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c/o Northco Group of Co.

Hydrogeological (Septic) Study
Proposed Seniors' Housing Development
Southwest of Highway 130 and Arthur Street West Intersection
Oliver Paipoonge, Ontario

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Legal Notification

This report was prepared by EXP Services Inc. for the account of **James Collie c/o Northco Group of Co.,** and its design team, for the project described herein.

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An "Interpretation & Use of Study and Report" outlining the intended use and interpretation of this report is attached as Appendix A. The "Interpretation & Use of Study and Report" forms an integral part of this report and must be included with any authorized copies of the report.

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1 Introduction

EXP Services Inc. (EXP) was authorized by Mr. James Collie c/o Northco Group of Co. to conduct a hydrogeological study and geotechnical investigation for the proposed Senior's Housing Development, located southwest of the Highway 130 and Arthur Street West Intersection, in the Municipality of Oliver Paipoonge, Ontario; see Figure 1, in Appendix B. Based on the information provided, it is understood that the proposed development will contain five blocks with residential development and one green space area. The total site area is about 11.6 ha (28.7 acres); however, the site may be expanded to the south (potential purchase of land) to include an additional strip of land of about 2.4 ha (5.9 acres) in area, with dimensions of about 60.6 m x 395.3 m. Details of the blocks, with proposed residential development and green space areas, are provided below:

Block 1: 2 Duplex Buildings and 2 Apartment Buildings (5 units each) ~ 1.76 ha
Block 2: 6 Duplex Buildings ~ 2.16 ha
Block 3: 6 Duplex Buildings ~ 2.08 ha
Block 4: 6 Duplex Buildings~ 2.22 ha
Block 5: 2 Duplex Buildings and 2 Assisted Living Buildings (12 units each) ~ 2.23 ha
Green Space: No Buildings ~ 1.17 ha
Future Green Space (potential purchase): No Buildings ~ 2.39 ha

The proposed development will also include asphalt paved roadways, municipal storm sewers and individual lot septic fields. In addition, potable water will be supplied via drilled wells.

The purpose of the hydrogeological study was to obtain subsurface soils and groundwater information to assist with the design and development, including septic fields, of the proposed housing development. This report is intended solely for the project described above and contains all of our findings and recommendations based on our current understanding of the project.

A geotechnical report will be prepared under separate cover, for the proposed buildings, asphalt paved roadways and servicing.

2 Site Description

The site is located southwest of the Highway 130 and Arthur Street West Intersection, in the Municipality of Oliver Paipoonge, Ontario; see Figures 1 and 2, in Appendix B. According to the preliminary drawing provide, the area of the site is about 116,168.50 m^2 or 28.71 acres. In addition, the site may include a future parcel of land south of the site (based on a potential purchase) with an area of about 23,948.50 m (5.9 acres).

According to the Ontario Ministry of Natural Resources (MNR) Ontario Geological Survey Map 5047, the predevelopment regional geology in the area consists the underlying native soil consists of sand and silt glaciolacustrine plain deposits; mainly low local relief, plain and dry surface conditions.

At the time of the field investigations, the site was undeveloped with the exception of a roadway at the northeast part of the site (access via Highway 130) and was generally tree cleared. An intermittent ditch was observed at the northwest part of the site and presumably flows (ditch was dry at the time of the fieldwork) southeast to near the east site limit, adjacent to a residential property, and then generally flows south to Pennock Creek, which is located near the south site limit; refer to Figure 2 in Appendix B. The site topography appears to be generally flat with the exception of the intermittent ditch, previously discussed. Of note, near the south site limit and at the potential Future Green Space area, the site topography slopes down towards Pennock Creek.

The site is bounded by a commercial building and a church to the north, residential development and Highway 130 to the east, Pennock Creek to the south, and industrial/commercial properties to the west. All surrounding development is understood to contain potable wells and individual septic fields.

Looking west across the site from the northeast corner of the site. The intermittent ditch is located in the centre and extends to the left (brush from within the ditch is visible).

3 Methodology

3.1 Field Work

To assess the subsurface soil and hydrogeological conditions at the site, EXP geotechnical personnel attended the site and monitored the drilling of seven (7) boreholes (MW1 to MW7), at the locations shown on Figure 2 in Appendix B.

The boreholes were advanced using a CME 750 rubber tire mounted drill rig (supplied and operated by RPM Drilling [RPM]), equipped with hollow stem continuous flight augers (HSA), and a 50 mm outside diameter split spoon sampler. The drilling was completed in two days, May 15 and 16, 2023. The boreholes were advanced to about 6.7 m below ground surface.

Standard Penetration Tests (SPTs) were performed to assess the compactness or consistency of the underlying soils and to obtain representative samples. In general, SPTs were performed at about 0.75 m intervals in the upper 3.0 m, at about 1.5 m intervals thereafter. The recovered soil samples were examined and logged in the field by EXP geotechnical personnel.

Representative samples of the various soil strata encountered in the boreholes were taken to the EXP laboratory in Thunder Bay for further examination by a geotechnical engineer and for completion of laboratory classification testing.

Monitoring wells were installed upon completion of each borehole (MW1 to MW7). Details of the monitoring well installations are provided on the Borehole / Monitoring Well Logs in Appendix C. In general, the monitoring wells were completed using 50 mm riser and screen pipes, silica sand (filter sand), bentonite and with a lockable protective above ground casing. In general, the wells were screened as high as about 0.6 m to as deep as 4.6 m below ground surface. Following the monitoring well installations, the wells were equipped with dedicated Waterra^{TM} tubing and foot valves to facilitate well development (i.e., groundwater purging). All installations were conducted by a MECP licensed well technician/contractor. A copy of the MECP well records submission is included in Appendix C.

Upon completion of drilling and well installation, the wells were developed by purging ten well volumes and/or until dryness. Groundwater levels at the monitoring wells were obtained on four different occasions in 2023, May 17, June 5, 13 and September 8. Subsequently, the monitoring wells were purged by removing a minimum of three well volumes, or to dryness. Purged water from all wells was disposed of on the ground surface adjacent to each well. Upon at least 80 percent recovery of static water level on the day of purging, groundwater samples for chemical analyses were then collected from all monitoring wells using dedicated Waterra tubing and foot valves. All samples were collected into laboratory-supplied bottles. The groundwater samples from the June and September sampling events (three events) for chemical analysis were kept in coolers with icepacks and were delivered in a secure cooler under chain of custody, to Bureau Veritas Laboratories (BV Labs), a Standards Council of Canada certified and accredited laboratory in Mississauga, Ontario.

Following the fieldwork, EXP personnel obtained GPS coordinates of the borehole locations using a handheld GPS unit. In addition, the locations as well as the ground surface and top of pipe geodetic elevations were surveyed by Delta Survey Inc. on September 26, 2023, and were provided to EXP via email on September 27, 2023.

3.2 Laboratory Testing

3.2.1 Geotechnical

Following the field investigation, representative soil samples were selected for laboratory grain size analyses (sieve and hydrometer), and natural moisture content determinations for soil type classification purposes as well as to allow estimation of the geotechnical properties.

Samples remaining after the testing will be stored for three months after which they may be discarded unless we are requested otherwise. The results are described in following sections of this report.

3.2.2 Chemical

Groundwater samples were collected for chemical analyses from all the monitoring wells (MW1-MW7), for nitrate and nitrite as well as total phosphorous . The groundwater samples were delivered, in a secure cooler under chain of custody, to the local BV Labs depot in Thunder Bay, which were ultimately sent to their Standards Council of Canada certified and accredited laboratory in Mississauga, Ontario.

4 Subsurface Conditions

Details of the subsurface conditions encountered at the borehole / monitoring well locations are provided on the Borehole / Monitoring Well Logs included in Appendix C of this report. The general subsurface soil conditions are summarized in the following sections.

4.1 Soil Conditions

4.1.1 Sand

Sand was encountered at the borehole locations. The sand was generally described as loose to compact, brown to grey, moist to wet at depth, and containing trace gravel, trace to some silt and trace organics in the upper 0.3 m to 1.5 m. Interbedded clayey silt seams were noted at MW4 and MW6 at depth. In addition, sand blow-up in the augers was encountered at MW2 and MW7 at about 3.0 m depth. The sand extended to the termination depth of the boreholes at about 6.7 m below ground surface.

Eleven (11) grain size analyses were performed on representative samples of the sand (MW1-S2, MW2-S2, MW2-S3, MW3-S3, MW3-S4, MW4-S2, MW5-S2, MW6-S2, MW6-S4, MW6-S5, MW7-S2); the results are compared to OPSS Granular "B" (Type 1) gradation and are presented on Figures 4 and 5 in Appendix B. Samples MW3-S4 and MW6-S5 meet Granular "B" gradation criteria, while all other tested samples did not. The tested samples are considered to possess low to moderate frost susceptibility.

Also based on the gradations, the coefficient of hydraulic conductivity, K, is estimated to be in the order of 10^{-4} m/s to 10^{-6} m/s.

Total saturated unit weights have been calculated based on the saturated moisture contents of the sand and are estimated to be about 18 to 21 kN/m^3.

4.2 Groundwater

Groundwater measurements at the monitoring well locations were taken between one to two days and up about three months after their completion, as shown on the Borehole / Monitoring Well Logs in Appendix B and as summarized in Table 1, below.

It must be noted that the depth to the groundwater table may fluctuate seasonally, or after periods of extended precipitation or drought, and as such may differ at other times.

Table 1: Groundwater Data

BH / MW & Surface Water Point	Date Completed	Date Measured	Ground Surface Elevation[2]	Top of Pipe Elevation[2]	Depth to Water[3]	Groundwater Elevation
MW1	May 16/23	May 17/23	221.29	222.19	1.22	220.07
		Jun. 5/23			1.02	220.27
		Jun. 13/23			1.43	219.86
		Sept. 8/23			1.89	219.40
MW2	May 15/23	May 17/23	221.20	222.12	1.06	220.14
		Jun. 5/23			1.23	219.97
		Jun. 13/23			0.89	220.31
		Sept. 8/23			1.59	219.61
MW3	May 15/23	May 17/23	221.42	222.31	1.22	220.20
		Jun. 5/23			1.32	220.10
		Jun. 13/23			1.45	219.97
		Sept. 8/23			1.86	219.56
MW4	May 16/23	May 17/23	221.29	222.24	2.24	219.05
		Jun. 5/23			2.25	219.04
		Jun. 13/23			1.82	219.47
		Sept. 8/23			2.57	218.72
MW5	May 15/23	May 17/23	221.18	222.17	1.86	219.32
		Jun. 5/23			1.94	219.24
		Jun. 13/23			1.83	219.35
		Sept. 8/23			2.56	218.62
MW6	May 16/23	May 17/23	221.37	222.31	3.14	218.23
		Jun. 5/23			3.19	218.18
		Jun. 13/23			1.51	219.86
		Sept. 8/23			3.41	217.96
MW7	May 15/23	May 17/23	221.82	222.80	1.53	220.29
		Jun. 5/23			1.44	220.38
		Jun. 13/23			1.45	220.37
		Sept. 8/23			2.14	219.68
SWP1[4]	--	Sept. 26/23	--	--	--	215.60
SWP2[4]	--	Sept. 26/23	--	--	--	215.60

Notes:
1) All units in meters.
2) Elevations of ground surface, top of riser pipe and top of water at surface water point locations (SWP1, SWP2) were surveyed by Delta Survey Inc. on September 26, 2023.
3) Depths are relative to ground surface.
4) Indicates top of surface water point.

Based on the groundwater elevations at the monitoring well locations and the surface water point elevations, the direction of local groundwater flow appears to be generally south to south-southeast towards Pennock Creek, which flows east to the Neebing River and ultimately to Lake Superior (about 15 km east of site).

4.3 Chemical Analysis Results

The analytical results are compared to the Ontario Ministry of Environment *Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines*, dated June 2003. There are no soil or groundwater criteria for nitrate and nitrite in the Ontario Ministry of Environment *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act* (April 15, 2011).

The laboratory reports of analyses are found in Appendix D, and the nitrate and nitrite groundwater results are summarized below in Table 2.

Table 2: Nitrate and Nitrite Groundwater Results[1]

Parameters		Nitrate	Nitrite	Nitrate (Mean)[4]	Nitrite (Mean)[4]
Sampling Locations	Sampling Date	ODWS[2]		ODWS[2]	
		10.0	1.0	10.0	1.0
MW1	Jun. 5/23	8.60	<0.010	6.12	<0.010
	Jun.13/23	9.73 (9.67)[3]	<0.010 (<0.010)		
	Sept. 8/23	<0.1	<0.010		
MW2	Jun. 5/23	0.42	<0.010	0.92	<0.010
	Jun.13/23	0.58	<0.010		
	Sept. 8/23	1.77	<0.010		
MW3	Jun. 5/23	0.66	<0.010	3.53	0.011
	Jun.13/23	5.15	<0.010		
	Sept. 8/23	4.78	0.022		
MW4	Jun. 5/23	0.43	<0.010	0.39	<0.010
	Jun.13/23	0.68	<0.010		
	Sept. 8/23	<0.1	<0.010		
MW5	Jun. 5/23	0.60	0.011	0.67	<0.010
	Jun.13/23	0.86	<0.010		
	Sept. 8/23	0.55	<0.010		
MW6	Jun. 5/23	0.25	<0.010	0.78	<0.010
	Jun.13/23	0.32	<0.010		
	Sept. 8/23	1.78	<0.010		
MW7	Jun. 5/23	1.36 (1.37)	<0.010 (<0.010)	1.34	0.018
	Jun.13/23	1.34	<0.010		
	Sept. 8/23	1.30 (1.31)	0.044 (0.043)		

Notes:

1. All concentrations are mg/L (ppm).
2. Criteria are from MECP *Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines* (June 2003). **Bold** results exceed criteria.
3. Bracketed ( ) values are the blind replicate results. The blind replicate was labelled as MW8 and submitted to the laboratory for QA/QC purposes.
4. Mean results are the arithmetic mean of three sampling events per monitoring well location. The blind replicate results were averaged with the original sample prior to calculating the arithmetic mean. In addition, non-detected values (indicated with a "<") were halved to calculate the arithmetic mean.

The groundwater results for nitrate and nitrite were all below the ODWS criteria.

The higher nitrate values were observed at MW1, MW3, and MW7. MW1 is located south of the church site, and MW3, MW5 and MW7 are located east of industrial commercial property, all of which are understood to contain individual septic fields. It should be noted that the June 5, June 13, and September 8, 2023, sampling events were conducted on Monday, Tuesday and Friday, respectively. At MW1 (south of a church which is typically utilized on Sundays), the results obtained during the Monday and Tuesday were high (8.6 and 9.7 mg/L), while the Friday results were non-detectable (<0.1 mg/L). Similarly, the results at MW3 (adjacent to commercial/industrial business which typically operate between Mondays and Fridays) on the Monday the results were low (0.66 mg/L) but were higher on Tuesday and Friday (5.2 and 4.8 mg/L). Based on the above, the data suggests that the nitrate levels on-site are largely influenced by neighbouring septic fields and do not appear to be due to natural or historical conditions.

4.4 **Environmental Conditions**

All of the recovered soil samples taken from the test pits were inspected for visual and olfactory evidence of contamination. Our inspection of these samples did not reveal any evidence of petroleum hydrocarbon contamination.

5 Discussions and Recommendations

5.1 General

Preliminary information provided provided by the client, including drawings, indicates that the proposed housing development will contain five blocks with residential development and one green space area. The total site area is about 11.6 ha (28.7 acres); however, the site may be expanded to the south (potential purchase of land) to include an additional strip of land of about 2.4 ha (5.9 acres) in area, with dimensions of about 60.6 m x 395.3 m.

The development will contain three different types of housing buildings, which include duplexes (22), apartments (2) and assisted living buildings (2), with each structure having its own septic field. Based on our understanding of the usage/occupancy of each structure, the effluent volumes from the Ontario Building Code based on the type of housing buildings proposed are summarized below:

Duplex = 750 L per dwelling (1 bedroom, 2 persons), so **1,500 L/day/duplex**

Apartment Bldg (5 Units = 10 ppl) = 275 L/day/person = **2,750 L/day/apartment bldg**

Assisted Living Bldg (12 Units = 12 ppl, plus 1 non-resident staff) = 200 L/day/person + 40 L/8 hrs/staff = **2,520 L/day/assisted living bldg**

Each of the five blocks (Block 1 to 5) will produce less than 10,000 L/day, as detailed below:

Block 1: 2 Duplexes & 2 Apartments = **8,500 L/day**
Block 2: 6 Duplexes = **9,000 L/day**
Block 3: 6 Duplexes = **9,000 L/day**
Block 4: 6 Duplexes = **9,000 L/day**
Block 5: 2 Duplexes & 2 Assisted Living Buildings = **8,040 L/day**
Green Space: No Buildings = **0 L/day**
Future Green Space (potential purchase): No Buildings = **0 L/day**

Total = 43,540 L/day

The proposed development will also include asphalt paved roadways, municipal storm sewers and individual lot septic fields. In addition, potable water will be supplied via drilled potable wells.

Storm drainage is understood to be directed to proposed storm water ditching / catch basins.

The discussions to follow are presented in general terms, and the recommendations are based on the above information and the findings of the investigation.

5.2 Septic Fields

5.2.1 Hydrogeological Assessment and T-Times

The boreholes were generally advanced for the purpose of collecting soil samples for grain size analyses to determine estimated percolation (T) times, as an indication of the suitability of the use of the soils for a Class 4 Sewage System.

The soil conditions on site were generally sand. Groundwater was encountered at the boreholes/monitoring well locations at depths ranging between about 0.9 m and 3.4 m below ground surface.

As indicated above, grain size analyses (sieve and hydrometer) were performed on eleven (11) grain size analyses were performed on representative samples of the sand (MW1-S2, MW2-S2, MW2-S3, MW3-S3, MW3-S4, MW4-S2, MW5-S2, MW6-S2, MW6-S4, MW6-S5, MW7-S2). The grain size analyses were performed for soil classification purposes and to allow for determination of the particle size corresponding to the 10% finer than fraction (D_{10}), which is used in the Hazen empirical estimation of hydraulic conductivity (K), which can be correlated to the T-time. The grain size results are presented graphically on Figures 4 and 5, in Appendix B.

While the Hazen method of estimating hydraulic conductivity, where K (cm/s) = $[D_{10}\ (mm)]^2$, was originally determined for uniformly graded sands, it can provide a rough, but useful, approximation for most cohesionless (non-plastic) soils.

The calculated K values are provided in Table 3, below, along with the estimated T-times, correlated to Table 2 and 3 of Supplementary Standard SB-6, of the (OBC) Ontario Building Code (2012) and the MECP correlation. The estimated **T-times**, based on this method, ranges between about **2 min/cm to 20 min/cm**. The T-time ranges for the determined soil groups, from the OBC, are also provided.

Table 3. Septic Sand Analysis

Sample No.	Sample Depth (m)	Percent (%) Passing 4.75	Percent (%) Passing 0.075	D_{10} (mm)	Hazen K (cm/s)	Est. T (min/cm) OBC / MECP	USCS Soil Group	T (min/cm) Soil Group
MW1-S2	0.8-1.4	100.0	12.8	0.017	2.9E-04	**10-15**	SM	8 - 20
MW2-S2	0.8-1.4	100.0	10.1	0.074	5.5E-03	**5-10**	SP-SM	2 - 20
MW2-S3	1.5-2.1	100.0	12.1	0.06[1]	3.6E-03	**5-10**	SM	8 - 20
MW3-S3	1.5-2.1	100.0	10.0	0.075	5.6E-03	**5-10**	SP-SM	2 - 20
MW3-S4	2.3-2.9	95.5	4.9	0.12	1.4E-02	**3-6**	SP	2 - 8
MW4-S2	0.8-1.4	100.0	6.2	0.085	7.2E-03	**4-8**	SP-SM	2 - 20
MW5-S2	0.8-1.4	100.0	10.9	0.070	4.9E-03	**5-10**	SP-SM	2 - 20
MW6-S2	0.8-1.4	100.0	6.6	0.083	6.9E-03	**4-8**	SP-SM	2 - 20
MW6-S4	2.3-2.9	100.0	21.6	0.016	2.6E-04	**10-15**	SM	8 - 20
MW6-S5	3.1-3.7	98.7	6.2	0.11	1.2E-02	**3-6**	SP	2 - 8
MW7-S2	0.8-1.4	100.0	7.8	0.078	6.1E-03	**5-10**	SP-SM	2 -20

Note:
1) Values were extrapolated.

Based on observed soil conditions and estimated T-times, it is concluded that the lots should be suitable for installation of in-ground individual septic systems. However, raised-beds may be necessary in areas with shallow groundwater; a minimum of 1.5 m of separation between the bottom of the septic field trenches (pipes) and the groundwater level is required. Test pit investigations will be required at the specific location of each septic field to determine soil and groundwater conditions prior to final design and construction.

Detailed design of the septic system is beyond EXP's currently approved scope. Design and construction of the septic system should be in accordance with the Ontario Building Code. EXP can provide design and related construction inspection services, as required.

5.2.2 **Impact Assessment**

EXP completed a hydrogeological assessment that was consistent with the requirements of Ministry of Environment (MOE – now called MECP) Procedure D-5-4.

MECP Procedure D-5-4 describes a three-step procedure to assess the impacts of individual on-site sewage systems:

- Step 1: Assess whether average lot size is greater than 1 hectare (ha).
- Step 2: Demonstrate whether on-site individual sewage systems are hydraulically isolated from existing or potential water supply aquifers.
- Step 3: Examine potential contaminant loadings to groundwater from the proposed on-site sewage systems.

The site is a proposed seniors' housing development, containing 22 duplexes, two apartment buildings, and two assisted living buildings, with a maximum on-site permanent resident occupancy of 132. The development is divided into five residential blocks and one green space area, for a total site area of 11.6 ha (28.7 acres). However, it is understood that the site could be enlarged by about 2.4 ha (5.9 acres) through a potential purchase of land to the south, resulting in a potential total area of about 14.0 ha (34.6 acres). The areas of the residential blocks range between about 1.76 ha and 2.22 ha.

The proposed development will also include asphalt paved roadways, municipal storm sewers and individual lot septic fields (i.e., one field per building). In addition, potable water will be supplied via drilled potable wells.

Based on this information, it is established that the average area/lot size per building is less than 1 ha, requiring the completion of Step 2 and Step 3.

MECP Procedures D-5-4 stipulates that individual on-site sewage systems may be deemed acceptable if it can be demonstrated that effluent from on-site sewage systems are hydraulically isolated from existing or potential supply aquifers in the vicinity.

The site is proposed to be serviced using on-site drilled potable wells. In addition, based on the MECP well record website (https://www.ontario.ca/environment-and-energy/map-well-records), individual domestic water wells exist within one kilometre of the site, and aquifers adjacent to the site are considered to have potential as drinking water supplies.

The subsurface conditions, based on the findings of the current report, herein, and the 1995 Hydrogeological Assessment[1] at the site are generally characterized by sand in about the upper 10 m, overlying clay in approximately the upper 18 m to 24 m, overlying glacial, gravel and shale/bedrock. These types of soils may be amenable as aquifers for individual (or communal) water wells. The 1995 report indicates that a substantial quantity of potable water for this site

[1] Wardrop Engineering Inc. (1995). *Hydrogeological Assessment, New Residential Subdivision, Township of Paipoonge, Ontario*. Ref. No. 943259-01-00. August 1995.

could be derived from the gravel layer which exists at depths of between about 25 m and 50 m. As the gravel layer is beneath the clay and till, it is considered isolated from the surface and the upper sand aquifer.

However, the conditions are not necessarily amenable to hydraulic isolation between surface infrastructure and the shallow overburden aquifer off-site and there may not exist hydraulic isolation from other shallow aquifers in this area (i.e., the upper sand) which may be used by other properties. Therefore, it is necessary to proceed to Step 3 of the procedure to assess the potential impacts of contaminant loadings of the on-site sewage systems on existing or potential shallow supply aquifers.

