory results of the grain size analysis are included in Appendix C. It was noted that cobbles were observed throughout most of the test pits. Test pits TP101-14, TP102-14, and TP103-14 were dry upon completion; however, the remaining test pits were wet upon completion, with observable water seepage.

The regional topography indicates that the inferred groundwater flow direction is towards an unnamed waterbody to the southeast.

### 3.3 WATER WELL RECORDS

A total of 66 MOE well records were identified for local surrounding wells from within approximately one (1) radial kilometre from the Site (Ministry of the Environment, 2014). The majority of the records were for water supply wells (domestic and livestock). The remaining records included 13 abandoned wells and seven (7) observation wells. The well records indicate that the regional area is underlain by fine grain overburden material with predominant gravel and cobbles. The overburden was encountered to a maximum depth of 85.34 metres below grade (mbg). Limestone bedrock was encountered in one (1) well at a depth of 36.58 mbg. From the well record
data, the average driller test rate was recorded as 35.17 litres per min (Lpm), with all wells except one (1) producing at least 13.64 Lpm (3 Imperial gallons per minute (igpm)) or greater. The minimum and maximum reported yields are 9.09 Lpm and 90.92 Lpm, respectively. Overall, the statistical analysis indicates that the groundwater resources at the Site are capable of sustaining water needs for the proposed development. According to the well records, the static water level was found between 231.12 and 287.28 mASL, for an average water level of 256.32 mASL. This would correspond to an on-site static water level of 25 to 30 mbg.

One (1) record (#5110970) was found for the Site for a well drilled used as a water supply for livestock. The well depth is 60.98 mbg, with a static water level of 26.52 mbg. The stratigraphy is noted as topsoil overlying clay till. A sand lens was encountered between 11.59 and 14.02 mbg, and the deep overburden aquifer (as described in 3.5.2) was encountered between 59.45 and 60.98 mbg, and consisted of coarse gravel. The well test yield was 18.18 Lpm (4 igpm).

As discussed in Section 4.1.2, three (3) additional on-site wells were drilled on the property in late December 2014.

### 3.4 LOCAL WELL SURVEY

A door-to-door survey was conducted on December 12 and 22, 2014. Where possible, a questionnaire was completed with the well owner and a water sample was collected for nitrate and other parameters outlined in the Ontario Drinking Water Quality Standards (ODWQS). As presented in Table 1, one (1) survey respondent indicated an issue with water supply quantity, but it is noted that this water supply was from a shallow dug well. According to the survey, there were treatment systems associated with at least four (4) of the wells; however, only three (3) were reportedly in use.

Initial analytical results indicated that the water supply from a dug well located on the Site had a nitrate concentration of 10.0 mg/L. The water sample was collected directly from the well using a bailer as the well pump was not in operation at the time. The well was subsequently flushed by allowing the house faucet to run over a 48-hour period. Following flushing, the well was re-sampled, and the analytical results indicated that the water supply had a nitrate concentration below the laboratory detection limit of 0.06 mg/L. Consultation with the property owner determined that prior to the initial sampling event, the floor of the on-site barn was power washed to remove manure and fertilizer materials. The barn is located up-gradient from the supply well, approximately 50 m southwest. As such, it is likely that the initial nitrate result of 10.0 mg/L was due to the shallow water supply having been contaminated by fertilizer-contaminated wash water.

Analytical results from two (2) neighbouring properties revealed total coliform levels of three (3) colony-forming unit per millilitre (cfu/mL) (RW1; 1866 Cora Court) and 11 cfu/mL (RW2; 901 Sharpe Line). On-site septic systems were observed at 1866 Cora Court and 901 Sharpe Line, which may have impacted the water quality at these properties. MOE records showing well construction details could not be located for either property.
Table 1 Summary of Neighbouring Well Details

<table>
<thead>
<tr>
<th>Well Sample Number</th>
<th>Address</th>
<th>Nitrate (mg/L)</th>
<th>Well Type</th>
<th>Comments and Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>RW1</td>
<td>1866 Cora Court</td>
<td>&lt;0.06</td>
<td>Drilled.</td>
<td>W/L = 36.7 m. Well depth approximately 42 m. Total coliforms previously reported as 85 CFU/100 ml.</td>
</tr>
<tr>
<td>RW2</td>
<td>901 Sharpe Line</td>
<td>0.55</td>
<td>Drilled inside previously dug well.</td>
<td>Dug well (8 m); drilled inside to 30 m. Water softener and UV treatment. Hard water.</td>
</tr>
<tr>
<td>RW3</td>
<td>909 Sharpe Line</td>
<td>0.28</td>
<td>Dug.</td>
<td>W/L = 1.95 m. Well depth approximately 13 m. Water softener and UV treatment. Water cloudy with some sediment.</td>
</tr>
<tr>
<td>RW4</td>
<td>1844 County Road 10</td>
<td>&lt;0.06a</td>
<td>Dug.</td>
<td>W/L = 1.92 m.</td>
</tr>
<tr>
<td>RW5</td>
<td>897 Sharpe Line</td>
<td>0.28</td>
<td>Dug.</td>
<td>Well depth approximately 10 m. The well is occasionally shocked with Javex.</td>
</tr>
<tr>
<td>RW6</td>
<td>1854 County Road 10</td>
<td>2.39</td>
<td>Dug.</td>
<td>W/L = 2.32 m. Well depth approximately 12 m. Water softener and UV treatment. Issues with water quantity in the past (last year).</td>
</tr>
<tr>
<td>RW7</td>
<td>1877 County Road 10</td>
<td>2.46</td>
<td>Dug.</td>
<td>Well depth approximately 12 m. Water softener and UV treatment, which is not operational.</td>
</tr>
<tr>
<td>n/a</td>
<td>1842 Cora Court</td>
<td>n/a</td>
<td>Drilled.</td>
<td>Well depth approximately 23 m.</td>
</tr>
</tbody>
</table>

Note a: As discussed in Section 3.4, the initial nitrate result was 10.0 mg/L.

3.5 AQUIFER SYSTEMS

An interpretation of the regional stratigraphy can be inferred from the available MOE well records. Three aquifers systems have been identified, as follows:

3.5.1 SHALLOW OVERBURDEN AQUIFER

This aquifer consists of sporadic water bearing zones within the shallow overburden, with stratigraphy generally recorded as a gravelly clay till with occasion cobbles. It is likely that lenses of coarse-grain material are interspersed within this aquifer, as is indicated by test yields ranging from 13.64 to 45.46 Lpm.

3.5.2 DEEP OVERBURDEN AQUIFER

The deep overburden aquifer generally consists of fine to coarse sand and gravel material. Numerous wells in the area tap into this aquifer, to a maximum depth of 85.34 mbg. Test yields of this aquifer range from 9.09 to
90.92 Lpm, though it should be noted that all wells except one (1) had a test yield greater than 13.64 Lpm (3 igpm). The deep overburden aquifer is the target aquifer for the proposed development.

3.5.3 **BEDROCK AQUIFER**

One (1) well record in the area identifies limestone bedrock as the water-bearing feature.
4.0 HYDROGEOLOGICAL ASSESSMENT FOR WATER SUPPLY

On-site water supply is the preferred means of servicing residential lots on lands where municipal water services are not available. Accordingly, Cambium conducted a water supply assessment of the proposed development for both water quality and quantity, in accordance with MOE guidelines.

4.1.1 WATER DEMAND REQUIREMENTS

Section 4.3.2 of Procedure D-5-5 Technical Guideline for Private Wells: Water Supply Assessment (Ministry of the Environment, 1996), provides a minimum per person water requirement of 450 litres per day. Procedure D-5-5 also establishes a home occupancy of the number of bedrooms plus one; however, a minimum of four (4) bedrooms must be assumed, and the water supply rate should be greater than 13.64 Lpm (3 igpm).

4.1.2 TEST WELLS

As per Section 4.1 of Procedure D-5-5, for sites of 15 hectares or less, three (3) test wells are required to characterize available groundwater resources. Therefore, the approximately 5.8 hectare subject Site requires the installation of three (3) test wells.

There is one (1) existing drilled on the Site; the well was drilled in 1983 and is located directly west of the existing barn and used for water supply for livestock. The well depth is 60.98 mbg, with a static water level of 26.52 mbg. The well is constructed in a concrete well pit approximately 2 m in depth; therefore was not easily accessible during the field investigation. Based on the well record for the well, the stratigraphy is noted as topsoil overlying clay till. A sand lens was encountered between 11.59 and 14.02 mbg. The well is screened into the Deep Overburden aquifer (as described in 3.5.2) was encountered between 59.45 and 60.98 mbg, and consisted of coarse gravel. The well test yield was reported at 18.18 Lpm (4 igpm). With upgrades to bring this well into compliance with O.Reg 903, this well may be used to supply one of the future residences, as it is completed into the target aquifer system.

In order to achieve the requirements of Procedure D-5-4, three (3) test wells were drilled on the Site, in the locations shown on Figure 3. The geology of the wells was generally observed to be a fine grain till overlying the Deep Overburden Aquifer (described in Section 3.5.2), which was observed to consist of sand and/or sand and gravel materials from depths ranging between 45.12 to 71.95 mbg. Table 2 summarizes the construction details for the three (3) test wells. Refer to Appendix D for the MOE test well records.
Table 2  Test Well Details

<table>
<thead>
<tr>
<th>Well</th>
<th>Casing Stick Up (m)</th>
<th>Total Well Depth (mbgs)</th>
<th>Static Water Level (mbgs)</th>
<th>Pump Depth (mbgs)</th>
<th>Driller Test Yield (Lpm)</th>
<th>Drawdown (m)</th>
<th>Rated Yield (Lpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TW-1</td>
<td>0.80</td>
<td>71.95</td>
<td>33.51</td>
<td>45.73</td>
<td>45.5</td>
<td>0.75</td>
<td>75 (igpm)</td>
</tr>
<tr>
<td>TW-2</td>
<td>0.80</td>
<td>65.85</td>
<td>36.55</td>
<td>45.73</td>
<td>90.9</td>
<td>3.40</td>
<td>50 (igpm)</td>
</tr>
<tr>
<td>TW-3</td>
<td>0.80</td>
<td>59.76</td>
<td>29.76</td>
<td>47.26</td>
<td>45.5</td>
<td>0.94</td>
<td>40 (igpm)</td>
</tr>
</tbody>
</table>

The yield in all three test wells was reported by the well driller to be fairly high compared to well records in the area. The wells were tested at a pumping rate of 45.5 to 90.9 Lpm (10 to 20 igpm). Drawdown was minimal in all three test wells considering the pumping rates. Drawdown was observed to be 0.12 m and 0.94 m in test wells TW-1 and TW-3, both of which were tested at a rate of 45.5 Lpm (10 igpm). Drawdown was greater in test well TW-2 at 3.4 m; however the pumping test was completed at a pumping rate of 90.9 Lpm (20 igpm). The reported well yield for the three on-site test wells was 340 Lpm (75 igpm), 227 Lpm (50 igpm), and 182 Lpm (40 igpm) for wells TW-1, TW-2 and TW-3, respectively. This indicates that the Deep Overburden Aquifer is a robust aquifer system on the Site and would likely be capable to be utilized as a water supply source for the 15 residential lots. The minimal drawdown in the test wells indicates that there will likely be minimal interference between the supply wells both on the Site and with surrounding water supply wells. This will be confirmed by on-site testing in the next phase of the study. Due to the recent completion of the well installations, on-site testing could not be completed for inclusion in this submission in time; however this next phase of the study is being undertaken shortly and will be submitted for review to the Township subsequently.

4.1.3 WATER QUALITY ASSESSMENT

Water quality samples were collected from two (2) drilled water supply wells (RW1 and RW2) located adjacent to the proposed development in order to characterize water quality in the Deep Overburden aquifer system. On-site water quality will be collected during the next phase of the study when pumping tests are completed.

Water quality was collected at RW1, located directly west of the Site on Cora Dr. Water quality results indicate that the water quality is generally good, with only a few exceedances of the Ontario Drinking Water Quality
Standards (ODWQS) and typical of overburden aquifers systems in the area with exceedances of hardness, turbidity and iron. All of these parameters exceeded an aesthetic or operational limit and could be treated with a conventional drinking water treatment system (i.e. water softening and/or iron filter).

Water quality was also collected at RW2, located directly north of the Site on Sharpe Line. Water quality results were also generally good with only exceedences for hardness, total dissolved solids (TDS) and total coliforms. Hardness exceeded the ODWQS for an operational guideline limit and can be treated using a conventional water softening system. TDS may be an indicator of higher concentrations of sodium and chloride in the area, which are both elevated in the well compared to the results at RW1, and may indicate increased road salting on Sharpe Line or nearby County Road 10. Neither concentration is approaching the ODWQS limit and are both fairly low in RW1, indicating a variation in the salt source. Total coliforms also exceeded the ODWQS limit. This, in conjunction with the salt concentration, leads to the speculation that the water source for this well could be connected to the shallow system, either through an improper annular seal or lack of a buried water confining unit (aquitard). A water well record could not be obtained from the home owner. Based on their reported well information, the well is a drilled well, to a depth of approximately 30 m. The drilled well was constructed inside a concrete bored well casing and could not be accessed during the survey to verify. Based on the water quality results, a proper annular seal may not have been installed when the drilled well was constructed.

The water quality results from the adjacent drilled wells are generally good, aside from a few treatable exceedances of the ODWQS. It is anticipated that the water quality results from the on-site wells will be similar in nature with likely exceedences of the ODWQS for hardness and potentially iron. With proper annular seals on the newly constructed wells and an reported aquitard unit separating the Shallow and Deep Overburden aquifer systems, total coliforms are not anticipated to be observed on-site. Water quality results will be collected and confirmed in the next phase of the study.
5.0 WASTEWATER ASSESSMENT

As per Procedure D-5-4 Technical Guideline for Individual On-Site Sewage Systems: Water Quality Risk Assessment (Ministry of the Environment, 1996), an assessment was completed to determine the feasibility of utilizing on-site sewage disposal for the development.

