strum

CONSULTING

LEVEL I GROUNDWATER ASSESSMENT
Hants County, NS

June 6, 2023

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June 6, 2023

Mr. Klaus Menger-Krug
M&M Developments Ltd.
PO Box 88
Enfield, NS B2T1C6

Dear Mr. Menger-Krug,

Re: Level I Groundwater Assessment
Hants County, NS

Attached is the Level I Groundwater Assessment prepared for a property located in Hants County, NS.

The report documents our observations, findings, and recommendations.

We trust this to be satisfactory at this time. Once you have had an opportunity to review this correspondence, please contact us to address any questions you may have.

Thank you,

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EXECUTIVE SUMMARY

M&M Developments Limited commissioned Strum Consulting to conduct a Level I Groundwater Assessment for a residential development off Renfrew Road in Hants County, NS. The proposed phases include a residential development area of approximately 12.7 hectares (ha) consisting of 16 lots ranging in size from 0.67 to 1.3 ha. Strum understands the site will be developed for residential purposes (i.e., no commercial or industrial uses).

Based on the findings of the Level I Groundwater Assessment, the following recommendations are found below. Please refer to the Report for a full analysis and a comprehensive list of recommendations.

1. The lot size recommended to meet the daily water balance calculation requirement is 7,942 m^2. If any lot falls below this size, steps should be taken to ensure well separation is adequate, well depth is increased, etc.

2. It is recommended that the next evaluation phase be undertaken, which is a Level II Groundwater Assessment. This will require the installation of a minimum of three test wells. The test well layout should be parallel and perpendicular to major structural trends to consider anisotropy. In addition, the density of wells, effects of linear well placement, and assessment of long-term interference between wells should be evaluated.

3. Well depth should be 91 m (300 feet) minimum, unless the desired air lift yield is attained at a shallower depth, with two casing lengths or to bedrock (whichever is greater) and grouted in place. Additional depth should be added if the driller's air lift yield is less than 22.8 Lpm. Wells should be spaced at least 30 m minimum from one another or greater at the planning stage.

4. Step drawdown, long-term pump testing, and analytical testing that meets current NS Guidelines for Subdivisions should be carried out on each test well. It will be important to confirm available information and verify how many wells can be supported in the given area, the long-term safe yield from each well, and evaluate potential interference effects and long-term trends in water levels in the bedrock aquifer.

5. During step testing and pump testing, observation wells should be monitored.

6. Analytical testing on samples from each test well should be collected as part of a Level II Groundwater Assessment, which would include an analysis of water samples for general chemistry and metals (RCAp-MS), fluoride, Volatile Organic Compounds (VOCs), and bacteria (total coliform and E. coli by actual count). In addition, water treatment options and management of those options (treatment devices) should be implemented if quality issues exist.

7. Monitoring of any surface water bodies within 60 m should be conducted during the pump test program to assess surface–groundwater interactions.

8. Potential environmental concerns related to the proposed future development were noted. These concerns are related to arsenic, elevated naturally occurring metals in site soils, karst terrain, radon, manganese, uranium, and potential wetlands. Recommendations concerning this are provided in Section 4.2.4.

9. A layout of lots, including location of proposed homes, well location, and septic should be developed. The design should include a stormwater management plan to minimize impacts to adjacent wetlands and watercourses.

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1.0 INTRODUCTION

Strum Consulting was commissioned by M&M Developments Limited ("M&M") to conduct a Level I Groundwater Assessment (the "Report") for a proposed residential subdivision in Hants County, Nova Scotia (NS). The proposed subdivision is located on Renfrew Road, across from the intersection of Monte Vista Road, and within the Municipality of the District of Hants East. The subject property comprising the proposed Development areas is herein referred to as the "site".

The Level I Groundwater Assessment was completed in accordance with the Nova Scotia Environment [now Nova Scotia Environment and Climate Change (NSECC)] Guide to Groundwater Assessments for Subdivisions Serviced by Private Wells (2011).

The Report presents the findings of the Level I Groundwater Assessment for the proposed residential subdivision.

2.0 SITE DESCRIPTION

2.1 Definition of Study Area

For the purpose of the Report, the site comprises the proposed development area, M&M residential subdivision, as described below in Section 2.2. Therefore, "adjacent properties" refers to the remaining portion near the study area, which includes all adjoining lands within 500 m of the site property boundaries.

2.2 The Site

The property (PID 45371069) consists of approximately 12.7 hectares (ha) of land on Renfrew Road, north of Monte Vista Road and West of Enfield Road. The entire property will be used for a residential subdivision. The site has been subdivided into 16 lots ranging from 0.67 to 1.3 ha.

Forested areas, lakes, wetlands, and watercourses surround or occur within/adjacent to the site. To the north are forested lands, lakes, and wetlands, with some forestry observed from satellite imagery. In the east are a few homes, with roads, fields, and a watercourse flowing south. To the south are wetlands, forested areas, and Little Grand Lake. Many homes and cottages surround the lake. To the west are more forested lands and wetlands.

A site map is provided as Figure 1 below. Including the 500 m buffer, or study area, around the proposed development.

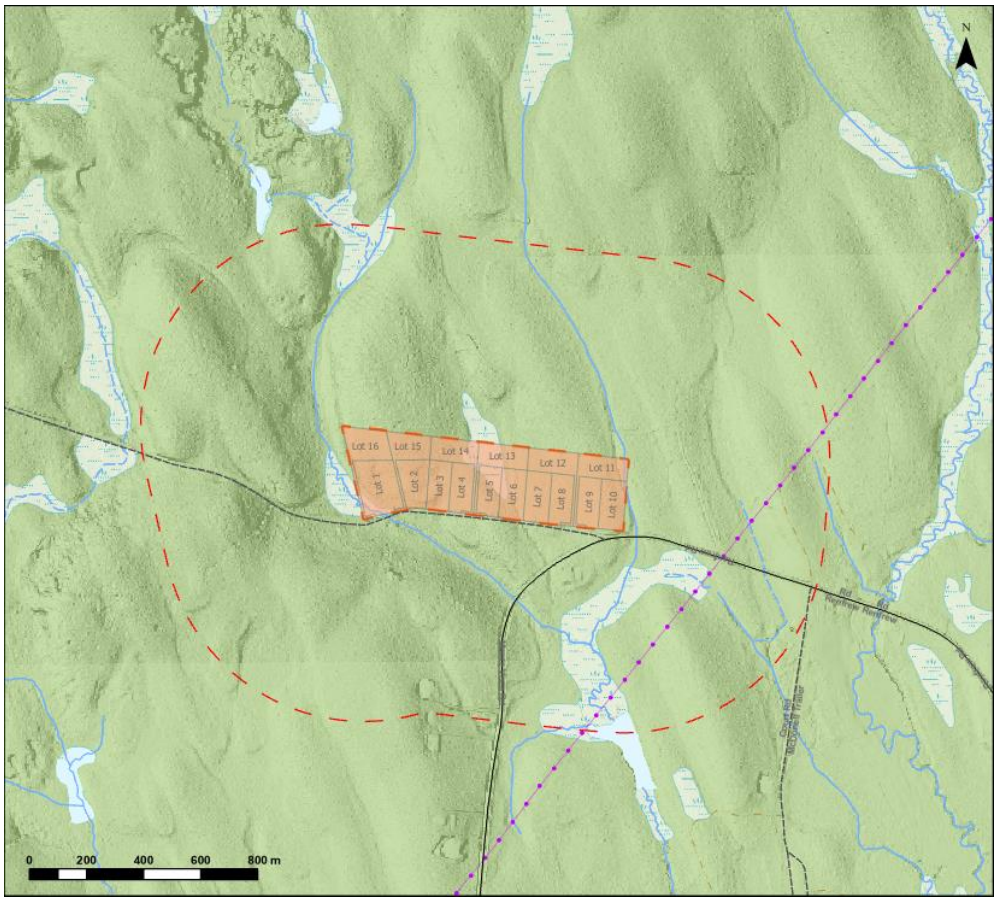

Figure 1: Site Location Map. Red dashed line indicates the study area. Purple line indicates an existing transmission line.

The general lot configuration of the proposed development is shown in Drawing 1, Appendix A. Proposed development details are summarized in Table 2.1.

Table 2.1: M&M Subdivision Details

Total Subdivision Area (ha)	12.70
Number of Lots	16
Minimum Lot Size (ha)	0.67
Maximum Lot Size (ha)	1.30
Average Lot Size (ha)	0.80

Refer to the Development Plan (Drawing 1, Appendix A) for a site plan of the development showing the overall property configuration and site boundaries, as well as other site details.

2.3 Proposed Future Site Development

According to the East Hants Municipality Proposed Zoning Tool, the proposed development area is located on a land parcel zoned Rural Use (RU) (East Hants, 2023).

3.0 SCOPE AND METHODOLOGY

3.1 Scope

The Level I Groundwater Assessment aims to characterize the local site geology and hydrogeology to assess the availability and issues related to the potable water supply to the site. The work scope for a Level I Groundwater Assessment consists of a description of the hydrogeology and characterization of the site, as outlined in Section 2.0 of the NSECC Guide to Groundwater Assessments for Subdivisions Serviced by Private Wells (2011). The overall objectives of completing groundwater assessments for proposed subdivision developments are as follows:

1. To minimize the risk of potable water quality and quantity problems in new residential subdivisions.
2. To minimize potential impacts of subdivision developments on existing groundwater users and the environment.

3.2 Methodology

The Level I Groundwater Assessment involved a historical review of pertinent records and interviews with persons who have relevant knowledge of hydrogeological conditions in the area, as well as the completion of a site visit to collect data on the site and surrounding properties. Given the nature of the anticipated development, information collected or reviewed as part of the assessment was used to provide a preliminary assessment of water quality and quantity.

3.2.1 Historical Data Review

Historical records of the site and its surrounding properties were reviewed as part of the Level I Groundwater Assessment. The primary sources of information included aerial photographs, land use, Geonova Interactive geologic and topographic maps, geochemical information, the NS Well Logs and Pumping Test databases, and online reports.

Discussions were also held with the developers and other experienced or qualified persons, where possible.

3.2.2 Site Visit

The objective of the site visit was to observe topographic trends on the site and accessible areas of the adjacent properties, view domestic well sites on the adjacent properties, and assess potential environmental concerns in the area that could negatively impact the site. Detailed observations of these conditions were noted and recorded in a photo log (Appendix B) and discussed in the subsequent sections.