EXP has conducted a predictive assessment of potential combined impacts from the on-site sewage systems to water supply aquifers at the subdivision boundaries was completed. Assumptions in the predictive assessment included:

- Nitrate-nitrogen is the critical contaminant;
- The Ontario Building Code stipulates the following sewage loading rates:
    - Duplex: 750 L per dwelling (1 bedroom, 2 persons) → 1,500 L/day
    - Apartment Building: 275 L/day/person (5 units, 2 persons) → 2,750 L/day
    - Assisted Living Building: (12 Units = 12 ppl, plus 1 non-resident staff) = 200 L/day/person + 40 L/8 hrs/staff → 2,520 L/day
- An effluent nitrate concentration (C_e) of 40 mg/L was used;
- Existing nitrate concentrations from infiltration (C_i), which includes on-site background results from the current study, varied on-site based on the chemical analyses results (previously presented/discussed) and nitrate concentrations from infiltration (C_i) per block are based on the arithmetic mean of nitrate concentrations at monitoring wells within/near each block; refer to Tables 4 to 7 below for details.
- Dilution from infiltrating precipitation as the only mechanism for attenuation of nitrate-nitrogen;
- Utilization of precipitation data from the nearest Environment Canada station;
- Estimation of infiltration based on site-specific conditions, including soils, topography, geology and impermeable surfaces (such as paved areas);

The nitrate-nitrogen concentration at the subdivision boundary (C_T) was derived from the total mass loading of nitrate-nitrogen in input waters (M_T) divided by the total volume of the input waters (V_T):

$$C_T = M_T / V_T$$

V_T is equal to the total volume of infiltrating precipitation (V_i) and the total volume of discharge from all on-site sewage systems (V_e). M_T is equal to the total mass of nitrate-nitrogen contained in both the infiltration precipitation (M_i) and the sewage effluent (M_e):

$$M_i = C_i \times V_i$$

$$M_e = C_e \times V_e$$

Where C_i and C_e are the nitrate-nitrogen concentrations in infiltrating precipitation and sewage effluent, respectively.

As previously indicated, the block sizes for the development range between about 1.76 ha and 2.23 ha, while the green space area is about 1.17 ha, for a total site area of about 11.6 ha. However, the site may be expanded to the south (potential purchase of land) to include an additional strip of land of about 2.4 ha (5.9 acres) in area.

Environment Canada precipitation data for the Thunder Bay area between 1971 and 2000 indicate an average annual precipitation rate of 711.6 mm. Typical average annual evapotranspiration in northern Ontario is approximately in the range of 400 mm. Based on these data, an average annual moisture surplus of 311 mm is designated for the subject site. It has been assumed that this entire moisture surplus is available for infiltration within the infiltration area. While some of the moisture surplus may become runoff, this is assumed to be a minimal amount. A varied nitrate-nitrogen concentration (range between about 0.7 to 3.5 mg/L) has been calculated and used for the infiltrating precipitation (C_i) for each individual block/green space in order to account for the existing nitrate-nitrite levels. This is considered conservative for the site conditions and precipitation in northern Ontario.

Based on the above assumptions, Table 4 summarizes the predicted nitrate-nitrogen loadings to groundwater from the proposed subdivision lots. The predicted loadings are based on projected loadings from infiltrating precipitation and from sewage effluent discharges, as outlined above.

The total calculated nitrate-nitrogen loading to groundwater at the proposed housing development based on the current site and the current site plus the addition of the Future Green Space land will be about 13.7 mg/L and 12.1 mg/L, respectively, both of which are above the Ontario Drinking Water Standard (ODWS) of 10 mg/L. Refer to Tables 4 and 5 below.

Table 4: Total Predicted Nitrate Loadings – Current Site

Property / Land Use	Lot size (Ha)	V_i (L/day)	C_i[1] (mg/L)	M_i (mg/day)	V_e[2] (L/day)	C_e (mg/L)	M_e (mg/day)	V_T (L/day)	M_T (mg/day)	C_T (mg/L)
		Infiltration Loading			Effluent Loading			Total Loading		
Block 1	1.76	14,477	3.52	50,960	8,500	40.0	340,000	22,977	390,960	17.0
Block 2	2.16	17,762	1.34	23,801	9,000	40.0	360,000	26,762	383,801	14.3
Block 3	2.08	17,078	2.1	35,863	9,000	40.0	360,000	26,078	395,863	15.2
Block 4	2.22	18,210	1.53	27,862	9,000	40.0	360,000	27,210	387,862	14.3
Block 5	2.23	18,300	0.7	12,810	8,040	40.0	321,600	26,340	334,410	12.7
Green Space	1.17	9,654	0.85	8,206	0	0.0	0	9,654	8,206	0.9
Totals	**11.62**	**95,481**		**159,502**	**43,540**		**1,741,600**	**139,021**	**1,901,102**	**13.7**

Notes:
1) C_i values are based on the arithmetic mean of existing nitrate results of monitoring wells within/near a block. Block 1 is the mean of MW1 and MW2. Block 2 is the mean of MW7. Block 3 is the mean of MW3 and MW5. Block 4 is the mean of MW3, MW4 and MW5. Block 5 is the mean of MW2, MW4 and MW6. The Green Space area is the mean of MW2 and MW6. Refer to Table 2 above for nitrate results.
2) V_e (total effluent volume) is based on values given in Section 5.1 - General.

Table 5: Total Predicted Nitrate Loadings – Current Site Plus Future Green Space

Property / Land Use	Lot size (Ha)	V_i (L/day)	C_i[1] (mg/L)	M_i (mg/day)	V_e[2] (L/day)	C_e (mg/L)	M_e (mg/day)	V_T (L/day)	M_T (mg/day)	C_T (mg/L)
		Infiltration Loading			Effluent Loading			Total Loading		
Block 1	1.76	14,477	3.52	50,960	8,500	40.0	340,000	22,977	390,960	17.0
Block 2	2.16	17,762	1.34	23,801	9,000	40.0	360,000	26,762	383,801	14.3
Block 3	2.08	17,078	2.1	35,863	9,000	40.0	360,000	26,078	395,863	15.2
Block 4	2.22	18,210	1.53	27,862	9,000	40.0	360,000	27,210	387,862	14.3
Block 5	2.23	18,300	0.7	12,810	8,040	40.0	321,600	26,340	334,410	12.7
Green Space	1.17	9,654	0.85	8,206	0	0.0	0	9,654	8,206	0.9
Future Green Space	2.39	19,684	0.73	14,369	0	0.0	0	19,684	14,369	0.7
Totals	**14.01**	**115,165**		**173,871**	**43,540**		**1,741,600**	**158,705**	**1,915,471**	**12.1**

Notes:
1) C_i values are based on the arithmetic mean of existing nitrate results of monitoring wells within/near a block. Block 1 is the mean of MW1 and MW2. Block 2 is the mean of MW7. Block 3 is the mean of MW3 and MW5. Block 4 is the mean of MW3, MW4 and MW5. Block 5 is the mean of MW2, MW4 and MW6. The Green Space area is the mean of MW2 and MW6. The Future Green Space area is the mean of MW5 and MW6. Refer to Table 2 above for nitrate results.
2) V_e (total effluent volume) is based on values given in Section 5.1 - General.

In order to reduce the nitrate-nitrogen loading, nitrate treatment has been considered to address this issue. There are a number of available nitrate treatment systems, including the POINT™ system, the Waterloo Biofilter and the Premier Tech Environment Ecoflow Biofilter, for example. Many of the readily available nitrate treatment systems are capable of removing 40% of nitrogen compounds consistently from the effluent. Typically, these systems require smaller field areas compared to conventional systems. More information on these types of systems can be found in the *SepticSmart* booklet (jointly published by the federal and Ontario governments), see Appendix E.

Tables 6 and 7 below, summarizes the predicted nitrate loadings based on pre-treatment nitrogen removal for the current site as well as the site plus the Future Green space land, respectively. In these cases, the required post-treatment nitrate-nitrogen concentration is 28 mg/L (i.e., 30% nitrogen removal) for the current site and 32 mg/L (i.e., 20% nitrogen removal) for the current site with the addition of the Future Green Space. The predicted loadings for both scenarios to groundwater indicate that nitrate-nitrogen at the proposed housing development boundary will be about 9.9 mg/L, which is below the ODWS of 10 mg/L.

Discussions with staff at Waterloo Biofilter and information provided (see Appendix F), including case studies, suggests that Waterloo Biofilters systems can remove the following total nitrogen compounds consistently:

- Single-Pass Waterloo System – 25 to 35% total nitrogen removal;
- Double-Pass Waterloo System – 50 – 65% total nitrogen removal; and
- WaterNOx-LS Autotrophic Upflow System – 80 to 95 % nitrogen removal.

Table 6: Total Predicted Nitrate Loadings – Current Site
30% Nitrogen Removal

Property / Land Use	Lot size (Ha)	V_i (L/day)	C_i[1] (mg/L)	M_i (mg/day)	V_e[2] (L/day)	C_e (mg/L)	M_e (mg/day)	V_T (L/day)	M_T (mg/day)	C_T (mg/L)
		Infiltration Loading			Effluent Loading			Total Loading		
Block 1	1.76	14,477	3.52	50,960	8,500	28.0	238,000	22,977	288,960	12.6
Block 2	2.16	17,762	1.34	23,801	9,000	28.0	252,000	26,762	275,801	10.3
Block 3	2.08	17,078	2.1	35,863	9,000	28.0	252,000	26,078	287,863	11.0
Block 4	2.22	18,210	1.53	27,862	9,000	28.0	252,000	27,210	279,862	10.3
Block 5	2.23	18,300	0.7	12,810	8,040	28.0	225,120	26,340	237,930	9.0
Green Space	1.17	9,654	0.85	8,206	0	0.0	0	9,654	8,206	0.9
Totals	**11.62**	**95,481**		**159,502**	**43,540**		**1,219,120**	**139,021**	**1,378,622**	**9.9**

Notes:
1) C_i values are based on the arithmetic mean of existing nitrate results of monitoring wells within/near a block. Block 1 is the mean of MW1 and MW2. Block 2 is the mean of MW7. Block 3 is the mean of MW3 and MW5. Block 4 is the mean of MW3, MW4 and MW5. Block 5 is the mean of MW2, MW4 and MW6. The Green Space area is the mean of MW2 and MW6. Refer to Table 2 above for nitrate results.
2) V_e (total effluent volume) is based on values given in Section 5.1 - General.

Table 7: Total Predicted Nitrate Loadings – Current Site Plus Future Green Space
20% Nitrogen Removal

Property / Land Use	Lot size (Ha)	V_i (L/day)	C_i[1] (mg/L)	M_i (mg/day)	V_e[2] (L/day)	C_e (mg/L)	M_e (mg/day)	V_T (L/day)	M_T (mg/day)	C_T (mg/L)
		Infiltration Loading			Effluent Loading			Total Loading		
Block 1	1.76	14,477	3.52	50,960	8,500	32.0	272,000	22,977	322,960	14.1
Block 2	2.16	17,762	1.34	23,801	9,000	32.0	288,000	26,762	311,801	11.7
Block 3	2.08	17,078	2.1	35,863	9,000	32.0	288,000	26,078	323,863	12.4
Block 4	2.22	18,210	1.53	27,862	9,000	32.0	288,000	27,210	315,862	11.6
Block 5	2.23	18,300	0.7	12,810	8,040	32.0	257,280	26,340	270,090	10.3
Green Space	1.17	9,654	0.85	8,206	0	0.0	0	9,654	8,206	0.9
Future Green Space	2.39	19,684	0.73	14,369	0	0.0	0	19,684	14,369	0.7
Totals	**14.01**	**115,165**		**173,871**	**43,540**		**1,393,280**	**158,705**	**1,567,151**	**9.9**

Notes:
1) C_i values are based on the arithmetic mean of existing nitrate results of monitoring wells within/near a block. Block 1 is the mean of MW1 and MW2. Block 2 is the mean of MW7. Block 3 is the mean of MW3 and MW5. Block 4 is the mean of MW3, MW4 and MW5. Block 5 is the mean of MW2, MW4 and MW6. The Green Space area is the mean of MW2 and MW6. The Future Green Space area is the mean of MW5 and MW6. Refer to Table 2 above for nitrate results.
2) V_e (total effluent volume) is based on values given in Section 5.1 - General.

5.2.3 **Potential Groundwater Mounding**

It is understood that potable groundwater will be provided to the site via drilled on-site wells and wastewater will be discharged into on-site septic fields. Considering that the on-site drawn water will also be discharge on site (i.e., water out is approximately equal to water in) no groundwater mounding analyses has been conducted.

6 Closing Comments

The recommendations made in this report are in accordance with our present understanding of the project and are provided solely for James Collie c/o Northco Group of Co. and the team responsible for the design of the proposed new development at the site investigated and described herein.

As described in the report, individual site specific septic system design will be required.

We recommend that we be retained to review our recommendations as the design nears completion to ensure that the final design is in agreement with the assumptions on which our recommendations are based and that our recommendations have been interpreted as intended. If not accorded this review, EXP will assume no responsibility for the interpretation and use of the recommendations in this report.

A subsurface investigation is a limited sampling of a site and the subsurface conditions have been established only at the test hole locations. Should any conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to allow reassessment of our recommendations. It may then be necessary to carry out additional fieldwork and analyses.

It should be recognized that unanticipated conditions might be encountered during construction. It is therefore recommended that EXP be retained to observe construction and perform testing relative to the geotechnical issues, as discussed in previous sections of this report. Such observation and testing is intended to minimize the risk of problems occurring during and following construction. It is not insurance however, nor does it constitute a warranty or guarantee of any type. In all cases, contractors *et al* retain responsibility for the quality of their work and for adhering to plans and specifications. Should EXP not be retained to provide such observations and testing, EXP would not have had the ability to perform a complete service and therefore assumes no responsibility for problems during or after construction that allegedly result from findings, conclusions, recommendations, plans or specifications developed by EXP.

Contractors bidding on or undertaking the works should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them. As part of the tendering process, it is recommended that test pits be excavated to allow bidding contractors to view the actual excavation and groundwater conditions.

We trust that this report is satisfactory to your present requirements and we look forward to assisting you in the completion of this project. Should you have any questions, please contact the undersigned at your convenience.

Yours truly,

EXP Services Inc.

Ahileas Mitsopoulos, P.Eng.
Project Engineer

Demetri N. Georgiou, MASc., P.Eng.
Principal Engineer/Branch Manager

Appendix A –
Interpretation & Use of Study and Report

INTERPRETATION & USE OF STUDY AND REPORT

1. STANDARD OF CARE

This study and Report have been prepared in accordance with generally accepted engineering consulting practices in this area. No other warranty, expressed or implied, is made. Engineering studies and reports do not include environmental consulting unless specifically stated in the engineering report.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report which is of a summary nature and is not intended to stand alone without reference to the instructions given to us by the Client, communications between us and the Client, and to any other reports, writings, proposals or documents prepared by us for the Client relative to the specific site described herein, all of which constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. WE CANNOT BE RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF THE REPORT

The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose that were described to us by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the document are only valid to the extent that there has been no material alteration to or variation from any of the said descriptions provided to us unless we are specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT OUR WRITTEN CONSENT. WE WILL CONSENT TO ANY REASONABLE REQUEST BY THE CLIENT TO APPROVE THE USE OF THIS REPORT BY OTHER PARTIES AS "APPROVED USERS". The contents of the Report remain our copyright property and we authorize only the Client and Approved Users to make copies of the Report only in such quantities as are reasonably necessary for the use of the Report by those parties. The Client and Approved Users may not give, lend, sell or otherwise make the Report, or any portion thereof, available to any party without our written permission. Any use which a third party makes of the Report, or any portion of the Report, are the sole responsibility of such third parties. We accept no responsibility for damages suffered by any third party resulting from unauthorized use of the Report.

5. INTERPRETATION OF THE REPORT

a. Nature and Exactness of Descriptions: Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature and even comprehensive sampling and testing programs, implemented with the appropriate equipment by experienced personnel, may fail to locate some conditions. All investigations, or building envelope descriptions, utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and all persons making use of such documents or records should be aware of, and accept, this risk. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b. Reliance on Provided information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to us. We have relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, we cannot accept responsibility for any deficiency, misstatement or inaccuracy contained in the report as a result of misstatements, omissions, misrepresentations or fraudulent acts of persons providing information.

c. To avoid misunderstandings, EXP Services Inc. (EXP) should be retained to work with the other design professionals to explain relevant engineering findings and to review their plans, drawings, and specifications relative to engineering issues pertaining to consulting services provided by EXP. Further, EXP should be retained to provide field reviews during the construction, consistent with building codes guidelines and generally accepted practices. Where applicable, the field services recommended for the project are the minimum necessary to ascertain that the Contractor's work is being carried out in general conformity with EXP's recommendations. Any reduction from the level of services normally recommended will result in EXP providing qualified opinions regarding adequacy of the work.

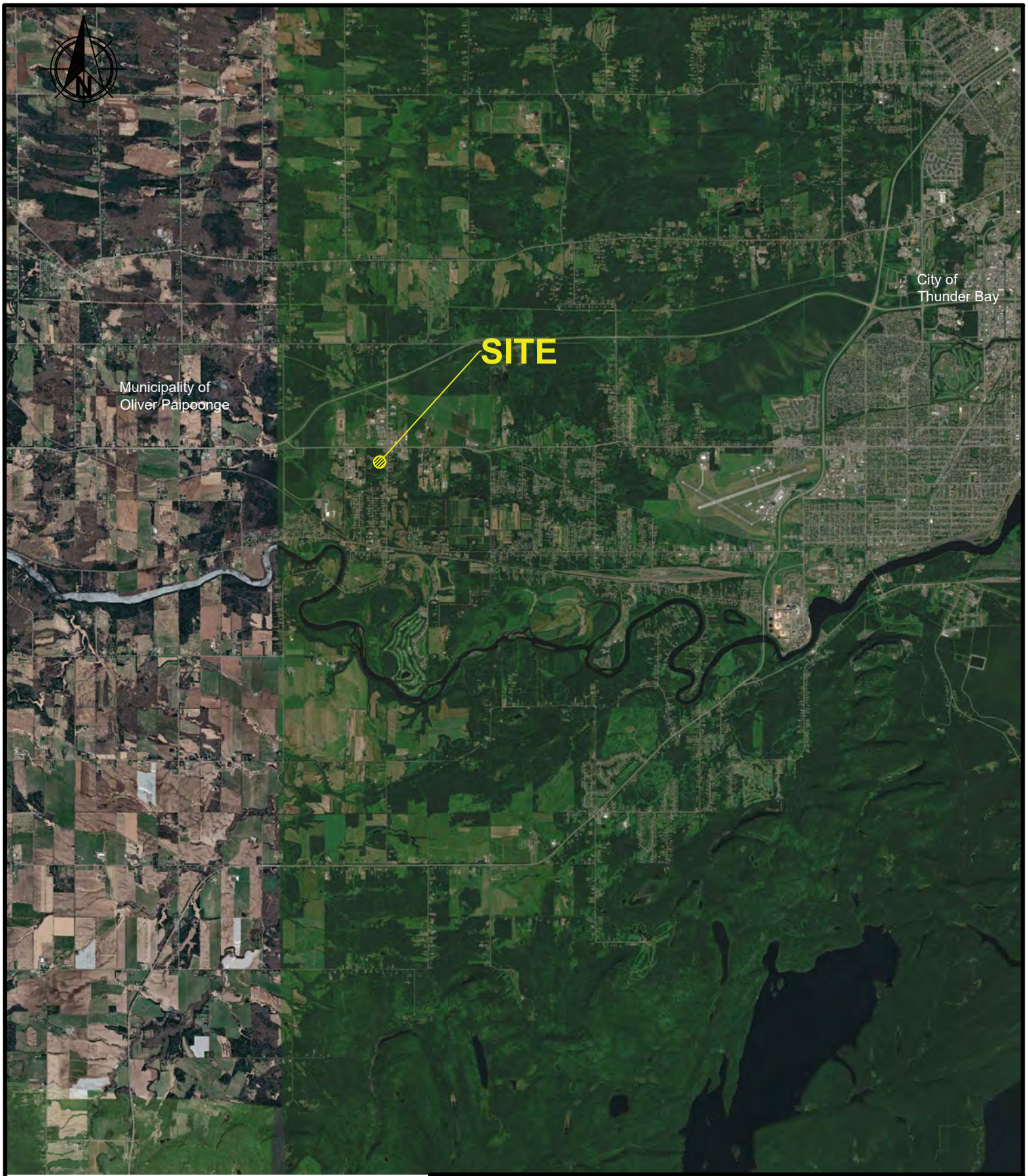
6.0 ALTERNATE REPORT FORMAT

When EXP submits both electronic file and hard copies of reports, drawings and other documents and deliverables (EXP's instruments of professional service), the Client agrees that only the signed and sealed hard copy versions shall be considered final and legally binding. The hard copy versions submitted by EXP shall be the original documents for record and working purposes, and, in the event of a dispute or discrepancy, the hard copy versions shall govern over the electronic versions. Furthermore, the Client agrees and waives all future right of dispute that the original hard copy signed version archived by EXP shall be deemed to be the overall original for the Project.

The Client agrees that both electronic file and hard copy versions of EXP's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except EXP. The Client warrants that EXP's instruments of professional service will be used only and exactly as submitted by EXP.

The Client recognizes and agrees that electronic files submitted by EXP have been prepared and submitted using specific software and hardware systems. EXP makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

Appendix B – Figures



NOTES:
1) Reference: Google Earth Satellite Imagery (2021).
2) Site boundary is approximate

100 0 100 200
IN METERS

exp.

Thunder Bay, Ontario

Figure 1

SITE PLAN

Geotechnical Investigation
Proposed Seniors' Housing Development
HWY 130, Oliver Paipoonge, ON
James Collie c/o Northco Group

PROJECT NO.:	THB-23005042-A0
SCALE:	1:10,000
DRAWN BY:	KM
CHECKED BY:	AM
DATE:	September 29, 2023

AREAS OF PROPERTY	SQ. M.	ACRES
BLOCK 1	17,614	4.35
BLOCK 2	21,610	5.34
BLOCK 3	20,778	5.14
BLOCK 4	22,156	5.48
BLOCK 5	22,265	5.50
GREEN SPACE	11,746	2.90
TOTAL	116,169	28.71
FUTURE GREEN SPACE	23,949	5.92
TOTAL WITH FUTURE GREEN SPACE	140,118	34.63

NOTES:

1) Reference: Base Map, including proposed development, block locations/sizes and green space areas, were prepared by Approach Design Architecture and Interiors, and produced on September 22, 2023.
2) Site Boundary is approximate.
3) Borehole/monitoring well locations were measured by EXP personnel on May 16, 2023, using a handheld GPS unit. The ground surface elevations were surveyed by Delta Survey Inc. on September 26, 2023; elevations are geodetic.

LEGEND:

MW1 Monitoring Well Location
221.29 Ground Surface Elevation (m)

SWP1 Surface Water Point Location
215.60 Top of Water Elevation (m)

20 0 20 40
IN METERS

exp. Thunder Bay, Ontario

FIGURE 2

MONITORING WELL LOCATION PLAN AND PROPOSED DEVELOPMENT

Geotechnical Investigation
Proposed Seniors' Housing Development
Highway 130, Oliver Paipoonge, ON
James Collie c/o Northco Group

PROJECT NO.:	THB-23005042-A0
SCALE:	1:2,000
DRAWN BY:	KM
CHECKED BY:	AM
DATE:	September 29, 2023

AREAS OF PROPERTY	SQ. M.	ACRES
BLOCK 1	17,614	4.35
BLOCK 2	21,610	5.34
BLOCK 3	20,778	5.14
BLOCK 4	22,156	5.48
BLOCK 5	22,265	5.50
GREEN SPACE	11,746	2.90
TOTAL	116,169	28.71
FUTURE GREEN SPACE	23,949	5.92
TOTAL WITH FUTURE GREEN SPACE	140,118	34.63

NOTES:

1) Reference: Base Map, including proposed development, block locations/sizes and green space areas, were prepared by Approach Design Architecture and Interiors, and produced on September 22, 2023.
2) Site Boundary is approximate.
3) Borehole/monitoring well locations were measured by EXP personnel on May 16, 2023, using a handheld GPS unit. The ground surface elevations were surveyed by Delta Survey Inc. on September 26, 2023; elevations are geodetic.