The creation of 15 residential lots will increase wastewater effluent loading on the Shallow Overburden aquifer system which is the receiving aquifer system. Within the effluent, nitrate is considered the limiting contaminant due to the human health concerns. Procedure D-5-4 requires that the effluent plume at the Site boundary to be within the ODWQS limit of 10 mg/L for nitrate to prevent contamination of adjacent properties. Although natural processes and soil interaction can result in nitrate being attenuated in the receiving aquifer system, Procedure D-5-4 states that only dilution can be used as the principal attenuation mechanism to predict future nitrate concentrations. As such, a mass balance calculation is used to determine the impact of developing residential lots on the Site.

5.1 AVAILABLE DILUTION

The total available dilution for the Site is estimated by the following equation:

\[ Q_i = A \times S \times I \]

Where: 
- \( Q_i \) – Volume of Available dilution water
- \( A \) - Area of the Site
- \( S \) – Water surplus
- \( I \) – Infiltration factor

The infiltration factor is based on the following components:

- Topography = 0.2 (rolling land)
- Soil = 0.3 (sandy silt till)
- Cover = 0.1 (cultivated lands)

Infiltration Factor = 0.6

The estimated surplus is calculated to be 305 mm/yr based on the calculated water balance for the Peterborough climatic station. After applying the infiltration factor of 0.6 to the water surplus, the net infiltration rate would be 183 mm/yr, which is in the range with the typical groundwater recharge rate for silty sands to sandy silts (150 to 200mm/yr).
The estimated dilution is calculated as follows:

- Total Site area = 5.8 ha
- Less = 0.29 ha (impervious services)
- Water Surplus = 0.305 m/yr
- Infiltration Factor = 0.6
- Total Dilation = 10,083 m³/year (27.6 m³/day)

5.2 PREDICTIVE ASSESSMENT

Based on Procedure D-5-4, each of the proposed development lots are anticipated to generate an average discharge of 1,000 L/day of sewage effluent. Total nitrogen (all species) ultimately convert to nitrate through the wastewater treatment process. Nitrate is considered to be the critical contaminate in sewage effluent. A nitrate loading of 40 grams/lot/day is required to be normally used to determine the effluent loading from conventional septic systems on the receiving groundwater system.

Water quality analytical results from the groundwater samples (Section 3.4) were used to assess the existence, extent, and level of impacts to the environment related to the proposed on-site wastewater treatment. Analytical data are attached as Appendix B and summarized in Table 3.

To evaluate the impact of a wastewater treatment system on a groundwater resource, a reference point or value is established to assist in determining the extent of the impact, if any. In this respect, the quality of the groundwater that is not impacted by the wastewater treatment system on the Site (i.e. background water quality) should be used for comparison purposes. From Site observations, a septic bed may be located on the north side of the on-site existing residence and shallow dug well. Furthermore, it is assumed that there are septic systems servicing the residential area surrounding the northeast, north, and northwest property boundaries of the Site. However, based on the analytical results from the on-site water supply well sourced from the shallow receiving aquifer system, which revealed a nitrate concentration below the laboratory detection limit (0.06 mg/L), the water quality results from the on-site water supply well can be utilized for background groundwater characterization.

To determine the adequate lot density for the Site, a mass balance calculation is used to determine the sewage loading for nitrate on the property boundary.

\[ Q_iC_i = Q_eC_e + Q_iC_i \]

Where:
- \( Q_i \) = Total volume (\( Q_e + Q_i \))
- \( C_i \) = Total concentration of nitrate at the property boundary
- \( Q_e \) = Volume of septic effluent (1,000 L/day x 15 lots =15,000 L/day)
\[ C_e \quad = \quad \text{Concentration of nitrate in effluent (40 mg/L)} \]
\[ Q_i \quad = \quad \text{Volume of available dilution water (27,600 L/day)} \]
\[ C_i \quad = \quad \text{Concentration of nitrate in dilution water (0.1 mg/L)} \]

In order to determine the concentration of nitrate at the property boundary \((C_t)\), the above mass balance equation is arranged as follows:

\[
C_i = \frac{Q_e C_e + Q_i C_i}{Q_t}
\]

Thus

\[
C_i = \frac{((15,000 \text{ L/day}) \cdot (40 \text{ mg/L})) + ((27,600 \text{ L/day}) \cdot (0.1 \text{ mg/L}))}{((15,000 \text{ L/day})) + (27,600 \text{ L/day})}
\]

\[
Ci = 14.07 \text{ mg/L}
\]

Based on the above mass balance calculation, the development of 15 residential lots using conventional septic systems would result in a nitrate concentration of 14.07 mg/L at the property boundary. In order to maintain the 15 lots for the Site, the use of a tertiary treatment system (i.e. Waterloo Biofilter Systems, Ecoflow Biofilter Treatment Systems, Bionest Technologies, etc.) is proposed for each of the residences. Tertiary treatments systems have become common place in on-site servicing in the past 10 years and are approved under the Ontario Building Code for use in servicing residences. Independent testing has verified that tertiary treatment systems can remove 59 to 84% of total nitrogen after treatment. Furthermore, additional NOx systems can be added to the treatment train to reduce total nitrogen to less than 5 mg/L if required. Considering this, the above mass balance equation has been recalculated incorporating a nitrate input of 20 mg/L in the effluent (50% reduction with tertiary treatment system).

Thus

\[
C_i = \frac{((15,000 \text{ L/day}) \cdot (20 \text{ mg/L})) + ((27,600 \text{ L/day}) \cdot (0.1 \text{ mg/L}))}{((15,000 \text{ L/day})) + (27,600 \text{ L/day})}
\]

\[
Ci = 7.03 \text{ mg/L}
\]

Therefore, the addition of 15 residential lots at the Site is plausible with the additional of tertiary treatment in the sewage system. Background nitrates on the Site were observed to be below detection limit area are observed to be below 1 mg/L in most of the surrounding residences, with exception at RW6 and RW7, both located northeast of the Site. Based on the variability observed in nitrate concentrations, it is presumed that the higher concentrations observed at RW6 and RW7 are likely the result of cross-contamination from surrounding septic systems. Although nitrate concentrations are low on the Site, the provision of tertiary treatment systems would allow for an input of up-gradient groundwater with greater nitrate concentrations, if this occurs (although not observed on-site), and still maintain nitrate concentrations below 10 mg/L at the down-gradient boundary.
6.0 SERVICING CONSIDERATIONS

6.1 GENERAL

The general development lot layouts and septic system locations have been provided on the Draft Plan of Subdivision, prepared by Engage Engineering (Engage Engineering, 2014) and the lot layouts are shown on Figure 6. The septic system locations have been developed in conjunction with the grading plan for the Site, and to minimize restrictions of setbacks to on-site and neighbouring wells by locating the septic systems within the front yards of the building lots. Wells are proposed to be located in the back yards. The placement of the septic system footprints is provided to demonstrate that they can be easily placed on each building lot. The actual location of the septic system may vary depending on the detailed design of the septic system on each lot.

6.2 WATER SUPPLY WELLS

The interim results of this study indicate that the proposed building lots can be adequately sourced by private supply wells on the Site. The target aquifer is the Deep Overburden aquifer system, approximately 60 m (200 ft) below the ground surface. Preliminary testing of the three (3) on-site water supply wells indicate that the target aquifer system is robust across the Site and would provide ample well yield for subsequent building lots, subject to on-site testing for a longer duration of 6 hours. The location of each of the test wells is suitable for future development of the lots.

Future wells should be constructed by a licenced Well Contractor who is experienced with construction of wells in overburden material, screen installation and well development.

Initial water quality results indicated that drinking water treatment systems may be required to reduce hardness and potentially iron.

6.3 SEWAGE SYSTEM DESIGN CONSIDERATIONS

The results of this study indicate that the Site can support the development of 15 residential lots, providing that tertiary treatment systems are incorporated in the sewage systems. Due to the presence of a high water table, raised areas beds and associated fill based mantles will be required; therefore, the proposed wastewater treatment system for each lot consists of a septic tank, an advanced treatment unit and a raised area bed and fill based mantle.

The sewage systems shown on the Draft Plan of Subdivision are based on a flow rate of 2,500 L/day (5 bedroom house) and have a contact area of 270 m², including the mantle area. There is adequate spacing in each of the building lots if a flow rate up to 3,000 L/day is required. The shallow soils on the Site are a sandy silt till (SM) with a percolation rate between 8 to 20 min/cm; as a conservative measure, a percolation time of 18 min/cm is
assumed. As such, a loading rate of 10 L/m² was used to determine the contact area shown on the Draft Plan of Subdivision.

The raised area beds will consist of a layer of gravel overlying a layer of clean sand fill (per OBC specifications) which will be imported to the Site; the soil and gravel used are to meet the requirements set forth in the OBC. The distribution lines will be situated in the gravel layer. The tertiary treatment units can either be placed in line between the septic tanks and the area beds or situated on top of the area beds.

Conceptual footprints were provided on the Draft Plan of Subdivision to illustrate the general layout of the servicing on the lot; the actual area of the raised area bed required will be dependent on the following:

- Sewage flow volume generated by the residence;
- Soil percolation rates where the area bed will be located; and,
- Level of treatment prior to final effluent disposal.

The design and construction of individual private sewage systems is governed under the Ontario Building Code and an individual assessment and design will be required at the time of application for approval by the appropriate authority.

A maintenance agreement must be signed with the tertiary treatment provider to inspect the wastewater treatment system to ensure proper operation.
7.0 CONCLUSIONS AND RECOMMENDATIONS

- The development of the Site for the proposed 15 lot subdivision is feasible, based on using private drilled wells and on-site sewage systems, provided that tertiary treatment is incorporated in the sewage system designs.

- This assessment included a hydrogeological investigation and terrain analysis/impact assessment to support private servicing of potable water and wastewater.

- Currently, the Site includes a vacant residence, a barn, several small farm-related structures, and cultivated lands, which occupies the majority of the property.

- The Site topography consists of a gently rolling topography with an increasing slope towards the southeast portion of the property. The regional topography indicates that the inferred groundwater flow direction is towards an unnamed waterbody to the southeast.

- There are two (2) water supply wells on-site, one (1) of which is a dug well supplying the vacant residence, and the other a drilled well (#5110970) supplying water for the barn. Neither of the two (2) on-site wells are currently in use.

- Twelve test pits were completed throughout the Site to determine the subsurface conditions across the property. Of the 12 test pits completed at the Site, 10 exhibited a similar stratigraphy of topsoil overlying sandy silt till. Test pit TP102-14, located near the barn structure, exhibited a surficial layer of topsoil to 0.46 mbg overlying a layer of coarse sand and gravel. Test pit TP 111-14, located near the man-made pond in the southwest portion of the Site, exhibited a surficial layer of topsoil to 0.38 mbg overlying a layer of well-graded sandy silt. Cobbles were observed at most test pit locations.

- Dry conditions were noted in the three (3) test pits completed in the southeastern portion of the Site (TP 101-14, 102-14 and 103-14). Seepage and wet conditions were noted in the test pits across the remaining portion of the Site.

- Shallow soil conditions are fairly consistent across the Site. Grain size analysis indicates a percolation time between 8 to 20 min/cm, with a percolation time of 18 min/cm used in the assessment.

- Three (3) drilled wells were installed to determine the extent of the aquifer system on the Site. The depth of the test wells ranged between 59.76 to 71.95 mBGs, and all were screened into the Deep Overburden Aquifer system. The drillers reported well yield for the three (3) test wells ranged between 182 to 340 Lpm, all more than adequate for residential use. A longer duration (6 hour) pumping test will be completed on three (3) test wells in the next phase of the study. Due to the high well yield, interference between the wells is not anticipated.
• Water quality results were collected from two (2) off Site drilled wells to assess the drinking water quality in the area. Water quality was found to be generally good, with only a few exceedances of the ODWQS; most notably, hardness and iron were found to exceed the guideline limits. It is anticipated that these parameters will likely be elevated above the ODWQS in the on-site test wells; however this will be confirmed with additional water quality sampling completed during the on-site pumping tests in the next phase of the study. Treatment systems for hardness will likely be required for the residences.

• Mass balance calculations were used to determine the nitrate loading from the addition of 15 residential lots. The calculations determined that the Site cannot support the addition of 15 lots using conventional sewage systems; however the Site can support the lots if tertiary treatment is incorporated in the sewage systems.

• Due to the presence of a high water table throughout most of the Site, raised area beds and associated mantles will be required.

• A conceptual footprint of the raised area beds and locations of the sewage systems are provided on the Draft Plan of Subdivision to illustrate that the systems can be adequately situated on each of the building lots.