4.0 DESKTOP RECORDS REVIEW AND SITE VISIT

The historical/desktop review and site visit findings are presented in the sections below.

4.1 Records Review Findings

4.1.1 Aerial Photographs

Aerial imagery from 1985 and Google Earth Pro (2021) aerial imagery from May 2003 to May 2020 were reviewed. The following observations were noted during the aerial photograph review:

- In 1985, the site appeared undisturbed (i.e., forested). Possibly two residential dwellings exist along the northern tip of Monte Vista Road (imagery is poor).
- In 2003, the site appeared undisturbed (i.e., forested). Two residential dwellings along the northern tip of Monte Vista Road (imagery is poor).
- Between June 2014 and May 2015, a dirt/gravel access road and a series of forestry strip cuts were completed along the neighbouring property to the north and east of the site.
- In 2016, a new home was built further south on Monte Vista Road. The site appears to be relatively unchanged from the previous two years.
- In 2017, another new home was built on Monte Vista Road, near the home built the year before.
- In 2019, three new homes were developed within the same area along Monte Vista Road as in 2016 and 2017.
- In 2020, the site remained relatively unchanged from when the forested section of its neighbour to the north was harvested.

No environmental concerns which may adversely affect the groundwater in the area were noted during the review of aerial photographs.

4.1.2 Regulatory Information

Strum submitted an NSECC environmental registry request as part of this assessment. This request was submitted for the following properties (PIDs: 45371069, 45222601, 45081429, 45121456, 45163292). This request found a Litter Abatement Order from 2021 that was issued to the Client. Based on the site visit for this Report, the order seems to have been followed. Additional records referenced a sewage septic system malfunction and replacement from 2017. This septic system malfunction occurred at 21 Monte Vista Road

(PID 45343035) which is located approximately 75 m south and down-gradient from the site. It is unlikely that this septic system malfunction would have any impact on the site. However, it is recommended that drilled wells be used to avoid contamination of surficial material.

The NSECC environmental registry request also discovered a municipal solid waste file that does not belong to the NSECC registry. To view this file would require a FOIPOP request, which was not pursued for this Report.

4.1.3 Company Records

Company records were requested from the site representative. Company records typically include site development plans, survey plans, and/or building condition and assessment reports.

Company plans or records provided to Strum by M&M as part of this assessment consisted of the Draft Landscape Plan and the Rezoned Landscape Plan. These plans were used to create drawings used for this Report (Appendix A).

4.1.4 Title Search

A land title search was not completed as part of this assessment.

4.1.5 Previous Environmental Reports

Prior to completing this report, no previous environmental reports were provided to Strum Consulting.

No additional environmental or geotechnical reports were provided for review as part of this assessment.

4.1.6 Geological Review

Bedrock geology, surficial geology, structural geology, mineral resource, and supporting geological information were also reviewed as part of this assessment. Details of the geological review are discussed in detail in Section 5.0.

4.2 Site Visit Findings

A visit to the site and adjacent properties was completed on May 11, 2023.

4.2.1 Site Observations

Access to the site was limited; however, some access was provided through Renfrew Road. The site visit consisted of a walk-through from the eastern portion of the site to the western portion along Renfrew Road. Additionally, a walk-through was completed of the forested area from the center of the site, on Renfrew Road, to the northern part of the site.

The site is forested throughout, with apparent wetlands and watercourses along the southwestern and eastern boundaries. Additionally, the center north part of the site contains

an apparent large wetland complex. Renfrew Road along the site is a dirt road with limited drivability. Solid waste (i.e., plastic containers) and animal remains were found within the site, although nothing significant was observed.

In general, the area slopes from the northwest to the southeast. The site's highest point was towards the northwestern corner, and the lowest point was seen along the southeast corner. The site demonstrated a variance in its microtopography. Wetland areas were found at lower elevations and upland at higher elevations.

Hikers and ATV traffic use the portion of Renfrew Road that abuts the site. Hikers and ATV tracks were observed. In addition, an apparent unofficial memorial was found along Renfrew Road across the site.

Refer to the photo log in Appendix B for photos taken during the site walk-through.

4.2.2 Adjacent Properties

The following section summarizes land use on the adjoining properties located in the study area:

- North – Timber harvests are located along the site's northern boundary along with a dirt/gravel access road.
- East – A dirt/gravel access road and timber harvest activities. An apparent watercourse and wetland complex flows through this area as well.
- South – Forested area with a few dwellings.
- West – An apparent wetland and watercourse were found, in addition to forested areas along the site's western boundary.

Note: the adjacent properties surrounding the site primarily consist of forested areas, wetlands and watercourses, or harvested areas. A few residential dwellings and farms were found within the immediate area outside the adjoining properties, as well as more wetlands and a transmission line.

4.2.3 Potential Environmental Concerns on the Adjacent Properties

No environmental concerns were seen while assessing the site and/or adjacent properties.

4.2.4 Potential Environmental Concerns on the Subject Site

After a site visit and a review of any available historical records, previous assessments and/or desktop resources, concerns related to future development activities are outlined in Table 4.1, below, along with recommendations.

Table 4.1: Potential Environmental Concerns

Concern	Risk/Recommendation
Arsenic	Arsenic is a naturally occurring element found in Nova Scotia groundwater. Exposure to arsenic through drinking water can lead to a variety of health effects. The site is considered a 'low risk' area, which is defined as an area where 5% of well water samples are likely to exceed drinking water guidelines (NSNRR, 2017). It is recommended that all potable wells be tested for physical, chemical, and biological qualities, as well as for volatile organic compounds, in order to evaluate drinking water risks.
Karst Terrain	The development of sinkholes in karst terrain can cause severe damage to roads and building infrastructure. This is caused by cavities formed in bedrock that have been dissolved. The site is considered a 'high-risk' area, which is defined as an area where there is 1 sinkhole per 100 km^2 (NSNRR 2021e). No recommendation forwarded.
Manganese	Manganese is a naturally occurring element in groundwater in Nova Scotia. Exposure to manganese in drinking water can lead to neurological issues in humans; children are especially vulnerable. The site is considered a 'high-risk' area, which is defined as an area where 15% of well water samples are likely to exceed drinking water guidelines (NSNRR, 2021d). It is recommended that all potable wells be tested for physical, chemical, and biological qualities, as well as for volatile organic compounds, in order to evaluate drinking water risks.
Radon	Based on the Nova Scotia Natural Resources and Renewables (NSNRR) (formerly the Department of Energy and Mines) interactive mapping (2009), the site is in an area with "low potential" to exceed the Health Canada Guideline of 200 Bq/m^3 for radon in air. In the low-risk areas, 5% of buildings exceed the guideline. Therefore, it is recommended that proposed buildings incorporate radon mitigation design features, followed by air sampling upon construction completion, to evaluate the site's radon risks.
Uranium	Uranium is a naturally occurring element found in Nova Scotia groundwater. Exposure to uranium can have a detrimental effect on kidney health. The site is considered a 'low risk' area, which is defined as an area where 5% of well water samples are likely to exceed drinking water guidelines (NSNRR, 2020). It is recommended that all potable wells be tested for physical, chemical, and biological qualities, as well as for volatile organic compounds, in order to evaluate drinking water risks.
Wetlands	Wetlands were observed on the site. Wetland delineation for this site has not been completed. Prior to any future development, such as disturbance, alteration, or infilling in these areas of the property, the completion of a wetland assessment consisting of characterization and delineation is recommended, as per NSECC regulations.

5.0 HYDROGEOLOGY

The hydrogeology of the proposed development area, including the site, will be discussed in two major sections: surficial and bedrock hydrogeology (Drawings 2 and 3, Appendix A, respectively). Each section contains an overview of geology, water quantity, and water quality.

5.1 Surficial Hydrogeology

The following sections discuss the surficial hydrogeology of the site.

5.1.1 Surficial Geology

The proposed development and surroundings are overlain by a silty till plain derived from local and non-local sources through deposits of glacial ice sheets (Drawing 2, Appendix A). Otherwise known by its unit type as a ground moraine and streamline drift, the till thickness typically ranges from 3 m to 30 m, creating a flat to rolling topography and few surface boulders (Stea et al., 1992).

An organic deposit is mapped to the east of the site. This surficial material comprises organic material generated through natural wetland accretion processes (Stea et al., 1992). This surficial deposit does not overlap with the site; however, wetlands and watercourses are mapped within the property boundary.

Based on the NS Well Logs Database (2022), no wells were found within a 500 m buffer of the site. Therefore, a larger radius of 2 km was used to look for wells near the location of the proposed site. Eight of the 21 wells recorded were dug wells (Table 1A, Appendix C). It should be noted that two of the dug wells (well numbers 971039 and 042685) were found at the same location along with drilled well (well number 981615).

5.1.2 Water Quality from Surficial Deposits

Surficial deposits' water quality is typically acceptable when compared to the Guidelines for Canadian Drinking Water Quality (GCDWQ) (2022). Hardness, iron, manganese, colour, turbidity, and low pH are the most common chemical parameters which may pose aesthetic issues to the user and may require point-of-entry (POE) treatment. Conventional treatment is available if necessary. Colour may be difficult to treat if it is due to humic substances. Various metals, including arsenic and uranium, may contribute to additional quality issues in surficial materials. Given the 'high risk' designation per the NSNRR (2021), manganese in this location is a particular concern.

5.1.3 Water Quantity from Surficial Deposits

No dug wells were identified within 500 m of the site; however, eight were found within a 2 km radius (Drawing 4, Appendix A). All of the dug wells within this 2 km radius were found in the same surficial material. On average, these wells were dug to a depth of 6.9 m and produced a yield of 86.6 Lpm (Table 1A, Appendix C).

5.1.4 Surficial Hydrogeology Summary

In summary, a silty till plain is mapped within the confines of the proposed development. The till coverage is generally moderately thick and does support dug wells in the area. However, the presence of wetlands and watercourses at the site could increase the potential for surface water influence to enter dug wells.

Dug wells, while an option, are not recommended for this development. Dug wells require greater clearance distances from septic systems and are more susceptible to surface contaminants. A test pit program would be required to evaluate potential for dug well use at this site.

In cases where sufficient surficial materials exist, drilled wells may be in sands and gravels, given adequate water quality and quantity.