LEGEND:

- 216.00 — Groundwater Contour Elevation (m)
- MW1 / 221.29 / [219.40] — Monitoring Well Location; Ground Surface Elevation (m); Groundwater Elevation (m) - September 8, 2023
- SWP1 / 215.60 — Surface Water Point Location; Top of Water Elevation (m)

20 0 20 40 IN METERS

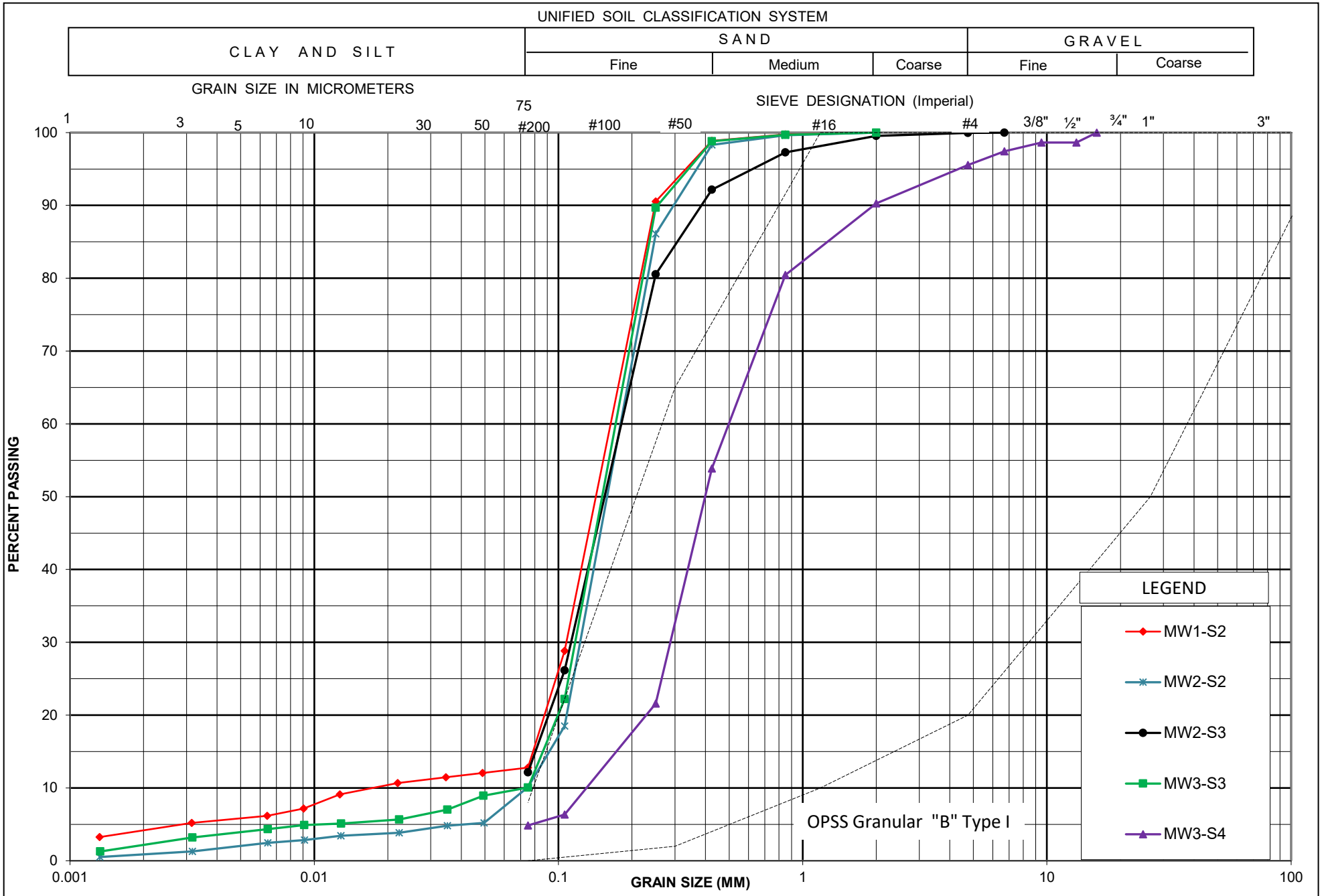
exp. Thunder Bay, Ontario

GROUNDWATER CONTOUR ELEVATION PLAN

Geotechnical Investigation
Proposed Seniors' Housing Development
Highway 130, Oliver Paipoonge, ON
James Collie c/o Northco Group

FIGURE 3

PROJECT NO.:	THB-23005042-A0
SCALE:	1:2,000
DRAWN BY:	KM
CHECKED BY:	AM
DATE:	September 29, 2023

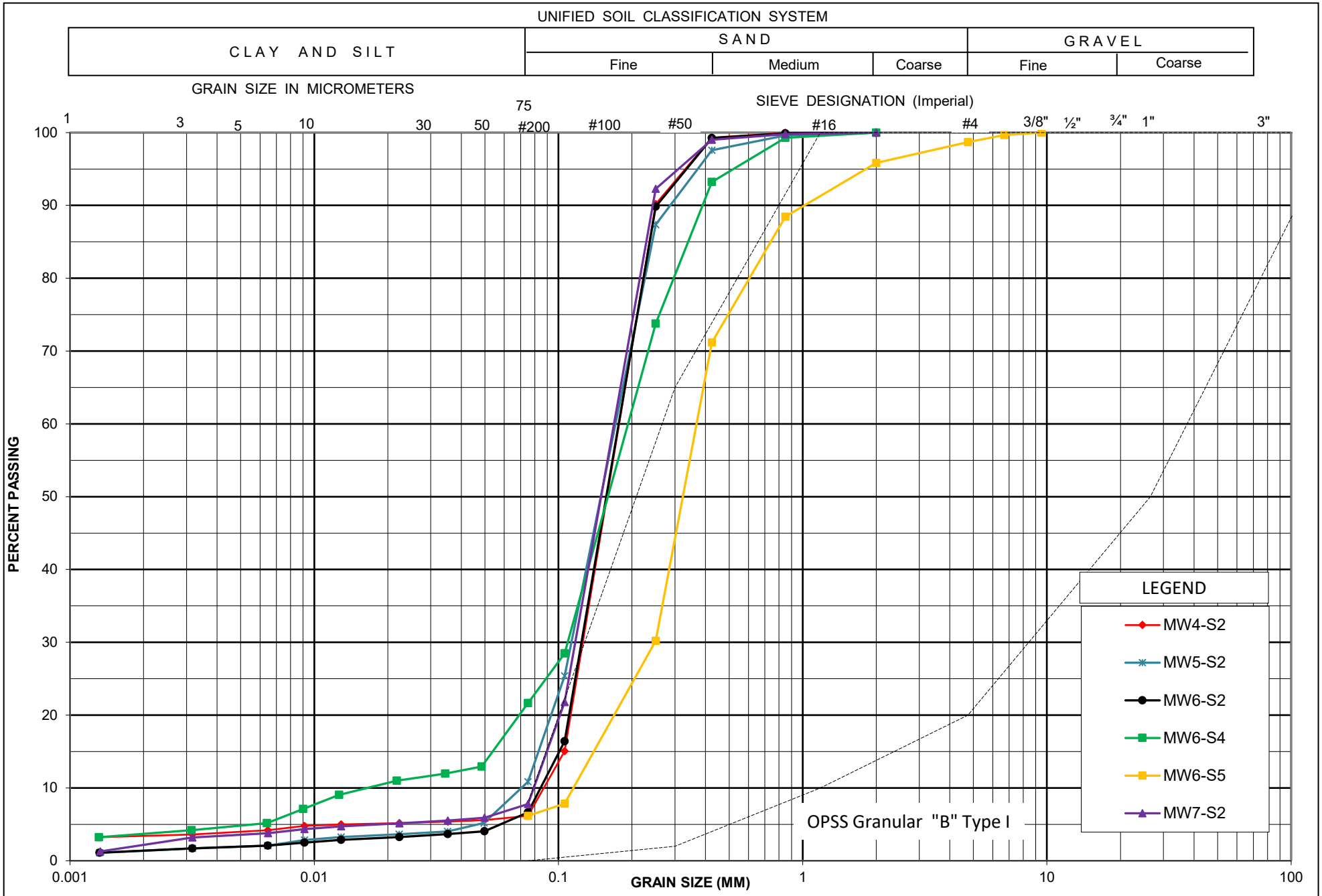


exp.

GRAIN SIZE DISTRIBUTION - MW1 to MW3

Proposed Seniors' Housing Development
Southwest of Hwy 130 & Arthur St. West Intersection, Oliver Paipoonge, ON

FIGURE No. 4
Ref. No. THB-23005042-A0
DATE September 29, 2023



exp.

GRAIN SIZE DISTRIBUTION - MW4 to MW7

Proposed Seniors' Housing Development
Southwest of Hwy 130 & Arthur St. West Intersection, Oliver Paipoonge, ON

FIGURE No. 5
Ref. No. THB-23005042-A0
DATE September 29, 2023

Appendix C – Borehole / Monitoring Well Logs and MECP Well Records

SYMBOLS AND TERMS USED ON THE BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Behavioural properties (i.e. plasticity, permeability) take precedence over particle gradation in describing soils.

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or slit and clay
Well Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Uniformly Graded	-	predominantly of one grain size.

Terminology used for describing soil strata based upon the proportion of individual particle sizes present:

Trace, or occasional	less than 10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. silt and sand)	35-50%

The standard terminology to describe cohesionless soils includes the relative density, as determined by laboratory test or by the Standard Penetration Test 'N' – value: the number of blows of 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sample one foot (305mm) into the soil.

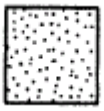
Relative Density	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Strength		'N' Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25-0.5	12.5-25	2-4
Firm	0.5-1.0	25-50	4-8
Stiff	1.0-2.0	50-100	8-15
Very Stiff	2.0-4.0	100-200	15-30
Hard	>4.0	>200	>30

STRATA PLOT


Gravel & Boulders

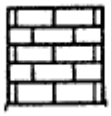

Sand


Silt


Clay


Fill

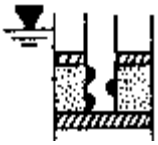

Igneous Bedrock


Sedimentary Bedrock


Metamorphic Bedrock

WATER LEVEL MEASUREMENT


Borehole or Standpipe


Piezometer

SAMPLES

SS…	Split spoon sample (obtained by performing the standard penetration test)
ST…	Shelby tube or thin wall tube
PS…	Piston sample
BS…	Bulk sample
WS…	Wash sample
RC…	Rock core AXT, BXL. etc… Rock core samples obtained with the use of standard diamond drilling bits.

OTHER TESTS

G…	Specific gravity
H…	Hydrometer analysis
S…	Sieve analysis
γ	Unit weight
C….	Consolidation
CD…	Consolidated drained triaxial
CU…	Consolidated undrained triaxial with pore pressure measurements
UU…	Unconsolidated undrained triaxial
DS…	Direct shear
P….	Field permeability

ROCK DESCRIPTION

The description of bedrock is based on the rock quality designation (RQD). The classification is based on a modified core recovery percentage in which all pieces of sound core over 100mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. In most cases RQD is run on NXL core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from normal insitu fractures.

RQD	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

exp Thunder Bay Branch

BOREHOLE LOG

MW1

Sheet 1 of 1

PROJECT **Proposed Seniors' Housing Development, Hwy 130, Oliver Paipoonge, ON** PROJECT NO. **THB-23005042-A0**

CLIENT **James Collie c/o Northco Group** DATUM **Geodetic**

DRILL TYPE/METHOD **CME 750 Rubber Tire/HSA** DATES: Boring **May 16, 2023** Water Level **June 13/23**

DEPTH (m)	ELEVATION (m) 221.29	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)	OTHER TESTS	SHEAR STRENGTH / Atterberg Limits and Moisture
0		**SAND** - loose to compact, dark brown, moist, trace to some silt, trace to some organics in upper 0.3 m			SS	S1A	130	2		
					SS	S1B	300	4		
		- becoming brown, wet at about 0.8 m depth								
1					SS	S2	510	10	H	
					SS	S3	560	13		
2										
					SS	S4	510	6		
3		- becoming grey to brown at about 3.1 m depth								
					SS	S5	560	2		
4					SS	S6	610	4		
5					SS	S7	610	2		
6										
	214.58				SS	S8	610	8		
7		**End of Borehole**								
8										

SHEAR STRENGTH
S Field Vane Test (#=Sensitivity)
Penetrometer Torvane
40 80 kPa
Atterberg Limits and Moisture
W_P W W_L
SPT N Value Dynamic Cone
20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

2) GPS coordinates in UTM NAD83 16 U 321049E 5361181N.

3) 50 mm PVC monitoring well installed on May 16, 2023, screened from about 0.6 m to 3.7 m below ground surface. Top of pipe elevation is 222.19 m.

SAMPLE LEGEND
AS Auger Sample SS Split Spoon ST Shelby Tube
Rock Core (eg. BQ, NQ, etc.) VN Vane Sample

OTHER TESTS
G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS
Apparent Measured Artesian (see Notes)

exp Thunder Bay Branch

BOREHOLE LOG

MW2

Sheet 1 of 1

PROJECT **Proposed Seniors' Housing Development, Hwy 130, Oliver Paipoonge, ON** PROJECT NO. **THB-23005042-A0**

CLIENT **James Collie c/o Northco Group** DATUM **Geodetic**

DRILL TYPE/METHOD **CME 750 Rubber Tire/HSA** DATES: Boring **May 15, 2023** Water Level **June 13/23**

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)	OTHER TESTS
0	221.20	**SAND** - loose to compact, light brown, moist, trace gravel, trace to some silt, trace organics in upper 0.8 m			SS	S1	300	8	
		- becoming brown, wet at about 0.8 m depth							
1					SS	S2	460	12	H
					SS	S3	460	15	S
2		- some silt to silty from about 2.3 m to 4.6 m depth			SS	S4	610	11	
3		- sand blow-up in augers at about 3.0 m depth			SS	S5	610	6	
4									
					SS	S6A	360	5	
5		- becoming dark grey at about 4.9 m depth			SS	S6B	250	7	
6									
	214.49				SS	S7	380	8	
7		**End of Borehole**							
8									

SHEAR STRENGTH

S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane

40 80 kPa

Atterberg Limits and Moisture

W_P W W_L

● SPT N Value × Dynamic Cone

20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

2) GPS coordinates in UTM NAD83 16 U 320910E 5361186N.

3) 50 mm PVC monitoring well installed on May 15, 2023, screened from about 1.5 m to 3.7 m below ground surface. Top of pipe elevation is 222.12 m.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube

▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

exp Thunder Bay Branch

BOREHOLE LOG

MW3

Sheet 1 of 1

PROJECT **Proposed Seniors' Housing Development, Hwy 130, Oliver Paipoonge, ON** PROJECT NO. **THB-23005042-A0**

CLIENT **James Collie c/o Northco Group** DATUM **Geodetic**

DRILL TYPE/METHOD **CME 750 Rubber Tire/HSA** DATES: Boring **May 15, 2023** Water Level **June 13/23**

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)	OTHER TESTS	SHEAR STRENGTH / Atterberg Limits and Moisture
0	221.42	**SAND** - loose to compact, brown, wet, trace to some silt, trace organics in upper 1.5 m			SS	S1	250	6		
1					SS	S2	510	13		
		- becoming wet at about 1.5 m depth			SS	S3	460	12	H	
2					SS	S4	560	15	S	
3					SS	S5	610	7		
4					SS	S6	610	3		
5					SS	S7	560	8		
6					SS	S8	610	5		
	214.71									
7		**End of Borehole**								
8										

SHEAR STRENGTH: ✚ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane; 40 80 kPa

Atterberg Limits and Moisture: W_P W W_L

● SPT N Value × Dynamic Cone; 20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

2) GPS coordinates in UTM NAD83 16 U 320780E 5361162N.

3) 50 mm PVC monitoring well installed on May 15, 2023, screened from about 0.9 m to 3.7 m below ground surface. Top of pipe elevation is 222.31 m.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube

▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

exp. Thunder Bay Branch

BOREHOLE LOG

MW4

Sheet 1 of 1

PROJECT **Proposed Seniors' Housing Development, Hwy 130, Oliver Paipoonge, ON** PROJECT NO. **THB-23005042-A0**

CLIENT **James Collie c/o Northco Group** DATUM **Geodetic**

DRILL TYPE/METHOD **CME 750 Rubber Tire/HSA** DATES: Boring **May 16, 2023** Water Level **June 13/23**

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)	OTHER TESTS
0	221.29	**SAND** - very loose to loose, brown, moist, trace to some silt, trace organics in upper 0.8 m			SS	S1	460	3	
1					SS	S2	610	9	H
		- becoming compact, wet at about 1.5 m depth			SS	S3	530	14	
2									
		- becoming dark brown at about 2.3 m depth			SS	S4	360	15	
3									
		- interbedded clayey silt seams from about 3.1 m to 6.1 m depth			SS	S5	510	4	
4									
5					SS	S6	560	6	
6									
		- becoming dark brown to grey at about 6.1 m depth			SS	S7	610	3	
	214.58								
7		**End of Borehole**							
8									

SHEAR STRENGTH
✤ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
40 80 kPa

Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

2) GPS coordinates in UTM NAD83 16 U 320860E 5361075N.

3) 50 mm PVC monitoring well installed on May 16, 2023, screened from about 1.5 m to 4.6 m below ground surface. Top of pipe elevation is 222.24 m.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS
G Specific Gravity
H Hydrometer
S Sieve Analysis
γ Unit Weight
P Field Permeability
K Lab Permeability
C Consolidation
CD Consolidated Drained Triaxial
CU Consolidated Undrained Triaxial
UU Unconsolidated Undrained Triaxial
UC Unconfined Compression
DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

exp. Thunder Bay Branch

BOREHOLE LOG

MW5

Sheet 1 of 1

PROJECT **Proposed Seniors' Housing Development, Hwy 130, Oliver Paipoonge, ON** PROJECT NO. **THB-23005042-A0**

CLIENT **James Collie c/o Northco Group** DATUM **Geodetic**

DRILL TYPE/METHOD **CME 750 Rubber Tire/HSA** DATES: Boring **May 15, 2023** Water Level **June 13/23**

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)	OTHER TESTS	SHEAR STRENGTH / Atterberg Limits and Moisture
0	221.18	**SAND** - loose to compact, brown, moist, trace to some silt, trace organics in upper 0.8 m			SS	S1	560	7		
1					SS	S2	510	14	H	
2					SS	S3	460	16		
		- becoming wet at about 2.3 m depth			SS	S4	460	16		
3					SS	S5	610	10		
4										
5					SS	S6	610	5		
6										
	214.47				SS	S7	610	1		
7		**End of Borehole**								
8										

SHEAR STRENGTH
S Field Vane Test (#=Sensitivity)
Penetrometer Torvane
40 80 kPa

Atterberg Limits and Moisture
W_P W W_L
SPT N Value Dynamic Cone
20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

2) GPS coordinates in UTM NAD83 16 U 320770E 5361025N.

3) 50 mm PVC monitoring well installed on May 15, 2023, screened from about 1.5 m to 4.6 m below ground surface. Top of pipe elevation is 222.17 m.

SAMPLE LEGEND
AS Auger Sample SS Split Spoon ST Shelby Tube
Rock Core (eg. BQ, NQ, etc.) VN Vane Sample

OTHER TESTS
G Specific Gravity C Consolidation
H Hydrometer CD Consolidated Drained Triaxial
S Sieve Analysis CU Consolidated Undrained Triaxial
γ Unit Weight UU Unconsolidated Undrained Triaxial
P Field Permeability UC Unconfined Compression
K Lab Permeability DS Direct Shear

WATER LEVELS
Apparent Measured Artesian (see Notes)

exp Thunder Bay Branch

BOREHOLE LOG

MW6

Sheet 1 of 1

PROJECT **Proposed Seniors' Housing Development, Hwy 130, Oliver Paipoonge, ON** PROJECT NO. **THB-23005042-A0**

CLIENT **James Collie c/o Northco Group** DATUM **Geodetic**

DRILL TYPE/METHOD **CME 750 Rubber Tire/HSA** DATES: Boring **May 16, 2023** Water Level **June 13/23**

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)	OTHER TESTS	SHEAR STRENGTH / Atterberg Limits and Moisture
0	221.37	**SAND** - loose to compact, brown, moist, trace to some silt, trace organics in upper 0.8 m			SS	S1	300	5		
1					SS	S2	510	9	H	
		- becoming wet at about 1.5 m depth			SS	S3	510	15		
2										
		- interbedded clayey silt seams at about 2.3 m depth			SS	S4	610	12	H	
3					SS	S5	560	13	S	
4					SS	S6	610	7		
5					SS	S7	610	7		
6										
					SS	S8	610	5		
	214.66									
7		**End of Borehole**								
8										

SHEAR STRENGTH: ✚ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane; 40 80 kPa

Atterberg Limits and Moisture: W_P W W_L

● SPT N Value × Dynamic Cone; 20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

2) GPS coordinates in UTM NAD83 16 U 320917E 5361020N.

3) 50 mm PVC monitoring well installed on May 16, 2023, screened from about 1.5 m to 4.6 m below ground surface. Top of pipe elevation is 222.31 m.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube

▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

exp Thunder Bay Branch

BOREHOLE LOG

MW7

Sheet 1 of 1

PROJECT **Proposed Seniors' Housing Development, Hwy 130, Oliver Paipoonge, ON** PROJECT NO. **THB-23005042-A0**

CLIENT **James Collie c/o Northco Group** DATUM **Geodetic**

DRILL TYPE/METHOD **CME 750 Rubber Tire/HSA** DATES: Boring **May 15, 2023** Water Level **June 13/23**

DEPTH (m)	ELEVATION (m) 221.82	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)	OTHER TESTS	SHEAR STRENGTH / Atterberg Limits and Moisture
0		**SAND** - loose to compact, brown, moist, trace to some silt, trace organics in upper 0.8 m			SS	S1	250	9		
		- becoming wet at about 0.8 m depth			SS	S2	300	12	H	
1					SS	S3	350	13		
2					SS	S4	610	12		
3		- sand blow-up in augers at about 3.0 m depth			SS	S5	510	8		
		- becoming grey to brown at about 3.8 m depth			SS	S6	510	4		
4					SS	S7	510	4		
5										
6					SS	S8	580	9		
	215.11									
7		**End of Borehole**								
8										

SHEAR STRENGTH: ✤ S Field Vane Test (#=Sensitivity) ▲ Penetrometer ■ Torvane; 40 80 kPa

Atterberg Limits and Moisture: W_P W W_L

● SPT N Value × Dynamic Cone; 20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

2) GPS coordinates in UTM NAD83 16 U 320799E 5361235N.

3) 50 mm PVC monitoring well installed on May 15, 2023, screened from about 0.9 m to 3.7 m below ground surface. Top of pipe elevation is 222.80 m.