• The site assessment detailed design for each sewage system will need to be completed individually based on the requirements of the Ontario Building Code for each building lot at the time of application for approval by the appropriate authority.
REFERENCES


ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<td>RFP</td>
<td>Request For Proposal</td>
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</tr>
<tr>
<td>MNR</td>
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<td>Environmental Protection Act</td>
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<tr>
<td>EAA</td>
<td>Environmental Assessment Act</td>
</tr>
<tr>
<td>MW</td>
<td>monitor well</td>
</tr>
<tr>
<td>masl</td>
<td>metres above sea level</td>
</tr>
<tr>
<td>kg</td>
<td>kilogram</td>
</tr>
<tr>
<td>mm</td>
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</tr>
<tr>
<td>ha</td>
<td>hectare</td>
</tr>
<tr>
<td>m²</td>
<td>cubic metres</td>
</tr>
<tr>
<td>m²</td>
<td>square metres</td>
</tr>
<tr>
<td>mg/l</td>
<td>milligrams per litre</td>
</tr>
<tr>
<td>µS</td>
<td>microSiemens</td>
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<td>PWQO</td>
<td>Provincial Water Quality Objectives</td>
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<td>TOC</td>
<td>Total Organic Carbon</td>
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<tr>
<td>VOC</td>
<td>Volatile Organic Compounds</td>
</tr>
<tr>
<td>BTU</td>
<td>British Thermal Unit</td>
</tr>
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<td>°C</td>
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<td>N/A</td>
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<td>%</td>
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<tr>
<td>cfm</td>
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<tr>
<td>ppmv</td>
<td>part per million by volume</td>
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<tr>
<td>ppm</td>
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<tr>
<td>max</td>
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<tr>
<td>kg/m³</td>
<td>kilograms per cubic metre</td>
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UNITS OF MEASUREMENT AND CONVERSIONS

**Length**

- 1 metre (m) = 3.28 feet
- 1 millimetre (mm) = 0.039 inches
- 1 kilometre (km) = 0.621 miles

**Area**

- 1 hectare (ha) = 2.47 acres
- 1 square metre (m²) = 10.76 square feet

**Volume**

- 1 cubic metre (m³) = 35.29 cubic feet
- 1 litre (L) = 0.220 gallons

**Mass**

- 1 metric ton (tonne) = 1.10 Imperial tons
- 1 kilogram (kg) = 2.20 lbs
- 1 pound (lb) = 453.6 g
- 1 gram (g) = ---
- 1 milligrams (mg) = 1 x 10⁻³ g
- 1 microgram (µg) = 1 x 10⁻⁶ g
- 1 nanogram (ng) = 1 x 10⁻⁹ g
- 1 kilogram (kg) = 1000 g
- 1 picogram (pg) = 1 x 10⁻¹² g
- 1 metric tonne (t) = 1000 kg
Hydrogeological Assessment for Subdivision Development, Ida Village
Mr. Ian Cameron
Ref. No.: 3751-001
2015-01-07

Appended Figures
HYDROGEOLOGICAL ASSESSMENT
IAN CAMERON
1844 County Road 10
Ida, Ontario

LEGEND
- Site Plan Subdivision Boundary
- Watercourse, Permanent
- Contour (index)
- Lot
- Wetland Area
- Provincially Significant Wetland
- Water Area
- Wooded Area

Notes:
- Base mapping features are © Queen's Printer of Ontario, 2010 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
- Cambium Inc. makes every effort to ensure this map is free from errors but cannot be held responsible for any damages due to error or omissions. This map should not be used for navigation or legal purposes. It is intended for general reference use only.

REGIONAL LOCATION PLAN

Project No.: 375 1-001
Date: December 2014
Rev.: TLC
Scale: 1:20,000
Projection: NAD 1983 UTM Zone 17N

Created by: TLC
Checked by: KDW
Figure: 1
TEST PIT AND WELL LOCATION PLAN

HYDROGEOLOGICAL ASSESSMENT
IAN CAMERON
1844 County Road 10
Ida, Ontario

LEGEND
- Test Pit Location
- Residential Well Location
- Site Plan Subdivision Boundary
- Subject Property
- Parcels
- Contour (index)
- Contour (5m)
- Lot

Notes:
- Base mapping features are © Queen's Printer of Ontario, 2010 (this does not constitute an endorsement by the Ministry of Natural Resources or the Ontario Government).
- Distances on this plan are in metres and can be converted to feet by dividing by 0.3048.
- Cambium Inc. makes every effort to ensure this map is free from errors but cannot be held responsible for any damages due to error or omissions. This map should not be used for navigation or legal purposes. It is intended for general reference use only.

Date: December 2014
Project No.: 3751-001
Scale: 1:2,000
Projection: NAD 1983 UTM Zone 17N

Created by: NLB
Checked by: KDW
Figure: 4
Hydrogeological Assessment for Subdivision Development, Ida Village

Mr. Ian Cameron

Ref. No.: 3751-001

2015-01-07

Appended Tables
## Table 3 - Summary of Well Water Quality

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<th>Units</th>
<th>RW 1</th>
<th>RW 2</th>
<th>RW 3</th>
<th>RW 4</th>
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<th>RW 5</th>
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<td>12-Dec-14</td>
<td>12-Dec-14</td>
<td>12-Dec-14</td>
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<td><strong>Alkalinity</strong> mg/L</td>
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<td>30 - 500</td>
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<td>330</td>
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<tr>
<td><strong>Bicarbonate</strong> mg/L</td>
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<td>203</td>
<td>330</td>
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<td><strong>Carbonate</strong> mg/L</td>
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<td>7.2</td>
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<td><strong>pH</strong> units</td>
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<td>6.5 - 8.5</td>
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<tr>
<td><strong>Fluoride</strong> mg/L</td>
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<td>0.0168</td>
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<td><strong>Hardness</strong> mg/L</td>
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<td><strong>Iron</strong> mg/L</td>
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<td><strong>Lead</strong> mg/L</td>
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<td><strong>Lithium</strong> mg/L</td>
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<td>0.000024</td>
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<tr>
<td><strong>Magnesium</strong> mg/L</td>
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<td>0.000048</td>
<td>0.000096</td>
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<td><strong>Manganese</strong> mg/L</td>
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<tr>
<td><strong>Nitrate (as N)</strong> mg/L</td>
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<td>1 &lt; 0.03</td>
<td>0.06</td>
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<td><strong>Nitrite (as N)</strong> mg/L</td>
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<td><strong>Phosphorus (total)</strong> mg/L</td>
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<td>&lt; 0.03</td>
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<tr>
<td><strong>Silver</strong> mg/L</td>
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<td>0.000048</td>
<td>0.000096</td>
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</tr>
<tr>
<td><strong>Total Coliforms</strong></td>
<td></td>
<td>CFU/100mL</td>
<td>0</td>
<td>3</td>
<td>14</td>
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<tr>
<td><strong>Total Dissolved Solids (calculated)</strong> mg/L</td>
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<td>500+</td>
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<td>602</td>
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**Notes:**
2. Parameter name in (parenthesis) indicate alternate chemical names.
3. Bold and shaded values exceed ODWS health-related criteria.
4. Shaded values exceed ODWS aesthetic and operational objectives.
5. "---" indicates value not analyzed.
6. NV indicates no value.

---

P:\3700 to 3799\3751-001 Ian Cameron - Hydrogeological Investigation, Cameron Subdivision\Deliverables\REPORT - HydroG\Final\Tables\Table 3 - Well Survey Analytical
<table>
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<th>Test Pit ID</th>
<th>Depth (mbsg(^1))</th>
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<tr>
<td>SS1</td>
<td>0 - 0.36</td>
<td>Dark brown to brown sandy silt topsoil, with some clay and trace gravel, loose, moist</td>
</tr>
<tr>
<td>SS2</td>
<td>0.36 - 2.00</td>
<td>Light brown sandy silt till with some clay and trace gravel, cobbles throughout, compact, moist</td>
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<tr>
<td></td>
<td>2.00</td>
<td>End of test pit</td>
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<tr>
<td></td>
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<td>Test pit dry upon completion</td>
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<tr>
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<tr>
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Notes:
1. mbsg = metres below ground surface
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<td>Light brown to grey and reddish grey sandy silt till with some clay and trace gravel, compact, moist to saturated</td>
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<td>1.00 - 2.00</td>
<td>Light brown to grey silty fine sand, loose to compact, saturated</td>
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<td>Test pit wet upon completion, water seeping in beginning at 0.61 m</td>
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<td>1.00 - 2.00</td>
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<td>Test pit wet upon completion, water seeping in beginning at 0.56 m</td>
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Notes: 1. mbgs = metres below ground surface
Appendix B

Laboratory Certificates of Analysis
### CERTIFICATE OF ANALYSIS

**Final Report**

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<td>12-Dec-14 11:30</td>
<td>12-Dec-14 12:30</td>
<td>12-Dec-14 13:30</td>
<td>12-Dec-14 14:45</td>
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<td>Alkalinity [mg/L as CaCO3]</td>
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<td>356</td>
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<td>Bicarbonate [mg/L as CaCO3]</td>
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<td>09:15</td>
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<td>Carbonate [mg/L as CaCO3]</td>
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<td>13:58</td>
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<td>Conductivity [µS/cm]</td>
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<td>Turbidity [NTU]</td>
<td>15-Dec-14</td>
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<tr>
<td>Phosphorus (total) [mg/L]</td>
<td>15-Dec-14</td>
<td>08:24</td>
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<td>&lt;0.03</td>
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<td>Organic Nitrogen [mg/L]</td>
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<td>Ammonia+Ammonium (N) [mg/L]</td>
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<td>Dissolved Organic Carbon [mg/L]</td>
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<td>Chloride [mg/L]</td>
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<td>Fluoride [mg/L]</td>
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<td>Nitrite (as N) [mg/L]</td>
<td>15-Dec-14</td>
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<td>Nitrate (as N) [mg/L]</td>
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<td>0.28</td>
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Test method information available upon request. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.
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<td>Sulphate [mg/L]</td>
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<td>Hardness [mg/L as CaCO3]</td>
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<td>Calcium [mg/L]</td>
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<td>Potassium [mg/L]</td>
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<td>Magnesium [mg/L]</td>
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<td>20.9</td>
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<td>---</td>
<td>---</td>
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</tr>
<tr>
<td>Titanium [ug/L]</td>
<td>16-Dec-14</td>
<td>09:53</td>
<td>0.09</td>
<td>0.16</td>
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<td>---</td>
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</tr>
<tr>
<td>Uranium [ug/L]</td>
<td>16-Dec-14</td>
<td>09:53</td>
<td>0.102</td>
<td>0.512</td>
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<tr>
<td>Vanadium [ug/L]</td>
<td>16-Dec-14</td>
<td>09:53</td>
<td>&lt; 0.01</td>
<td>0.26</td>
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### Analysis

<table>
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<tbody>
<tr>
<td>Zinc [µg/L]</td>
<td>16-Dec-14</td>
<td>09:53</td>
<td>4</td>
<td>94</td>
<td>---</td>
<td>---</td>
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</tr>
<tr>
<td>Total Coliform [cfu/100mL]</td>
<td>15-Dec-14</td>
<td>09:16</td>
<td>3</td>
<td>11</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>E. Coli [cfu/100mL]</td>
<td>15-Dec-14</td>
<td>09:16</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Total Dissolved Solids (calculated) [mg/L]</td>
<td>---</td>
<td>---</td>
<td>233</td>
<td>602</td>
<td>---</td>
<td>---</td>
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</tr>
<tr>
<td>Saturation pH [pHs @ 4°C]</td>
<td>---</td>
<td>---</td>
<td>7.94</td>
<td>7.30</td>
<td>---</td>
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<tr>
<td>Saturation pH [pHs @ 20°C]</td>
<td>---</td>
<td>---</td>
<td>7.62</td>
<td>6.98</td>
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<tr>
<td>Conductivity (calculated) [µS/cm]</td>
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<td>464</td>
<td>1125</td>
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<tr>
<td>Cation sum [meq/L]</td>
<td>---</td>
<td>---</td>
<td>4.54</td>
<td>10.8</td>
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<td>Anion Sum [meq/L]</td>
<td>---</td>
<td>---</td>
<td>4.74</td>
<td>11.6</td>
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<tr>
<td>Anion-Cation Balance [% difference]</td>
<td>---</td>
<td>---</td>
<td>-2.10</td>
<td>-3.56</td>
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<tr>
<td>Langelier's Index [@4°C]</td>
<td>---</td>
<td>---</td>
<td>0.17</td>
<td>0.67</td>
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<tr>
<td>Langelier's Index [@20°C]</td>
<td>---</td>
<td>---</td>
<td>0.49</td>
<td>0.99</td>
<td>---</td>
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NR - Not reportable under O.Reg 170/03 or 243/07 of the SDWA or O.Reg 318/08 & 319/08 of the HPPA as per client.

Brian Graham B.Sc.
Project Specialist
Environmental Services, Analytical
CERTIFICATE OF ANALYSIS

Final Report

<table>
<thead>
<tr>
<th>Analysis</th>
<th>1: Analysis Start Date</th>
<th>2: Analysis Start Time</th>
<th>3: Analysis Approval Date</th>
<th>4: Analysis Approval Time</th>
<th>7: RW 4</th>
<th>8: RW 6</th>
<th>9: RW 7</th>
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<tbody>
<tr>
<td>Sample Date &amp; Time</td>
<td></td>
<td></td>
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<td>22-Dec-14 11:45</td>
<td>22-Dec-14 13:00</td>
<td>22-Dec-14 14:15</td>
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<tr>
<td>Temperature Upon Receipt [°C]</td>
<td>---</td>
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<td>4.0</td>
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<tr>
<td>pH [no unit]</td>
<td>22-Dec-14 14:23</td>
<td>23-Dec-14</td>
<td>15:35</td>
<td>8.27</td>
<td>8.24</td>
<td>7.64</td>
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<tr>
<td>Phosphorus (total) [mg/L]</td>
<td>23-Dec-14 06:40</td>
<td>23-Dec-14</td>
<td>14:55</td>
<td>0.06</td>
<td>0.14</td>
<td>0.07</td>
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<tr>
<td>Organic Nitrogen [mg/L]</td>
<td>23-Dec-14 14:51</td>
<td>23-Dec-14</td>
<td>14:55</td>
<td>&lt; 0.05</td>
<td>0.19</td>
<td>&lt; 0.05</td>
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<tr>
<td>Total Kjeldahl Nitrogen [as N mg/L]</td>
<td>23-Dec-14 06:41</td>
<td>23-Dec-14</td>
<td>14:41</td>
<td>&lt; 0.5</td>
<td>&lt; 0.5</td>
<td>&lt; 0.5</td>
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<tr>
<td>Ammonia+Ammonium (N) [mg/L]</td>
<td>23-Dec-14 10:54</td>
<td>23-Dec-14</td>
<td>14:55</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
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<tr>
<td>Dissolved Organic Carbon [mg/L]</td>
<td>23-Dec-14 06:30</td>
<td>23-Dec-14</td>
<td>14:48</td>
<td>&lt; 1</td>
<td>&lt; 1</td>
<td>3.1</td>
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<tr>
<td>Nitrite (as N) [mg/L]</td>
<td>23-Dec-14 10:07</td>
<td>23-Dec-14</td>
<td>14:52</td>
<td>&lt; 0.03</td>
<td>&lt; 0.03</td>
<td>&lt; 0.03</td>
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</tr>
<tr>
<td>Nitrate (as N) [mg/L]</td>
<td>23-Dec-14 10:07</td>
<td>23-Dec-14</td>
<td>14:52</td>
<td>&lt; 0.06</td>
<td>2.39</td>
<td>2.46</td>
<td></td>
</tr>
<tr>
<td>Nitrate + Nitrite (as N) [mg/L]</td>
<td>23-Dec-14 10:07</td>
<td>23-Dec-14</td>
<td>14:52</td>
<td>&lt; 0.06</td>
<td>2.39</td>
<td>2.46</td>
<td></td>
</tr>
</tbody>
</table>

Brian Graham  B.Sc.
Project Specialist
Environmental Services, Analytical
Appendix C
Grain Size Analysis
**Client:** Ian Cameron  
**Project:** Hydrogeological Investigation  
**Sample No.:** S-2  
**Sampled By:** Cambium Inc.  
**Depth:** ---  
**Date:** December, 2014

### UNIFIED SOIL CLASSIFICATION SYSTEM

<table>
<thead>
<tr>
<th>CLAY &amp; SILT (&lt;0.075mm)</th>
<th>SAND (&lt;4.75 to 0.075mm)</th>
<th>GRAVEL (&gt;4.75mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FINE</td>
<td>MEDIUM</td>
</tr>
</tbody>
</table>

### U.S. BUREAU OF SOILS CLASSIFICATION

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Sample No.</th>
<th>Depth</th>
<th>Gravel</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
<th>Moisture</th>
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</thead>
<tbody>
<tr>
<td>TP-11</td>
<td>S-2</td>
<td>---</td>
<td>0</td>
<td>32</td>
<td>68</td>
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</tbody>
</table>

**Description:** SANDY SILT  
**Classification:** ML  
**D_10:** 0.070  
**D_30:** 0.050  
**C_6:** 0.025
Client: Ian Cameron
Project: Hydrogeological Investigation
Sample No.: S-2
Sampled By: Cambium Inc.