5.2 Bedrock Hydrogeology

The following sections discuss the bedrock hydrogeology of the proposed development area.

5.2.1 Bedrock Geology

The early carboniferous age, Windsor Group bedrock underlies the site. This site is further divided into two formations, the Middle Windsor Group, Wentworth Station, Miller Creek, MacDonald Road and Elderbank Formations and the Lower Windsor Group, White Quarry, Stewiacke, Carrolls Corner, Macumber and Gays River Formations. The contact between these formations is found on the site. Additionally, a fault line is found within the southeastern corner of the site (Drawing 3, Appendix A). These geological formations are described below (Keppie, 2000).

The Windsor Group is characterized as a carbonate/evaporite bedrock, which generally provides poor water quality due to water hardness. Groundwater chemistry data provided by NSNRR (2021c) demonstrate hardness that exceeds the Health Canada (2022) guidelines. In general, hardness in the Windsor Group was found to be approximately 222.9 mg/L across the geological bedrock group. The Health Canada guidelines consider an acceptable range between 80 mg/L and 100 mg/L. Although hardness is not an established guideline, this is considered a balanced range between corrosion and incrustation. Furthermore, the established issues with hardness within the Windsor Group are a generalization and an overview of potential issues. No drilled wells were found within the study area (Table 1B, Appendix C), and therefore site-specific quality or quantity conditions cannot be determined.

Additional concerns with the Windsor Group bedrock are found using the NSNRR (2021d, 2021e) risk mapping resources. Manganese in groundwater is considered 'high risk' within the site area. The risk of encountering karst terrain is also considered 'high risk' in the site area.

5.2.2 Bedrock Structure

The Windsor Group is a marine formation that contains other rocks, gypsum, limestone, dolostone, anhydrite and salt. It is an Early Carboniferous unit that occupies a range of about 600 km by 150 km in area. These carbonates/evaporites are primarily derived from shells and corals from the Carboniferous Period. The Lower Windsor Group is comprised of thin carbonates with evaporites overlain above. The Middle Windsor Group comprises interbedded evaporators and classics (siltstone and thin carbonates) (NBNRED, undated).

5.2.3 Bedrock Mineralization

The Mineral Resource Land Use Atlas (MRLUA) (NSNRR, 2002) was reviewed as part of this assessment. The MRLUA provides locations where bedrock mineralization is known or suspected, such as former or active mines, quarries, gold districts, diamond drill holes mineral occurrences, as well as zones containing sulphide-bearing slates. None of these conditions were found within 2 km of the site.

The geological contact zone separating the Lower and Middle Windsor Group formations is located within the site. Mineralization can occur near contact zones. A fault zone is also found within the eastern portion of the site; mineralization can also occur near fault zones (Drawing 3, Appendix A) (Micklethwaite et al., 2010).

5.2.3.1 Mineral Occurrences

Relevant information within the NS Mineral Occurrence Database (NSNRR, 2021a) was reviewed. No mineral occurrences were noted within the site or 2 km.

5.2.4 Water Quality Data

5.2.4.1 Water Quality from the Bedrock Aquifer

Groundwater derived from drilled wells in the Windsor bedrock group is generally found to be poor due to high dissolved solids contributing to hardness. Although no water chemistry results from wells were found within the site, general water chemistry parameters can be inferred from other resources. NSNRR (2021c) shows that a hardness exceeding 200 mg/L can be found in this geological bedrock. Hardness over 100 mg/L is generally too hard (Health Canada, 2022). Water from wells installed in or through Windsor Group bedrock can be very challenging to treat effectively.

There are relatively few cases in Nova Scotia where bacteria contaminate the aquifer. On-site sewage systems are designed to treat household wastewater and may risk groundwater quality. Installation guidelines provide adequate separation distances to groundwater wells; therefore, contamination is unlikely.

In some areas, additional casing and grouting could be required to protect the groundwater further. For example, in subdivision developments such as the proposed development, a minimum of 12.2 m of casing, with at least 3 m of grout, is recommended at the bottom of the casing, placed from the bottom upwards.

This site is considered high risk for manganese per Nova Scotia Natural Resources and Renewables (NSNRR 2021d).

Groundwater chemistry data was compiled from the NSNRR online database (2021c) and compared with the Health Canada GCDWQ (2022). Chemistry data from wells were not found within 5 km of the site and the Windsor bedrock group. Therefore, a greater area of 25 km was analyzed, and 17 drilled well chemistry reports were available, all completed within the Windsor Group bedrock. A summary of the water quality details is provided in Table 2 (Appendix C).

Conventional treatment is available for iron, manganese, and hardness if desired. All are usually treated at POE in household systems. The most common treatment method for hardness is water softening provided by ion exchange, which replaces hardness-causing ions with sodium or potassium, depending on whether the unit is backwashed/regenerated with sodium chloride (NaCl) or potassium chloride (KCl). Iron and manganese in commonly occurring concentrations are also removed by water softening.

Other common naturally occurring groundwater contaminants are arsenic and uranium. Both can be treated by conventional treatment, generally, at the point of use (POU) at a single faucet for water for drinking, cooking, and other human consumption uses. However, more property owners have been electing to treat arsenic and uranium at POE in recent years. More common and effective methods at POE include reverse osmosis (RO), anion exchange, and distillation. In addition, other emerging technologies are showing promise for effective heavy metal reduction, such as activated alumina and other adsorption media. Based on NSNRR's Groundwater Atlas (2022), arsenic and uranium risk in bedrock wells are categorized as low.

It is important to understand that the chemistry data were found for wells further than 5 km from the site; therefore, it is not necessarily indicative of the chemical properties of the on-site wells.

Note that water treatment dealers are not regulated in Nova Scotia. However, with all treatment technologies, consumers should only purchase systems certified by an accredited certification body to meet the appropriate National Sanitation Foundation (NSF) International standards. In addition, a detailed chemical analysis at an accredited laboratory is essential to assess a treatment unit's effectiveness.

5.2.5 Water Quantity Data

5.2.5.1 Water Quantity from the Bedrock Aquifer

The underlying Windsor Group bedrock is used as a water supply source for homes in the surrounding area. As such, wells placed within the site will require adequate depth and yield to supply newly constructed residences. The fault line along the eastern portion of the site

(Drawing 3, Appendix A) could act as a barrier or potentially improve the groundwater flow by creating a new, preferential flow path (Fronzi et al., 2021).

Table 1B (Appendix C) summarizes drilled well data from the NS Well Logs Database (2022) for the existing domestic wells located within 2 km of the site. As noted above, two of the dug wells (well numbers 971039 and 042685) were found at the same location along with drilled well (well number 981615).

The well logs indicate that according to the driller's interpretation of the bedrock type encountered during drilling, wells were installed through bedrock consisting of shale, sandstone, limestone, gypsum, and granite. Granite is an anomalous bedrock to find here and is perhaps attributed to an underlying granitoid lithology, possibly originating from the Horton Group (NBNRED, undated) and not representative of the area. Alternatively, the granite bedrock recorded in the Driller's log may result from erroneous identification.

Based on short-term driller's estimates for the 13 drilled wells mapped within the bedrock hydrostratigraphic units (HUs) within 2 km of the site, the average yield is approximately 104.0 Lpm for the Lower Windsor Group. These yields represent very short-term air lift yields estimated by the driller at the completion of well construction. However, it is important to note that long-term well production rates are typically 33% to 50% of the drillers' estimates, indicating actual longer-term yields may be in the 34.3 Lpm to 52.0 Lpm, or less, range.

The average drilled well depth was approximately 38.2 m. The well depths ranged from 25.9 m to 97.4 m.

The wells were drilled through varying surficial materials, including clay, sand, silt, and boulders ranging from 3.0 m to 33.5 m in thickness, followed by either shale, sandstone, limestone, gypsum, or granite bedrock.

Bedrock fractures in drilled wells appear to provide adequate supply for single-family residential needs. In situations where fracturing is well developed and interconnected or fracture traces intersect, larger yields may occur. However, poorly developed fractures resulting in low-yielding wells are possible and could result in an inadequate water supply as a primary source for residential needs. Driller's logs note fractures at various depths; however, most records list at least two fractures from any log; thus, the depth(s) of the main water-bearing fracture(s) is (are) not always known.

5.2.5.2 Drilled Well Data (NS Pumping Test Database)

Longer-term or more continuous safe yields must be evaluated by pump testing. Information on pump testing can be found on the Nova Scotia pumping test database (2021b). The nearest well with pump testing data within the Windsor Group formation is 11 km from the site. A list of the five pump test wells found within 15 km of the site, within the Windsor Group, can be found in Table 3 (Appendix C). Although these wells are located within the

same bedrock group, these wells are quite a distance from the site. This means that the information from these pump test wells grants a limited understanding of the local bedrock aquafer performance at the site.

The pump test statistics in Table 3 (Appendix C) indicate an average long-term safe yield (Q_{20}) of approximately 121.7 Lpm and an average apparent transmissivity (T) of 17.6 m^2/d. The Q_{20} and T ranges for the wells are 19.1 Lpm to 290.9 Lpm and 2.4 m^2/d to 64.0 m^2/d, respectively.

5.2.5.3 Nova Scotia Groundwater Observation Well Network - Fall River Well

An observation well (No. 076) is situated approximately 20 km south of the site, in the community of Fall River, Halifax County, which forms part of the Nova Scotia Groundwater Observation Well Network (NSECC, 2015).

According to available data, monitoring of the Fall River well started in 2008. In the Nova Scotia Groundwater Observation Well Network 2015 Report, the Fall River observation well is listed at 61.0 m deep, with 13.1 m of casing and drilled through slate bedrock. Based on a 4-hour pump test completed in 2008 by NSNRR (2021b), results indicated a T of 0.07 m^2/d, hydraulic conductivity of 1.21 x 10^{-3} m/day and an estimated safe yield rate of 1.48 Lpm. Groundwater chemistry results from 2008 indicated that no health-based drinking water guidelines were exceeded; however, three aesthetic drinking water guidelines were exceeded (pH, iron, and manganese). In addition, Volatile Organic Compounds (VOCs) and pesticides were not detected in this well during the analytical testing.

5.2.5.4 Municipal Wells

Based on the Nova Scotia Groundwater Atlas (NSNRR and NSECC, 2022) interactive map, no municipal wells are located near the site.