SAMPLE LEGEND

☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube

▯ Rock Core (eg. BQ, NQ, etc.) ▯ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS

▽ Apparent ▼ Measured ▲ Artesian (see Notes)

Ontario — Ministry of the Environment, Conservation and Parks

Well Tag No. (Place Sticker and/or Print Below): A371096

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 2

Measurements recorded in: ☑ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
~~Cottie~~ James	~~James~~ Collie		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1001 William St.	ThunderBay	ON	P7B6M1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Hwy 130			

County/District/Municipality	City/Town/Village	Province	Postal Code
	ThunderBay	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 8 3	16	321648	5361176		

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
	Brown Fine Sand	Some Silt		0	3.0
	Grey Fine Medium Sand	Trace Silt		3.0	3.7
			MW #1 Stick Up 0.9		

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	0.6	Bentonite Chips	0.02
0.6	3.7	Well Sand	0.09

Method of Construction

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

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.0	Plastic	0.5	0	0.6

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.0	Plastic	#10	0.6	3.7

Status of Well

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

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water: Fresh / Untested / Other, specify
1.4	☐	
	☐	
	☐	

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	3.7	20.0

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ____ hrs + ____ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min/GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min/GPM)

Well production (l/min/GPM)

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

See attached site plan

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Maple Leaf Drilling Ltd	7012

Business Address (Street Number/Name)	Municipality
605 Hewitson St	ThunderBay

Province	Postal Code	Business E-mail Address
ON	P7B5N5	office@mapleleafdrilling

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
2042243084	Raynak Peter

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2389		2023/05/29

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

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 2023/05/16

Ministry Use Only

Audit No. Z403090

Received

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Ministry's Copy

Ontario — Ministry of the Environment, Conservation and Parks

Measurements recorded in: ☑ Metric ☐ Imperial

Well Tag No. (Place Sticker and/or Print Below) A328591

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 2

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
~~Gott~~ James	Callie		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1001 William St	Thunder Bay	ON	P7B 6M1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Hwy 130			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Thunder Bay	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	16	320908	5361190		

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Fine Sand	Some Silt		0	3.1
Grey	Fine Sand	Some Silt		3.1	3.8
			MW #2		
			Stick Up 0.9		

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	1.2	Bentonite Chips	0.04
1.2	3.8	Well Sand	0.08

Method of Construction

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

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.0	Plastic	0.5	0	1.5

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.0	Plastic	#10	1.5	3.8

Status of Well

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

Water Details

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

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	3.8	20.3

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ____ hrs + ____ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min/GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min/GPM)

Well production (l/min/GPM)

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

See attached site plan

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Maple Leaf Drilling Ltd	7022

Business Address (Street Number/Name)	Municipality	Province	Postal Code	Business E-mail Address
605 Hewitson St	Thunder Bay	ON	P7B 5N5	

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)	Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2042243084	Raynak Peter	2389		2023/05/29

Well owner's information package delivered ☐ Yes ☐ No

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 2023/05/15

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Audit No. Z403088

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Well Tag No. (Place Sticker and/or Print Below): A371098

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 2

Measurements recorded in: ☑ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
James	Collie		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1001 William St	Thunder Bay	ON	P7B 6M1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Hwy 130			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Thunder Bay	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	16	320780	5361163		

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Fine Sand	Some Silt		0	1.5
Brown	Fine Medium Sand	Trace Silt		1.5	3.0
Grey	Fine Coarse Sand	Trace Silt		3.0	3.7
			MW 3		
			Stick Up 0.9		

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	0.6	Bentonite Chips	0.02
0.6	3.7	Well Sand	0.09

Method of Construction

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

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.0	Plastic	0.5	0	0.6

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.0	Plastic	#10	0.6	3.7

Status of Well

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

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water: Fresh / Untested / Other, specify
1.8	☐	
	☐	
	☐	

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	3.7	20.3

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ____ hrs + ____ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min/GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min/GPM)

Well production (l/min/GPM)

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

See attached site plan

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Maple Leaf Drilling Ltd	7022

Business Address (Street Number/Name)	Municipality	Province	Postal Code	Business E-mail Address
605 Hewitson St	Thunder Bay	ON	P7B 5V5	

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)	Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2042243084	Raynak Peter	2389		2023/05/29

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

Date Package Delivered: YYYY/MM/DD

Date Work Completed: 2023/05/15

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Well Tag No. (Place Sticker and/or Print Below): A371093

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 2

Measurements recorded in: ☑ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
James	Callie		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1001 Williams St	Thunder Bay	ON	P7B6M1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Hwy 130			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Thunder Bay	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	16	320851	5361075		

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Fine Sand	some Silt		0	3.0
Grey	Fine Medium Sand	Trace Silt		3.0	3.8
Grey	Clayey Silt			3.8	4.6
			MW #4		
			Stick Up 0.9		

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	1.2	Bentonite Chips	0.03
1.2	4.6	Well Sand	0.08

Method of Construction

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

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.0	Plastic	0.5	0	1.5

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.0	Plastic	#10	1.5	4.6

Status of Well

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

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water: Fresh / Untested / Other, specify
1.2	☐	
	☐	
	☐	

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	4.6	20.0

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ____ hrs + ____ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min/GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min/GPM)

Well production (l/min/GPM)

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

See attached site plan

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Maple Leaf Drilling Ltd	7022

Business Address (Street Number/Name)	Municipality	Province	Postal Code	Business E-mail Address
605 Hewitson St	Thunder Bay	ON	P7B5V5	office@mapleleafdrilling.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)	Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2042243084	Raynak Peter	2389		2023/05/29

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No		2023/05/11

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Ontario — Ministry of the Environment, Conservation and Parks

Well Tag No. (Place Sticker and/or Print Below): A371097

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 2

Measurements recorded in: ☑ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
James	Collie		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1001 ~~James~~ William St	Thunder Bay	ON	P7B 6M1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
~~E~~ Hwy 130			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Thunder Bay	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	16	320770	5361025		

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Fine Sand	Trace Silt		0	1.5
Grey	Fine Medium Sand	Some Silt		1.5	4.6
			MW 5 Stick Up 0.9		

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0	1.2	Bentonite Chips	0.04
1.2	4.6	Well Sand	0.10

Method of Construction

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

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.0	Plastic	0.5	0	1.5

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.0	Plastic	#10	1.5	4.6

Status of Well

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

Water Details

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

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	4.6	20.3

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ____ hrs + ____ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min/GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min/GPM)

Well production (l/min/GPM)

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

See attached site plan

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
MapleLeaf Drilling Ltd	7012

Business Address (Street Number/Name)	Municipality	Province	Postal Code	Business E-mail Address
605 Hewitson St	Thunder Bay	ON	P7B 5V5	

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
2042243084	Raynak Peter

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2389		2023/05/29

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

Date Package Delivered: YYYY/MM/DD

Date Work Completed: 2023/05/25

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Well Tag No. (Place Sticker and/or Print Below) A371095

Well Record

Regulation 903 Ontario Water Resources Act

Measurements recorded in: [x] Metric [ ] Imperial

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	[ ] Well Constructed by Well Owner
James	Collie		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1001 ~~James~~ William St	Thunder Bay	ON	P7B 6M1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Hwy 130			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Thunder Bay	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 8 3	16	320516	5361012		

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Fine Sand	Some Silt		0	4.6
			MW#6		
			Stick Up 0.9		

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	1.2	Bentonite Chips	0.03
1.2	4.6	Well Sand	0.08

Method of Construction

[ ] Cable Tool [ ] Diamond
[ ] Rotary (Conventional) [ ] Jetting
[ ] Rotary (Reverse) [ ] Driving
[x] Boring [ ] Digging
[ ] Air percussion
[ ] Other, specify

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.0	Plastic	0.5	0	1.5

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.0	Plastic	#10	1.5	4.6

Status of Well

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

Water Details

Water found at Depth (m/ft)	Gas	Kind of Water: Fresh / Untested / Other, specify
2.7	[ ]	
	[ ]	
	[ ]	

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0	4.6	20.0

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
Maple Leaf Drilling Ltd	7012

Business Address (Street Number/Name)	Municipality
605 Hewitson St	Thunder Bay

Province	Postal Code	Business E-mail Address
ON	P7B 5N5	office@mapleleafdrilling.ca

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
2044243084	Raynak Peter

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2389		2023/05/29

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ____ hrs + ____ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min/GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min/GPM)

Well production (l/min/GPM)

Disinfected? [ ] Yes [ ] No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

See attached site plan

Comments:

Well owner's information package delivered: [ ] Yes [ ] No

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 2023/05/16

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Well Tag No. (Place Sticker and/or Print Below): A371092

Well Record

Regulation 903 Ontario Water Resources Act

Measurements recorded in: ☑ Metric ☐ Imperial

Well Owner's Information

First Name	Last Name/Organization	E-mail Address	☐ Well Constructed by Well Owner
James	Collie		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
1001 William St	Thunder Bay	ON	P7B6M1	

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
Hwy 130			

County/District/Municipality	City/Town/Village	Province	Postal Code
	Thunder Bay	Ontario	

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	16	320802	5361235		

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	Depth (m/ft) To
Brown	Fine Sand	Some Silt		0	1.5
Grey Brown	Fine Medium Sand	Trace Silt		1.5	3.7
			MW 7 Stick Up 0.9		

Annular Space

Depth Set at (m/ft) From	Depth Set at (m/ft) To	Type of Sealant Used (Material and Type)	Volume Placed (m^3/ft^3)
0	0.6	Bentonite Chips	0.02
0.6	3.7	Well Sand	0.09

Method of Construction

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

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	Depth (m/ft) To
5.0	Plastic	0.5	0	0.6

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	Depth (m/ft) To
6.0	Plastic	#10	0.6	3.7

Status of Well

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

Water Details

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

Hole Diameter

Depth (m/ft) From	Depth (m/ft) To	Diameter (cm/in)
0	3.7	20.3

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft)

Pumping rate (l/min / GPM)

Duration of pumping ____ hrs + ____ min

Final water level end of pumping (m/ft)

If flowing give rate (l/min/GPM)

Recommended pump depth (m/ft)

Recommended pump rate (l/min/GPM)

Well production (l/min/GPM)

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.

See attached site plan

Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
MapleLeaf Drilling Ltd	7012

Business Address (Street Number/Name)	Municipality	Province	Postal Code	Business E-mail Address
605 Hewitson St	Thunder Bay	ON	P7B5N5	

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
2042243084	Raynak Peter

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
2389		2023/05/29

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

Date Package Delivered: Y Y Y Y M M D D

Date Work Completed: 2023/05/15

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Audit No. Z403087

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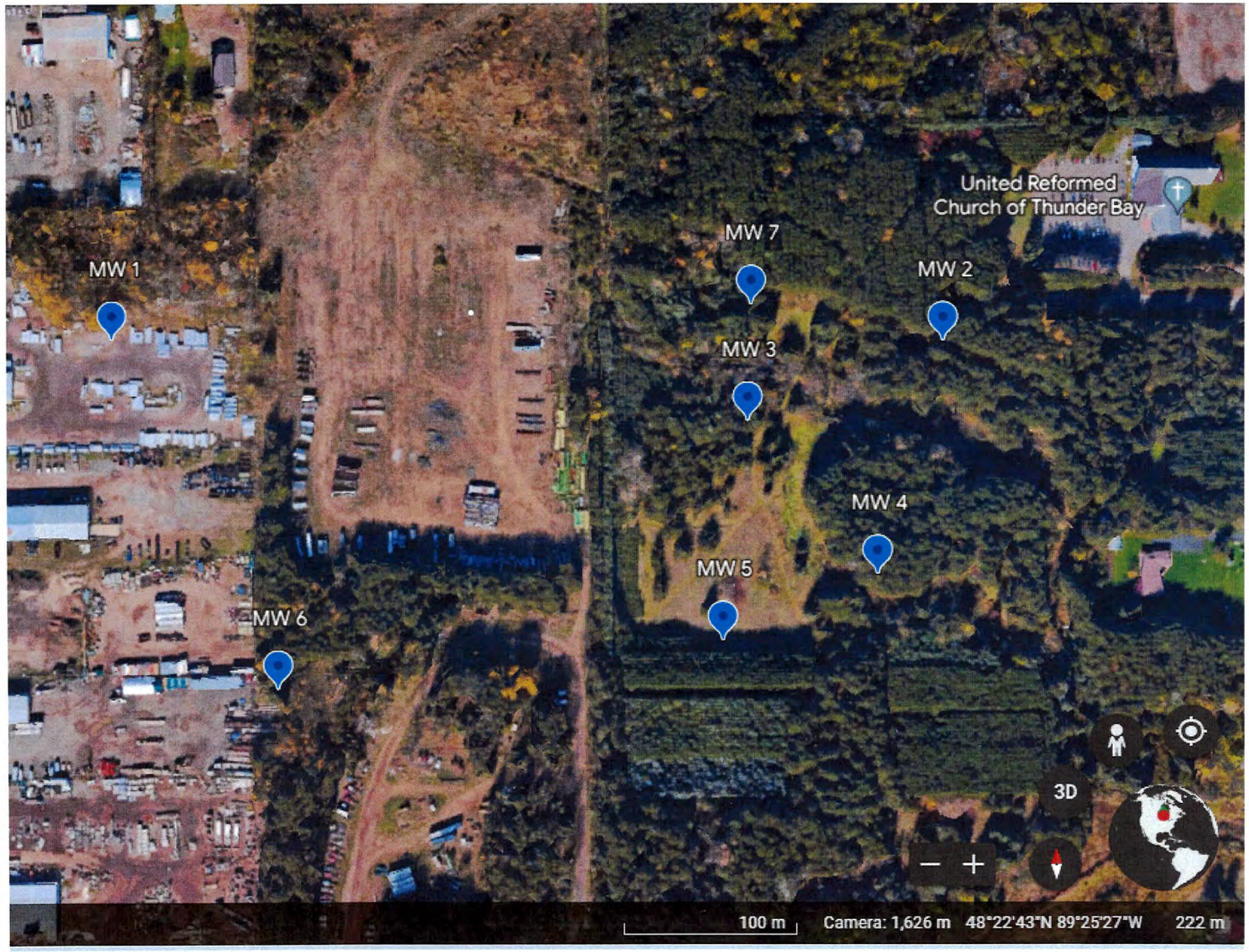
United Reformed
Church of Thunder Bay
MW 7
MW 2
MW 1
MW 3
MW 4
MW 5
MW 6
3D
100 m
Camera: 1,626 m 48°22'43"N 89°25'27"W 222 m

Appendix D –
Laboratory Reports of Analysis

Your Project #: THB-23005042-A0
Site Location: PROPOSED SENIORS SUBD, OLIVER PAIPOONGE
Your C.O.C. #: 938143-01-01

Attention: Ahileas Mitsopoulos

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
CANADA P7B 5M4

Report Date: 2023/06/09
Report #: R7665029
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3G3527
Received: 2023/06/06, 12:57

Sample Matrix: Water
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Nitrate & Nitrite as Nitrogen in Water (1)	8	N/A	2023/06/08	CAM SOP-00440	SM 23 4500-NO3I/NO2B
Total Phosphorus (Colourimetric)	8	2023/06/08	2023/06/09	CAM SOP-00407	SM 23 4500-P I

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCCFP, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
(1) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Bureau Veritas 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvna.com

Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Your Project #: THB-23005042-A0
Site Location: PROPOSED SENIORS SUBD, OLIVER PAIPOONGE
Your C.O.C. #: 938143-01-01

Attention: Ahileas Mitsopoulos

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
CANADA P7B 5M4

Report Date: 2023/06/09
Report #: R7665029
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3G3527
Received: 2023/06/06, 12:57

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Julie Clement, Technical Account Manager
Email: Julie.CLEMENT@bureauveritas.com
Phone# (613)868-6079

==========

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Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.

Bureau Veritas Job #: C3G3527
Report Date: 2023/06/09

exp Services Inc
Client Project #: THB-23005042-A0
Site Location: PROPOSED SENIORS SUBD, OLIVER PAIPOONGE
Sampler Initials: KM

RESULTS OF ANALYSES OF WATER

Bureau Veritas ID			WAI347	WAI348	WAI349	WAI350	WAI351	WAI352		
Sampling Date			2023/06/05 12:30	2023/06/05 11:30	2023/06/05 01:35	2023/06/05 03:15	2023/06/05 02:00	2023/06/05 02:40		
COC Number			938143-01-01	938143-01-01	938143-01-01	938143-01-01	938143-01-01	938143-01-01		
	UNITS	**MAC**	**MW1**	**MW2**	**MW3**	**MW4**	**MW5**	**MW6**	**RDL**	**QC Batch**
Inorganics										
Total Phosphorus	mg/L	-	1.2	1.6	1.3	1.1	0.77	0.84	0.004	8713490
Nitrite (N)	mg/L	**1**	<0.010	<0.010	<0.010	<0.010	0.011	<0.010	0.010	8712388
Nitrate (N)	mg/L	**10**	8.60	0.42	0.66	0.43	0.60	0.25	0.10	8712388
Nitrate + Nitrite (N)	mg/L	**10**	8.60	0.42	0.66	0.43	0.61	0.25	0.10	8712388

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
MAC: Ontario Drinking Water Standards - Maximum Acceptable Concentration [MAC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

Bureau Veritas ID			WAI353	WAI354		
Sampling Date			2023/06/05 01:00	2023/06/05 11:10		
COC Number			938143-01-01	938143-01-01		
	UNITS	**MAC**	**MW7**	**MW8**	**RDL**	**QC Batch**
Inorganics						
Total Phosphorus	mg/L	-	2.0	1.9	0.004	8713490
Nitrite (N)	mg/L	**1**	<0.010	<0.010	0.010	8712388
Nitrate (N)	mg/L	**10**	1.36	1.37	0.10	8712388
Nitrate + Nitrite (N)	mg/L	**10**	1.36	1.37	0.10	8712388

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
MAC: Ontario Drinking Water Standards - Maximum Acceptable Concentration [MAC] & Table 4-Chemical/Physical Objectives [A/O] - Not Health Related, respectively
(Made under the Ontario Safe Drinking Water Act, 2002)

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Bureau Veritas Job #: C3G3527
Report Date: 2023/06/09

exp Services Inc
Client Project #: THB-23005042-A0
Site Location: PROPOSED SENIORS SUBD, OLIVER PAIPOONGE
Sampler Initials: KM

TEST SUMMARY

Bureau Veritas ID: WAI347 **Collected:** 2023/06/05
Sample ID: MW1 **Shipped:**
Matrix: Water **Received:** 2023/06/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8712388	N/A	2023/06/08	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8713490	2023/06/08	2023/06/09	Sachi Patel

Bureau Veritas ID: WAI348 **Collected:** 2023/06/05
Sample ID: MW2 **Shipped:**
Matrix: Water **Received:** 2023/06/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8712388	N/A	2023/06/08	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8713490	2023/06/08	2023/06/09	Sachi Patel

Bureau Veritas ID: WAI349 **Collected:** 2023/06/05
Sample ID: MW3 **Shipped:**
Matrix: Water **Received:** 2023/06/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8712388	N/A	2023/06/08	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8713490	2023/06/08	2023/06/09	Sachi Patel

Bureau Veritas ID: WAI350 **Collected:** 2023/06/05
Sample ID: MW4 **Shipped:**
Matrix: Water **Received:** 2023/06/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8712388	N/A	2023/06/08	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8713490	2023/06/08	2023/06/09	Sachi Patel

Bureau Veritas ID: WAI351 **Collected:** 2023/06/05
Sample ID: MW5 **Shipped:**
Matrix: Water **Received:** 2023/06/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8712388	N/A	2023/06/08	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8713490	2023/06/08	2023/06/09	Sachi Patel

Bureau Veritas ID: WAI352 **Collected:** 2023/06/05
Sample ID: MW6 **Shipped:**
Matrix: Water **Received:** 2023/06/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8712388	N/A	2023/06/08	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8713490	2023/06/08	2023/06/09	Sachi Patel

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Bureau Veritas Job #: C3G3527
Report Date: 2023/06/09

exp Services Inc
Client Project #: THB-23005042-A0
Site Location: PROPOSED SENIORS SUBD, OLIVER PAIPOONGE
Sampler Initials: KM

TEST SUMMARY

Bureau Veritas ID: WAI353
Sample ID: MW7
Matrix: Water

Collected: 2023/06/05
Shipped:
Received: 2023/06/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8712388	N/A	2023/06/08	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8713490	2023/06/08	2023/06/09	Sachi Patel

Bureau Veritas ID: WAI354
Sample ID: MW8
Matrix: Water

Collected: 2023/06/05
Shipped:
Received: 2023/06/06

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8712388	N/A	2023/06/08	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8713490	2023/06/08	2023/06/09	Sachi Patel

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	4.0°C

Results relate only to the items tested.

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Bureau Veritas Job #: C3G3527
Report Date: 2023/06/09

QUALITY ASSURANCE REPORT

exp Services Inc
Client Project #: THB-23005042-A0
Site Location: PROPOSED SENIORS SUBD, OLIVER PAIPOONGE
Sampler Initials: KM

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
8712388	Nitrate (N)	2023/06/08	98	80 - 120	101	80 - 120	<0.10	mg/L	NC	20		
8712388	Nitrite (N)	2023/06/08	101	80 - 120	103	80 - 120	<0.010	mg/L	NC	20		
8713490	Total Phosphorus	2023/06/09	92	80 - 120	98	80 - 120	<0.004	mg/L	2.9	20	98	80 - 120

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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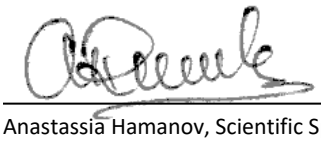
Bureau Veritas Job #: C3G3527
Report Date: 2023/06/09

exp Services Inc
Client Project #: THB-23005042-A0
Site Location: PROPOSED SENIORS SUBD, OLIVER PAIPOONGE
Sampler Initials: KM

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



Anastassia Hamanov, Scientific Specialist

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Page 1 of 1

CHAIN OF CUSTODY RECORD

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#17501 exp Services Inc	Company Name:	EXP	Quotation #:	C20328	Bureau Veritas Job #:	Bottle Order #: 938143
Attention:	Accounts Payable	Attention:	Kristin MN, Ahileas Mitsopoulos	P.O. #:			
Address:	1142 Roland St Thunder Bay ON P7B 5M4	Address:	Kristin.mclean-munn@exp.com	Project:	23005042-40	COC #: C#938143-01-01	Project Manager: Julie Clement
Tel:	(807) 623-9495 Fax: (807) 623-8070	Tel:	Fax:	Project Name:	Proposed Seniors Subd.		
Email:	AP@exp.com	Email: cc	ahileas.mitsopoulos@exp.com	Site #:	Oliver Paipoonge		
				Sampled By:	RM		

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
- ☐ Table 1 ☐ Res/Park ☐ Medium/Fine
- ☐ Table 2 ☐ Ind/Comm ☐ Coarse
- ☐ Table 3 ☐ Agri/Other ☐ For RSC
- ☐ Table ___

Other Regulations
- ☐ CCME ☐ Sanitary Sewer Bylaw
- ☐ Reg 558 ☐ Storm Sewer Bylaw
- ☐ MISA Municipality ___
- ☐ PWQO ☐ Reg 406 Table ___
- ☒ Other ODWS

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: X
(will be applied if Rush TAT is not specified)
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___ ☐
Rush Confirmation Number: ___ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Nitrate & Nitrite as Nitrogen in Water	Total Phosphorus (Colourimetric)	# of Bottles	Comments
1		MW1	06/05/23	12:30	GW		X	X	2	06-Jun-23 12:57
2		MW2	06/05/23	11:30	GW		X	X	2	Julie Clement
3		MW3	06/05/23	1:35	GW		X	X	2	C3G3527
4		MW4	06/05/23	3:15	GW		X	X	2	RJM ENV-1303
5		MW5	06/05/23	2:00	GW		X	X	2	
6		MW6	06/05/23	2:40	GW		X	X	2	
7		MW7	06/05/23	1:00	GW		X	X	2	Rec'd In Thunder Bay
8		MW8	06/05/23	11:10	GW		X	X	2	
9										Custody Seal Present (Yes) Intact (No)
10										Cooling Media (Yes) No

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
KristinMclean-Munn	23/06/06	2:00	Sherrie Bramwell	2023/06/06	12:57	
			FAST PRABJOT	23/06/07	09:13	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	4.3,5	Present	2	
		Intact	2	

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/CHAIN-CUSTODY-FORMS-COCS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

White: Bureau Veritas Yellow: Client

1/0/0

Bureau Veritas Canada (2019) Inc.