Project No.: 3751-001
Hole No.: TP-2
Depth: ---
Date: December, 2014

### Unified Soil Classification System

<table>
<thead>
<tr>
<th>Clay &amp; Silt (&lt;0.075mm)</th>
<th>Sand (4.75 to 0.075mm)</th>
<th>Gravel (&gt;4.75mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine</td>
<td>Medium</td>
<td>Coarse</td>
</tr>
<tr>
<td>Fine</td>
<td>Fine</td>
<td>Coarse</td>
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### U.S. Bureau of Soils Classification

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Sample No.</th>
<th>Depth</th>
<th>Gravel</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
<th>Moisture</th>
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</thead>
<tbody>
<tr>
<td>TP-2</td>
<td>S-2</td>
<td>---</td>
<td>24</td>
<td>73</td>
<td>2</td>
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<tr>
<td>Description</td>
<td>Classification</td>
<td>D_{50}</td>
<td>D_{50}</td>
<td>D_{10}</td>
<td>C_{u}</td>
<td>C_{c}</td>
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<tr>
<td>GRAVELY SAND</td>
<td>SW</td>
<td>2.10</td>
<td>0.75</td>
<td>0.33</td>
<td>6</td>
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</table>

---

**Grain Size Distribution Chart**

*Perf-Test results as of December 2014.*
Grain Size Distribution Chart

Client: Ian Cameron                      Project No.: 3751-001
Project: Hydrogeological Investigation  Hole No.: TP-3
Sample No.: S-2                          Depth: ---
Sampled By: Cambium Inc.                  Date: December, 2014

UNIFIED SOIL CLASSIFICATION SYSTEM

<table>
<thead>
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<th></th>
<th>CLAY &amp; SILT (&lt;0.075mm)</th>
<th>SAND (&lt;4.75 to 0.075mm)</th>
<th>GRAVEL (&gt;4.75mm)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>FINE</td>
<td>MEDIUM</td>
<td>COARSE</td>
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<tr>
<td></td>
<td>FINE</td>
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<td>COARSE</td>
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U.S. BUREAU OF SOILS CLASSIFICATION

<table>
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<th>Borehole No.</th>
<th>Sample No.</th>
<th>Depth</th>
<th>Gravel</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
<th>Moisture</th>
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<td>Description</td>
<td>Classification</td>
<td>D_10</td>
<td>D_30</td>
<td>D_10</td>
<td>C_s</td>
<td>C_c</td>
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<tr>
<td>SAND &amp; SILT</td>
<td>SM</td>
<td>0.120</td>
<td>0.012</td>
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</table>
Grain Size Distribution Chart

Client: Ian Cameron
Project: Hydrogeological Investigation
Sample No.: S-2
Sampled By: Cambium Inc.

Project No.: 3751-001
Hole No.: TP-8
Date: December, 2014

UNIFIED SOIL CLASSIFICATION SYSTEM

<table>
<thead>
<tr>
<th></th>
<th>CLAY &amp; SILT (&lt;0.075mm)</th>
<th>SAND (&lt;4.75 to 0.075mm)</th>
<th>GRAVEL (&gt;4.75mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FINE</td>
<td>MEDIUM</td>
<td>COARSE</td>
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</tbody>
</table>

U.S. BUREAU OF SOILS CLASSIFICATION

<table>
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<tr>
<th>Borehole No.</th>
<th>Sample No.</th>
<th>Depth</th>
<th>Gravel</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
<th>Moisture</th>
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<tr>
<td>TP-8</td>
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<td>15</td>
<td>40</td>
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<tr>
<td>Description</td>
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<td>D_{50}</td>
<td>D_{30}</td>
<td>D_{10}</td>
<td>C_{v}</td>
<td>C_{u}</td>
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<tr>
<td>SAND &amp; SILT some clay and gravel</td>
<td>SM</td>
<td>0.200</td>
<td>0.012</td>
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Appendix D
Well Records
### WATER WELL RECORD

#### GENERAL INFORMATION

- **County or Township:** Doran
- **TOWNSHIP:** BOROUGH
- **Lot:** 21 1/2
- **Date Completed:** 10/13/1970
- **Municipality:** CAUAN
- **ONT.:** 21 1/2
- **GPM:** 1903046
- **CON. MAJ.:** TRELITON

#### LOG OF OVERBURDEN AND BEDROCK MATERIALS

<table>
<thead>
<tr>
<th>General Colour</th>
<th>Most Common Material</th>
<th>Other Materials</th>
<th>Description</th>
<th>Depth - Feet</th>
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</thead>
<tbody>
<tr>
<td>Brown</td>
<td>Top Soil</td>
<td></td>
<td>Packed</td>
<td>01</td>
</tr>
<tr>
<td>Brown Med. Sand</td>
<td></td>
<td></td>
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<td>136</td>
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<tr>
<td>Brown Sandy Gravel</td>
<td></td>
<td></td>
<td>Packed-Dry</td>
<td>34 45</td>
</tr>
<tr>
<td>Brown Gravel</td>
<td></td>
<td></td>
<td>Packed</td>
<td>42 94</td>
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<tr>
<td>Brown Gravel</td>
<td>Pebbles</td>
<td></td>
<td>Dense</td>
<td>101 101</td>
</tr>
<tr>
<td>Grey Sandy Gravel</td>
<td></td>
<td></td>
<td>Dense</td>
<td>101 133</td>
</tr>
<tr>
<td>Brown Gravel</td>
<td>Pebbles</td>
<td></td>
<td>Dense</td>
<td>133 154</td>
</tr>
<tr>
<td>Brown Med. Sand</td>
<td>Pebbles</td>
<td></td>
<td>Dense</td>
<td>154 180</td>
</tr>
<tr>
<td>Brown Med Gravel</td>
<td>Pebbles</td>
<td></td>
<td>Dense</td>
<td>180 201</td>
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<tr>
<td>Brown Gravel</td>
<td>Pebbles</td>
<td></td>
<td>Porous</td>
<td>201 206</td>
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#### WATER RECORD

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<tr>
<th>Kind of Water</th>
<th>Initial WaterLevel</th>
<th>Water Level During Pumping</th>
<th>Duration of Pumping</th>
<th>Pumping Rate</th>
<th>Recovery</th>
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</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>178 feet</td>
<td>201 feet</td>
<td>0 minutes</td>
<td>0.01 GPM</td>
<td>0.01 GPM</td>
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#### CASING & OPEN HOLE RECORD

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<th>Screen</th>
<th>Depth Set At Feet</th>
<th>Material and Type</th>
<th>Cement, Group, Etc.</th>
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<tr>
<td>0</td>
<td>08</td>
<td>Stainless Steel</td>
<td>17.4</td>
</tr>
<tr>
<td>0.0004</td>
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</table>

#### LOCATION OF WELL

- **In Diagram Below Show Distances of Well from Road and Lot Line. Indicate North by Arrow.**

#### FINAL STATUS OF WELL

<table>
<thead>
<tr>
<th>Method of Drilling</th>
<th>Final Status</th>
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</table>

#### WATER USE

- 01

#### DATE OF INSPECTION

- NOV 19/71

#### OFFICE USE ONLY

- 11/75 7/5 7 20

- **OWRC COPY**
**WATER WELL RECORD**

**GENERAL COLOUR**
- MOST COMMON MATERIAL
  - TOP SOIL
  - HARDpan + STONES
  - GREY CLAY
  - MUD STONES
  - BLUE CLAY

**LOG OF OVERRUN AND BEDROCK MATERIALS**
(SEE INSTRUCTIONS)

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>THICKNESS</th>
<th>DEPTH - FEET</th>
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<tbody>
<tr>
<td></td>
<td>from</td>
<td>to</td>
</tr>
<tr>
<td>SOIL</td>
<td>0'</td>
<td>1'</td>
</tr>
<tr>
<td>HARDpan</td>
<td>1'</td>
<td>12'</td>
</tr>
<tr>
<td>STONES</td>
<td>12'</td>
<td>18'</td>
</tr>
<tr>
<td>GREY CLAY</td>
<td>18'</td>
<td>25'</td>
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**WATER RECORD**

<table>
<thead>
<tr>
<th>KIND OF WATER</th>
<th>WELLS</th>
<th>DEPTH - FEET</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>FROM</td>
<td>TO</td>
</tr>
<tr>
<td>FRESH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SULPHUR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MINERAL</td>
<td></td>
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<td>SALT</td>
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**CASING & OPEN HOLE RECORD**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>DEPTH - FEET</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>FROM</td>
</tr>
<tr>
<td>STEEL</td>
<td>30'</td>
</tr>
<tr>
<td>GALVANIZED</td>
<td>3'</td>
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<tr>
<td>CONCRETE</td>
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<tr>
<td>OPEN HOLE</td>
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</table>

**SCREEN MATERIAL AND TYPE**

<table>
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<th>TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PLUGGING & SEALING RECORD**

**LOCATION OF WELL**

**FINAL STATUS OF WELL**

- WATER SUPPLY
- OBSERVATION WELL
- FISH HOLE
- RECHARGE WELL
- DOMESTIC
- STOCK
- COMMERCIAL
- MUNICIPAL
- INDUSTRIAL
- COOLING OR AIR CONDITIONING
- OTHER

**METHOD OF DRILLING**

- CABLE TOOL
- ROTARY (CONVENTIONAL)
- ROTARY (REVOLUTE)
- ROTARY (AIR)
- AIR PERCUSSION

**WELL DRILLER**

**OWRC COPY**
# Water Well Record

## General Information

- **Identification Number:** 1903637
- **County or City:** Muncie
- **Towndship, Township, Range:** E
- **Lot:** 20
- **Date Completed:** 10-30-73
- **Drillers Remarks:**
  - **Draillers Name:** Tony Kehe
  - **Company Name:** Tony Kehe Drilling Ltd.
  - **Date of Completion:** Feb. 12, 1974
  - **Remarks:**

## Log of Overburden and Bedrock Materials

<table>
<thead>
<tr>
<th>General Colour</th>
<th>Most Common Material</th>
<th>Other Materials</th>
<th>General Description</th>
<th>Depth - Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Top Soil</td>
<td>0' 1'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Grey Clay</td>
<td>1' 12'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stones</td>
<td>4'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blue Clay</td>
<td>12' 32'</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stones</td>
<td>4'</td>
</tr>
</tbody>
</table>

## Water Record

- **Kind of Water:** Fresh
- **Material:** Sulfur
- **Thickness (inches):** 4
- **Depth from:** 0' 3'
- **Depth to:** 0' 3'

## Casing & Open Hole Record

- **Number:** 02
- **Depth:** 0' 3'
- **Material:** Steel
- **Thickness (inches):** 4
- **Depth from:** 0' 3'
- **Depth to:** 0' 3'

## Plugging & Sealing Record

- **Date of Opening:** 10-30-73
- **Location:** E
- **Diameter:** 36
- **Length:** 92

## Pumping Test

- **Pumping Rate:** 0.007 GPM
- **Duration of Pumping:** 00:00:00

## Final Status of Well

- **Water Supply:** 1
- **Observation Well:** 2
- **Test Well:** 3
- **Recharge Well:** 4

## Water Use

- **Domestic:** 5
- **Commercial:** 6
- **Municipal:** 7
- **Irrigation:** 8
- **Public Supply:** 9
- **Industrial:** 10
- **Other:** 11

## Method of Drilling

- **Name of Well Contractor:** Tony Kehe
- **Driller's Name:** Tony Kehe
- **Company Name:** Tony Kehe Drilling Ltd.
- **Submission Date:** Day 07, 01, 73

---

**Note:** The document includes various records and specifications related to a water well, including detailed information about the well's construction and usage.
**WATER WELL RECORD**

**LOG OF OVERBURDEN AND BEDROCK MATERIALS**

<table>
<thead>
<tr>
<th>General Colour</th>
<th>Most Common Material</th>
<th>Other Materials</th>
<th>General Description</th>
<th>Depth - Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>TOP SOIL</td>
<td>0' 1&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>HARDPAN &amp; STONES</td>
<td>1' 12&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>WET BLUE CLAY</td>
<td>12' 30&quot;</td>
</tr>
</tbody>
</table>

**WATER RECORD**

**CASING & OPEN HOLE RECORD**

<table>
<thead>
<tr>
<th>Dia. (Inches)</th>
<th>Material</th>
<th>Wall Thickness (Inches)</th>
<th>Depth - Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>STEEL</td>
<td>3</td>
<td>0' 1&quot;</td>
</tr>
<tr>
<td>12</td>
<td>GALVANIZED CONCRETE</td>
<td>2</td>
<td>3' 0&quot;</td>
</tr>
<tr>
<td>30</td>
<td>STEEL</td>
<td>3</td>
<td>3' 0&quot;</td>
</tr>
</tbody>
</table>

**SIZES OF OPENING**

- Diameter: 27.33
- Length: 37.40
- Depth: 47.25

**PLUGGING & SEALING RECORD**

<table>
<thead>
<tr>
<th>Material and Type</th>
<th>Depth Set At - Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0' 0&quot;</td>
</tr>
</tbody>
</table>

**LOCATION OF WELL**

- Diagram showing distances of well from road and lot line.
- Indicate north by arrow.