5.2.5.5 Potential Water Shortages, Well Construction, and Well Interference

The site is situated in an area with limited available resources to estimate potential well performance. Site performance cannot be determined without sufficient information of the underlying aquifer. Due to the lack of information on the performance of wells surrounding the site, it is recommended that a detailed Level II Assessment be completed.

Based on the review of well data near the study site, it must be assumed that water shortages can potentially arise. Therefore, as a precautionary plan, if development is to proceed, it is recommended that a detailed Level II well placement and pump testing program be undertaken.

Well construction should include the following technical requirements:

- All wells should be drilled to avoid contamination from septic systems.
- Typical well depth should be a minimum of 91 m unless high-yield surficial deposits are encountered.
- Well casing should be two lengths long or longer if the depth to bedrock exceeds 12.2 m (40 feet).
- Casing should be grouted in bedrock.
- Wells should be staggered between adjacent lots to reduce demand on the aquifer from wells too closely placed. A minimum of 30 m separations is recommended on smaller lots, preferably 50 m or more.
- Wells should have a yield of at least 22.8 Lpm (drillers air lift estimate) or be deepened accordingly to eliminate inadequate supply or excessive dewatering in wells (i.e., Q_{20} minimum of 9.1 Lpm).

Should water quantity be less than expected or shortages be experienced, several options are available, including:

- Deepening the well so that additional cold-water storage is available in the well bore itself.
- Well-stimulation/rehabilitation by hydraulic fracturing ('hydrofracturing'), surging, and jetting.
- Construction of additional well(s).
- Installation of secondary storage for peak demand.
- Augmentation of the well supply.

The various options available must be evaluated on a site-specific basis. However, to ensure that these options are cost-effective, the sooner any issues are resolved, the more cost-effective the development shall remain.

5.2.5.6 Water Conservation

Water conservation practices should be implemented into the planning process for new developments for areas serviced with groundwater wells. Examples of practices which may be considered include:

- Installing a water meter to provide awareness of water use, assist in problem investigations, and allow earlier leak detection.
- Using low-flow water devices such as toilets and shower heads.
- Consider alternative supplies in combination with drilled/dug wells, such as rainwater cisterns (e.g., use rainwater for outdoor uses such as washing vehicles, lawn watering, garden irrigation, etc.).
- Deliver water to fill swimming pools.
- Educating property owners on simple water conservation practices in the home, such

as spreading out loads of laundry rather than doing several loads at once, avoiding using several fixtures at one time (e.g., dishwasher, washing machine, shower), turning off faucets when not in use, checking for leaks, and turning the water off when away.

For a detailed review of water conservation measures, refer to Environment Canada and Climate Change (ECCC) and NSECC fact sheets (ECCC, 1995; NSECC, undated).

6.0 GROUNDWATER SUPPLY AND INFLUENCE

NSECC (2011) estimates a daily usage of approximately 1,350 Lpd per single residential household. For today's luxury homes with multiple bathrooms, hot tubs, swimming pools, water treatment units, etc., the daily use value may sometimes not be conservative enough. A simplified water balance calculation was used to estimate whether the available groundwater on each lot would meet the target water volume of 1,350 Lpd. The calculation and definitions below are based on those outlined in the NS Guide to Groundwater Assessments for Subdivisions Serviced by Private Wells (NSECC, 2011). According to NSECC (2011):

"The calculation assumes that the available groundwater is equal to the groundwater recharge that occurs on the lot, minus the amount of groundwater reserved for ecological use. Ecological use refers to groundwater that helps maintain ecological habitats by discharging as baseflow to surface waterbodies. Ecological use is assumed to be 50% of the groundwater recharge."

$$Q_{lot} = \frac{IA_{lot}E_{use}}{365\ days} \quad (1)$$

Where: Q_{lot} = Available groundwater from each lot (L/day)
I = Groundwater recharge rate (mm/year)
A_{lot} = Lot area contributing to recharge, excludes impermeable areas (m^2)
E_{use} = Percentage for recharge reserved for baseflow/ecological support (%)

Province-wide estimates for annual groundwater recharge have been compiled by NSNRR (Kennedy et al., 2010) using baseflow estimates from gauged watercourses. In addition, a literature survey was conducted, and all available baseflow estimates in Nova Scotia were compiled. Additional flow data from the Water Survey of Canada (WSC, 2009) gauging stations (>20-year continuous record, non-regulated) was compiled, and baseflow estimates were generated using a digital recursive filter (Lim *et al*., 2005). Finally, baseflow estimates were converted to recharge ratios, which could be used to estimate the distribution of groundwater recharge across the province. For the Primary Watershed, a recharge ratio of

14% was estimated, resulting in a recharge rate (**I**) of 188 mm/year.

$$A_{lot} = A_{avg} - \left(A_{avg} \times ISP\right) \quad (2)$$

Where **ISP** equals the percentage of impervious surface area in subdivision development. Based on a geomatic assessment of nearby residential subdivisions in Enfield, the percentage of the impervious surface area is approximately 4%; therefore, a conservative ISP of 8% was assumed for the lot water balance calculation. $\mathbf{A_{avg}}$ was determined by measuring the area of the site and then dividing it by the number of lots (16) for a value of 7,942 m^2.

Therefore:

$$A_{lot} = 7{,}942 - (7{,}942 \times 0.08) = 7{,}306.64\ m^2$$

As previously discussed, $\mathbf{E_{use}}$ is assumed to be 50% of available groundwater recharge (NSECC, 2011). Based on the equation and data noted above, the lot water balance calculation is as follows:

$$Q_{lot} = \frac{188mm/yr \times 7{,}306.64\ m^2 \times 0.5}{365days} = 1{,}882\ L/day$$

The site meets the lot water balance criteria since the available groundwater from each lot exceeds the target water supply volume of 1,350 Lpd. However, if the lot size is less than the target 7306.64 m^2, steps should be taken to compensate for the reduced water balance, such as additional well depth, increased lot size, etc.

To better evaluate the maximum density and long-term safe pumping rates, well separation distances, influence on nearby wells, and water quality, pump tests using observation wells are recommended. These effects, which can lead to negative interference between wells in a subdivision, can be significant and cumulative. Adequate lot size, adequate depth of wells, well spacing, and cold-water storage are key to reducing or eliminating these adverse effects. This data should be obtained in the subsequent development phase to help ensure that long-term water supply quantities of acceptable quality are available at the site.

There is a potential for decreased yield and/or lowered water levels over the long term as planned housing densities increase in the area, both in the study area and within the planned development. Therefore, long-term monitoring concerning this issue should be evaluated.

7.0 TOPOGRAPHY, DRAINAGE, AND WATERSHEDS

7.1 Regional Topography, Drainage, and Watersheds

The site lies within the Central Lowlands Ecodistrict, one of the largest ecodistricts in the Valley and Central Lowland Ecoregion. This area is drained by several large rivers, which all drain to the Bay of Fundy, except for the Musquodoboit River, which drains to the Atlantic Ocean. Some of the soils in this area experience a moisture deficiency in the summer, which can create opportunities for forest fires, and the majority of the ecodistrict is level with hummocky to undulating topography. The elevation within this ecodistrict rarely rises above 90 m above sea level [masl] (NSNRR, 2015).

The site sits at a maximum of 48 masl in the northwest corner and slopes off to a low of 30 masl in the southeast corner. The site is located within the Shubenacadie/Stewiacke Primary Watershed and the Shubenacadie River Secondary Watershed; these watersheds primarily drain to the Bay of Fundy. Headwaters for this area arrive from ecodistricts to the west, south, and east (NSNRR, 2015). Much of this headwater flows to the Grand Shubenacadie Lake, ultimately to the Bay of Fundy.

Surface water on the site will be controlled by topography and drainage ditches along established access roads. Drainage throughout the site shall flow according to the local topography (Drawing 5, Appendix A). As the site's highest elevation is at the northeastern corner, precipitation will naturally flow towards the south/southwest, and drain towards the Shubenacadie Grande Lake. From there, water will flow through the Shubenacadie River to the Bay of Fundy.

8.0 CONCLUSIONS

The proposed development area comprises a residential area of approximately 12.7 ha. A total of 16 lots are proposed, ranging in size from 0.67 to 1.3 ha. It is understood that the site is to be developed for residential purposes (i.e., no commercial or industrial uses). Road access to the site is gained through Renfrew Road, which is currently a dirt road along the site's southern boundary.

Although surficial wells are found within the study area, these are not recommended for use at the site. Surficial wells require a greater clearance from septic systems and are generally more likely to be impacted by surface or near-surface contaminants. A test pit program would be required to evaluate potential for surficial wells at this site.

The bedrock aquifer is expected to consist of the early Carboniferous age bedrock designated as the Windsor Group. The site is underlain by the Lower and Middle Windsor Formations.

Based on short-term driller's estimates from 13 drilled wells within the bedrock aquifer, the average yield from the Windsor Group formations within 2 km of the site was 104.0 Lpm.

Longer-term or more continuous safe yields were reviewed from the NS Pumping Test Database for wells located in the Windsor Group and found to be within approximately 25 km radius of the site. The average long-term safe yield (Q_{20}) is approximately 121.7 Lpm, with an average apparent transmissivity (T) of 17.6 m^2/d. Therefore, as a planning minimum, airlift estimates on wells should be at least 22.8 Lpm or more with long-term sustainable yield, Q_{20}, of at least 9.1 Lpm. Wells with these yields or lower should be deepened and re-evaluated. If yield cannot be increased, well depth must be increased to enhance cold water storage.

Based on recorded yields for the study area and various pump tests within the Windsor Group aquifers, adequate sustainable yields are possible in wells within this proposed development. However, the contact zone and fault line found within the site could impact groundwater availability more locally. In addition, the lack of available pumping data closer to or within the site reduces the confidence of whether adequate water quantity is available for the development.

There are no water chemistry wells near the site. A survey of wells within 25 km of the site and within the same bedrock group was used to gauge likely water quality concerns. Water quality from these drilled wells indicates significant water quality issues pertaining to hardness, pH, iron, and manganese. Treatment options are available to reduce these groundwater contaminants in line with the proposed Health Canada Guidelines, although water quality in wells placed in Windsor Group bedrock can be extremely challenging to treat effectively. The lack of water chemistry data near the site is a concern and reduces the confidence in predicted water quality within the site.