Your Project #: 23005042-AO
Site Location: OLIVER PAIPOONGE/PROPOSED SENIORS SUBD
Your C.O.C. #: 939319-01-01

Attention: Ahileas Mitsopoulos

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
CANADA P7B 5M4

Report Date: 2023/06/20
Report #: R7680497
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3H4068
Received: 2023/06/14, 14:18

Sample Matrix: Water
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Nitrate & Nitrite as Nitrogen in Water (1)	8	N/A	2023/06/19	CAM SOP-00440	SM 23 4500-NO3I/NO2B
Total Phosphorus (Colourimetric)	8	2023/06/19	2023/06/20	CAM SOP-00407	SM 23 4500-P I

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCCFP, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
(1) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Your Project #: 23005042-AO
Site Location: OLIVER PAIPOONGE/PROPOSED SENIORS SUBD
Your C.O.C. #: 939319-01-01

Attention: Ahileas Mitsopoulos

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
CANADA P7B 5M4

Report Date: 2023/06/20
Report #: R7680497
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3H4068
Received: 2023/06/14, 14:18

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Julie Clement, Technical Account Manager
Email: Julie.CLEMENT@bureauveritas.com
Phone# (613)868-6079

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Bureau Veritas Job #: C3H4068
Report Date: 2023/06/20

exp Services Inc
Client Project #: 23005042-AO
Site Location: OLIVER PAIPOONGE/PROPOSED SENIORS SUBD
Sampler Initials: KM

RESULTS OF ANALYSES OF WATER

Bureau Veritas ID		WCN803		WCN804		WCN805	WCN806	WCN807		
Sampling Date		2023/06/13 02:00		2023/06/13 01:35		2023/06/13 02:55	2023/06/13 03:55	2023/06/13 03:30		
COC Number		939319-01-01		939319-01-01		939319-01-01	939319-01-01	939319-01-01		
	UNITS	**MW1**	**QC Batch**	**MW2**	**QC Batch**	**MW3**	**MW4**	**MW5**	**RDL**	**QC Batch**
Inorganics										
Total Phosphorus	mg/L	1.4	8736826	2.8	8736826	1.5	2.0	4.1	0.004	8736826
Nitrite (N)	mg/L	<0.010	8733576	<0.010	8733814	<0.010	<0.010	<0.010	0.010	8733576
Nitrate (N)	mg/L	9.73	8733576	0.58	8733814	5.15	0.68	0.86	0.10	8733576
Nitrate + Nitrite (N)	mg/L	9.73	8733576	0.58	8733814	5.15	0.68	0.86	0.10	8733576

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Bureau Veritas ID		WCN808			WCN808			WCN809	WCN810		
Sampling Date		2023/06/13 04:30			2023/06/13 04:30			2023/06/13 02:30	2023/06/13 12:30		
COC Number		939319-01-01			939319-01-01			939319-01-01	939319-01-01		
	UNITS	**MW6**	**RDL**	**QC Batch**	**MW6 Lab-Dup**	**RDL**	**QC Batch**	**MW7**	**MW8**	**RDL**	**QC Batch**
Inorganics											
Total Phosphorus	mg/L	3.1	0.004	8736826				2.8	1.4	0.004	8736826
Nitrite (N)	mg/L	<0.010	0.010	8733814	<0.010	0.010	8733814	<0.010	<0.010	0.010	8733576
Nitrate (N)	mg/L	0.32	0.10	8733814	0.32	0.10	8733814	1.34	9.67	0.10	8733576
Nitrate + Nitrite (N)	mg/L	0.32	0.10	8733814	0.32	0.10	8733814	1.34	9.67	0.10	8733576

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.bvna.com

Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Bureau Veritas Job #: C3H4068
Report Date: 2023/06/20

exp Services Inc
Client Project #: 23005042-AO
Site Location: OLIVER PAIPOONGE/PROPOSED SENIORS SUBD
Sampler Initials: KM

TEST SUMMARY

Bureau Veritas ID: WCN803 **Collected:** 2023/06/13
Sample ID: MW1 **Shipped:**
Matrix: Water **Received:** 2023/06/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8733576	N/A	2023/06/19	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8736826	2023/06/19	2023/06/20	Sachi Patel

Bureau Veritas ID: WCN804 **Collected:** 2023/06/13
Sample ID: MW2 **Shipped:**
Matrix: Water **Received:** 2023/06/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8733814	N/A	2023/06/19	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8736826	2023/06/19	2023/06/20	Sachi Patel

Bureau Veritas ID: WCN805 **Collected:** 2023/06/13
Sample ID: MW3 **Shipped:**
Matrix: Water **Received:** 2023/06/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8733576	N/A	2023/06/19	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8736826	2023/06/19	2023/06/20	Sachi Patel

Bureau Veritas ID: WCN806 **Collected:** 2023/06/13
Sample ID: MW4 **Shipped:**
Matrix: Water **Received:** 2023/06/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8733576	N/A	2023/06/19	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8736826	2023/06/19	2023/06/20	Sachi Patel

Bureau Veritas ID: WCN807 **Collected:** 2023/06/13
Sample ID: MW5 **Shipped:**
Matrix: Water **Received:** 2023/06/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8733576	N/A	2023/06/19	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8736826	2023/06/19	2023/06/20	Sachi Patel

Bureau Veritas ID: WCN808 **Collected:** 2023/06/13
Sample ID: MW6 **Shipped:**
Matrix: Water **Received:** 2023/06/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8733814	N/A	2023/06/19	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8736826	2023/06/19	2023/06/20	Sachi Patel

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Bureau Veritas Job #: C3H4068
Report Date: 2023/06/20

exp Services Inc
Client Project #: 23005042-AO
Site Location: OLIVER PAIPOONGE/PROPOSED SENIORS SUBD
Sampler Initials: KM

TEST SUMMARY

Bureau Veritas ID: WCN808 Dup
Sample ID: MW6
Matrix: Water

Collected: 2023/06/13
Shipped:
Received: 2023/06/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8733814	N/A	2023/06/19	Chandra Nandlal

Bureau Veritas ID: WCN809
Sample ID: MW7
Matrix: Water

Collected: 2023/06/13
Shipped:
Received: 2023/06/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8733576	N/A	2023/06/19	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8736826	2023/06/19	2023/06/20	Sachi Patel

Bureau Veritas ID: WCN810
Sample ID: MW8
Matrix: Water

Collected: 2023/06/13
Shipped:
Received: 2023/06/14

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8733576	N/A	2023/06/19	Chandra Nandlal
Total Phosphorus (Colourimetric)	SKAL/P	8736826	2023/06/19	2023/06/20	Sachi Patel

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Bureau Veritas Job #: C3H4068
Report Date: 2023/06/20

exp Services Inc
Client Project #: 23005042-AO
Site Location: OLIVER PAIPOONGE/PROPOSED SENIORS SUBD
Sampler Initials: KM

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	5.7°C

Results relate only to the items tested.

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Bureau Veritas Job #: C3H4068
Report Date: 2023/06/20

QUALITY ASSURANCE REPORT

exp Services Inc
Client Project #: 23005042-AO
Site Location: OLIVER PAIPOONGE/PROPOSED SENIORS SUBD
Sampler Initials: KM

			Matrix Spike		SPIKED BLANK		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits	% Recovery	QC Limits
8733576	Nitrate (N)	2023/06/19	97	80 - 120	97	80 - 120	<0.10	mg/L	0.43	20		
8733576	Nitrite (N)	2023/06/19	99	80 - 120	98	80 - 120	<0.010	mg/L	NC	20		
8733814	Nitrate (N)	2023/06/19	98	80 - 120	99	80 - 120	<0.10	mg/L	0.54	20		
8733814	Nitrite (N)	2023/06/19	97	80 - 120	98	80 - 120	<0.010	mg/L	NC	20		
8736826	Total Phosphorus	2023/06/20	93	80 - 120	100	80 - 120	<0.004	mg/L	16	20	98	80 - 120

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

QC Standard: A sample of known concentration prepared by an external agency under stringent conditions. Used as an independent check of method accuracy.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).

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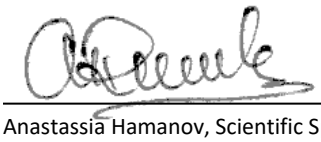
Bureau Veritas Job #: C3H4068
Report Date: 2023/06/20

exp Services Inc
Client Project #: 23005042-AO
Site Location: OLIVER PAIPOONGE/PROPOSED SENIORS SUBD
Sampler Initials: KM

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



Anastassia Hamanov, Scientific Specialist

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by {0}, {1} responsible for {2} {3} laboratory operations.

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Bureau Veritas
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Page of

CHAIN OF CUSTODY RECORD

INVOICE TO:		REPORT TO:		PROJECT INFORMATION:		Laboratory Use Only:	
Company Name:	#17501 exp Services Inc	Company Name:	EXP	Quotation #:	C20328	Bureau Veritas Job #:	Bottle Order #: 939319
Attention:	Accounts Payable	Attention:	Kristin MN, Ahileas Mitsopoulos	P.O. #:			
Address:	1142 Roland St Thunder Bay ON P7B 5M4	Address:	Kristin.mclean-nunn@exp.com	Project:	23005042-A0	COC #: C#939319-01-01	Project Manager: Julie Clement
Tel:	(807) 623-9495 Fax: (807) 623-8070	Tel:	Fax:	Project Name:	Proposed Seniors Subd.		
Email:	AP@exp.com	Email:	ahileas.mitsopoulos@exp.com	Site #:	Oliver Paipoonge, ON		
				Sampled By:	KM		

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)	Other Regulations	Special Instructions
☐ Table 1 ☐ Res/Park ☐ Medium/Fine ☐ Table 2 ☐ Ind/Comm ☐ Coarse ☐ Table 3 ☐ Agri/Other ☐ For RSC ☐ Table ___	☐ CCME ☐ Sanitary Sewer Bylaw ☐ Reg 558 ☐ Storm Sewer Bylaw ☐ MISA Municipality ___ ☐ PWQO ☐ Reg 406 Table ___ ☒ Other ODWS	

Include Criteria on Certificate of Analysis (Y/N)? ___

Field Filtered (please circle): Metals / Hg / Cr VI

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Nitrate & Nitrite as Nitrogen in Water	Total Phosphorus (Colourimetric)	# of Bottles	Comments
1		MW1	6/13/23	2:00	GW	X	X	2	
2		MW2	6/13/23	1:35	GW	X	X	2	
3		MW3	6/13/23	2:55	GW	X	X	2	
4		MW4	6/13/23	3:55	GW	X	X	2	
5		MW5	6/13/23	3:30	GW	X	X	2	
6		MW6	6/13/23	4:30	GW	X	X	2	
7		MW7	6/13/23	2:30	GW	X	X	2	
8		MW8	6/13/23	12:30	GW	X	X	2	
9									
10									

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: ☒
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___ ☐
Rush Confirmation Number: ___ *(call lab for #)*

14-Jun-23 14:18
Julie Clement
C3H4068
AK0 ENV-622

Rec'd In Thunder Bay

Custody Seal Present Intact (no)
Cooling Media (Yes) No

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
Kristin McLean-Nunn	23/06/14	11:00	Sherwell Sherwell Bramwell	2023/06/14	14:18	
			Ashley Sullivan BSH TPW Sullivan	2023/06/14	09:42	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	4.5.8	Present	✓	
		Intact		

White: Bureau Veritas Yellow: Client

-2/-2/-3

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/CHAIN-CUSTODY-FORMS-COCS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

Bureau Veritas Canada (2019) Inc.

Your Project #: THB-23005042-AO
Site#: OLIVER PAIPOONGE
Site Location: PROPOSED SENIORS SUBDIVISION
Your C.O.C. #: 953076-01-01

Attention: Ahileas Mitsopoulos

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
CANADA P7B 5M4

Report Date: 2023/09/13
Report #: R7810667
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3R9092
Received: 2023/09/11, 12:11

Sample Matrix: Water
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Nitrate & Nitrite as Nitrogen in Water (1)	8	N/A	2023/09/13	CAM SOP-00440	SM 23 4500-NO3I/NO2B

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, MELCCFP, EPA, APHA.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.
Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.
This Certificate shall not be reproduced except in full, without the written approval of the laboratory.
Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
(1) Values for calculated parameters may not appear to add up due to rounding of raw data and significant figures.

Your Project #: THB-23005042-AO
Site#: OLIVER PAIPOONGE
Site Location: PROPOSED SENIORS SUBDIVISION
Your C.O.C. #: 953076-01-01

Attention: Ahileas Mitsopoulos

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
CANADA P7B 5M4

Report Date: 2023/09/13
Report #: R7810667
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C3R9092
Received: 2023/09/11, 12:11

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Julie Clement, Technical Account Manager
Email: Julie.CLEMENT@bureauveritas.com
Phone# (613)868-6079

==========

This report has been generated and distributed using a secure automated process.
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Bureau Veritas Job #: C3R9092
Report Date: 2023/09/13

exp Services Inc
Client Project #: THB-23005042-AO
Site Location: PROPOSED SENIORS SUBDIVISION

RESULTS OF ANALYSES OF WATER

Bureau Veritas ID		WYQ431	WYQ432	WYQ433	WYQ434	WYQ435	WYQ436		
Sampling Date		2023/09/08 10:40	2023/09/08 10:00	2023/09/08 11:45	2023/09/08 12:45	2023/09/08 12:00	2023/09/08 12:25		
COC Number		953076-01-01	953076-01-01	953076-01-01	953076-01-01	953076-01-01	953076-01-01		
	UNITS	**MW1**	**MW2**	**MW3**	**MW4**	**MW5**	**MW6**	**RDL**	**QC Batch**
Inorganics									
Nitrite (N)	mg/L	<0.010	<0.010	0.022	<0.010	<0.010	<0.010	0.010	8912356
Nitrate (N)	mg/L	<0.10	1.77	4.78	<0.10	0.55	1.78	0.10	8912356
Nitrate + Nitrite (N)	mg/L	<0.10	1.77	4.80	<0.10	0.55	1.78	0.10	8912356

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Bureau Veritas ID		WYQ437	WYQ438		
Sampling Date		2023/09/08 11:00	2023/09/08 01:15		
COC Number		953076-01-01	953076-01-01		
	UNITS	**MW7**	**MW8**	**RDL**	**QC Batch**
Inorganics					
Nitrite (N)	mg/L	0.044	0.043	0.010	8912356
Nitrate (N)	mg/L	1.30	1.31	0.10	8912356
Nitrate + Nitrite (N)	mg/L	1.34	1.36	0.10	8912356

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Bureau Veritas Job #: C3R9092
Report Date: 2023/09/13

exp Services Inc
Client Project #: THB-23005042-AO
Site Location: PROPOSED SENIORS SUBDIVISION

TEST SUMMARY

Bureau Veritas ID: WYQ431 **Collected:** 2023/09/08
Sample ID: MW1 **Shipped:**
Matrix: Water **Received:** 2023/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8912356	N/A	2023/09/13	Chandra Nandlal

Bureau Veritas ID: WYQ432 **Collected:** 2023/09/08
Sample ID: MW2 **Shipped:**
Matrix: Water **Received:** 2023/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8912356	N/A	2023/09/13	Chandra Nandlal

Bureau Veritas ID: WYQ433 **Collected:** 2023/09/08
Sample ID: MW3 **Shipped:**
Matrix: Water **Received:** 2023/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8912356	N/A	2023/09/13	Chandra Nandlal

Bureau Veritas ID: WYQ434 **Collected:** 2023/09/08
Sample ID: MW4 **Shipped:**
Matrix: Water **Received:** 2023/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8912356	N/A	2023/09/13	Chandra Nandlal

Bureau Veritas ID: WYQ435 **Collected:** 2023/09/08
Sample ID: MW5 **Shipped:**
Matrix: Water **Received:** 2023/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8912356	N/A	2023/09/13	Chandra Nandlal

Bureau Veritas ID: WYQ436 **Collected:** 2023/09/08
Sample ID: MW6 **Shipped:**
Matrix: Water **Received:** 2023/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8912356	N/A	2023/09/13	Chandra Nandlal

Bureau Veritas ID: WYQ437 **Collected:** 2023/09/08
Sample ID: MW7 **Shipped:**
Matrix: Water **Received:** 2023/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8912356	N/A	2023/09/13	Chandra Nandlal

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

Bureau Veritas Job #: C3R9092
Report Date: 2023/09/13

exp Services Inc
Client Project #: THB-23005042-AO
Site Location: PROPOSED SENIORS SUBDIVISION

TEST SUMMARY

Bureau Veritas ID: WYQ438
Sample ID: MW8
Matrix: Water

Collected: 2023/09/08
Shipped:
Received: 2023/09/11

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Nitrate & Nitrite as Nitrogen in Water	LACH	8912356	N/A	2023/09/13	Chandra Nandlal

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	0.3°C
Package 2	5.0°C

Results relate only to the items tested.

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

QUALITY ASSURANCE REPORT

			Matrix Spike		SPIKED BLANK		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
8912356	Nitrate (N)	2023/09/13	83	80 - 120	99	80 - 120	<0.10	mg/L	2.3	20
8912356	Nitrite (N)	2023/09/13	104	80 - 120	103	80 - 120	<0.010	mg/L	2.3	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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Microbiology testing is conducted at 6660 Campobello Rd. Chemistry testing is conducted at 6740 Campobello Rd.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Cristina Carriere

Cristina Carriere, Senior Scientific Specialist

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NONT-09-035

Page of

INVOICE TO:

Company Name: #17501 exp Services Inc
Attention: Accounts Payable
Address: 1142 Roland St, Thunder Bay ON P7B 5M4
Tel: (807) 623-9495 Fax: (807) 623-8070
Email: AP@exp.com

REPORT TO:

Company Name: EXP
Attention: Ahileas Mitsopoulos
Address:
cc. Kristin.mclean-nunn@exp.com
Tel: Fax:
Email: Ahileas.mitsopoulos@exp.com

PROJECT INFORMATION:

Quotation #: C20328
P.O. #:
Project: THB-23005042 - AO
Project Name: Proposed Senior Subdivision
Site #: Oliver Paipoonge, ON
Sampled By: KM

Only:

Bottle Order #: 953076
COC #: C#953076-01-01
Project Manager: Julie Clement

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)
☐ Table 1 ☐ Res/Park ☐ Medium/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ For RSC
☐ Table ___

Other Regulations
☐ CCME ☐ Sanitary Sewer Bylaw
☐ Reg 558 ☐ Storm Sewer Bylaw
☐ MISA Municipality ___
☐ PWQO ☐ Reg 406 Table ___
☐ Other ___

Special Instructions

Include Criteria on Certificate of Analysis (Y/N)? ___

Field Filtered (please circle): Metals / Hg / Cr VI

ANALYSIS REQUESTED (PLEASE BE SPECIFIC)

Turnaround Time (TAT) Required:
Please provide advance notice for rush projects

Regular (Standard) TAT: X
(will be applied if Rush TAT is not specified):
Standard TAT = 5-7 Working days for most tests.
Please note: Standard TAT for certain tests such as BOD and Dioxins/Furans are > 5 days - contact your Project Manager for details.

Job Specific Rush TAT (if applies to entire submission)
Date Required: ___ Time Required: ___
Rush Confirmation Number: ___ *(call lab for #)*

	Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Nitrate & Nitrite as Nitrogen in Water	# of Bottles	Comments
1		MW1	09/08/23	10:40 AM	GW	X	1	
2		MW2	09/08/23	10:00 AM	GW	X	1	
3		MW3	09/08/23	11:45 AM	GW	X	1	
4		MW4	09/08/23	12:45 PM	GW	X	1	
5		MW5	09/08/23	12:00 PM	GW	X	1	
6		MW6	09/08/23	12:25 PM	GW	X	1	
7		MW7	09/08/23	11:00 AM	GW	X	1	
8		MW8	09/08/23	1:15 PM	GW	X	1	Rec'd In Thunder Bay
9								
10								

Custody Seal Present (Yes) Intact (Yes)
Cooling Media No

* RELINQUISHED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	RECEIVED BY: (Signature/Print)	Date: (YY/MM/DD)	Time	# jars used and not submitted
Kristin Mclean-Nunn	23/09/11	12:00 PM	Bramwell - Sherrie Bramwell	2023/09/11	12:11	
			[illegible]	2023/09/12	10:08	

Laboratory Use Only

Time Sensitive	Temperature (°C) on Recei	Custody Seal	Yes	No
	0,0,1/5,2,2	Present	~	
		Intact		

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COC-TERMS-AND-CONDITIONS.

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** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/CHAIN-CUSTODY-FORMS-COCS.

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

White: Bureau Veritas Yellow: Client

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Appendix E – SepticSmart Booklet

SepticSmart!

Advanced Treatment Systems — Alternatives to Conventional Septic Systems

Booklet Number 2 — AF146

Canada

Ontario

Almost all residents in rural homes depend upon onsite septic systems to treat household wastewater (sewage). The conventional septic system used across Ontario has two main components: a septic tank and a leaching bed. These conventional systems treat wastewater using sand, gravel and native soil. They are soil absorption systems that are economical and easy to maintain (to learn more about conventional septic systems and how they work, see Booklet 1: *Septic Smart! — Understanding Your Home's Septic System).*

In conventional septic systems, 30–50 percent of the wastewater treatment is done in the septic tank and 50–70 percent is done in the soil (ref. *US EPA,* Chapter 4.6.1). Conventional septic systems can perform very well in a variety of soil types and site situations; however, there are properties where conventional septic systems are not suitable. Some properties have inadequate conditions (e.g. heavy clay, shallow soil depth to bedrock, limited space, steep slopes or high water table) for a conventional septic system. In these situations, homeowners may turn to advanced treatment systems.

Advanced treatment systems, although less well known, may offer reliable, approved treatment of household wastewater. The difference with advanced treatment systems is that approximately 90 percent of the wastewater treatment is done in the pre-treatment tank and advanced treatment unit and 10 percent is done in the soil (ref. *US EPA,* Chapter 4.6.1). Cleaner effluent exiting the advanced treatment unit makes the advanced treatment system more versatile than a conventional septic system.

This booklet will help you become familiar with advanced treatment units that provide a higher level of treatment than septic tanks as well as the type of final distribution and soil treatment that could be used with them in Ontario, namely:

1) aerobic treatment units (ATUs);
2) filtration units.

Advanced Treatment Systems: Advantages and Disadvantages

Advantages

- provide the opportunity to service sites not suited for conventional septic systems
- have the potential to remove significantly more bacteria and organic material than a conventional septic system
- may extend the life of an existing leaching bed
- take up less room in the yard
- require mandatory maintenance (ensures the unit is functioning properly)
- may reduce nutrient output (depending on type)

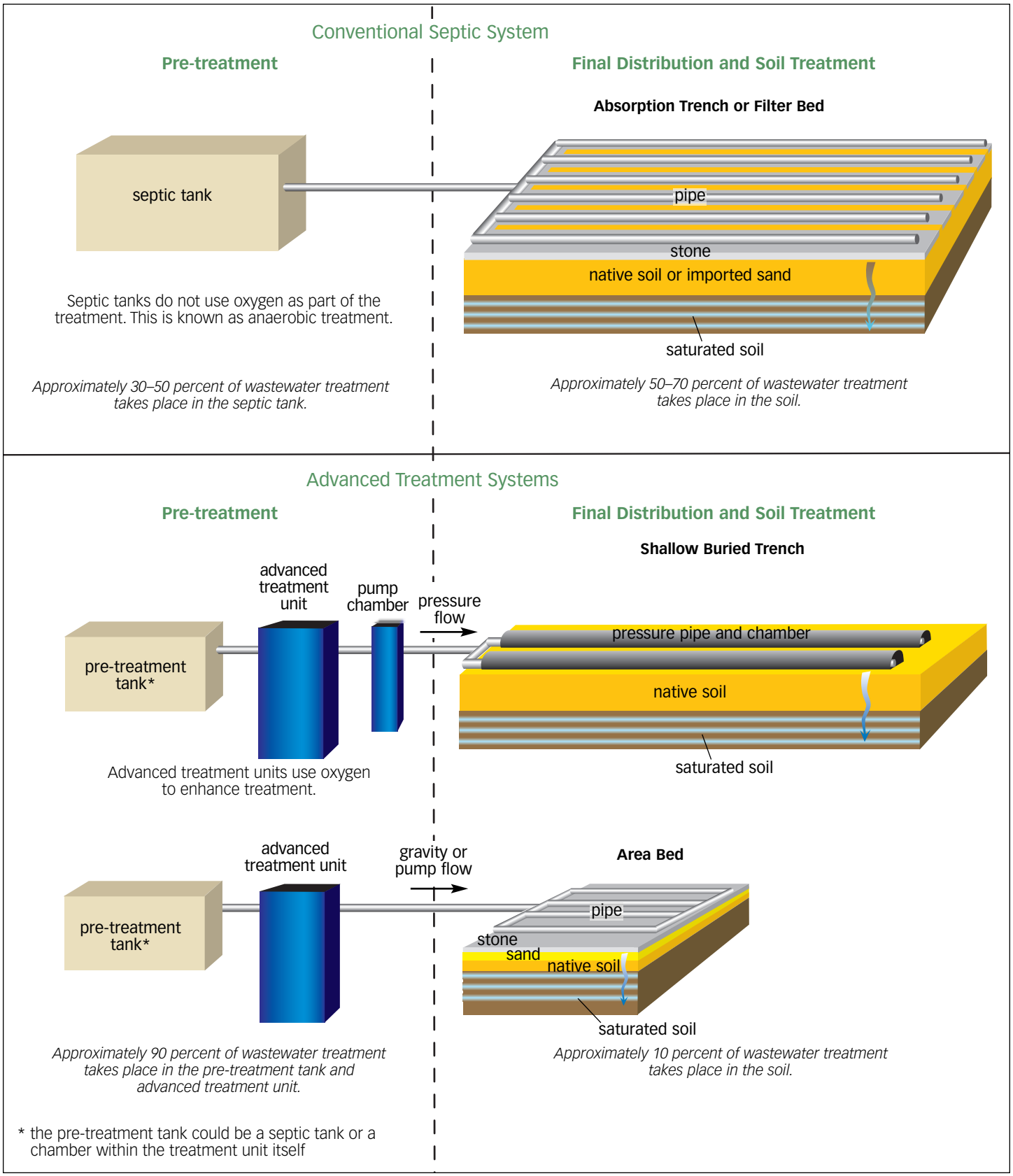
Disadvantages

- may be more expensive to purchase and install depending on site characteristics
- are more expensive to operate than a septic system (e.g. yearly electrical costs, media replacement)
- includes more mechanical parts that can break down or need replacement
- requires mandatory maintenance (increases costs)

Homeowners may want to consider advanced treatment systems when:

- dealing with properties with inadequate conditions for conventional systems
- coping with small lots that can't accommodate the size of a conventional leaching bed
- replacing a failed septic system
- rejuvenating failing conventional leaching beds
- building on hard-to-access properties where finding and/or transporting traditional materials for conventional systems is costly or difficult
- wanting to provide additional protection to groundwater by additional nitrate reduction which some of the treatment units could provide

Comparing Conventional Septic System and Advanced Treatment Systems



1. Aerobic Treatment Units (ATUs)

ATUs treat wastewater by adding air. ATUs inject and circulate air so that oxygen-dependent bacteria can thrive. The bacteria break down organic matter, reduce pathogens and transform nutrients (e.g., ammonia to nitrate).

ATUs receive wastewater from household plumbing fixtures (toilets, showers, sinks, etc). These units often have a pre-treatment tank where the scum and solids are separated and stored before the effluent is passed to an aeration chamber. At the aeration chamber, air is added to the effluent, which allows the bacteria to feed on the contaminants thereby producing cleaner effluent.