**FINAL STATUS OF WELL**

- WATER SUPPLY
- ABANDONED, INSUFFICIENT SUPPLY
- ABANDONED, POOR QUALITY
- TEST HOLE
- UNFINISHED

**WATER USE**

- DOMESTIC
- COMMERCIAL
- INDUSTRIAL
- COOLING OR AIR CONDITIONING
- OTHER

**METHOD OF DRILLING**

- CABLE TOOL
- ROTARY (CONVENTIONAL)
- ROTARY (REV/REVERSE)
- ROTARY (AIR)
- AIR PERCUSSION

**DESCRIPTORS**

- Contractor: "Kohr's Well Drilling Ltd" (329)
- Address: "Kohr's Well Drilling Ltd" (329)
- Name of Owner or Builder: "Cavan" (329)
- Signature of Contractor: "Cavan" (329)

**OFFICE USE ONLY**

- Data Source: "329" (329)
- Date Received: "070873" (329)
- Date of Inspection: "7/17/74" (329)
- Inspector: "K" (329)
**Log of Overburden and Bedrock Materials**

<table>
<thead>
<tr>
<th>General Colour</th>
<th>Most Common Material</th>
<th>Other Materials</th>
<th>General Description</th>
<th>Depth - Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Loam</td>
<td>Clay</td>
<td>Soft</td>
<td>0</td>
</tr>
<tr>
<td>Brown</td>
<td>Clay</td>
<td>Small stone</td>
<td>Hard</td>
<td>1.20</td>
</tr>
<tr>
<td>Blue</td>
<td>Clay</td>
<td>Sand seams</td>
<td>Stoney</td>
<td>20.415</td>
</tr>
</tbody>
</table>

**Water Well Record**

**General Colour**
- Black
- Brown
- Blue

**Most Common Material**
- Loam
- Clay

**Other Materials**
- Small stone
- Sand seams

**General Description**
- Soft
- Hard
- Stoney

**Location of Well**

**Method of Drilling**

**Name of Well Contractor**

**Date/Location**

**Office Use Only**

**Ministry of the Environment Copy**
### WATER WELL RECORD

**MINISTRY OF THE ENVIRONMENT**

**The Ontario Water Resources Act**

**COUNTY OF** Durham

**STATION** Cavan

**MUNICIPALITY** Otona

**DEPARTMENT** 20.09.73

**DATE COMPLETED** 04.29.73

**ELEVATION** 200.94

**BASIN CODE** 244

### LOG OF OVERBURDEN AND BEDROCK MATERIALS

- **Black loam**
- **Brown clay**
- **Small stone hard**
- **Blue clay**
- **Sand seams**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>GENERAL DESCRIPTION</th>
<th>FROM</th>
<th>TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black loam</td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Brown clay</td>
<td></td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Small stone hard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue clay</td>
<td></td>
<td>18</td>
<td>40</td>
</tr>
<tr>
<td>Sand seams</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### WATER RECORD

**KIND OF WATER**

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>TYPICAL</th>
<th>CALCIUM</th>
<th>SOFTENED</th>
<th>SULPHUR</th>
<th>MINERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salt</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfur</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WATER LEVEL OF PUMPING**

- **PUMP LEVEL**
- **WATER LEVEL DURING**
  - **15 MINUTES**
  - **30 MINUTES**
  - **50 MINUTES**
  - **60 MINUTES**

**FINAL STATUS OF WELL**

- **DOMESTIC**
- **COMMERCIAL**
- **INDUSTRIAL**
- **PUBLIC SUPPLY**
- **COOLING OR AIR CONDITIONING**
- **NOT USED**

**METHOD OF DRILLING**

- **MACHINE TOOL**
- **DRILL (REVERSED)**
- **ROTARY (AIR)**
- **AIR PERCUSSION**

**WELL NUMBER** 3

**NAME OF WELL CONTRACTOR**

**LICENSE NUMBER** 5207

**ADDRESS**

**NAME OF BURials OR BORINGS**

**LICENSE NUMBER** 5207

**SIGNATURE OF CONTRACTOR**

**DATE COMPLETED**

**OFFICE USE ONLY**

**MINISTRY OF THE ENVIRONMENT COPY**

**FORM** 07-091
## WATER WELL RECORD

### LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

<table>
<thead>
<tr>
<th>GENERAL COLOUR</th>
<th>MOST COMMON MATERIAL</th>
<th>OTHER MATERIALS</th>
<th>GENERAL DESCRIPTION</th>
<th>DEPTH - FEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>DARK</td>
<td>Top Soil</td>
<td>SAND</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>GREY</td>
<td>CLAY</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>5.5</td>
</tr>
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<td></td>
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<td>5.5</td>
</tr>
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<td></td>
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<td>15.0</td>
</tr>
<tr>
<td>BLUE</td>
<td>GREY</td>
<td></td>
<td></td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>180</td>
</tr>
<tr>
<td>BROWN</td>
<td>SAND</td>
<td></td>
<td></td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>190</td>
</tr>
</tbody>
</table>

### CASING & OPEN HOLE RECORD

<table>
<thead>
<tr>
<th>WATER RECORD</th>
<th>Casing &amp; Open Hole Record</th>
<th>Depth in feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 ft.</td>
<td></td>
<td>1.31</td>
</tr>
</tbody>
</table>

### PLUGGING & SEALING RECORD

<table>
<thead>
<tr>
<th>WATER RECORD</th>
<th>PLUGGING &amp; SEALING Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 ft.</td>
<td></td>
</tr>
</tbody>
</table>

### LOCATION OF WELL

In diagram below show distances of well from road and lot line. Indicate north by arrow.

- Distance 1: 11.12 ft.
- Distance 2: 10.13 ft.

**Drillers Remarks:**
- Name: R. B. Roberts
- License Number: 1904
- Date: 16-09-76

**Contractor:**
- Name: R. B. Roberts
- License Number: 1904
- Date: 16-09-76

---

**MINISTRY OF THE ENVIRONMENT COPY**
# Water Well Record

**General Colour**
- Black
- Brown
- Blue

**Most Common Material**
- Top Soil
- Clay
- Clay+Sand
- Water

**Other Materials**
- Stones
- Concrete

**General Description**
- Soft
- Hard
- Firm

<table>
<thead>
<tr>
<th>Depth, Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1</td>
</tr>
<tr>
<td>1 - 20</td>
</tr>
<tr>
<td>20 - 23</td>
</tr>
<tr>
<td>23 - 27</td>
</tr>
</tbody>
</table>

## Log of Overburden and Bedrock Materials

<table>
<thead>
<tr>
<th>Depth, Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1</td>
</tr>
<tr>
<td>1 - 20</td>
</tr>
<tr>
<td>20 - 23</td>
</tr>
<tr>
<td>23 - 27</td>
</tr>
</tbody>
</table>

## Water Record

<table>
<thead>
<tr>
<th>Kind of Water</th>
<th>Material</th>
<th>Water Level</th>
<th>Water Level After Pumping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh Water</td>
<td>Salty</td>
<td>10.5 feet</td>
<td>0 feet</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Salty</td>
<td>10.5 feet</td>
<td>0 feet</td>
</tr>
<tr>
<td>Mineral</td>
<td>Salty</td>
<td>10.5 feet</td>
<td>0 feet</td>
</tr>
<tr>
<td>Pressure</td>
<td>Saline</td>
<td>10.5 feet</td>
<td>0 feet</td>
</tr>
</tbody>
</table>

## Casing & Open Hole Record

<table>
<thead>
<tr>
<th>Inside Diam</th>
<th>Outside Diam</th>
<th>Material</th>
<th>Water Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 feet</td>
<td>8 feet</td>
<td>Concrete</td>
<td>0 feet</td>
</tr>
</tbody>
</table>

## Pumping Test

<table>
<thead>
<tr>
<th>Static Level</th>
<th>Water Level Before Pumping</th>
<th>Water Level After Pumping</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 feet</td>
<td>10 feet</td>
<td>0 feet</td>
</tr>
</tbody>
</table>

## Location of Well

- Diagram showing distances of well from road and lot line.

## Drilling Method
- Cable Tool
- Rotary (Conventional)
- Air Percussion

## Well Status

- Domestic
- Commercial
- Municipal
- Industrial
- Cooling or Air Conditioning
- Other

## Well Use

- Water

## Licence Number

- 16507

## Contractor Information

- Stephen Dunn
- 1174 Rossland West
- Orangeville, ON N4M 3R5
- 519-208-1877

## Licence Information

- Licence Number: 0867
- Licence Date: 08/06/94
- Licence Name: A.B. Science

## Plotting Details

- Plotted by: J. M. 13/79

---

**Note:** This document is a scanned copy of a water well record form from the Ministry of the Environment.
**Water Well Record**

**Log of Overburden and Bedrock Materials**

<table>
<thead>
<tr>
<th>General Colour</th>
<th>Most Common Material</th>
<th>Other Materials</th>
<th>General Description</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHITE</td>
<td>CLAY</td>
<td>STONES</td>
<td>TOP SOIL</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>BROWN</td>
<td>SAND</td>
<td>FINE</td>
<td></td>
<td>38</td>
<td>46</td>
</tr>
<tr>
<td>WHITE</td>
<td>CLAY</td>
<td></td>
<td></td>
<td>46</td>
<td>144</td>
</tr>
<tr>
<td>WHITE</td>
<td>CLAY</td>
<td>SAND</td>
<td></td>
<td>144</td>
<td>176</td>
</tr>
<tr>
<td>WHITE</td>
<td>CLAY</td>
<td>SILT</td>
<td></td>
<td>176</td>
<td>175</td>
</tr>
<tr>
<td>BROWN</td>
<td>GRAVEL</td>
<td></td>
<td></td>
<td>195</td>
<td>200</td>
</tr>
</tbody>
</table>

**Water Record**

<table>
<thead>
<tr>
<th>Water Found At Feet</th>
<th>Kind of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>15'</td>
<td>FRESH</td>
</tr>
<tr>
<td>15-18</td>
<td>FRESH</td>
</tr>
<tr>
<td>20-25</td>
<td>FRESH</td>
</tr>
<tr>
<td>25-28</td>
<td>FRESH</td>
</tr>
<tr>
<td>28-32</td>
<td>FRESH</td>
</tr>
</tbody>
</table>

**Screen**

- Stainless Steel

**Location of Well**

*In diagram below show distances of well from road and lot line. Indicate north by arrow.*

**Water Use**

- **02**

**Method of Drilling**

- **71**

**Drillers Name**

- **14 02 84**

**Contractor**

- **4635**

**Date of Inspection**

- **14 02 84**

**Drillers Number**

- **Robert Ruth Jr.**

**Signature of Contractor**

- **Robert Ruth Jr.**

**Office Use Only**

- **CSS.ES**

**Form No. 0596-27-77 Form 7**

**Ministry of the Environment Copy**

---

**The Ontario Water Resources Act**

**Well No. 3, CAVAN, Ontario**

**County or District**

- **PETERBOROUGH**

**Township, Borough, City, Town, Village**

- **CAVAN**

**Date Completed**

- **10-24-85**

**Date of Inspection**

- **10-14-85**

**CON 10**

---

**Comprehensive Well File Survey etc.**

---

**CON 10**

---

**MINISTRY OF THE ENVIRONMENT COPY**
Well Record

Well Tag No. (Place Sticker and/or Print Below)
A0170664

Regulation 933 Ontario Water Resources Act
Page of

Well Owner's Information
First Name: Ian
Last Name: Cameron

Mailing Address (Street Number/Name)
1844 Cty Rd 10

Municipality: Cavan
Province: Ontario
Postal Code: LOA 1CO

Well Location
Address of Well Location (Street Number/Name)
1844 Cty Rd 10

Township: Cavan Monaghan

County/District/Municipality: Peterborough

UTM Coordinates (Zone, Easting, Northing)

Municipal Plan and Section Number

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

General Colour: Black
Most Common Material: Topsoil
Other Materials: Sand

General Description: 0 2

Annular Space
Depth Set at (m/ft) From 0 To 20
Type of Sealing Used Bentonite
Volume Placed 0 2

Method of Construction

Use

Construction Record - casing

Intrac Diameter (m/ft): 6" Steel
Wall Thickness (m/ft): .188 +.25
Depth (m/ft): 232

Status of Well

WaterSupply

Construction Record - Screen

Outside Diameter (m/ft): 6" Steel

Water Details

Water found at Depth: 232 m/ft

Kind of Water: Fresh

Depth of Water: 20 m/ft

Hole Diameter

Well Contractor and Well Technician Information

Business Name: G. Hart & Sons Well Drilling Ltd
Municipality: Cavan
Province: Ontario
Postal Code: KON 1N0
Business E-mail Address: ghartghart.ca

Well Driller's Licence No: 26626
...