Potential environmental concerns related to the proposed future development were noted during the site visit, historical records review, or previous assessment. These concerns are related to arsenic, elevated naturally occurring metals in site soils, karst terrain, radon, manganese, uranium, and potential wetlands.

A simplified water balance calculation estimated the available groundwater on each lot to be 1,882 Lpd. NSECC (2011) estimates a daily usage of approximately 1,350 Lpd, per single-family dwelling. Since the available groundwater from each lot is greater than the target water supply volume of 1,350 Lpd, it meets the lot water balance criteria. It is important to note that as the density of homes and wells increases in any area, there is more potential for change in well yields and water levels in the aquifer with time. Therefore, assessing such effects on the proposed development and surrounding homes in the study area should be considered. Given expected yields and water balance assessment, wells placed for individual residential homes in this development are expected to be sustainable. Assuming wells provide similar yields when drilled, and are adequate in depth, minimal effect is anticipated on surrounding users on drilled wells.

Limited information is available which speaks to the performance of the bedrock aquifer at the site. Additionally, two distinct geological features are found at the site, a contact zone and a fault line, which have an unknown impact on groundwater flow at the site. For these reasons, a Level II Groundwater Assessment is recommended to better examine whether there will be proper quality and quantity of groundwater for the development.

9.0 RECOMMENDATIONS

Based on the findings of the Level I Groundwater Assessment, the following recommendations are forwarded:

1. The lot size recommended to meet the daily water balance calculation requirement is 7,942 m^2. If any lot falls below this size, steps should be taken to ensure well separation is adequate, well depth is increased, etc.

2. It is recommended that the next evaluation phase be undertaken, which is a Level II Groundwater Assessment. This will require the installation of a minimum of three test wells. The test well layout should be parallel and perpendicular to major structural trends to consider anisotropy. In addition, the density of wells, effects of linear well placement, and assessment of long-term interference between wells should be evaluated.

3. Well depth should be 91 m (300 feet) minimum, unless the desired air lift yield is attained at a shallower depth, with two casing lengths or to bedrock (whichever is greater) and grouted in place. Additional depth should be added if the driller's air lift yield is less than 22.8 Lpm. Wells should be spaced at least 30 m minimum from one another or greater at the planning stage.

4. Step drawdown, long-term pump testing, and analytical testing that meets current NS Guidelines for Subdivisions should be carried out on each test well. It will be important to confirm available information and verify how many wells can be supported in the given area, the long-term safe yield from each well, and evaluate potential interference effects and long-term trends in water levels in the bedrock aquifer.

5. During step testing and pump testing, observation wells should be monitored.

6. Analytical testing on samples from each test well should be collected as part of a Level II Groundwater Assessment, which would include an analysis of water samples for general chemistry and metals (RCAp-MS), fluoride, Volatile Organic Compounds (VOCs), and bacteria (total coliform and E. coli by actual count). In addition, water treatment options and management of those options (treatment devices) should be implemented if quality issues exist.

7. Monitoring of any surface water bodies within 60 m should be conducted during the pump test program to assess surface–groundwater interactions.

8. Potential environmental concerns related to the proposed future development were noted. These concerns are related to arsenic, elevated naturally occurring metals in site soils, karst terrain, radon, manganese, uranium, and potential wetlands. Recommendations concerning this are provided in Section 4.2.4.

9. A layout of lots, including location of proposed homes, well location, and septic should be developed. The design should include a stormwater management plan to minimize impacts to adjacent wetlands and watercourses.

10.0 STATEMENT OF QUALIFICATIONS AND LIMITATIONS

This Report (the "Report") has been prepared by Strum Consulting (the "Consultant") for the benefit of M&M Developments Ltd. (the "Client") in accordance with the agreement between the Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations, and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations")
- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- was prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental, or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental, or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

Consultant agrees that the Report represents its professional judgement as described above and that the Information has been prepared for the specific purpose and use described in the Report and the Agreement, but Consultant makes no other representations, or any guarantees or warranties whatsoever, whether express or implied, with respect to the Report, the Information or any part thereof.

The Report is to be treated as confidential and may not be used or relied upon by third parties, except:

- as agreed in writing by Consultant and Client
- as required by law
- for use by governmental reviewing agencies

Consultant accepts no responsibility, and denies any liability whatsoever, to parties other than Client who may obtain access to the Report or the Information for any injury, loss, or damage suffered by such parties arising from their use of, reliance upon, or decisions or actions based on the Report or any of the Information ("improper use of the Report"), except to the extent those parties have obtained the prior written consent of Consultant to use and rely upon the Report and the Information. Any damages arising from improper use of the Report or parts thereof shall be borne by the party making such use.

This Statement of Qualifications and Limitations forms part of the Report and any use of the Report is subject to the terms hereof.

Should additional information become available, Strum requests that this information be brought to our attention immediately so that we can re-assess the conclusions presented in this report. This report was prepared by Alex Scott, BSc., EPt, Junior Environmental Scientist and reviewed by A. Bruce Strum, P.Geo., Senior Hydrogeologist.

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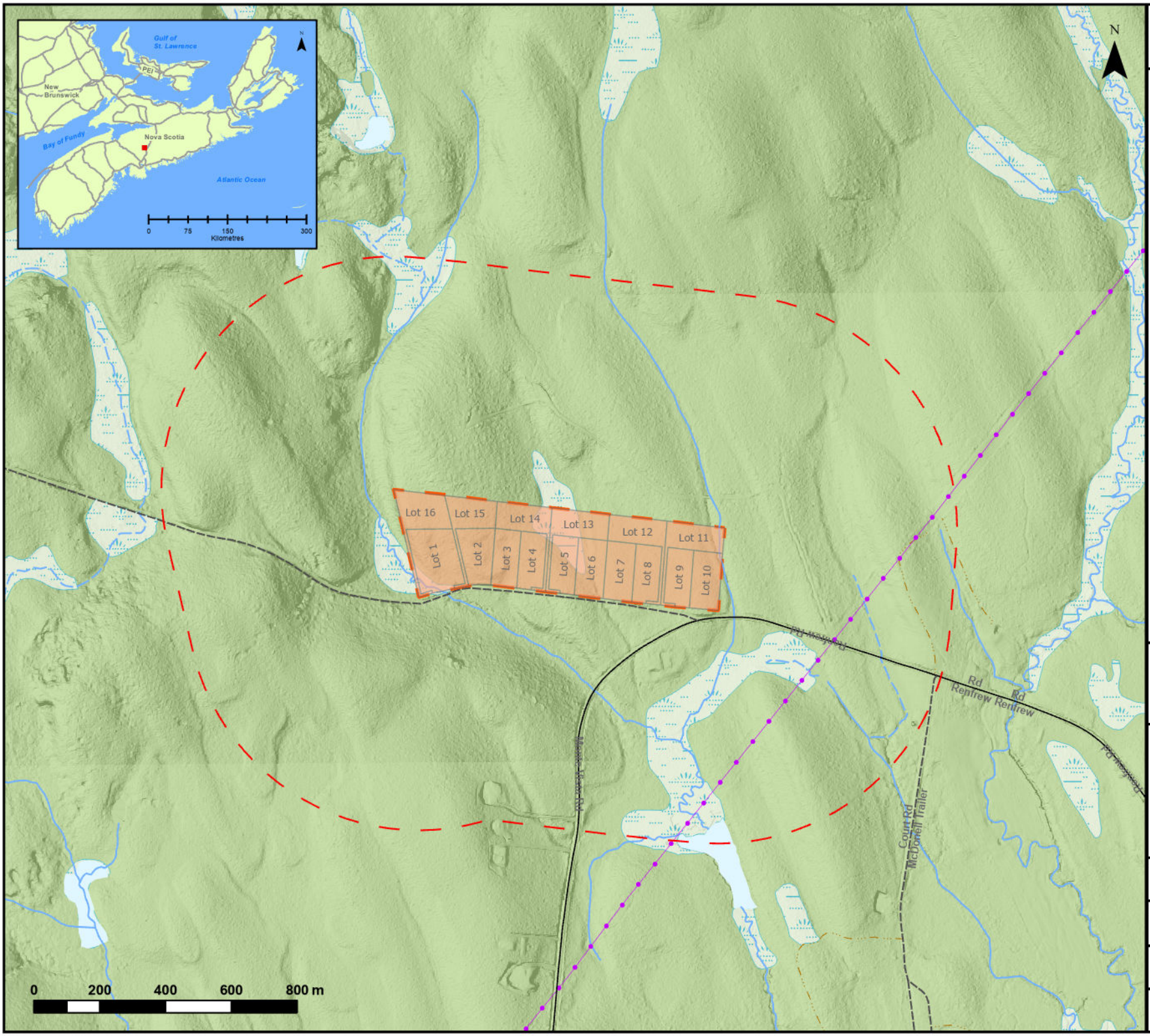
APPENDIX A
DRAWINGS



Notes:

1. Sources: ESRI Basemaps, GeoNOVA, NSTD, HERE, Garmin, USGS, NRCan
2. Projection: NAD83 UTM Zone 20 North.

- Study Area
- Proposed Development

Transportation

- Local Road
- Unpaved Road
- Track

Utilities (line)