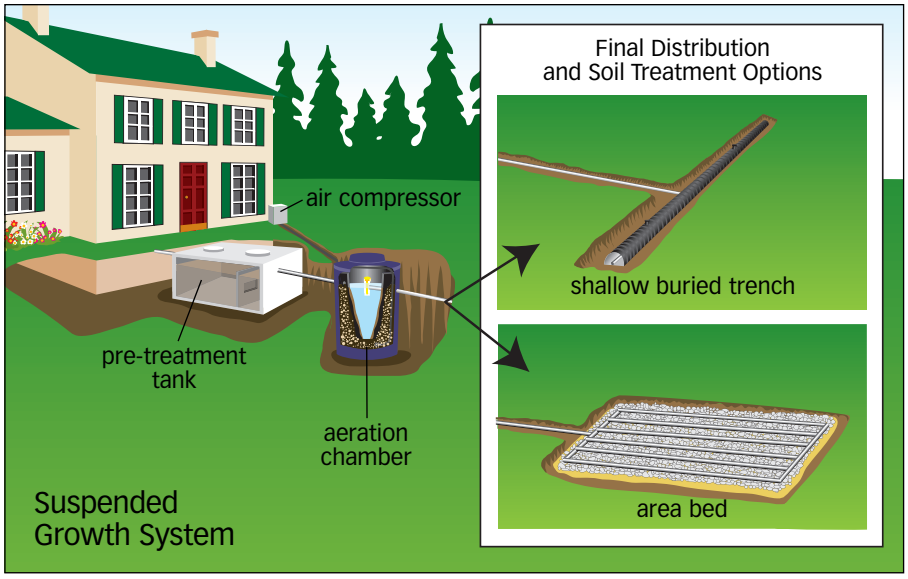
Generally, ATUs are classified based on the status of bacteria in the wastewater within the treatment unit. Bacteria are either suspended in the liquid or attached to some media.

ATUs used in conjunction with an area bed or shallow buried trench are well-suited for replacement systems on mature, landscaped lots with limited space.

Aerobic Treatment Units:

- can be part of a new system, a replacement system or added to an existing conventional system to prolong the life of the leaching bed
- require air compressors and in most cases pumps
- can use an area bed or shallow buried trench for final distribution and treatment
- can be used for residential, communal and commercial applications
- require a maintenance agreement

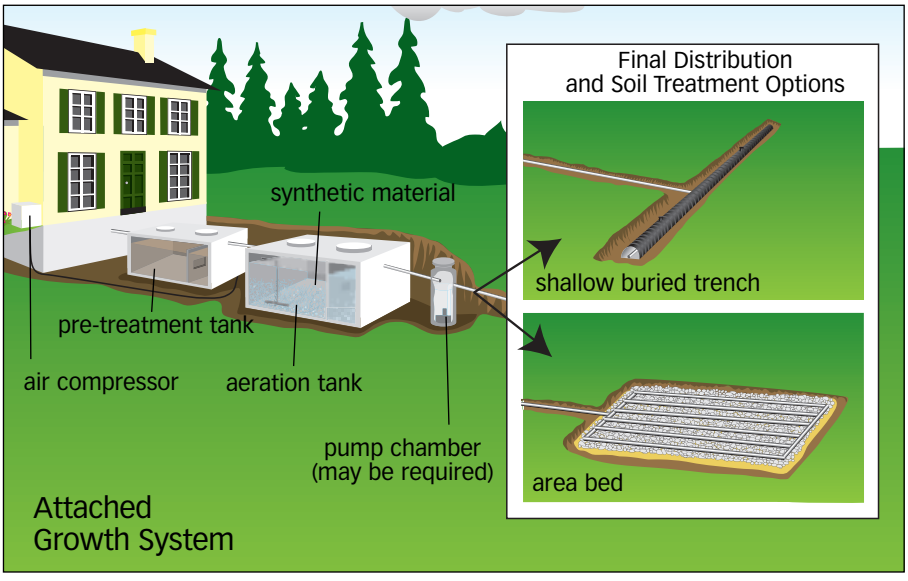
In **suspended growth treatment units,** wastewater flows from the pre-treatment tank into the aeration chamber where an air compressor and air diffuser supply oxygen and mix the liquid waste. The air keeps the bacteria "suspended" or floating in the liquid waste. It does not attach to any surface. The oxygen supports the growth of the bacteria and other micro-organisms that break down the wastewater and solids. The effluent then flows into a shallow buried trench or area bed.

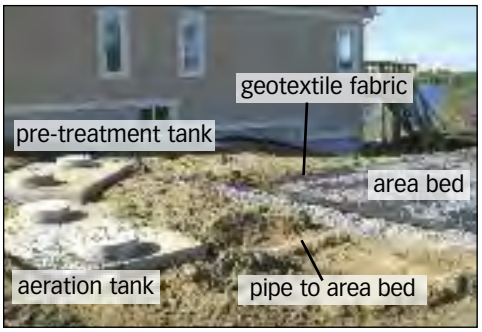


Large sewage design flows may require more than one aeration chamber.

Effluent treated by a suspended growth unit can be distributed back into the native soil through a shallow buried trench or an area bed.

In **attached growth treatment units,** wastewater from the pre-treatment tank flows into an aeration tank that contains pieces of plastic or other synthetic material. Attached growth units rely on oxygen-dependent bacteria to break down wastewater and solids similar to suspended growth units. The difference is that attached growth units let the bacteria attach, grow and thrive on the synthetic material (e.g., plastic shavings, balls, etc.). An air diffuser provides continuous aeration around the synthetic material to enhance bacterial activity and waste treatment. Some attached growth treatment units require an air compressor. The effluent then flows to a shallow buried trench or area bed.



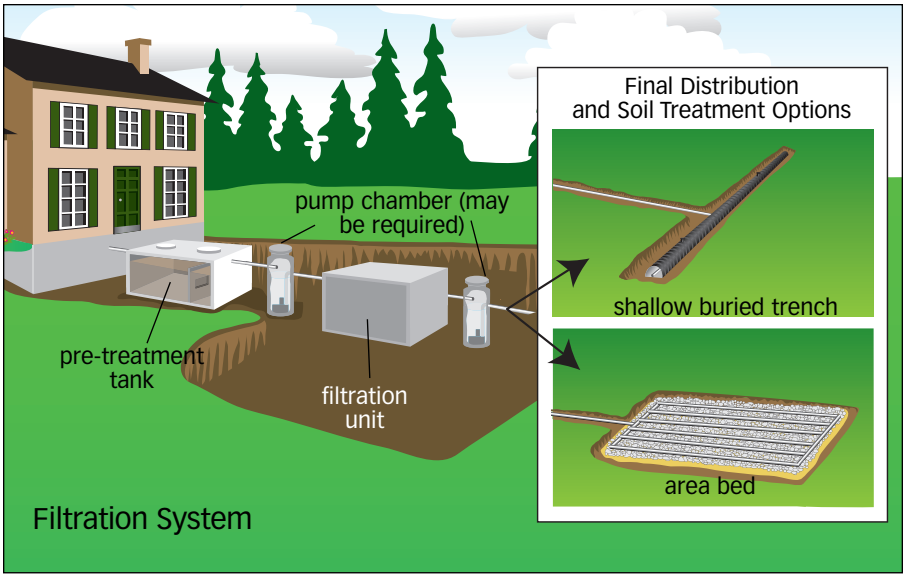


Pre-treatment tank followed by an aeration tank and area bed.

Effluent treated by an attached growth unit can be dispersed back into the native soil through a shallow buried trench or an area bed.

2. Filtration Units

Filtration units utilize trickling filter technology. Wastewater flows from the home to a pre-treatment tank. Wastewater then flows from the pre-treatment tank into the filtration unit that is filled with materials such as peat moss, sand or a synthetic medium. As the wastewater trickles or percolates down through the filtration unit, a bacterial slime grows and thrives. Typically, trapped air fills the voids in the medium and encourages aerobic conditions where bacteria break down the waste as it slowly moves through the filter medium. The effluent then flows to a shallow buried trench or an area bed for final distribution and treatment in the soil.



Effluent from a filtration unit can be distributed back into the native soil through a shallow buried trench or an area bed.

Synthetic media — geotextile sheets.

Synthetic media — foam cubes (top view).

Sand filter.

Peat moss.

Filtration Units:

- can be part of a new system, a replacement system or added to an existing conventional system to prolong the life of the leaching bed
- require pumps for in-ground installation
- can use a shallow buried trench or an area bed for final distribution and treatment
- can be used for residential, communal and commercial applications
- require a maintenance agreement
- require replacement of filter material (peat, sand or synthetic material) approximately every 8 to 15 years

Homeowner Tips

- Always check with the distributor to ensure that your installer is licensed to install their product.
- Always check that the installer has the required qualifications, i.e., Building Code Identification Number (BCIN).
- Put all your approvals, construction information, and pumping, service and maintenance agreements in a safe place.
- Keep accurate and up-to-date records on maintenance, pumping and repairs.
- If selling a property with an advanced treatment system, ensure that the purchaser is aware of maintenance requirements.
- If used seasonally, check with the manufacturer for recommendations on disconnecting the power supply to the air compressor and/or pumps as well as start-up recommendations.
- After a power outage or when restarting a system, ensure the system's components (e.g., pumps, compressors) are functioning.

Care and Maintenance of Your Advanced Treatment Unit

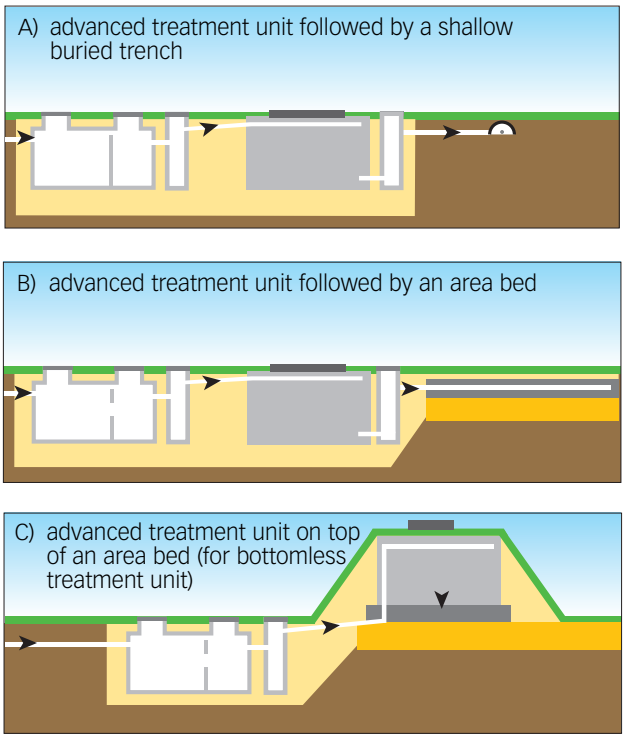
Routine care and maintenance are key elements to the safe and efficient operation of advanced treatment units. These units require more attention and care than conventional septic tanks. **Homeowners with an advanced treatment unit must have a maintenance contract with an authorized representative of the manufacturer of the treatment technology.** Be sure to know precisely who is providing maintenance so that you will feel confident that your maintenance/service agreement will meet regulatory requirements. Maintenance agreements will outline the schedule of the inspection of the treatment unit components as well as the effluent sampling requirements to ensure the system is performing in compliance with the basis upon which it was approved. Following the maintenance requirements and schedules outlined by the manufacturer in the operations manual will ensure that the advanced treatment system operates effectively and efficiently. **All technologies will require some type of regular pre-treatment tank maintenance — removing sludge or replacement/cleaning of filters.**

Regular maintenance will help ensure that small problems won't become larger, resulting in more expensive repairs. For more tips on caring for your septic system, see Booklet Number 1: *Septic Smart! — Understanding Your Home's Septic System.*

Final Distribution and Soil Treatment

Advanced treatment units are very effective in treating wastewater. With cleaner effluent leaving these units, the size of the soil component (leaching bed) that is needed to complete the treatment is smaller than for those using septic tanks only. Advanced treatment units could use one of two small leaching bed systems that are currently approved or authorized in Ontario: shallow buried trench and area bed.

Advanced treatment units can be used with a variety of above ground and in-ground distribution options. They also offer several unique final distribution options.

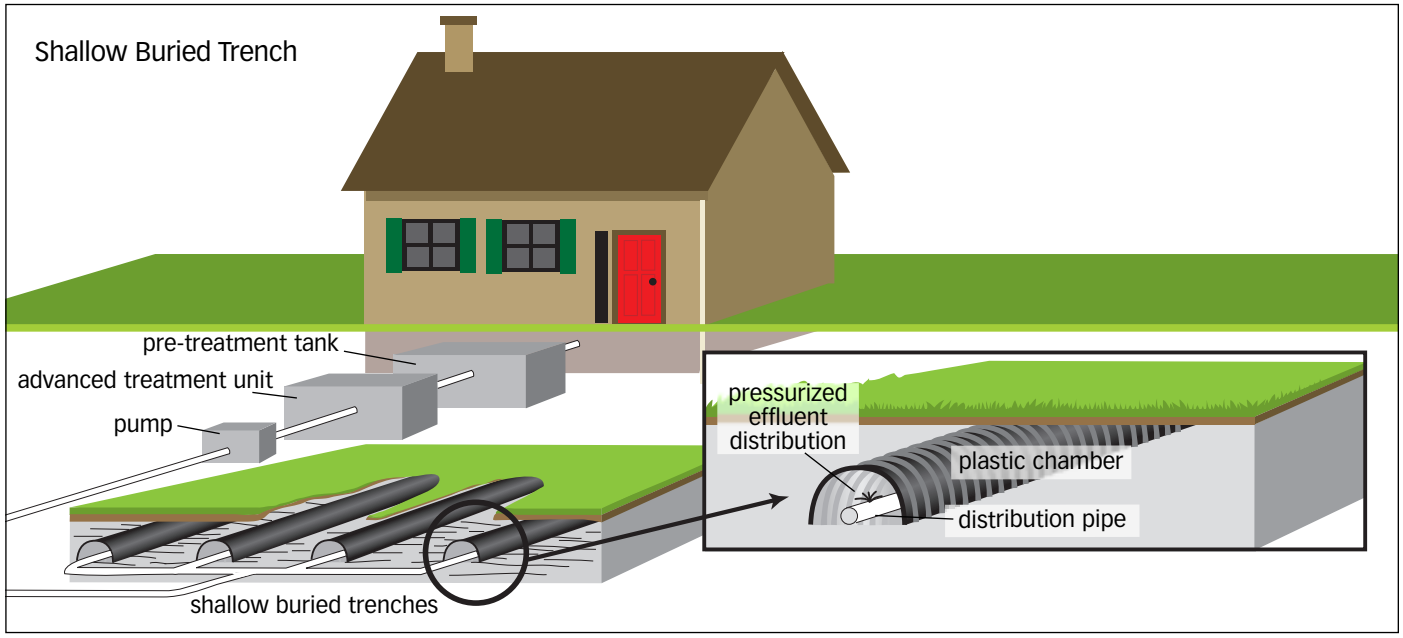


Side views of three distribution and soil treatment options for advanced treatment units.

Shallow Buried Trench

A shallow buried trench consists of small-diameter pipes running through open-bottom plastic chambers. Effluent from the advanced treatment unit is pumped under pressure through distribution pipes at regular intervals (time-dosed). The pressurized piping has small holes on the top that allow for even distribution of the effluent on the soil surface under the plastic chamber. This pressurized distribution allows for small doses to be evenly distributed along the entire length of the trench. This greatly enhances the soil's ability to receive and treat the effluent. Shallow buried trenches are typically installed in the natural soil close to the surface of the ground, allowing plant roots and bacteria in the soil to take up additional nutrients.

Trenches can be installed as one row or several rows to meet minimum trench length standards as required by the *Ontario Building Code*. This method is versatile because the trench can follow an irregular pattern (e.g., around trees).

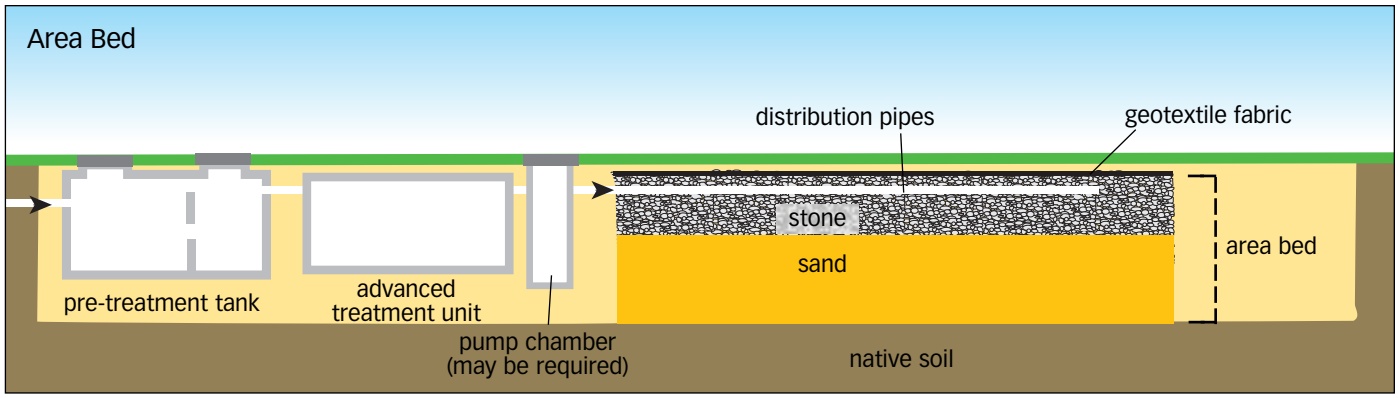


Shallow buried trenches showing equal distribution methods. Note: before placement of chambers.

Single line shallow buried trench.

Area Bed

An area bed consists of a stone layer overlying a sand layer. The sand layer may vary in depth and size depending on the treatment unit being used. Some advanced treatment systems have open bottoms that sit right on top of the stone layer while others have distribution pipes placed in the stone layer for effluent distribution. Typically effluent from the advanced treatment unit will flow by gravity to an area bed. However, some systems have a pump as an integral part of the system, and sometimes a pump is added to overcome an elevation difference between the advanced treatment unit and the area bed.



A side view of an area bed following an advanced treatment unit. Note: some system designs allow for the treatment unit to be located on top of the area bed.

An area bed showing stone layer, pipes and geotextile fabric.

An area bed in a small space.

Cost Considerations

There are numerous ways to compare the costs associated with advanced treatment systems versus conventional septic systems. There are times where your site limitations will require the use of an advanced treatment system to meet the requirements in Ontario's *Building Code*. Conventional septic systems would normally cost less than those using advanced treatment units. However, in some cases where construction of a conventional septic system would require a raised bed, this difference may not be significant, and the use of the treatment unit with a smaller leaching bed would be more economical.

Other Considerations

Site conditions are not the only factor when comparing costs. For new home construction, you may have plans for pools, decks, wells, sheds, gardens and trees. How will it all fit and look on your property? Conventional systems may limit your options in terms of how you use your space. Advanced treatment systems may give you more options with your property. Homeowners should consult with their builder and septic contractor to ensure the final product will suit their property objectives.

Treatment systems can be incorporated into your property's landscape features.

Approval of Advanced Treatment Units in Ontario

Advanced treatment units must meet the effluent standards set out in Part 8 of the *Ontario Building Code*. Units listed in SB-5 of the Code are deemed to meet these requirements. Advanced treatment units that produce tertiary quality effluent could be used with the shallow buried trench system which is regulated under the *Ontario Building Code* or with an area bed pursuant to an authorization issued by the Building Materials Evaluation Commission (BMEC). Authorizations issued by the BMEC can be found on the Ontario Ministry of Municipal Affairs and Housing web site at www.ontario.ca/buildingcode.

List of Approved Advanced Treatment Units Listed in Supplementary Standards SB-5

Treatment Units	Treatment Method	Requires Hydro	Can Sit on Area Bed	Media Requires Cleaning or Replacement
Aquarobic Canada	suspended growth	constant	no	no
Aqua Safe and Aqua Air	suspended growth	constant	no	no
Biocycle Aerated Wastewater System	suspended growth	constant	no	no
Bio-Microbics — FAST® Wastewater Treatment Systems	attached growth	constant	no	no
Bionest Technologies Inc.	attached growth	constant	no	no
Clearstream Treatment Systems	suspended growth	constant	no	no
Nayadic Wastewater Treatment Systems	attached growth	constant	no	no
Norweco Singulair Treatment Systems	suspended growth	intermittent	no	no
Orenco AdvanTex® Wastewater Treatment System	synthetic media filter	intermittent	no	yes
Orenco Treatment Systems	sand filter	intermittent	no	yes
Premier Tech Environment — Ecoflo Biofilter Treatment Systems	peat filter	if required — intermittent	yes	yes
Puraflo® Peat Fiber Biofilter Treatment Systems	peat filter	intermittent	yes	yes
Rotordisk Wastewater Systems	attached growth	constant	no	yes
Waterloo Biofilter Treatment Systems	synthetic media filter	intermittent	yes	yes
Whitewater Treatment Systems	suspended growth	constant	no	no
WSB® Clean Treatment Systems	suspended growth	constant	no	no

Approved units as listed in the *Supplementary Standards* to the *Ontario Building Code* may change over time. The reader is advised to check the current SB-5 listing. This information can be obtained from Service Ontario Publications: www.publications.serviceontario.ca. To see samples of aerobic treatment units, visit one of two Ontario Rural Wastewater Centre Demonstration Sites (Guelph and Ottawa). Visit www.uoguelph.ca/orwc to learn more.

Special Approval for Other Treatment Systems

Other treatment units and distribution systems do exist, such as subsurface constructed wetlands, drip dispersal systems and membrane technology. However, at this time they are not specifically addressed in the *Ontario Building Code*. You can seek special approval for any of these systems from the local authority that enforces the *Ontario Building Code*. Local authorities (municipalities, health units, conservation authorities) have the authority to approve the use of such systems as alternative solutions to the *Ontario Building Code* regulated systems if you can demonstrate that the technology you would like to use meets or exceeds the level of performance of the *Ontario Building Code* regulated systems. Some systems may be regulated under the *Ontario Water Resources Act* (OWRA) and therefore an approval from the Ontario Ministry of the Environment may be required.

Subsurface constructed wetland.

Subsurface Constructed Wetland

Subsurface constructed wetlands are designed and built to simulate the cleaning functions of natural wetlands. Wastewater from the house goes directly to a septic tank where solids and liquids are allowed to separate. The wastewater then flows to the wetland that is filled with pea stone and emergent plants, like bulrushes, cattails, reeds, rushes and sedges. Plant roots aerate the subsurface wastewater, allowing bacteria to thrive in aerobic conditions. Bacteria attach to both the roots and pea stone and feed on the waste products in the water. The plants also absorb nitrates and phosphorus, lessening their impact on the receiving environment.

Drip Dispersal Systems

Subsurface drip dispersal systems are an option to consider. Drip dispersal systems deliver an even and slow distribution of effluent into the soil. Wastewater goes from the house to the septic tank and then to an advanced treatment unit. Effluent is then pumped through a network of small-diameter plastic pipes that are placed in the top soil. The treated effluent helps sustain grass growth and in turn recycled nutrients.

Drip dispersal system.

Membrane Technology

Membrane technology is currently being used for commercial buildings (resorts, hotels, schools), but the technology is moving towards smaller units designed for single homes.

Pumps are used to gently pull the wastewater through thousands of membrane fibre. Each fibre is filled with billions of microscopic pores that physically block suspended solids, bacteria and viruses from passing through.

These options are only three examples. Other systems are likely to be developed in the future.

Information provided in this publication is not intended to convey legal advice. The reader should not rely on the information presented for the specific design of a system. Refer to recent codes and check with local authorities and individual manufacturers for the most up-to-date information.

Mention of trade names and individual companies in this booklet are not intended as endorsements; nor is criticism intended towards products or systems not identified. Several factors will guide your decision regarding septic system design, including: the physical features of the site, practicality, level of performance, cost, maintenance, availability and personal preference. While care has been taken to ensure accuracy, the examples and explanations in this booklet are given for the purpose of illustration only. Readers must refer to the actual wording of the *Ontario Building Code* or other authorization issued by the BMEC.

Cover Illustration
- From left to right: conventional system, advanced treatment system with shallow buried trench and advanced treatment system with area bed.