Comments

Well Owner's Information
Date Package Delivered

Ministry Use Only
Audit No: 195130
2014 12 23

Ministry's Copy
### Well Owner's Information
- **First Name:** Ian
- **Last Name / Organization:** Cameron
- **Mailing Address (Street Number/Name):** 1846 Cty Rd 10
- **City/town/Village:** Cavan
- **Municipality:** Cavan Monaghan
- **County/Distrct/Municipality:** Peterborough
- **Township:** Ida
- **Compensation:**
- **Provincial:** Ontario
- **Post Code:** L0A 1C0
- **Telephone No.:**
- **Well Constructed by Well Owner:**

### Well Location
- **Address of Well Location (Street Number/Name):** 1846 Cty Rd 10
- **City/town/Village:** Cavan
- **Municipality:** Cavan Monaghan
- **County/Distrct/Municipality:** Peterborough
- **Township:** Ida
- **Compensation:**
- **Provincial:** Ontario
- **Post Code:**
- **Telephone No.:**
- **Well Constructed by Well Owner:**

### Overburden and Bedrock Material/Abandonment Sealing Record

<table>
<thead>
<tr>
<th>General Colour</th>
<th>Most Common Material</th>
<th>Other Material</th>
<th>General Description</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>Topsoil</td>
<td>Stones</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Black</td>
<td>Topsoil</td>
<td>Stones</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Brown</td>
<td>Sandy Clay</td>
<td>Gravel</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Brown</td>
<td>Sandy Clay</td>
<td>Gravel</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Grey</td>
<td>Clay</td>
<td>Clay</td>
<td></td>
<td>30</td>
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<tr>
<td>Grey</td>
<td>Clay</td>
<td>Clay</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>Grey</td>
<td>Clay</td>
<td>Clay</td>
<td></td>
<td>42</td>
</tr>
<tr>
<td>Grey</td>
<td>Clay</td>
<td>Clay</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>Grey</td>
<td>Clay</td>
<td>Clay</td>
<td></td>
<td>148</td>
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<tr>
<td>Grey</td>
<td>Clay</td>
<td>Clay</td>
<td></td>
<td>216</td>
</tr>
</tbody>
</table>

### Annular Space

<table>
<thead>
<tr>
<th>Depth Set at (m) From</th>
<th>Type of Sealing Used (Material and Type)</th>
<th>Volume Placed (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Bentonite az mud</td>
<td></td>
</tr>
</tbody>
</table>

### Method of Construction
- **Cable Tool**
- **Rotary (Conventional)**
- **Rotary (Reverse)**
- **Diaphragm**
- **Air percussion**
- **Other:**

### Well Use
- **Water Supply**
  - **Water Tank**
  - **Rental Well**
  - **Water Reuse**
- **Drinking Water**
  - **Supply Well**
  - **Monitoring Well**
- **Recharge Well**
  - **Recharge Well**
  - **Recharge Well**
- **Devastating Well**
  - **Devastating Well**
  - **Devastating Well**
- **Observation well**
  - **Observation well**
  - **Observation well**
- **Monitoring Hole**
  - **Monitoring Hole**
  - **Monitoring Hole**
- **Alteration of Construction**
  - **Alteration of Construction**
  - **Alteration of Construction**
- **Abandoned**
  - **Abandoned**
  - **Abandoned**
- **Insufficient Supply**
  - **Insufficient Supply**
  - **Insufficient Supply**
- **Abandoned, Poor Water Quality**
  - **Abandoned, Poor Water Quality**
  - **Abandoned, Poor Water Quality**
- **Abandoned, other, specify**
  - **Abandoned, other, specify**
  - **Abandoned, other, specify**
- **Other, specify**
  - **Other, specify**
  - **Other, specify**

### Construction Record - Drilling

<table>
<thead>
<tr>
<th>Inside Diameter (cm)</th>
<th>Open Hole Drilled Material (Categorized, Fines, Concrete, Plastic, Steel)</th>
<th>Depth (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Steel</td>
<td>188</td>
</tr>
</tbody>
</table>

### Results of Well Yield Testing
- **Draw Down:**
  - **Time (min):** 1
  - **Water Level (m):** 119.9
  - **Recovery:**
    - **Time (min):** 1
    - **Water Level (m):** 124.4
    - **Recovery:**
      - **Time (min):** 1
      - **Water Level (m):** 124.1
- **Pump Inlet set at (m):** 150
- **Pumping rate (L/min / GPM):**
  - **Time (min):** 1
  - **Water Level (m):** 123.8
  - **Recovery:**
    - **Time (min):** 1
    - **Water Level (m):** 121.1

### Status of Well
- **Wells Supply:**
  - **Water Tank**
  - **Rental Well**
  - **Water Reuse**
- **Drinking Water:**
  - **Supply Well**
  - **Monitoring Well**
- **Recharge Well:**
  - **Recharge Well**
  - **Recharge Well**
- **Devastating Well:**
  - **Devastating Well**
  - **Devastating Well**
- **Observation well:**
  - **Observation well**
  - **Observation well**
- **Monitoring Hole:**
  - **Monitoring Hole**
  - **Monitoring Hole**
- **Alteration of Construction:**
  - **Alteration of Construction**
  - **Alteration of Construction**
- **Abandoned:**
  - **Abandoned**
  - **Abandoned**
- **Insufficient Supply:**
  - **Insufficient Supply**
  - **Insufficient Supply**
- **Abandoned, Poor Water Quality:**
  - **Abandoned, Poor Water Quality**
  - **Abandoned, Poor Water Quality**
- **Abandoned, other, specify:**
  - **Abandoned, other, specify**
  - **Abandoned, other, specify**
- **Other, specify:**
  - **Other, specify**
  - **Other, specify**

### Water Details
- **Water found at Depth (m):**
  - **Kind of Water:** Fresh
  - **Kind of Water:** Fresh

### Well Contractor and Well Technician Information
- **Business Name of Well Contractor:** G. Hart & Sons Well Drilling Ltd
- **Business Address (Street Number/Name):** P.O. Box 850 Selton Falls
- **Province:** Ont
- **Postal Code:** KON 1NO
- **Telephone No.:** 705 887 3331
- **Name of Well Technician (Last Name, First Name):** Rochette, Mike
- **Well Technician's License No.:**
- **Supply Well:**
  - **Water Tank:**
  - **Rental Well:**
  - **Water Reuse:**
- **Drinking Water:**
  - **Supply Well:**
  - **Monitoring Well:**
- **Recharge Well:**
  - **Recharge Well:**
  - **Recharge Well:**
- **Devastating Well:**
  - **Devastating Well:**
  - **Devastating Well:**
- **Observation well:**
  - **Observation well:**
  - **Observation well:**
- **Monitoring Hole:**
  - **Monitoring Hole:**
  - **Monitoring Hole:**
- **Alteration of Construction:**
  - **Alteration of Construction:**
  - **Alteration of Construction:**
- **Abandoned:**
  - **Abandoned**
  - **Abandoned**
- **Insufficient Supply:**
  - **Insufficient Supply**
  - **Insufficient Supply**
- **Abandoned, Poor Water Quality:**
  - **Abandoned, Poor Water Quality**
  - **Abandoned, Poor Water Quality**
- **Abandoned, other, specify:**
  - **Abandoned, other, specify**
  - **Abandoned, other, specify**
- **Other, specify:**
  - **Other, specify**
  - **Other, specify**

### Comments

### Map of Well Location
- **Legend:**
  - **Yes**
  - **No**

### Ministry Use Only
- **Audit No.:** 195128
**Well Information**

- **Tag #:** A170666
- **Well Owner:** Ian Cameron
- **Location:** 1844 Cty Rd 10, Cavan Monaghan, Ontario
- **UTM Coordinates:** NAD 1984, Zone 17, E489926
- **Well Details:**
  - **Well Diameter:** 61" steel
  - **Water Details:**
    - Water found at Depth: 19.2 ft
      - Kind of Water: Fresh, Untested
      - Depth of Water: 20 ft
  - **Water Flow:**
    - Water found at Depth: 196 ft
      - Kind of Water: Fresh, Untested
- **Overburden and Bedrock Materials:**
  - Black Topsoil: 0 ft
  - Brown Sandy Clay: 2 ft
  - Grey Sandy Clay: 7 ft
  - Grey Silty Clay: 136 ft
- **Aquifer Details:**
  - **Aquifer:** 155 ft
  - **Water Level:** 96 ft

**Well Drilling Records**

- **Method of Construction:**
  - **Type:** Dual rotary
  - **Material:** Steel, Barbed Wire
- **Construction Record - Screen:**
  - **Depth:** 192 ft
  - **Type:** 6" steel
  - **Kind of Water:** Fresh, Untested
  - **Water Found:** 192 ft
- **Results of Well Yield Testing:**
  - **Draw Down:**
    - Time: 10 min
    - Level: 97.6 ft
  - **Recovery:**
    - Time: 10 min
    - Level: 97.6 ft

**Map of Well Location**

**Well Contractor:**
- **Company:** Hart & Sons Well Drilling Ltd
- **Address:**
  - P.O. Box 850, Fenelon Falls, ON K0M 1NO
  - Telephone: 705-867-3331

**Well Details:**

- **Water Flow:**
  - Water found at Depth: 19.2 ft
    - Kind of Water: Fresh, Untested
  - Water found at Depth: 196 ft
    - Kind of Water: Fresh, Untested

**Well Use:**

- **Use:** Clear and sand free, Other: None

**Status of Well:**

- **Incomplete:** Yes

**Well Use:**

- **Use:** Clear and sand free, Other: None

**Well Contractor's License No.:**

- **Name:** Hart & Sons Well Drilling Ltd
- **Address:** P.O. Box 850, Fenelon Falls, ON K0M 1NO
- **Telephone:** 705-867-3331

**Well Owner's Information:**

- **Name:** Ian Cameron
- **Address:** 1844 Cty Rd 10, Cavan Monaghan, Ontario
- **Telephone:** 705-867-3331

**Well Tag No.:** A170666

**Well Location:**

- **Address:** 1844 Cty Rd 10, Cavan Monaghan, Ontario
- **Telephone:** 705-867-3331

**Well Owner's Information:**

- **Name:** Ian Cameron
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Appendix E

Wastewater Treatment Equipment Specifications
Performance Claim

The BIONEST SA-3, the BIONEST SA-3D, and BN-400 are wastewater treatment systems for household use. The BN-400 and SA-3 models are equivalent in conception differing only by size of the bioreactor.

The BIONEST SA-3 system is a submerged fixed film bioreactor using a non-biodegradable media. The BIONEST SA-3 system is a stand-alone wastewater treatment system. The system was tested in compliance with NQ 3680-910/2000-06-16 M1 (2004-09-10) at a hydraulic capacity of 1,260 L/day. The system (at influent temperature ranging between 14.2-21.4°C, pH in the range of 7.3-8.3, with an average CBOD₅ of 259 mg/l, TSS of 250.4 mg/l and Fecal coliforms of 3 161 246 CFU/100ml) was capable of reducing CBOD₅ to less than 3 mg/l, TSS to less than 4 mg/l, and fecal coliform organisms to less than 5 000 CFU/100ml.

The BIONEST SA-3 was also tested under similar conditions in compliance with NSF/ANSI Standard 40 - Residential Wastewater Treatment Systems between March 14, 2005 and August 2005 and was capable of reducing TKN and TON concentrations to less than 2 mg/L.

The BIONEST SA-3D is a stand-alone wastewater treatment system with UV disinfection. The system was tested in compliance with NQ 3680-910/2000-06-16 M1 (2004-09-10) at a hydraulic capacity of 1,260 L/day. The system (at influent temperature ranging between 14.2-21.4°C, pH in the range of 7.3-8.3, with an average CBOD₅ of 259 mg/l, TSS of 250.4 mg/l and Fecal coliforms of 3 161 246 CFU/100ml) was capable of reducing CBOD₅ to less than 3 mg/l, TSS to less than 4 mg/l, and fecal coliform organisms to less than 5 CFU/100ml.

Testing completed under NQ 3680-910/2000-06-16 M1 (2004-09-10) was conducted at the Bureau de Normalisation du Québec Laboratory based in Québec City, Québec while testing under NSF/ANSI Standard 40 - Residential Wastewater Treatment Systems 04/10/2015/060 was conducted at the NSF facility in Waco, Texas.

Technology Application

The BIONEST SA-3, the BIONEST SA-3D and the BN-400 are wastewater treatment systems for household use. The technology developed by Bionest is based on the well established principle of biological digestion of residential sewage using sequential biological reactors operated under forced aerobic conditions. The BIONEST SA-3D is a stand-alone wastewater treatment system with UV disinfection. The BIONEST SA-3 and the BN-400 systems are stand-alone wastewater treatment systems without UV disinfection. The BN-400 and the SA-3 models are equivalent in conception differing only by the size of the bioreactor. The hydraulic loading rate and the hydraulic retention time of the two models are virtually the same.
Technology Description

The Bionest system is a submerged fixed film bioreactor using a non-biodegradable media. The treatment train takes place in two tanks installed in series. The primary treatment uses a conventional two-compartment septic tank equipped with an effluent filter. The second tank is called the “bioreactor”.

The wastewater flows to the bioreactor by hydraulic displacement from the primary treatment tank. Treatment in the bioreactor is achieved using a biological process of microbial culture, fixed to a synthetic media, in an aerobic condition. The media is a non-toxic polymer ribbon, engraved to facilitate the fixation of microbial culture, having a relative density of 1.04. A specific quantity of Bionest media is placed in the two compartments of the bioreactor. It is provided with a linear air pump and with fine bubble air diffusers. A recirculation pump is installed in the last compartment of the bioreactor and returns part of the effluent to the first compartment of the septic tank to provide denitrification.

Verification

Two separate experiments were conducted and data was submitted to the verification process. The first set of data was obtained between August 2004 and February 2005 when testing the system for its efficiency to treat residential sewage water and to remove suspended solids, BOD₅ and fecal coliform using the NSF/ANSI 40-2000 test protocol. Testing was completed at the BNQ facility in Québec City, Québec, and was intended to verify the conformity of the equipment with BNQ standard NQ3680-910/200-06016 M1 (2004-09-10).