- Existing Transmission Lines

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers
- Mapped Wet Area

Site Plan

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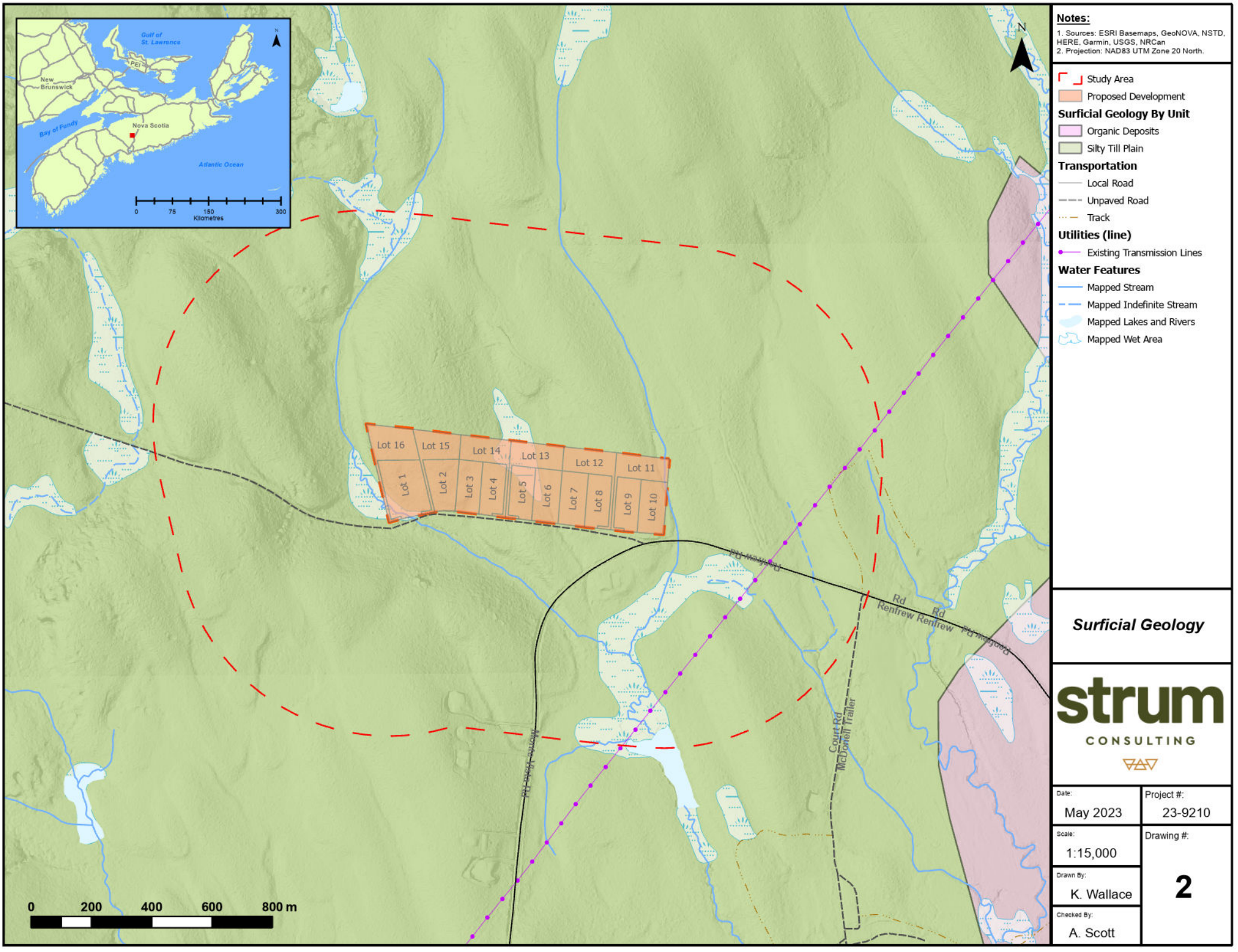
Date: May 2023	Project #: 23-9210
Scale: 1:15,000	Drawing #: 1
Drawn By: K. Wallace	
Checked By: A. Scott	



Notes:

1. Sources: ESRI Basemaps, GeoNOVA, NSTD, HERE, Garmin, USGS, NRCan
2. Projection: NAD83 UTM Zone 20 North.

- Study Area
- Proposed Development

Surficial Geology By Unit

- Organic Deposits
- Silty Till Plain

Transportation

- Local Road
- Unpaved Road
- Track

Utilities (line)

- Existing Transmission Lines

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers
- Mapped Wet Area

Surficial Geology

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Date: May 2023	Project #: 23-9210
Scale: 1:15,000	Drawing #: 2
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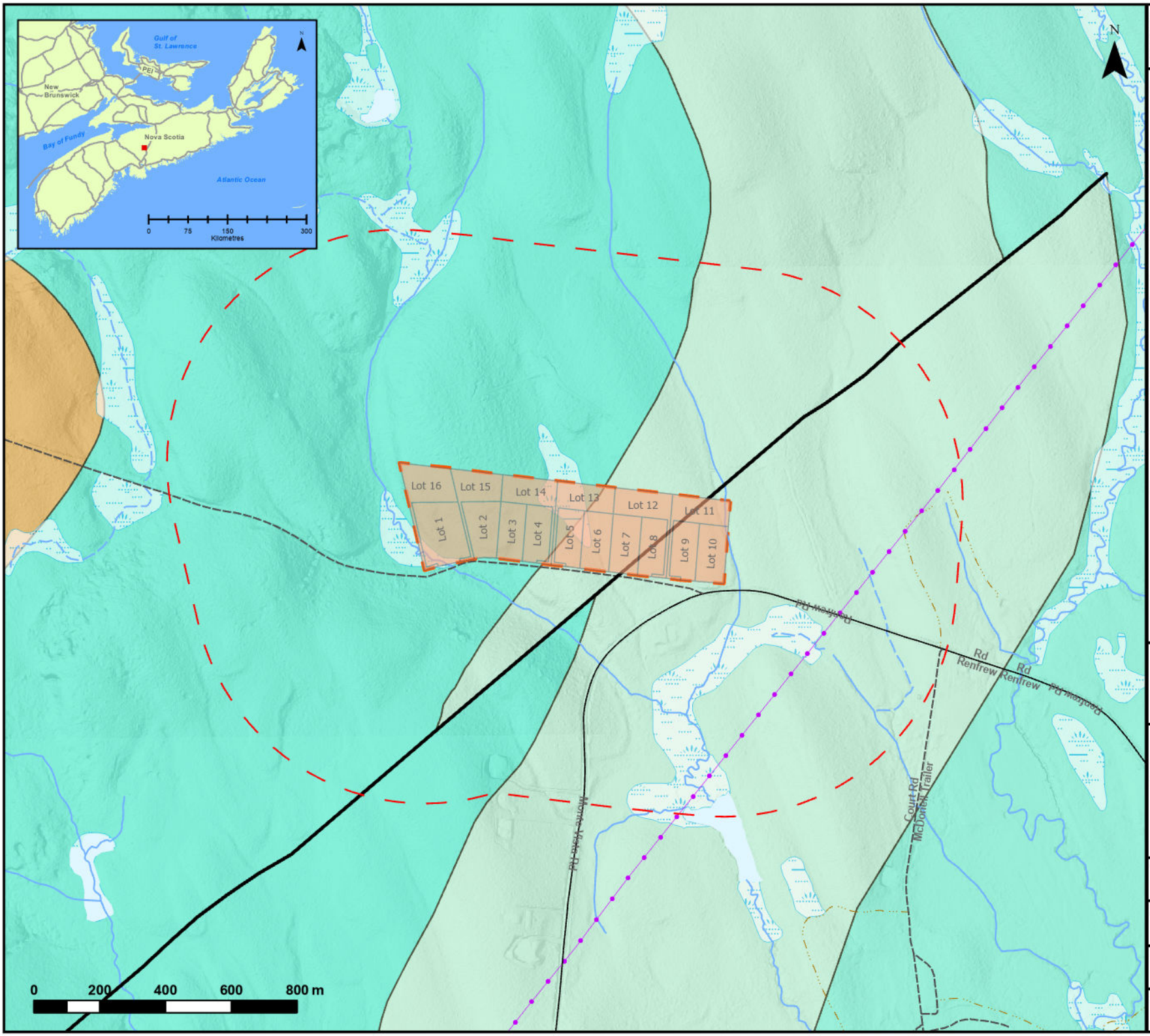
Checked By: A. Scott	



Notes:

1. Sources: ESRI Basemaps, GeoNOVA, NSTD, HERE, Garmin, USGS, NRCan
2. Projection: NAD83 UTM Zone 20 North.

- Study Area
- Proposed Development

Bedrock Geology By Formation

- Murphy Road, Pesaquid and Green Oaks Formations
- Wentworth Station, Miller Creek, MacDonald Road and Elderbank Formations
- White Quarry, Stewiacke, Carrolls Corner, Macumber and Gays River Formations
- Goldenville Formation
- Fault Line

Transportation

- Local Road
- Unpaved Road
- Track

Utilities (line)

- Existing Transmission Lines

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers
- Mapped Wet Area

Bedrock Geology

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Date: May 2023	Project #: 23-9210
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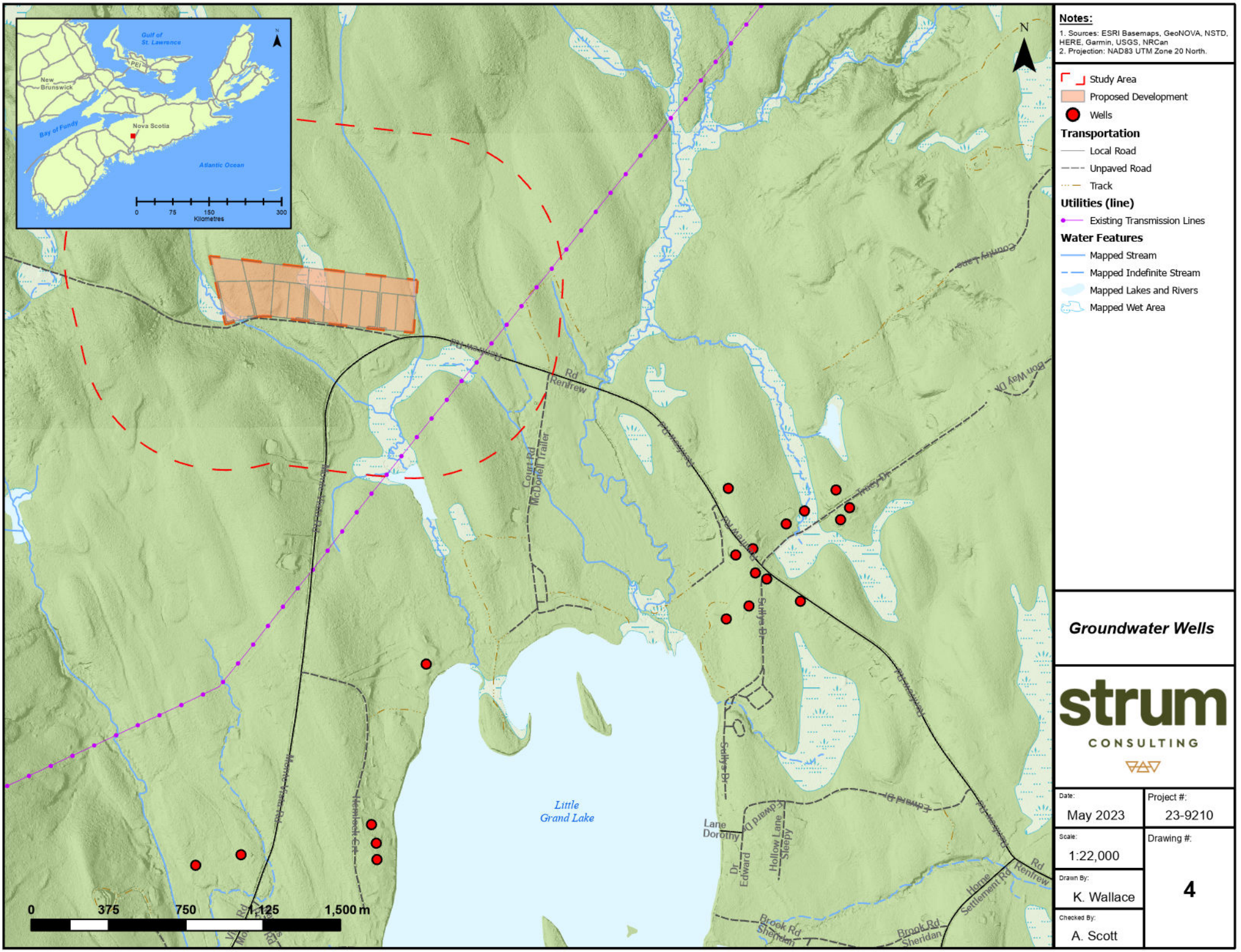
Checked By: A. Scott	