Sources of Additional Information:
- *Septic Smart! — Understanding Your Home's Septic System (Booklet Number 1)*
- *Ontario Building Code 2006*
- Canadian Mortgage and Housing Corporation
- Ontario Onsite Wastewater Association
- Ontario Rural Wastewater Centre (Guelph and Ottawa)
- National Sanitation Foundation, NSF40

Document References:
- Based on original *Septic Smart! New Ideas for Household Septic Systems on Difficult Sites*, 1999.
- *Pipeline Newsletter,* National Small Flows Clearing House, National Environmental Service Centre (800) 624-8301.
- *Onsite Wastewater Treatment Systems Manual,* United States Environmental Protection Agency, February 2002.

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- Wade Morrison — Agriculture and Agri-Food Canada
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- Ahmed Sharaf — Ontario Ministry of Municipal Affairs and Housing
- Hugh Simpson — Ontario Ministry of Agriculture, Food and Rural Affairs
- H.J. Smith — Ontario Ministry of Agriculture, Food and Rural Affairs
- Bob Stone — Technical Advisor/Reviewer
- Ted Taylor — Ontario Ministry of Agriculture, Food and Rural Affairs

Issue Date: July 2011
Cette publication est également disponible en français.

Appendix F –
Waterloo Biofilter Information

June 13, 2016

Ahileas Mitsopoulos, P.Eng.
exp Services Inc.
1142 Roland Street
Thunder Bay ON P7B 5M4

Re: ***Expected Nitrogen Removal using the Waterloo Biofilter for Domestic Strength Sewage Applications***

The purpose of this letter is to address the expected nitrogen concentration from a double-pass Waterloo Biofilter treatment system for residential applications.

The Waterloo Biofilter System has been thoroughly tested by independent third parties such as EPA-ETI and EPA-NSF-ETV, most significantly at the EPA Buzzards Bay test facility. Our individual 3-bedroom and 4-bedroom re-circulating systems were tested for 24 months (ETI in triplicate) and 13 months (ETV including NSF-40 stress tests) respectively, and lowered the total nitrogen level (TN = TKN + NO_3-N + NO_2-N) from 35 mg/L to 14 mg/L (~ 10.4 mg/L nitrate), and from 37 mg/L to 13 mg/L (10 mg/L nitrate), respectively. This total nitrogen removal efficiency of 60% and 65% was attainable on a regular basis in this sewage source which is similar to normal domestic sewage with normal chemical use. The treatment systems were tested under adverse conditions with the sewage being loaded at the full peak design flow per day for the entire period. In addition, the sewage loading was varied during the day to reflect the diurnal usage of a typical household (35% a.m., 25% noon, 40% evening with no loading during the intervening times) and the composite samples were taken immediately after the loading events (not during the slack period when treatment is optimum). The sewage at Buzzards Bay was very cold during the winters at < 10°C for at least 3 months of the year, down to 6°C.

It is normal that the first 12 months is the most difficult to nitrify and denitrify, and these independent tests are during this period (13 months & 24 months). Simple on-going maintenance programs keep the denitrification process on-going. These NSF & EPA tests therefore represent the most difficult period, and most experts agree that, like at any municipal sewage treatment plant with proper operation, the nitrification-denitrification process continues for the lifetime of the system.

143 Dennis Street, Rockwood Ontario N0B 2K0 T: 519 856-0757 F: 519 856-0759 www.waterloo-biofilter.com

In addition to water usage and chemical use, the characteristics of the sewage play a role in the treatment capability of biological systems like the Waterloo Biofilter. Below are some known factors that affect treatment performance:

1. **Alkalinity:** Nitrification depends on the alkalinity of the wastewater. Nitrification reactions are severely hindered if there is not enough alkalinity in the wastewater to buffer pH drops. If the houses are on the Paleozoic carbonate substrate of southern Ontario, there is typically adequate alkalinity for nitrification-denitrification.
2. **Temperature:** Nitrification is dependent on influent temperature, although microbial reactions in the septic tank and Biofilter typically generate enough heat to support nitrification. It is recommended to install the tanks with a minimum of 457 mm of cover. The tanks can also be insulated with 50 mm of styrofoam board.
3. **Disinfectants, medications, and other anti-microbial agents:** This is a major concern with all biological systems. These substances inhibit microorganisms from performing optimally, especially in the case of nitrifying bacteria. Waterloo provides a homeowner's manual of best practice which minimizes problems due to these chemicals.
4. **Ammonium Cleaners:** Use of high ammonium cleaners during the construction stage, and in the spring cleaning rituals can raise the levels of nitrogen coming into the systems to > 40 and up to 70-80 mg/L. When this happens, the system typically cannot cope with removing the nitrogen to the desired level.
5. **Operations and maintenance:** Simple O+M of the sewage treatment system is a vital component to the treatment process, and we recommend on-going maintenance contracts. Operators trained by Waterloo Biofilter have our expertise to help them with potential problems to help maintain the denitrification process.
6. **Hydraulic loading and residence time:** It is important to correctly design and size the system for optimum denitrification. The residential systems that Waterloo Biofilter provides are mainly pre-engineered and should provide the required treatment performance, with reasonable use by the homeowner.

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Given the factors affecting nitrogen removal, based on the removal rates from our third-party testing, and assuming that the median influent TN is 35-40 mg/L (typical TN value of domestic sewage), a median effluent nitrate removal percentage of 60 mg/L is within our tested limits.

Summaries of the test results are included and the full reports are available by following the links below:

http://www.buzzardsbay.org/etistuff/results/waterlooresults.pdf for the ETI

and

http://www.epa.gov/etv/pdfs/vrvs/09_vr_waterloo.pdf for the ETV

I trust this meets with your requirements.

Sincerely,
Waterloo Biofilter Systems Inc.

Brady Straw, B.Sc.
Engineering Department

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NSF International

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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. BOD_5/$CBOD_5$ and TSS Data Summary

	BOD_5 Influent (mg/L)	$CBOD_5$ Effluent (mg/L)	Removal Percent	TSS Influent (mg/L)	TSS Effluent (mg/L)	TSS Removal Percent
Samples	53	53	53	53	53	52
Average	210	10	95	150	7	95
Median	**200**	**7.4**	**96**	**130**	**5**	**97**
Max	370	43	99	340	55	>99
Min	67	1.0	71	61	<1	51
Std. Dev.	73	9.0	6.0	66	8	8

Table 2. Nitrogen Data Summary

	TKN (mg/L)		NH4 (mg/L)		Total Nitrogen (mg/L)		Nitrate (mg/L)	Nitrite (mg/L)	Temperature (C)
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Effluent	Effluent	Effluent
Samples	53	53	53	53	53	53	53	53	51
Average	37	3.7	23	2.4	37	14	10	0.19	15
Median	**37**	**1.6**	**23**	**0.7**	**37**	**13**	**10**	**0.14**	**14**
Maximum	45	31	29	24	45	45	33	0.84	24
Minimum	24	<0.5	18	<0.2	24	6.8	0.6	<0.05	5.2
Std. Dev.	4.2	5.5	2.4	4.0	4.2	6.0	5.0	0.20	5.9

NSF Contact: Thomas Stevens
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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 99.99% 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/etiresults.htm)

Biofilter organic results including start-up period (124-133 samples)

	$c+nBOD_5$ mg/L	TSS mg/L	Fecals cfu/100 mL	NH_4-N mg/L	TN mg/L
Influent Median	162	161	3100K	24.2	34.6
Effluent Median	9	6	32K	0.5	13.9
% Removal	**94.4**	**96.3**	**99.0**	**97.9**	**59.8**

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

	Lysimeter A1 May '00 — Jul '01 cfu/100 mL	Lysimeter A2 June '00 — July '01 cfu/100 mL	Lysimeter A3 June '00 — July '01 cfu/100 mL
Influent Sewage	3 700 000	3 800 000	3 700 000
Effluent After Waterloo + 12" of T = 0.8 min/cm Sand	400	295	100
% Removal	**99.989**	**99.992**	**99.997**
Effluent After Waterloo + 10" of T = 5 min/cm Sand	-	-	<1
% Removal	**-**	**-**	**>99.999**

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

	# of Samples	cBOD mg/L	TSS mg/L	DO mg/L	TN mg/L
Influent Median	37	214	130	0	37
Effluent Median	19	6.4	3.0	5.6	23.1
% Removal	**-**	**97.0**	**97.7**	**-**	**42.4**

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Project Overseers
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FULL-SCALE PERFORMANCE OF A TWO-STAGE BIOFILTRATION SYSTEM FOR REDUCTION OF NITROGEN

Damann Anderson[1], Josefin Hirst[2], Richard Otis[3], Elke Ursin[4], and Daniel Smith[5]

ABSTRACT

Onsite Wastewater Systems (OWS) serve approximately one-third of all households in Florida. The relative impact of OWS on total nitrogen loading varies from watershed to watershed with estimates ranging from below five to more than 20 percent. Regardless of the source, excessive nitrogen has negative effects on public health and the environment. There is widespread interest in the management of OWS and the nitrogen impacts in Florida and the nation. For these reasons, the State has initiated the Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Project. As part of the FOSNRS project, passive nitrogen reduction systems (PNRS) were developed, pilot tested, and are now being evaluated at single family homes. Because of the flat topography common to the state, the definition of "passive" included the use of up to 1 pump as the only mechanical input to the system. The goal of these systems is to reduce nitrogen inputs to watersheds where OWS have been identified as a significant source of nitrogen.

Results from a full-scale PNRS installed at a 3 bedroom single family residence in Hillsborough County are presented here. This PNRS utilizes a two-stage passive biofiltration concept treating septic tank effluent (STE). The first stage provides ammonification and nitrification via a recirculating porous media biofilter. The second stage provides denitrification via an anoxic biofilter with reactive media. The system was monitored over an 18 month period, receiving STE with an average total nitrogen concentration of 54.7 mg N/L. The Stage 1 biofilter with recirculation of nitrified effluent has consistently produced a nitrified effluent with ammonia N less than 4 mg N/L and an average total nitrogen concentration of 31 mg N/L. The second stage biofilter has consistently produced a final effluent with NO_2/NO_3 nitrogen (NO_x) concentrations below the method detection limit of 0.02 mg N/L. Residual ammonia nitrogen in the effluent from the Stage 1 biofilter passes through the Stage 2 biofilter resulting in an average TN concentration in the overall system effluent of 2.5 mg N/L, a reduction in total nitrogen of over 95%. These results suggest the potential to significantly reduce N input to sensitive watersheds from OWS.

BACKGROUND

In 2008, the Florida legislature passed Specific Appropriation 1682, requiring FDOH to develop cost-effective, passive strategies for nitrogen reduction that complement the use of conventional OWS. For the purposes of this study, passive systems were defined as treatment technologies that utilize no more than one pump, no aerators or blowers, and a reactive media for denitrification. Reactive media were defined as supplemental materials that would act as electron donors in the passive denitrification process. The FOSNRS project began in 2009 starting with an evaluation of nitrogen reduction options for OWS, followed by the development and testing of pilot-scale passive nitrogen reduction systems (Hazen and Sawyer and AET, 2014). Previous studies

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had indicated that a two-stage biofiltration process was effective for nitrogen reductions from OWS (Rich, 2007; Smith, Otis, and Flint, 2008; Smith, 2009a; Smith, 2009b; Smith, 2011). Additionally, lignocellulosic based media (Robertson and Cherry, 1995; Long, 1995; Robertson, Blowes et al., 2000; Schipper and Vodvodic-Vukovic, 2001; Dupuis, Rowland et al., 2002; Loomis, Dow et al., 2004; Robertson, Ford et al., 2005; EPA, 2007; Rich, 2007; Vallino and Foreman, 2007; Schipper, Cameron, and Warneke, 2010) and elemental sulfur (Flere and Zhang, 1998; Shan and Zhang, 1998; Koenig and Liu, 2002; Nugroho, Takanashi et al., 2002; Zhang, 2002; Kim, Hwang et al., 2003; Zhang, 2004; Zeng and Zhang, 2005; Sengupta and Ergas, 2006; Sengupta et al., 2007; Smith, Otis, and Flint, 2008) have been shown to be effective as reactive media for denitrification in OWS.

The PNRS pilot-scale results over a test period of 18 months indicated that a two-stage biofiltration process was effective in nitrogen removal from wastewater primary effluent (Hirst et. al., 2014, this conference). The two stage process consisted of an aerobic, unsaturated porous media biofilter for nitrification, followed by an anoxic, saturated reactive media biofilter for denitrification. The unsaturated (Stage 1) biofilters in single pass and recirculation mode using either expanded clay, clinoptilolite or sand porous media consistently reduced ammonia nitrogen to less than 1 mg/L. Anoxic (saturated Stage 2) biofilters were operated in upflow and horizontal modes using either elemental sulfur or lignocellulosic media (Southern Yellow Pine sawmill waste) as electron donors. Oxidized nitrogen (nitrate and nitrite) was consistently reduced to less than 1 mg/L in sulfur containing biofilters. Lignocellulosic biofilters did not perform as well, and this appeared due to insufficient hydraulic retention time in the media (Hirst et. al., 2014, this conference). Two-stage biofiltration, aerobic biofiltration followed by anoxic biofiltration, continuously achieved total nitrogen removals of over 95% from primary effluent in several of the pilot units over the 18 month study. The pilot-scale testing results indicated that two-stage biofiltration appears to be a viable technology for nitrogen removal. The results of this pilot study provided guidance for the development, design and construction of full-scale systems for testing at individual Florida home sites. The performance of one of these full-scale systems was the subject of this paper.

MATERIALS AND METHODS

The full-scale PNRS studied utilized the two-stage passive biofiltration concept at a home located in Hillsborough County, FL, just southeast of Tampa. The nitrogen reducing OWS for the 3 bedroom single family residence was installed in September 2012. Primary treated wastewater, consisting of STE from the home's existing septic tank was discharged to a two-stage treatment system consisting of a first stage unsaturated porous media recirculating biofilter for ammonification and nitrification, followed in series by a second stage saturated anoxic upflow porous media biofilter for denitrification. Flow to the system averaged 108 gallons per day during the study period. The system tankage consists of a 1,050 gallon two chamber concrete primary (septic) tank; 300 gallon concrete recirculation tank; 900 gallon concrete stage 1 unsaturated media biofilter; 300 gallon concrete pump tank; and 1,500 gallon two chamber concrete Stage 2 saturated media biofilter. The stage 1 unsaturated biofilter utilized an expanded clay porous media. Nitrified effluent from the stage 1 biofilter was pumped to the stage 2 biofilter and also recirculated back to the stage 1 biofilter at a ratio of approximately 3:1 recirculation flow R to forward flow Q. The system was designed with two recirculation modes of operation. The first mode of operation was to have the recirculated, nitrified effluent return to the recirculation tank for mix-

ing with incoming septic tank effluent (see Figure 1). Following satisfactory performance of this mode, the second mode of operation tested had the recirculated nitrified effluent not pass through the recirculation tank, but rather be dispersed by three spray nozzles directly to the top of the Stage 1 biofilter, while the STE from the home was applied by gravity distribution (see Figure 2). This second mode was tested to determine the performance of the system without a recirculation tank, which could reduce system cost if successful.

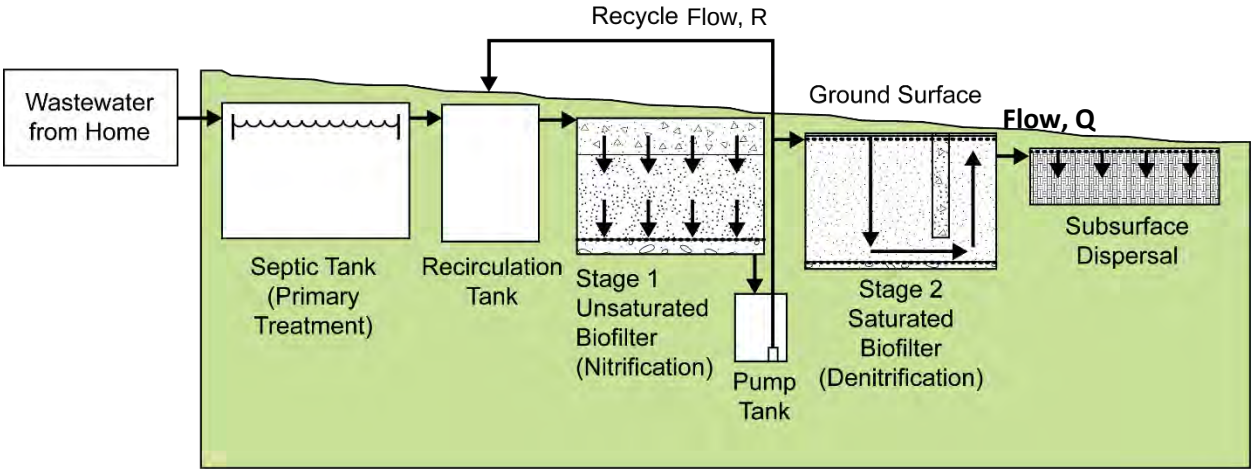


Fig. 1. Flow Schematic for the First Operational Mode for the PNRS Installed in Hillsborough County, Florida.

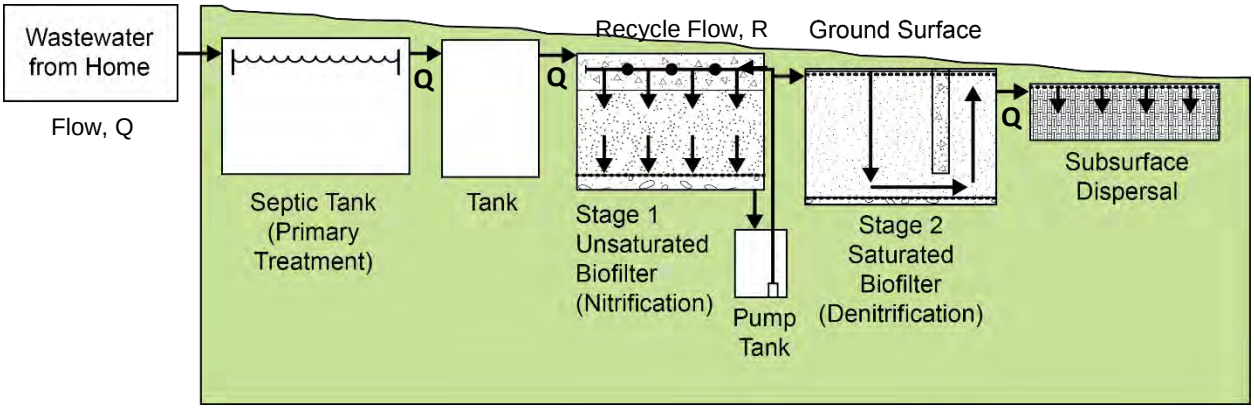


Fig. 2. Flow Schematic for the Second Operational Mode for the PNRS Installed in Hillsborough County, Florida.

The stage 2 saturated anoxic biofilter consisted of two compartments, the stage 2A compartment containing lignocellulosic media (southern yellow pine saw mill waste) and stage 2B compartment containing elemental sulfur as electron donor reactive media for heterotrophic and autotrophic denitrification, respectively. This dual media denitrification approach was derived from the results of the pilot testing, where stage 2 sulfur biofilters alone performed extremely well for NO_x reduction, but resulted in relatively high sulfate concentrations in system effluents (Hazen and Sawyer and AET, 2014). By using lignocellulosic media first, followed by sulfur

media for denitrification, much less sulfate is produced in the effluent. A collection pipe along the bottom transfers the first chamber (2A, lignocellulosic media) effluent to the second chamber, 2B (sulfur media). Crushed oyster shell was added in for alkalinity control in the stage 2B biofilter sulfur compartment. The denitrified treated effluent was discharged into the home's existing drainfield/soil treatment unit for final treatment and dispersal. Stainless steel samplers were positioned at various depths throughout the lignocellulosic and sulfur media for vertical profiling of water quality.

Water quality samples from the system were collected from the primary tank (STE), recirculation tank, pump tank (Stage 1 effluent), Stage 2A and 2B vertical profile samplers, and Stage 2 effluent for water quality analysis. Sample collection, handling and analyses methods were in accordance with Florida Department of Environmental Protection Standard Operating Protocols. A peristaltic pump was used to collect samples and route them directly into analysis-specific containers, with appropriate preservatives, after sufficient flushing of the tubing had occurred. Field parameters were then recorded. Routine QC checks were performed of sampling and analysis procedures for both field QC samples and laboratory QC samples. The number of QC samples collected was approximately 10 percent of the total number of samples collected in the overall monitoring. Field QC samples included field blanks, equipment rinsates, and duplicates. Chain of custody forms were used to document the transfer of samples from field personnel to the analytical laboratory. All analyses were performed by independent and fully NELAC certified analytical laboratories. Table 1 lists the analytical parameters, analytical methods, and detection limits for laboratory analyses. Field parameters were measured using portable electronic probes and included temperature (Temp), dissolved oxygen (DO), oxidation-reduction potential (ORP), pH, and specific conductance.

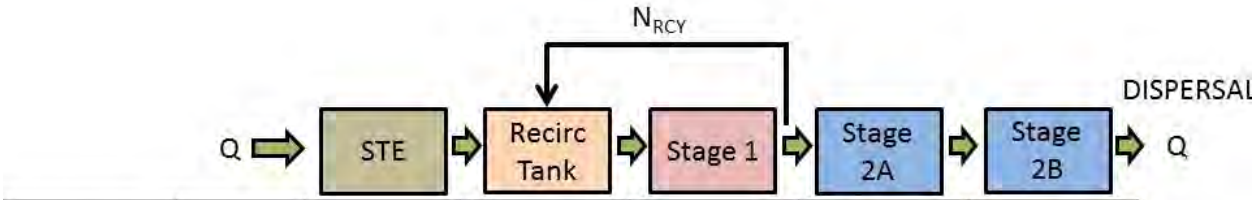
Table 1. Analytical parameters, method of analysis, and detection limits.

Analytical Parameter	**Method of Analysis**	**Method Detection Limit (mg/L)**
Total Alkalinity as $CaCO_3$	SM 2320B	2 mg/L
Chemical Oxygen Demand (COD)	EPA 410.4	10 mg/L
Total Kjeldahl Nitrogen (TKN-N)	EPA 351.2	0.05 mg/L
Ammonia Nitrogen (NH_3-N)	EPA 350.1	0.005 mg/L
Nitrate Nitrogen (NO_3-N)	EPA 300.0	0.01 mg/L
Nitrite Nitrogen (NO_2-N)	EPA 300.0	0.01 mg/L
Nitrate+Nitrite Nitrogen (NOX-N)	EPA 300.0	0.02 mg/L
Total Phosphorus (TP)	SM 4500P-E	0.01 mg/L
Carbonaceous Biological Oxygen Demand ($CBOD_5$)	SM5210B	2 mg/L
Total Solids (TS)	EPA 160.3	.01 % by wt
Total Suspended Solids (TSS)	SM 2540D	1 mg/L
Total Organic Carbon (TOC)	SM5310B	0.06 mg/L
Sulfate	EPA 300.0	2.0 mg/L
Hydrogen Sulfide (unionized)	SM 4550SF	0.01 mg/L
Fecal Coliform (fecal)	SM9222D	2 ct/100mL
E.coli	SM9223B	2 ct/100mL

RESULTS AND DISCUSSION

The results from the first mode of operation are based on system monitoring between experimental Day 0 through experimental Day 316. The system received an average of 110 gpd of STE with an average total nitrogen (TN) concentration of 50.5 mg N/L during this period. Table 2 provides results illustrating the mean water quality through the treatment train during the first mode of operation. The Stage 1 biofilter with recirculation of nitrified effluent to the recirculation tank consistently produced nitrified effluent with average ammonia N of 0.9 mg N/L and TN concentrations averaging under 20 mg N/L. This Stage 1 recirculation scheme resulted in an average 61 percent reduction in TN through the first stage alone, from denitrification using STE carbon in the recirculation tank.

Table 2. Mean Water Quality Results for First Mode of Operation of PNRS (Experimental Day 0 through Experimental Day 316).