The second experiment aimed at assessing the system’s efficiency to treat residential sewage water and its conformity with NSF/ANSI 40-2004 standard. The data submitted from this experiment was obtained by conducting additional sampling not included in the NSF standard. Samples were collected and analyzed to evaluate the equipment ability to reduce TKN and TON concentrations. This portion of the testing was completed between March and August 2005 at the NSF Wastewater Technology Test Facility located in Waco, Texas under environmental conditions closer to Canadian summer conditions than to winter conditions.

The verification was completed by Centre National en Électrochimie et Technologies Environnementales Inc. (CNETE) using ETV Canada’s General Verification Protocol (March, 2000).

What is the ETV Program?

The Canadian Environmental Technology Verification (ETV) Program is delivered by ETV Canada under a license agreement from Environment Canada. The Canadian ETV Program is designed to support Canada’s environment industry by providing credible and independent verification of technology performance claims.

For more information on BIONEST SA-3, SA-3D and BN-400 please contact:
Bionest Technologies Inc.
55 12th Street P.O. Box 10070
Grand-Mère, Québec
G9T 5K7 Canada
Tel: (819) 538-5662
Fax: (819) 538-5707
Toll Free: 1 (866) 538-5662
www.bionest.ca

ETV Canada Contact Information:
ETV Canada
2070 Hadwen Road Unit 201A
Mississauga, Ontario
L5K 2C9 Canada
Tel: (905) 822-4133
Fax: (905) 822-3558
E-mail: etv@etvcanada.ca
www.etvcanada.ca

Limitation of Verification
Environment Canada, ETV Canada, and the Verification Entity provide the verification services solely on the basis of the information supplied by the applicant or vendor and assume no liability therefor. The responsibility for the information supplied remains solely with the applicant or vendor and the liability for the purchase, installation, and operation (whether consequential or otherwise) is not transferred to any other party as a result of the verification.
Evaluation of the absorption bed's efficiency under the Ecoflo® Biofilter

Summary of the conference presented by M. Roger Lacasse within the context of the 30th Symposium on wastewater treatment
Performance evaluation of the absorption bed located underneath the Ecoflo® Biofilter
Roger Lacasse¹ and Naider Fanfan²

The Ecoflo® Biofilter is a wastewater treatment system designed for the sanitary drainage of decentralized dwellings. Preceded by a septic tank, the chain of treatment comprises a biofiltration unit and a polishing field allowing the treated wastewater to be absorbed by the receptor ground. The Ecoflo® Biofilter performances have been evaluated by numerous organizations (MDDEP, BNQ, NSF, CSTB, etc.) for the last 20 years. All studies have demonstrated that the system produces an effluent with concentrations much lower than the criteria required for an advanced secondary treatment level which is 15 mg/L in TSS and BOD₅, and 50 000 FCU/100 mL in fecal coliforms. However, little data have been collected to this day to assess the efficiency of the absorption bed or of the polishing field receiving the waters treated by the Ecoflo® Biofilter.

Within the process of the approval of the Ecoflo® technology in the State of Virginia, an independent study has been realized from 2003 to 2007 to determined the quality of the waters treated by the system comprising an Ecoflo® Biofilter and a 30 cm thick absorption bed in accordance with the State requirements. This study was directed by Dr Robert Rubin, respected professor emeritus at North Carolina University.

Material and method
The testing protocol includes the monitoring of six different residential sites during an 18 month period for the four types of soils present in Virginia and defined in Table 1. Notice that the types of soils are comparable to the ones defined in the U.S. EPA Quebec regulation.

<table>
<thead>
<tr>
<th>Tableau 1</th>
<th>Types of soils</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Virginia</td>
</tr>
<tr>
<td>Type of soil</td>
<td>Permeability (min/cm)</td>
</tr>
<tr>
<td>I</td>
<td>≤ 6</td>
</tr>
<tr>
<td>II</td>
<td>&gt; 6 and ≤ 18</td>
</tr>
<tr>
<td>III</td>
<td>&gt; 18 and ≤ 35</td>
</tr>
<tr>
<td>IV</td>
<td>&gt; 35 and ≤ 47</td>
</tr>
</tbody>
</table>

Each site installation comprises a septic tank followed by an Ecoflo® Biofilter and an absorption bed located underneath the biofilter. Three suction lysimeters (High flow porous ceramic cup suction lysimeter model 1920F1-B01M3) have been installed on each site in order to measure the quality of the water upstream of the absorption bed (lysimeter # 3 not illustrated in figure 1), at 30 cm under the absorption bed located just underneath the Ecoflo® Biofilter (lysimeter # 1), and at 3 m downstream of the biofilter (lysimeter # 2). Figure 1 presents a typical installation of the biofilter and the monitoring equipment.

¹ Roger Lacasse, Research and Development Director, Premier Tech Environment, 1, ave Premier, Rivière-du-Loup, Québec Canada, GSR 6C1. lacr@premiertech.com
² Naider Fanfan, Project Engineer, Premier Tech Environment, 1, ave Premier, Rivière-du-Loup, Québec Canada, GSR 6C1. fanf@premiertech.com
Figure 1  Typical installation of the Ecoslo\textsuperscript{®} Biofilter and the monitoring equipment
The sample pick-up has been realized monthly at the septic tank effluent and at the Ecoflo® Biofilter's as well as at the three lysimeters. As per the Virginia regulations, the following parameters have been measured monthly: feeding rate, BOD₅, TSS, fecal coliforms, nitrates and NTK. The sampling of the total phosphorus have been taken three times a year on four sites selected for this purpose, with types of soils I, II and III, and in a sporadic manner on four other sites. Notice should be taken that the BOD₅ and the TSS concentrations were not measured in the lysimeters installed at 30 cm deep (lysimeter # 1) in the ground underneath the biofilters. This situation is due to the fact that the concentrations at the Ecoflo® Biofilter’s effluent were much lower than the values required by the State of Virginia’s regulations, that is to say, 30 mg/L.

End results
Until now, the monitoring has been completed for 18 sites which are corresponding to soil types I, II and III. The two sites with soil type IV are being monitored presently. The mean flow reached for the sites altogether corresponds to a value of 590 L/d which is the equivalent to the flow rate produced by an average Quebec family (2.3 persons x 270 L/pers.-d or 620 L/d). Beyond that, 90% of the measured values were lower or equal to 942 L/d. Last, it should be noticed that, in some cases, the flow rates have exceeded the capacity of the system with values reaching up to 3 000 L/d. The BOD₅ and TSS concentrations obtained at the Ecoflo® Biofilter's outlet are presented in Table 2. We notice that the biofilter's performances reached during the Virginia monitoring correspond to the values already measured in actual conditions by Premier Tech (PTE) and during the different testings for the certification of the technology.

Table 2 Performances of the Ecoflo® Biofilter in TSS and BOD₅

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Virginia</th>
<th>PTE's monitoring (11 years, n = 163)</th>
<th>Certification (Ecoflo® effluent)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STE</td>
<td>Ecoflo® Effluent</td>
<td>STE</td>
</tr>
<tr>
<td>TSS (mg/L)</td>
<td>34 ± 23 (n = 141)</td>
<td>6 ± 7 (n = 337)</td>
<td>52 ± 48 (n = 337)</td>
</tr>
<tr>
<td>BOD₅ (mg/L)</td>
<td>186 ± 113 (n = 340)</td>
<td>8 ± 8 (n = 337)</td>
<td>176 ± 89 (n = 337)</td>
</tr>
</tbody>
</table>

The evaluations realized underneath the absorption bed have verified its efficiency at reducing nitrogen, phosphorus and fecal coliforms still present in the effluent treated by the Ecoflo® Biofilter. The mean concentrations measured at the outlet of the different steps of the treatment are presented in Table 3. Table 4 shows the values corresponding to the 90 percentile. The absorption bed composed of a 30 cm layer of soil fed by the Ecoflo® Biofilter's effluent fills the role of completely polishing the treated effluent.

Discussion

Total nitrogen removal
The result analysis presented in Table 3 and 4 demonstrates that the system comprising an Ecoflo® Biofilter and a 30 cm thick absorption bed allows reducing total nitrogen content by 84%. It is important to mention that this performance does not take into account the total nitrogen already present in the groundwater table upstream of the absorption bed (4 ± 3 mg/L). Considering this background noise, we realize that the total nitrogen concentration at a 30 cm soil depth underneath the biofilter is, in average, lower than 5 mg/L and 12 mg/L for 90% of the results, which respects the mean requirement of 10 mg/L established by different regulations. The values measured in the four soil types do not show any influence on the part of this parameter on the total nitrogen removal efficiency. The performances observed would be imputable to a good nitrification of the wastewater in the biofilter (mean of 80 %) and to the presence of anoxic micro-zones in the soil matrix.
In the presence of soluble carbon coming from the peat base filtering media, these zones would bring favorable conditions to the effluent denitrification.

Table 3  Mean efficiency (± standard deviation) of the Ecoflo® Biofilter and absorption

<table>
<thead>
<tr>
<th>Parameters</th>
<th>STE</th>
<th>Ecoflo® Effluent</th>
<th>Effluent at 30 cm under the Ecoflo®</th>
<th>Water upstream at 30 cm</th>
<th>Performances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ecoflo®</td>
</tr>
<tr>
<td>N total (mg/L)</td>
<td>45 ± 24 (n = 72)</td>
<td>32 ± 18 (n = 76)</td>
<td>8 ± 9 (n = 77)</td>
<td>4 ± 4 (n = 40)</td>
<td>29%</td>
</tr>
<tr>
<td>P total (mg/L)</td>
<td>5,9 ± 0,9 (n = 11)</td>
<td>5,2 ± 0,9 (n = 11)</td>
<td>0,12 ± 0,04 (n = 15)</td>
<td>-</td>
<td>12%</td>
</tr>
<tr>
<td>F.C. (CFU/100 mL)</td>
<td>34 262 (n = 51)</td>
<td>1 029 (n = 308)</td>
<td>2 (n = 336)</td>
<td>-</td>
<td>1,5 log</td>
</tr>
</tbody>
</table>

Table 4  Efficiency for the 90 percentile of the Ecoflo® Biofilter and absorption bed

<table>
<thead>
<tr>
<th>Parameters</th>
<th>STE</th>
<th>Ecoflo® Effluent</th>
<th>Effluent at 30 cm under the Ecoflo®</th>
<th>Water upstream at 30 cm</th>
<th>Performances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ecoflo®</td>
</tr>
<tr>
<td>N total (mg/L)</td>
<td>77</td>
<td>56</td>
<td>22</td>
<td>10</td>
<td>27%</td>
</tr>
<tr>
<td>P total (mg/L)</td>
<td>7,1</td>
<td>6,5</td>
<td>0,2</td>
<td>-</td>
<td>8%</td>
</tr>
<tr>
<td>F.C. (CFU/100 mL)</td>
<td>240 000</td>
<td>34 300</td>
<td>2</td>
<td>-</td>
<td>0,8 log</td>
</tr>
</tbody>
</table>

Fecal coliforms

We notice that the absorption bed allows fecal coliforms reduction under the detection level of 2 FCU/100 mL and this, for 90% of the results. The 336 values measured are lower than the usual limit of 200 FCU/100 mL, the maximal value corresponding to 170 FCU/100 mL. This attenuation of the fecal coliforms is associated to the retention/fixation phenomenon at the soil particle surface and at the change in physico-chemical conditions of the soils. It is also important to mention that the geometric mean of the fecal coliforms observed at the outlet of the Ecoflo® Biofilter during this study, that is, 1029 FCU/100 mL, corresponds to the results obtained in other monitorings and testings. Indeed, a concentration of 1000 FCU/100 mL has been reached within the context of PTE’s monitoring realized in 1995, of 1250 FCU/100 mL during the BNQ certification testing and of 630 FCU/100 mL at the NSF testing.
Total phosphorus

The performances of the Ecoflo® Biofilter to remove phosphorus are in conformity with the existing data since the beginning of the development of the technology which is a removal in the order of 10 to 15% of total phosphorus in the filtering bed. However, the match-up of the biofilter with a polishing field composed of a layer of at least 30 cm of natural soil, allows the global removal of 38% of the phosphorus present at the septic tank effluent. The total phosphorus mean concentration at a 30 cm depth in the absorption bed equals 0,12 mg/L and 90% of the values are equal or lower than 0,2 mg/L. Remember that the usual disposal criteria corresponds to 1,0 mg/L. These results have been obtained in the soil types I to III installations in operation for more than 40 months and no influence has been noticed with the permeability of the soils used. As per the existing literature, the phosphorus fixation in acid soils is mainly associated with its adsorption to the surface of the metallic elements present in the soil (iron and aluminum). According to Pellerin and al. (2005), the Quebec acid soils, at neutral, can be classified in three groups as far as their ability to retain phosphorus (low capacity: 1,46, mean capacity: 3,04 and high capacity: 5,66 g P/kg of soil). The results have been obtained after analysis of more than 275 soil samplings covering 75 series of soils in a horizon varying between 0 and 70 cm of the surface. Analysis of 25 soil samplings picked-up in different regions of Quebec for the implementation of decentralized sanitary systems indicate comparable results, that is, a retention capacity varying between 0,94 and 5,74 gP / kg of soil (mean of 2,90 gP/kg of soil) and separate from the soil in place permeability. By way of comparison, the analysis of the soils experimented in Virginia present results of the same order which is a retention capacity of the phosphorus of 3 gP/kg of soil for the three soil types used. The access to this phosphorus retention capacity of the soil and the stability of the phosphorus retained, depend on the following main factors: the quality of the effluent infiltrated allowing to prevent clogging of the receptor soil, the withholding of a high redox potential (aerobic) assuring reaction stability with iron and the non saturation of the absorption bed (over the high seasonal groundwater table).