Notes:

1. Sources: ESRI Basemaps, GeoNOVA, NSTD, HERE, Garmin, USGS, NRCan
2. Projection: NAD83 UTM Zone 20 North.

- Study Area
- Proposed Development
- Wells

Transportation

- Local Road
- Unpaved Road
- Track

Utilities (line)

- Existing Transmission Lines

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers
- Mapped Wet Area

Groundwater Wells

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Date: May 2023	Project #: 23-9210
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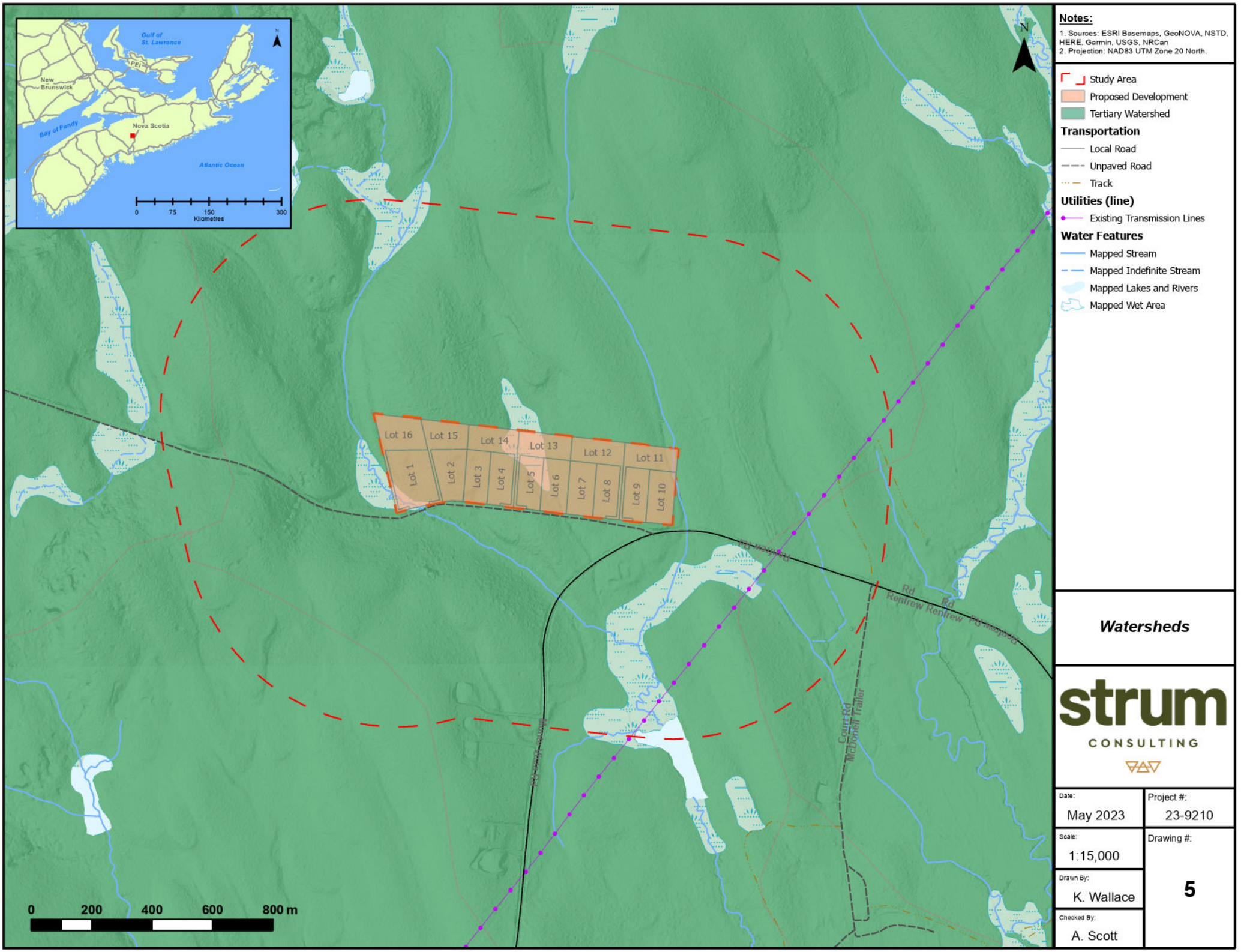
Checked By: A. Scott	



Notes:

1. Sources: ESRI Basemaps, GeoNOVA, NSTD, HERE, Garmin, USGS, NRCan
2. Projection: NAD83 UTM Zone 20 North.

- Study Area
- Proposed Development
- Tertiary Watershed

Transportation

- Local Road
- Unpaved Road
- Track

Utilities (line)

- Existing Transmission Lines

Water Features

- Mapped Stream
- Mapped Indefinite Stream
- Mapped Lakes and Rivers
- Mapped Wet Area

Watersheds

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Date: May 2023	Project #: 23-9210
Scale: 1:15,000	Drawing #: 5
Drawn By: K. Wallace	
Checked By: A. Scott	

APPENDIX B
PHOTOGRAPH LOG

Photo 1: View looking west from the access road entry on Renfrew Road.

Photo 2: View looking east from the access road entry on Renfrew Road.

Photo 3: View looking north from northeast corner of the site along Renfrew Road.

Photo 4: View looking north from Renfrew Road of a mapped watercourse along the eastern boundary of the site.

Photo 5: View looking northwest on the Renfrew Road, from the southwest corner of the site. Mapped wetland that abuts site boundary.

Photo 6: View looking north from the within the center of the site. Apparent wetland as seen from imagery.

Photo 7: View looking to the south from Renfrew Road. Transmission line found a few hundred metres to the east of the site. Large open bodies of water.

Photo 8: View looking to the west from Renfrew Road. An access road which leads to deforested lands to the north of the site.

Photo 9: View looking south from the Renfrew Road. Apparent unofficial memorial of an old automobile accident.

Photo 10: Rubbish found within site. Including a plasitc bin, plastic bag, an aluminium can, and animal remains.

APPENDIX C
DATA TABLES

Table 1A: Summary of Dug Well Data from the NS Well Logs Database (for properties located within 2 km of the Project site)

Project #23-9210

DUG WELL LOCATION					DUG WELL INSTALLATION DETAILS								GEOLOGICAL AND HYDROGEOLOGICAL DETAILS FROM WELL LOGS			
Well Number	Address	Property ID	Community	County	Date	Well Depth (m)	Casing (m)	Bedrock (m)	Static (m)	Estimated Driller's Yield (Lpm)	Water Use	Well Type	Till Depth (m)	Till Lithology	Bedrock Lithology	WBF (m)
Ground Morraine and Streamlined Drift																
101687	416 MONTE VISTA ROAD, ENFIELD, HANTS EAST	45207263	MONTAVISTA	HANTS	2010-11-05	7.31	-	-	-	-	Domestic	DUG	7.31	Topsoil, Sand and Clay	-	2, 4
81137	133 HEMLOCK COURT, ENFIELD	45211414	MONTAVISTA	HANTS	2008-12-19	7.00	-	-	1.83	18.16	Domestic	DUG	7.00	Topsoil, Clay and Sand	-	2, 4, 5, 7
991302	HEMLOCK COURT	45211406	HORNE SETTLEMENT	HANTS	1999-06-08	5.48	5.48	-	4.87	317.80	Domestic	DUG	5.48	Topsoil and Sand Lenses	-	-
80371	31 HEMLOCK COURT, ENFIELD	45336534	MONTAVISTA	HANTS	2008-10-28	6.39	-	-	1.83	15.89	Domestic	DUG	6.39	Sand and Clay	-	2, 6
1564	HEMLOCK COURT	45211398	HORNE SETTLEMENT	HANTS	2000-10-29	7.31	7.61	-	2.44	154.36	Domestic	DUG	7.31	Loam, Topsoil, Clay and Rock	-	-
42685	MONTEVISTA ROAD	-	HORNE SETTLEMENT	HANTS	2004-08-25	9.14	9.14	-	1.83	45.40	Domestic	DUG	9.14	Silt, Sand, and Clay	-	3, 8
971039	LAKE ROAD	-	HORNE SETTLEMENT	HANTS	1997-07-28	6.39	6.39	-	3.65	9.08	Domestic	DUG	6.39	Clay and Unknown	`	-
980769	BACKYARD, ENFIELD	-	HORNE SETTLEMENT	HANTS	1998-01-15	6.09	6.09	-	1.52	45.40	Domestic	DUG	6.09	Loam and Clay	-	-
					Minimum	5.48	5.48	0.00	1.52	9.08						
					Maximum	9.14	9.14	0.00	4.87	317.80						
					Average	6.89	6.94	-	2.57	86.58						

Shading indicated wells found at the same location

Table 1B: Summary of Drilled Well Data from the NS Well Logs Database (for properties located within 2 km of the Project site)