Parameter	Statistic	Septic tank effluent	Recirc tank effluent	Stage 1 effluent	Stage 2A Lignocellulosic Effluent	Stage 2B Sulfur Effluent
n		5	5	5	5	5
$CBOD_5$ mg/L	mean	105.6	25.2	15.2	47.6	67.6
TKN mg N/L	mean	50.4	12.8	3.1	2.8	3.4
NH_3 mg N/L	mean	41.6	9.0	0.9	1.5	2.2
NO_x mg N/L	mean	0.05	6.1	16.7	0.02	0.02
TN mg N/L	mean	50.5	18.9	19.7	2.8	3.5
Sulfate mg/L	mean	83.4	not analyzed	not analyzed	159	192
Fecal Coliform (Ct/100 Ml)	geomean	115,416	38,350	166	38	53

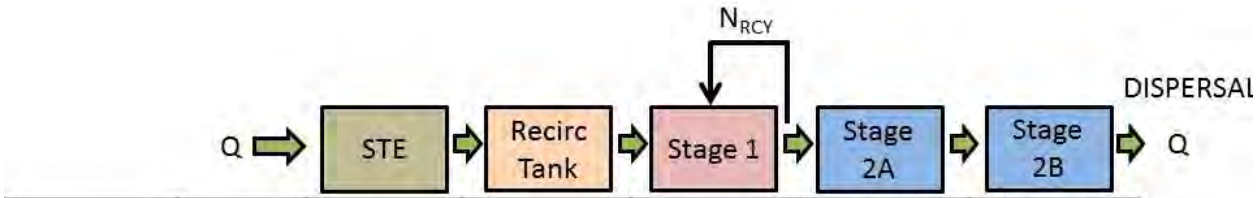
The second stage biofilter consistently produced a final effluent with NO_x concentrations below the method detection limit of 0.02 mg N/L. Residual TKN nitrogen in the effluent from the Stage 1 biofilter and nitrogen from media and biomass in the Stage 2 biofilter resulted in an average TN concentration in the overall system effluent of 3.5 mg N/L. These results represent a reduction in total nitrogen of over 93% prior to discharge and subsequent additional treatment in the soil treatment unit (drainfield).

TN in the effluent from the two stage system consisted of approximately 40 percent organic nitrogen and 60 percent ammonia N. Thus, increasing the nitrification performance of the stage 1

biofilter could further enhance nitrogen removal from these systems. Energy use by the system averaged 0.30 kWh per day, or 2.8 kWh per 1000 gallons treated during this mode of operation.

The results from the second tested mode of operation are based on system monitoring between Experimental Day 317 through Experimental Day 535. The system received 106 gpd of STE with an average TN concentration of 57.8 mg N/L during this monitoring period. Table 3 provides results illustrating the mean water quality through the treatment train. The Stage 1 biofilter with recirculation of nitrified effluent to the Stage 1 sprayers consistently produced nitrified effluent with average ammonia N of 0.9 mg N/L and a total nitrogen concentration averaging 38.5 mg N/L. This Stage 1 recirculation scheme resulted in an average 33 percent reduction in TN through the first stage.

Table 3. Mean Water Quality Results for Second Mode of Operation of PNRS (Experimental Day 317 through Experimental Day 535).



Parameter	Statistic	Septic tank effluent	Recirc tank effluent	Stage 1 effluent	Stage 2A Lignocellulosic Effluent	Stage 2B Sulfur Effluent
n		7	6	7	7	7
$CBOD_5$ mg/L	mean	254.3	171.7	8.4	13.1	54.9
TKN mg N/L	mean	57.7	58.6	4.5	2.4	1.8
NH_3 mg N/L	mean	41.1	41.3	0.9	0.7	0.7
NO_x mg N/L	mean	0.05	0.06	34.0	4.0	0.02
TN mg N/L	mean	57.8	58.6	38.5	6.3	1.8
Sulfate mg/L	mean	32.4	8.1	154	153	209
Fecal Coliform (Ct/100 Ml)	geomean	75,579	92,508	4,997	11	21

The second stage biofilter consistently produced a final effluent with NO_x concentrations below the method detection limit of 0.02 mg N/L. The average TN concentration in the system effluent was 1.8 mg N/L in the second mode of operation, a reduction in total nitrogen of over 96%.

In operation mode 2, TN in the effluent from the two stage system consisted of approximately 60 percent organic nitrogen and 40 percent ammonia N. Energy use by the system averaged 0.25 kWh per day, or 2.4 kWh per 1000 gallons treated in this operational mode.

Over the entire study period, including the data from both operational modes, the treatment system received STE with an average total nitrogen concentration of 54.7 mg N/L, and consistently

produced a final effluent with NO_x concentrations below the method detection limit of 0.02 mg N/L. The average effluent TN concentration was 2.5 mg N/L, a reduction in total nitrogen of over 95%.

Figure 3 provides a time series of the nitrogen data over the experimental study period. The numerous data points at the end of the study period are from daily sampling over a 1 week period. This sampling was performed to investigate day to day variability in relation to the study period variability, and they compared well as the figure shows.

More importantly, Figure 3 illustrates that higher average TN reduction occurred in the Stage 1 biofilter when recirculation of nitrified effluent went to the recirculation tank as compared to recirculation to the Stage 1 biofilter sprayers. The treatment system total nitrogen reduction for the two modes was similar, but operational mode two (recirculation to sprayers) shifted more of the nitrogen removal to the second stage biofilter. For long-term operation, increased nitrogen reduction within Stage 1 using a recirculation tank may be beneficial in that less of the reactive media is required for treatment downstream within the Stage 2 biofilter, resulting in longer life of the stage 2 media before replenishment. However, the second mode of operation also produced excellent treatment results and could eliminate the recirculation tank from the system design.

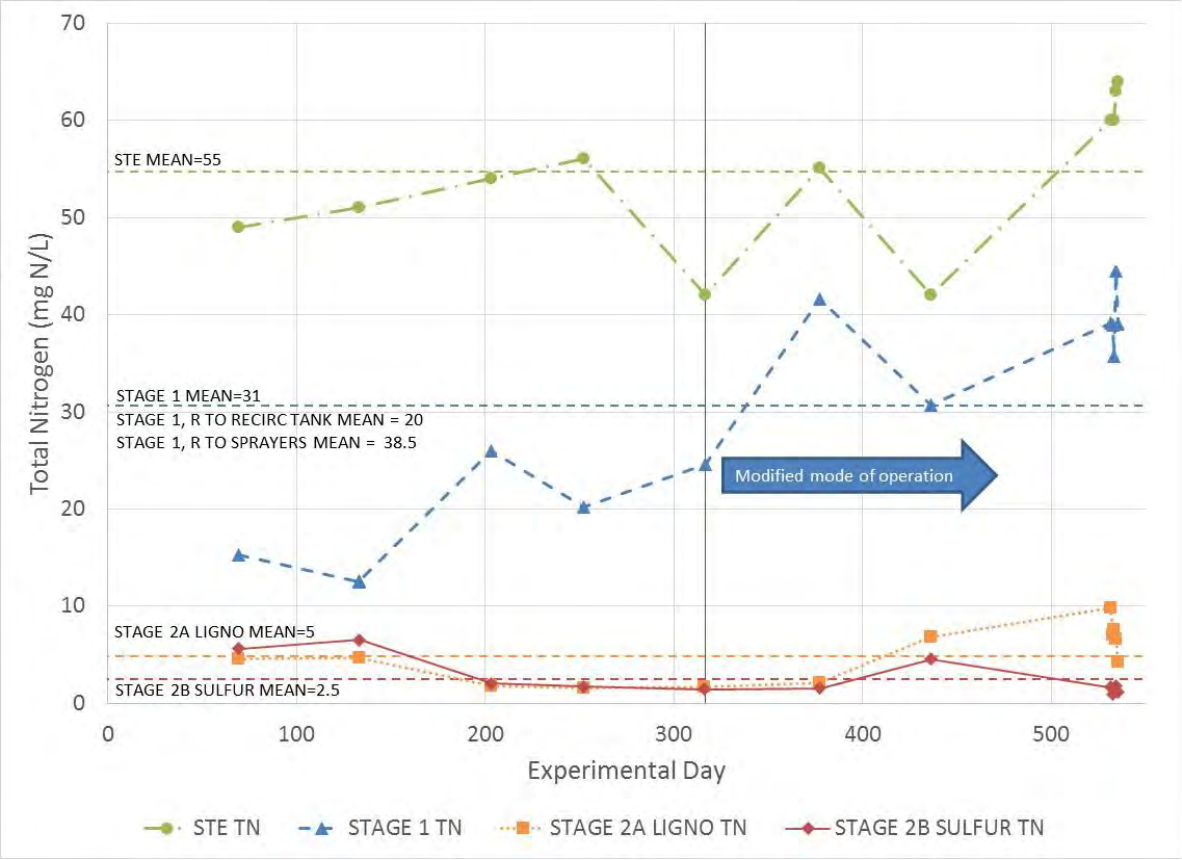


Fig. 3. Time Series of Nitrogen Data for the Hillsborough PNRS.

This shift to stage 2 can also be observed when comparing the vertical profile results on Day 316 (Figure 4) and Day 436 (Figure 5). Towards the end of the study period (Figure 5) the lignocellulosic Stage 2A media effluent (LIGNO-0) showed higher NO_X concentrations deeper in the profile and ultimately feeding higher NO_x to the Stage 2B sulfur media as compared to Day 316 (Figure 4). This was due to the higher NO_x load applied to the Stage 2 biofilter in the second mode of operation.

2A Lignocellulosic Compartment

FROM PUMP	TKN	NH3-N	NOX-N
Influent	1.6	0.28	23.0
6" LIGNO	1.9	0.46	3.90
12" LIGNO	1.8	0.34	4.60
18" LIGNO	1.6	0.13	1.40
24" LIGNO	1.2	0.10	0.02
30" LIGNO	1.4	0.19	0.02
36" LIGNO	1.0	0.10	0.06
Effl. LIGNO	1.6	0.42	0.02

Tank Wall

2B Sulfur Compartment

	TKN	NH3-N	NOX-N
Effl. Sulfur	1.4	0.41	0.02
18" SULFUR	1.6	0.41	0.02
12" SULFUR	1.8	0.41	0.02
7" SULFUR	1.5	0.44	0.02
3" SULFUR	1.7	0.40	0.02

Fig. 4. Stage 2 Biofilter Vertical Profile Day 316, a Snapshot at End of First Mode of Operation.

2A Lignocellulosic Compartment

FROM PUMP	TKN	NH3-N	NOX-N
Influent	4.0	0.2	27.0
6" LIGNO	4.9	2.5	21.0
12" LIGNO	4.9	2.8	18.0
18" LIGNO	6.7	3.8	9.5
24" LIGNO	4.3	1.2	7.4
30" LIGNO	4.4	1.1	3.7
36" LIGNO	4.2	1.9	0.2
Effl. LIGNO	4.6	2.7	2.3

Tank Wall

2B Sulfur Compartment

	TKN	NH3-N	NOX-N
Effl. Sulfur	4.5	2.7	0.02
18" SULFUR	5.3	3.5	0.02
12" SULFUR	4.9	2.0	0.02
7" SULFUR	5.2	3.2	0.05
3" SULFUR	4.9	3.2	0.04

Fig. 5. Stage 2 Biofilter Vertical Profile Day 436, a Snapshot during Second Mode of Operation.

Operation and maintenance of the two stage biofilter PNRS was minimal after an initial start-up period where system settings were established. There was no indication of any reduction in the reactive media (lignocellulosic or sulfur) levels after 18 months of operation, and initial observa-

tions suggest that the media will last for many years. Further monitoring of the stage 2 monitoring is being conducted to better estimate media life.

CONCLUSIONS

Results of full-scale PNRS testing in the FOSNRS project indicate that consistent nitrogen reductions of over 90%, with total nitrogen effluent concentrations consistently under 5 mg N/L are possible with a two-stage biofilter system as described herein. These results suggest the potential to significantly reduce N input to sensitive watersheds from OWS. Six additional full-scale PNRS are currently under early stages of evaluation, and results from these systems will provide key additional data regarding PNRS performance.

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Residential Nitrogen Removal

Options:

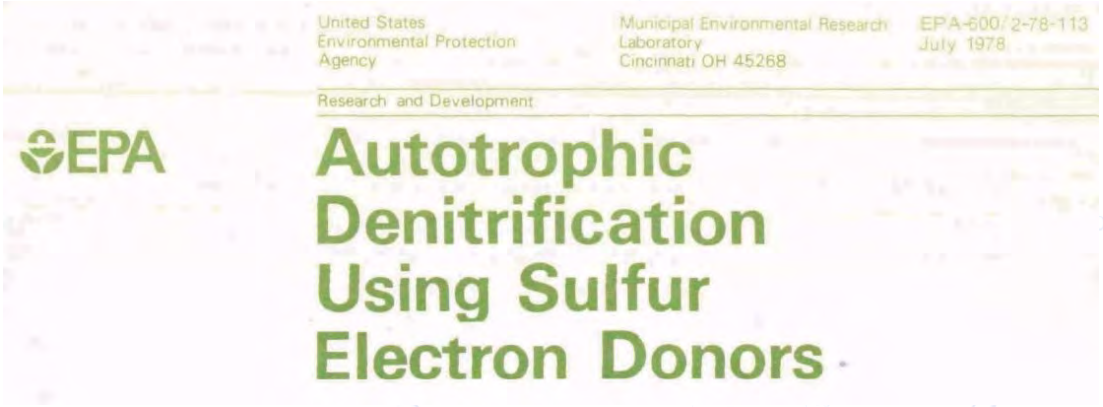
1. Single-Pass Waterloo System
   - 25 – 35% TN removal
   - Internal carbon source of wastewater

2. Double-Pass Waterloo System
   - 50 – 65% TN removal
   - Septic tank carbon source through recirculation

3. WaterNOx-LS Autotrophic Upflow System
   - 80 – 95% TN removal
   - Passive agricultural sulphur source to Biofilter effluent

Waterloo BIOFILTER

WaterNOx-LS



- EPA lab study using agricultural sulphur at Cornell University, 1978
- Recent Florida & Massachusetts work using wood chips + native sulphur
- FULL-SCALE PERFORMANCE OF A TWO-STAGE BIOFILTRATION SYSTEM FOR REDUCTION OF NITROGEN
  Damann Anderson, Josefin Hirst, Richard Otis, Elke Ursin, and Daniel Smith, 2014
- PILOT STUDY OF TWO-STAGE BIOFILTRATION FOR REDUCTION OF NITROGEN FROM OWS
  Josefin Hirst, Damann Anderson, and Daniel Smith, 2014

Waterloo BIOFILTER

WaterNOx-LS

Hillsborough Denitrification Site, Tampa FL
Damann Anderson January 2015

Waterloo BIOFILTER

Autotrophic Denitrification

- Nitrate plume in groundwater below septic system is removed entirely after in-ground LS-type system installed in Florida;
  Anderson and Hirst 2015

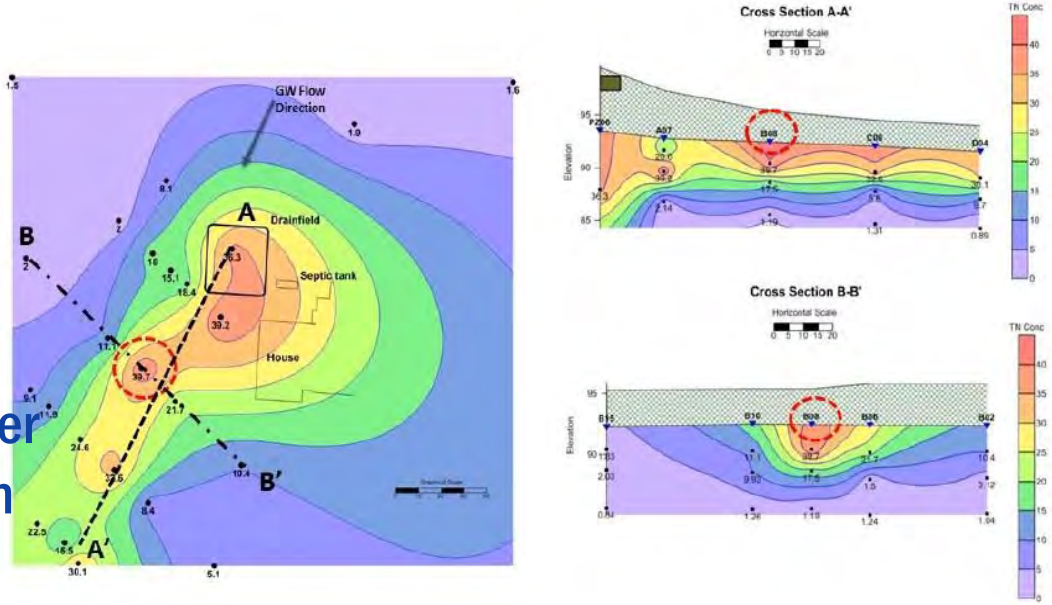


Figure 6. Groundwater total nitrogen concentrations down gradient of the conventional OWS prior to full scale in-ground PNRS installation

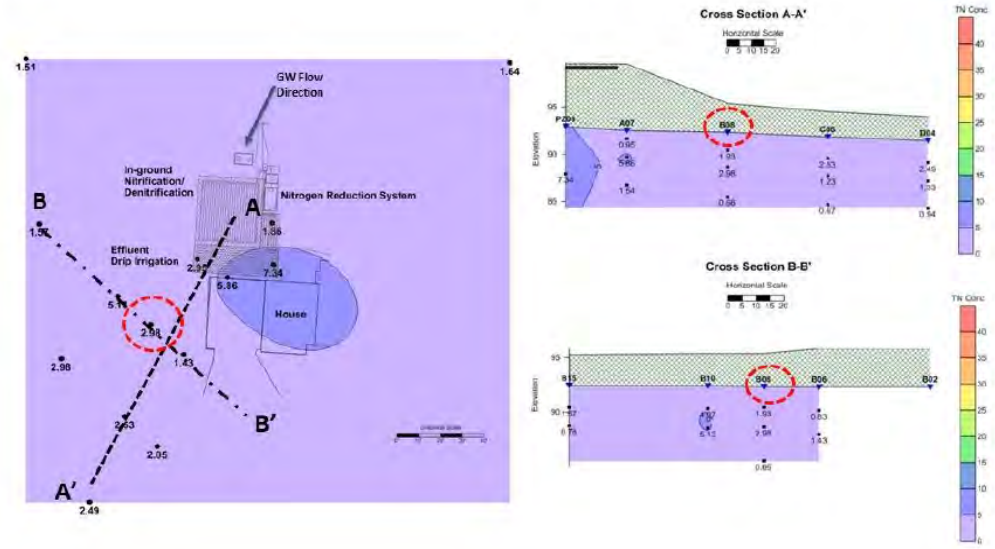


Figure 7. Groundwater total nitrogen concentrations 468 days following full scale PNRS start-up

Waterloo BIOFILTER

Waterloo WaterNOx-LS

- Excellent immediate denitrification
- Consistent very low Total Nitrogen
- No impact on TSS
- Marginally increased BOD
  - Polished by LS-P
- Lower maintenance than carbon addition
- Handles influent TKN variability much more readily
- pH buffered to neutral

Waterloo BIOFILTER

WaterNOx-LS: Sewage

Parameter	Raw Sewage TKN						
	pH	Temp	DO	cBOD	TSS	TP	TKN
Units	-	˚C	mg/L	mg/L	mg/L	mg/L	mg/L
Date							
13-Jul-15	6.93	18.7	0.23	72	26	10.6	56.2
31-Jul-15	6.97	17.8	0.69	56	76	9.2	52.8
10-Aug-15	7.04	16.5	1.55	53	18	8.0	32.4
24-Aug-15	7.08	17.4	0.81	64	22	9.2	45.6
8-Sep-15	6.99	18.7	1.05	60	13	11.4	50.7
21-Sep-15	7.09	18.8	0.29	246	24	11.0	2.4
5-Oct-15	6.97	16.1	0.90	231	44	8.8	116.0
19-Oct-15	5.11	14.6	2.11	393	53	10.8	101.0
2-Nov-15	5.86	14.7	2.74	275	34	10.7	119.0
20-Nov-15	7.09	13.0	2.30	209	34	12.5	101.0
1-Dec-15	7.24	10.7	1.75	60	10	11.1	41.3
15-Dec-15	5.06	11.7	2.09	173	16	8.6	26.6
29-Dec-15	7.04	9.9	1.60	114	13	9.8	22.3
14-Jan-16	7.69	7.1	0.72	124	19	8.6	22.0
28-Jan-16	7.19	6.4	1.59	131	19	7.5	23.3
10-Feb-16	7.67	7.4	0.81	167	33	10.3	85.8
22-Feb-16	7.15	11.5	1.17	224	38	10.4	76.9
9-Mar-16	7.45	11.7	0.72	70	14	10.0	27.0
21-Mar-16	7.75	9.4	1.48	72	9	9.2	16.1
5-Apr-16	7.87	9.3	1.02	119	64	6.7	74.9
Mean	**6.96**	**13.1**	**1.28**	**146**	**29**	**9.7**	**54.7**
Median	**7.09**	**12.4**	**1.11**	**122**	**23**	**9.9**	**48.2**

WaterNOx-LS: Biofilter

Parameter	Biofilter Effluent TN									
	pH	Temp	DO	cBOD	TSS	TKN	TAN	NO_3-N	NO_2-N	Total N
Units		˚C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Date										
13-Jul-15	7.39	20.1	7.94	4	2	1.1	0.1	6.95	0.03	8.08
10-Aug-15	7.59	19.9	8.05	4	2	0.5	0.1	4.13	0.03	4.66
8-Sep-15	7.70	22.4	7.57	4	2	2.4	0.1	17.20	0.03	19.63
5-Oct-15	7.27	16.7	8.18	4	2	1.2	0.1	23.90	0.30	25.40
2-Nov-15	6.11	14.5	9.26	4	2	0.5	0.1	25.20	0.30	26.00
1-Dec-15	7.59	10.0	8.61	4	2	2.0	0.1	33.40	0.03	35.43
14-Jan-16	7.61	6.6	7.95	10	3	4.1	2.2	9.76	0.03	13.89
10-Feb-16	7.61	6.8	7.86	8	2	1.3	1.3	7.11	0.30	8.71
9-Mar-16	7.67	10.6	7.72	4	2	1.9	2.0	19.00	0.30	21.20
5-Apr-16	7.28	7.8	6.68	4	2	1.1	0.2	16.20	0.03	17.33
Mean	**7.38**	**13.5**	**7.98**	**5**	**2**	**1.6**	**0.6**	**16.29**	**0.14**	**18.03**
Median	**7.59**	**12.6**	**7.95**	**4**	**2**	**1.3**	**0.1**	**16.70**	**0.03**	**18.48**

WaterNOx-LS: Final

Parameter		WaterNOx-LS Effluent TN										
	HRT	pH	DO	Temp	cBOD	TSS	TKN	NO_3-N	NO_2-N	TN	Sulphate	Alkalinity
Units	hours		mg/L	˚C	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Date												
13-Jul-15	33.6	7.35	2.61	21.6	4	2	0.7	0.06	0.03	0.79	230	249
31-Jul-15	33.6	7.20	0.76	23.6	25	2	0.5	0.06	0.03	0.59	220	269
10-Aug-15	33.6	7.21	0.38	18.8	21	2	0.5	0.06	0.03	0.59	270	278
24-Aug-15	33.6	7.18	0.90	20.2	36	2	0.6	0.06	0.03	0.69	230	288
7-Sep-15	33.6	7.06	0.18	22.2	16	2	0.6	0.06	0.03	0.69	270	262
21-Sep-15	33.6	6.98	0.64	16.5	6	2	0.7	0.06	0.60	1.36	360	231
5-Oct-15	22.4	7.01	0.88	12.4	12	2	0.9	0.06	0.30	1.26	360	228
19-Oct-15	22.4	-	-	-	26	3	0.7	0.06	0.30	1.06	380	213
2-Nov-15	22.4	5.67	2.91	12.8	4	2	0.6	0.06	0.30	0.96	340	210
16-Nov-15	16.8	-	-	-	4	2	0.8	0.06	0.03	0.89	410	183
1-Dec-15	16.8	6.93	1.50	20.3	8	2	1.4	0.06	0.03	1.49	490	177
4-Jan-16	16.8	7.20	1.53	12.3	5	2	0.6	0.06	0.30	0.96	340	213
14-Jan-16	16.8	7.52	1.10	9.4	4	4	0.5	0.06	0.03	0.59	330	261
10-Feb-16	16.8	7.44	0.76	14.7	8	2	1.1	0.06	0.30	0.30	240	264
9-Mar-16	16.8	7.54	0.62	19.7	4	2	1.6	0.06	0.30	1.96	330	214
5-Apr-16	8.4	7.03	0.93	11.8	4	2	0.8	0.71	0.66	1.37	230	212
Mean	**-**	**7.09**	**1.1**	**16.88**	**12**	**2**	**0.8**	**0.1**	**0.21**	**0.97**	**314**	**235**
Median	**-**	**7.19**	**0.9**	**17.65**	**7**	**2**	**0.7**	**0.1**	**0.17**	**0.93**	**330**	**230**

WaterNOx-LS

- Biofilter TN % Removal = 72%
- WaterNOx-LS TN % Removal = 95%
- Total TN % Removal = 98%