The hydrodynamic and physico-chemical characteristics of the effluent produced by the Ecoflo® Biofilter facilitate phosphorus fixation in the soil. Indeed, the peat base filtering media releases humic and fulvic acids that cause soil particle alteration in the absorption bed, which increase iron and aluminum availability in the soil to react to phosphorus. Also, the low pH conditions prevailing in the filtering media during its start-up phase allow release of iron and aluminum present in the peat, thus creating and additional doping of these metals in the receptor soil. Furthermore, the retention capacity associated with the selected filtering media ensures peak flow attenuation which is translated by a regulation of the flow infiltrated, thus facilitating the non saturation of the soil in the absorption bed. These non saturated conditions are also maximized by the pulsed feeding to the biofilter, by creating repeated wetting/drainage cycles bringing air to the soil. Notice that the air present in the gravel area at the base of the biofilter is renewed by the aeration process integrated into the system. Last, to maintain this access to the soil capacity to fix phosphorus, it is essential that the treated effluent to be infiltrated presents an excellent quality in all conditions (variations in flow and in loads, start-up following a prolonged stop, etc.), in order to prevent clogging of the soil by the suspended matter and introduction of too large concentrations of organic matters. These two last factors diminish the redox potential in the soil and reduce soil capacity to fix phosphorus. As demonstrated during testing with particular stresses (NSF, 2005 and BNQ, 2005), the Ecoflo® Biofilter produces an effluent of which the TSS and BOD₅ concentrations fluctuate very little (lower than 5 mg/L) in peak conditions or at start-up after a long period of no feeding. On the basis of the previous data, of the occupancy rate of the residences and of the quantity of phosphorus produced by the occupants, we estimate that the system « Ecoflo® Biofilter + receptor soil » allows retention of the phosphorus produced by a residence for a duration of at least 20 years in the majority of the cases, without taking into account the contribution in iron, aluminum, humic and fulvic acids associated with the filtering media selected.
Conclusion
The results obtained within the context of the independent study realized in the State of Virginia demonstrate an interesting potential for the system comprising an Ecoflo® Biofilter followed by a 30 cm thick layer of soil for the removal of nitrogen, phosphorus and fecal coliforms to levels of usual disposal under 10 mg/L for total nitrogen, 1,0 mg/L for phosphorus and 200 FCU/100 mL for fecal coliforms. In accordance with the recommendations of experts in the decentralized sanitation field (Tchobanouglu, 2003), this study clearly demonstrates the importance of reserving natural soils for the polishing of an effluent having undergone a high level of treatment and presenting little variations. The use of soil for the treatment of primary or secondary effluent presenting variations would not allow exploitation of the full potential for sanitary drainage of this natural matrix. On the basis of these promising results, experimentation goes on to optimize the approach in different conditions, in order to maximize the longevity of the system.

References


Waterloo Biofilter Systems Inc.
on-site wastewater treatment

Advanced Septic Systems for Homes and Cottages

ET
U.S. EPA's Environmental Technology Verification Program
www.epa.gov.etv
Is Yours a Waterloo?

Developed at the University of Waterloo in Ontario, the Waterloo Biofilter® is an advanced septic system ideal for use in individual homes and cottages. Since 1991 the Waterloo Biofilter has proven itself to be the most reliable wastewater treatment system available. The key to its success is the engineered filter medium that is optimized to be stable over long periods of time, accept very high loading rates without plugging, provide an aerobic treatment environment passively, and absorb wastewater thereby increasing retention time and treatment levels.

Waterloo Biofilter filter medium provides an ideal environment for beneficial bacteria to thrive and degrade contaminants found in wastewater.

<table>
<thead>
<tr>
<th>Advantage</th>
<th>Waterloo Biofilter</th>
<th>Other Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent Filter Medium</td>
<td>Filter medium is warranted to last 20 years and will likely last much longer</td>
<td>Can require periodic replacement of filter medium at your cost, significantly increasing the cost of ownership</td>
</tr>
<tr>
<td>Energy Efficient</td>
<td>Uses less electricity than a recirculating sand filter, and in some cases can be dosed by siphon eliminating all electrical needs</td>
<td>Can require huge amounts of electricity to operate, significantly increasing the cost of ownership</td>
</tr>
<tr>
<td>Smallest Footprint</td>
<td>Has the smallest footprint approved in Ontario -- can be installed in even the most difficult sites</td>
<td>Require larger disposal beds increasing costs, reducing flexibility, and reducing potential uses of your property</td>
</tr>
<tr>
<td>Property Aesthetics</td>
<td>Blends in naturally with your site, minimizes unsightly raised mounds and minimizes tree removal</td>
<td>Require more trees be cut down and can often leave large, unexpected raised mounds</td>
</tr>
<tr>
<td>Wide Product Selection</td>
<td>Offers numerous system configurations each with their own unique advantages</td>
<td>Offer less choice in finding a solution suited to your individual property and preferences</td>
</tr>
<tr>
<td>Nitrogen Removal</td>
<td>Removes up to 65% of Total Nitrogen, helping to protect our lakes and source waters</td>
<td>Remove less or no Nitrogen, which can contribute to algae blooms, fish kills and human health problems</td>
</tr>
<tr>
<td>No Air Compressor</td>
<td>Provides an aerobic treatment environment passively without the need for forced aeration</td>
<td>Can require the use of loud, high-maintenance, high-energy air compressors and diffusers</td>
</tr>
<tr>
<td>No Activated Sludge</td>
<td>Provides aerobic treatment without producing activated sludge</td>
<td>Can produce activated sludge that must periodically (typically annually) be pumped out or treatment levels fall dramatically</td>
</tr>
</tbody>
</table>

Engineered & Manufactured in Ontario!

Waterloo Biofilters are known in the onsite industry for their outstanding treatment consistency, longevity, low power consumption and Nitrogen removal capabilities.
Four Flexible Solutions

Blends into Your Garden

Modular and very lightweight, Flat Bed Biofilters™ follow the natural contours of your land for a pleasing and easily landscaped installation. Flat Beds are ideal for cottages and can be dosed with an electricity-free siphon pump where site elevation allows.

Below Ground and Out of Sight

Basket Biofilter™ systems are completely below ground and can be scaled up for use with any size home. Configured for enhanced Nitrogen removal, Basket systems are ideal for environmentally sensitive areas, high water tables, and clay soils.

Smallest Footprint in Ontario

Ideal for small lots, minimizing raised mounds, and minimizing tree removal, Cedar Shed Biofilters™ naturally blend in with a rural setting. These discrete systems can be located away from your house as the Shed itself contains no electrical equipment.

Lightweight and Easily Transported

HDPE Tank Biofilters™ are completely below ground, offer enhanced Nitrogen removal, and have a faster and easier installation. These lightweight tanks can be barged to islands, easily maneuvered onto remote sites, and are corrosion resistant in high-sulphur areas.

20 Year Warranty!

We've always claimed our filter medium would last for over 20 years. Now we guarantee it!

Waterloo Biofilters use very little energy; up to 85% less power than aeration technologies using air compressors!

Power Consumption*
A Waterloo Biofilter* is the ideal septic solution for your home or cottage

Waterloo Biofilters provide a permanent combination of biological treatment and physical filtration of wastewater not matched by any other treatment technology. Our unique and patented process uses a filter medium that is highly resistant to clogging, has the highest surface area to volume ratio in the industry, and is warranted to last at least 20 years.

Designed to work in even the most difficult sites, Waterloo Biofilters are the ideal solution for clay soils, bedrock, high water table, small lots, remote locations, and environmentally sensitive areas. Waterloo Biofilters work like a low-pressure membrane, providing a physical barrier that wastewater must pass through for treatment before entering the environment. Even when the power supply is interrupted, the Waterloo Biofilter's design ensures no untreated sewage enters the environment, so you can feel confident you are protecting your family, your property, and your water supplies from contamination.

Time-Proven Technology

The Waterloo Biofilter has been proven in many thousands of installations across North America since 1991. No other technology can match the Waterloo Biofilter's:

- Very low energy usage
- Few moving parts & low maintenance requirements
- Tertiary quality treatment even in very cold climates
- High level of Nitrogen removal
- Aesthetically pleasing impact on your property

No other septic system preserves the value of your property by naturally blending in with your site like a Waterloo Biofilter. Waterloo Biofilters have the smallest system footprint approved in Ontario, and help to minimize unsightly raised mounds and tree removal.

Other benefits of the Waterloo Biofilter include:

- The lowest long-term operating costs
- One of the best warranties in the industry
- Easily handles surge flows and seasonal use
- Quickly recovers from system abuse or neglect
- Air filters block potential odours

The Choice is Clear
Is Yours a Waterloo?

Please call us or visit our website to locate a certified installer near you!
Data Summary for Waterloo Biofilter® Model 4 Bedroom Under the EPA ETV Water Quality Protection Center

The following is a preliminary summary of the test results obtained for the Waterloo Biofilter® Model 4 Bedroom for nutrient reduction under the ETV Water Quality Protection Center. These results have been QA reviewed, but will not be considered final until all EPA reviews have been completed. The testing was completed at the Massachusetts Septic Systems Test Center during the period of March 2001 through April 2002. A full report for this testing will be completed soon and posted on the EPA (www.epa.gov/etv) and NSF (www.nsf.org/etv) web sites.

Table 1. BOD₅/CBOD₅ and TSS Data Summary

<table>
<thead>
<tr>
<th></th>
<th>BOD₅</th>
<th>CBOD₅</th>
<th></th>
<th>TSS</th>
<th>Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Influent (mg/L)</td>
<td>Effluent (mg/L)</td>
<td>Removal Percent</td>
<td>Influent (mg/L)</td>
<td>Effluent (mg/L)</td>
</tr>
<tr>
<td>Samples</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>Average</td>
<td>210</td>
<td>10</td>
<td>95</td>
<td>150</td>
<td>7</td>
</tr>
<tr>
<td>Median</td>
<td>200</td>
<td>7.4</td>
<td>96</td>
<td>130</td>
<td>5</td>
</tr>
<tr>
<td>Max</td>
<td>370</td>
<td>43</td>
<td>99</td>
<td>340</td>
<td>55</td>
</tr>
<tr>
<td>Min</td>
<td>67</td>
<td>1.0</td>
<td>71</td>
<td>61</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>73</td>
<td>9.0</td>
<td>6.0</td>
<td>66</td>
<td>8</td>
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</tbody>
</table>

Table 2. Nitrogen Data Summary

<table>
<thead>
<tr>
<th></th>
<th>TKN (mg/L)</th>
<th>NH₄ (mg/L)</th>
<th>Total Nitrogen (mg/L)</th>
<th>Nitrate (mg/L)</th>
<th>Nitrite (mg/L)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Influent</td>
<td>Effluent</td>
<td>Influent</td>
<td>Effluent</td>
<td>Influent</td>
<td>Effluent</td>
</tr>
<tr>
<td>Samples</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>Average</td>
<td>37</td>
<td>3.7</td>
<td>23</td>
<td>2.4</td>
<td>37</td>
<td>14</td>
</tr>
<tr>
<td>Median</td>
<td>37</td>
<td>1.6</td>
<td>23</td>
<td>0.7</td>
<td>37</td>
<td>13</td>
</tr>
<tr>
<td>Maximum</td>
<td>45</td>
<td>31</td>
<td>29</td>
<td>24</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>Minimum</td>
<td>24</td>
<td>&lt;0.5</td>
<td>18</td>
<td>&lt;0.2</td>
<td>24</td>
<td>6.8</td>
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<tr>
<td>Std. Dev.</td>
<td>4.2</td>
<td>5.5</td>
<td>2.4</td>
<td>4.0</td>
<td>4.2</td>
<td>6.0</td>
</tr>
</tbody>
</table>

NSF Contact: Thomas Stevens  
(734) 769-5347  
stevenst@nsf.org
ETI Independent Testing
Buzzard's Bay Test Facility, MA

24-Month Waterloo Biofilter Testing with 50% Recirculation in Triplicate for the Period of June 1999-June 2001

Results
- The Waterloo Biofilter can be loaded at very high rates
- Tertiary quality effluent
- ~60% total nitrogen removal
- Fecal coliforms are reduced by 99% in the Waterloo Biofilter and 99.999% with an additional foot of coarse sand or >99.999% with 10" of fine sand
- 10" of soil or fine sand after the Biofilter is equivalent to an under-drained 60" thick Title 5 sand filter system, but with much better nitrogen removal
- Very low power consumption; less than a re-circulating sand filter and 1/3 of a standard ATU producing secondary effluent (www.buzzardsbay.org/etireults.htm)

Fecal coliform results for 12" and 10" lysimeter testing (25-31 samples)

<table>
<thead>
<tr>
<th>Lysimeter</th>
<th>May '00 — Jul '01</th>
<th>June '00 — July '01</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Lysimeter A2</td>
<td>Lysimeter A3</td>
</tr>
<tr>
<td>Influent Sewage</td>
<td>3 700 000</td>
<td>3 800 000</td>
</tr>
<tr>
<td>Effluent After Waterloo + 12&quot; of T = 0.8 min/cm Sand</td>
<td>400</td>
<td>295</td>
</tr>
<tr>
<td>% Removal</td>
<td>99.989</td>
<td>99.992</td>
</tr>
<tr>
<td>Effluent After Waterloo + 10&quot; of T = 5 min/cm Sand</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>% Removal</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

21-Month Single-Pass Waterloo Biofilter Testing (No Recirculation)

Results
- A single pass through the Waterloo Biofilter is very effective at removing dissolved organics and solids
- ~40% total nitrogen removal
- Very low power consumption; about half that of a re-circulating sand filter and 1/6 of a standard ATU producing secondary effluent

Biofilter single pass organic results from September 2001 - June 2002

| Influent Median | 37 | 21.4 | 130 | 0 | 37 |
| Effluent Median | 19 | 6.4 | 3.0 | 5.6 | 23.1 |
| % Removal | - | 97.0 | 97.7 | - | 42.4 |

Waterloo Biofilter Systems Inc.
143 Dennis Street
P.O. Box 400
Rockwood, ON
Canada NO8 2K0
Phone: 519-856-0757
www.waterloo-biofilter.com

Buzzard's Bay Site Manager
George Heifelder
Phone: 508-291-3625
Buzzard's Bay Project
Site: 508-563-6757
2870 Cranberry Highway
East Wareham, MA
02538

Project Overseers
USEPA
MDEP
USDOD
BCDHE
NEIPCC