Project #23-9210

DRILLED WELL LOCATION					DRILLED WELL INSTALLATION DETAILS								GEOLOGICAL AND HYDROGEOLOGICAL DETAILS FROM WELL LOGS			
Well Number	Address	Property ID	Community	County	Date	Well Depth (m)	Casing (m)	Bedrock (m)	Static (m)	Estimated Driller's Yield (Lpm)	Water Use	Well Type	Till Depth (m)	Till Lithology	Bedrock Lithology	WBF (m)
White Quarry, Stewiacke, Carrolls Corner, Macumber and Gays River Formations (Lower Windsor Group)																
150107	529 RENFREW ROAD, ENFIELD	45081346	BELNAN	HANTS	2015-09-01	31.97	21.32	18.27	3.04	68.10	Domestic	DRILLED	18.27	Clay	Shale and Sandstone	27, 30
150127	517 RENFREW ROAD, ENFIELD	45235413	HORNE SETTLEMENT	HANTS	2015-09-30	35.02	9.44	3.04	1.83	181.60	Domestic	DRILLED	3.04	Sand	Limestone	32
130774	9 TRACEY DRIVE (TRACY DRIVE), ENFIELD	45393212	HORNE SETTLEMENT	HANTS	2013-10-23	37.15	31.67	11.57	3.65	136.20	Domestic	DRILLED	11.57	Clay and Stone	Limestone and Shale	35
111034	24 TRACY DRIVE (TRACEY DRIVE), ENFIELD	45283744	HORNE SETTLEMENT	HANTS	2011-06-22	36.84	29.08	6.39	6.39	136.20	Domestic	DRILLED	6.39	Clay and Boulders	Limestone and Shale	30, 32, 35
82065	34 TRACEY (TRACY) DRIVE, ENFIELD, HRM	45283769	BELNAN	HANTS	2008-01-05	31.97	13.40	10.66	4.57	45.40	Domestic	DRILLED	10.66	Clay	Sandstone	15, 30
140515	505 RENFREW ROAD, ENFIELD	45396470	HORNE SETTLEMENT	HANTS	2014-12-11	25.88	14.31	11.57	-	45.40	Domestic	DRILLED	11.57	Clay	Sandstone	18, 24
100836	35 & 37 TRACY DRIVE (TRACEY DRIVE), ENFIELD	45283751	HORNE SETTLEMENT	HANTS	2010-06-23	31.06	18.27	5.18	5.79	340.50	Domestic	DRILLED	5.18	Clay and Stones	Shale and Limestone	18, 23, 26, 30
981615	RR#2 SHUBENACADIE	-	HORNE SETTLEMENT	HANTS	1998-07-07	97.44	35.02	33.50	-	-	Domestic	DRILLED	33.50	Clay and Boulders	Granite and Unknown	-
200422	SULLYS DRIVE	45403243	ENFIELD	HANTS	2020-08-10	42.63	18.27	14.01	-	90.80	Domestic	DRILLED	14.01	Clay	Gypsum	31, 37
200185	479 RENFREW ROAD	45081320	ENFIELD	HANTS	2020-06-16	25.88	10.96	9.14	4.57	45.40	Domestic	DRILLED	9.14	Clay	Limestone	12, 17, 18
100768	536 RENFREW ROAD, ENFIELD	45209467	HORNE SETTLEMENT	HANTS	2010-09-08	31.97	24.97	22.53	9.14	36.32	Domestic	DRILLED	22.53	Clay	Sandstone, Limestone	31
101356	25 TRACEY DRIVE (OFF RENFREW ROAD), ENFIELD	45283736	HORNE SETTLEMENT	HANTS	2010-10-05	30.45	18.27	14	-	68.10	Domestic	DRILLED	13.70	Silt	Sandstone	15, 20, 25
160034	521 RENFREW ROAD, ENFIELD	45235421	HORNE SETTLEMENT	HANTS	2016-05-03	38.06	16.75	14.92	-	54.48	Domestic	DRILLED	14.92	Clay	Sandstone	21, 37
					Minimum	25.88	9.44	3.04	1.83	36.32						
					Maximum	97.44	35.02	33.50	9.14	340.50						
					Average	38.18	20.13	13.42	4.87	104.04						

Shading indicated wells found at the same location

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Table 2: Summary of Groundwater Chemistry from Drilled Wells within 25 km of the Study Area *Project # 23-9210*

Sample ID	Sample Date	Groundwater Region	Alkalinity (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	F (mg/L)	SO_4 (mg/L)	Cl (mg/L)	Hardness (mg/L)	TDS (mg/L)	pH	NO3 - NO2N (mg/L)	As (µg/L)	U (µg/L)	Fe (µg/L)	Mn (µg/L)
GSC2495	1975-07-15	Carbonate/Evaporite	31	-	-	-	-	-	-	0.05	-	-	-	-	5.94	-	-	0.1	5	**95**
Reg5476	2017-09-19	Carbonate/Evaporite	180	180	1.5	11	1.1	81	13	0.22	41	54	260	320	7.95	0.025	0.5	0.05	150	10
GSC2450	1975-07-12	Carbonate/Evaporite	67	-	-	-	0.5	23.5	-	0.05	-	4.9	-	-	8.06	-	-	0.1	192	**137**
Reg5265	2017-06-16	Carbonate/Evaporite	190	190	0.5	55	1.2	80	9.2	0.05	25	110	240	410	7.63	0.025	0.5	0.82	25	18
GSC2487	1975-07-15	Carbonate/Evaporite	238	-	-	-	-	-	-	0.05	-	-	-	-	6.74	-	-	0.4	276	19
Reg5245	2017-06-16	Carbonate/Evaporite	88	88	0.5	33	0.54	39	5.1	0.13	120	4.3	120	260	7.48	0.025	3	0.19	330	**110**
Reg5917	2012-07-19	Carbonate/Evaporite	240	240	1.4	144	1.6	-	30.6	0.11	150	**460**	680	**1170**	7.78	0.025	0.5	0.5	303	**466**
GSC2482	1975-07-14	Carbonate/Evaporite	140	-	-	-	-	-	-	0.05	-	-	-	-	6.37	-	-	1.4	115	**29**
Reg6583	2020-09-02	Carbonate/Evaporite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**42**
SWAG45	2002-09-18	Carbonate/Evaporite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-	-
GSC2492	1975-07-15	Carbonate/Evaporite	171	-	-	-	-	-	-	0.05	-	-	-	-	7.32	-	-	0.9	3394	**20**
Reg6611	2020-09-21	Carbonate/Evaporite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**2220**
GSC2503	1975-07-15	Carbonate/Evaporite	41	-	-	-	-	-	-	0.05	-	-	-	-	5.93	-	-	0.4	81	11
Reg5184	1993-09-29	Carbonate/Evaporite	298	-	-	90	1.9	132	40.2	-	30	229	495	-	7.4	0.85	1	2.8	30	**50**
SWAG114	2002-09-18	Carbonate/Evaporite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	-	-
GSC2489	1975-07-15	Carbonate/Evaporite	57	-	-	-	-	-	-	0.05	-	-	-	-	6.3	-	-	0.1	6152	**113**
Reg5289	2017-08-28	Carbonate/Evaporite	100	99	0.5	10	1.2	32	3.2	0.12	4.9	12	93	140	8	0.064	1.1	0.05	25	2.2
Health Canada Drinking Water Guidelines			-	-	-	**200 (AO)**	-	-	-	**1.5 (MAC)**	**500 (AO)**	**250 (AO)**	**80-100**	**500 (AO)**	**7-10.5**	-	**10 (MAC)**	**20 (MAC)**	**300 (AO)**	**120 (MAC) 20 (AO)**

Notes:

MAC = Maximum Concentration, **AO** = Aesthetic Objective

*** MAC, and AO values based on Guidelines for Canadian Drinking Water Quality (Health Canada, 2022)**

Shading indicates exceedence of MAC

Bold Bolding indicates exceedance of AO

Shading indicates outside of optimal range

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Table 3: Summary of Pumping Test Data - Wells Drilled Through the Windsor Group Bedrock *Project # 23-9210*

Pumping Test ID	Well No.	County	Community	Test For	Test Start	Test End	Geology (HU)	Well Depth (m)	Casing Diameter (mm)	Static (m)	Pump Setting (m)	Average Pumping Rate (m^3/d)	Available Drawdown (m)	Max Drawdown (m)	Total Recovery (m)	Recovery (mins)	Hydraulic Conductivity (m/d)	Transmissivity (apparent) (m^2/d)	Specific Capacity (m^2/d)	Long-Term Yield (Q_{20}) (Lpm)
Windsor Group																				
HAL-124	50891	Halifax	Carrolls Corner	Carrolls Corner Community Centre, Halifax Regional Municipality	1-19-2006	1-20-2006	WI	56.39	152.4	5.31	48.77	46.34	46.65	8.93	9.52	120	4.70E-02	2.4	5.19	52.8
HAN-11	640238	Hants	Milford Station	Colchester-Hants East Rural High School, Municipality of the County of Colchester	3-18-1973	3-21-1973	WI	51.82	152.4	5.43	48.77	294.55	42.67	16.15	-	-	2.87E-01	12.68	18.23	204.5
HAN-16	-	Hants	Milford Station	NS Housing Commission/Housing Authority Project	12-28-1989	12-31-1989	WI	27.74	152.4	5.87	-	120.44	18.29	11	10.82	180	-1.00E+04	2.77	10.95	19.1
HAN-20	972405	Hants	Milford Station	Milford Station Middle School		8-12-1997	WI	62	203.2	26.5	-	399.27	27.9	11.5	-	-	1.73E+00	64	36.5	290.9
HAN-32	-	Hants	Milford Station	Chignecto Central Regional School Board	7-30-2009	7-31-2009	WI	37.8	152.4	7.3	32	245.4	24.7	18.72	17.84	240	1.99E-01	6.1	13.1	41
							Minimum	27.74	152.4	5.31	32	46.34	18.29	8.93	9.52	120	-1.00E+04	2.4	5.19	19.1
							Maximum	62.0	203.2	26.5	48.8	399.3	46.7	18.7	17.8	240.0	1.7	64.0	36.5	290.9
							Average	47.15	162.56	10.08	43.18	221.20	32.04	13.26	12.73	180.00	-1999.35	17.59	16.79	121.66