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TECHNICAL REPORT

Potable Well Water Quality Survey, Village of Spencerville
Report Date: November 6, 2020

Purpose

The ministry was contacted by multiple residents from the Village of Spencerville during July and August of 2020 with respect to adverse bacterial groundwater quality results and concerns that the issue may be the result of recent activities conducted in the village. The adverse bacterial results were identified through private water samples being collected by village residents and submitted to the Ontario Public Health Lab through the local Health Unit. Some residents also reported a noticeable change to the colour and odour of their groundwater supply. Specific concerns were raised with respect to the activities associated with the construction of a four-unit residential building under construction at 32 David Street. Those items identified as a potential concern included: bedrock excavation for foundation and sewer connection installations, the installation of four (4) drinking water wells, and alleged concerns related to the sewer connection installations.

In response to the concerns, the ministry conducted a survey of groundwater quality in the community to determine the cause of the adverse bacterial water quality results. This report is intended to provide a summary of the groundwater quality survey and to provide conclusions, for consideration, with respect to the future management of private supply wells in the area.

Background

The village of Spencerville is located approximately 15 kilometres north of Prescott in the Township of Edwardsburgh / Cardinal. Residences in Spencerville are privately serviced for water supply (individual water wells) however sewage is handled by a communal sewage system (sanitary sewers direct wastewater to lagoons located east of the village).

The communal sewage system was installed following a private well and septic system study completed by M.S Thompson and Associates in 1984 (Thomson 1985). The 1984 study was funded through a provincial grant program after concerns from residents were received and based on the results of a joint study conducted by the Ministry of the Environment and the Health Unit in 1982. This study indicated that many of the 190 residences and commercial buildings used by the population of 350 at that time had contaminated well water supplies. The detailed study completed by Thompson was undertaken to determine remediation options to address widespread poor well water quality. The study determined the following:

- 54% of 184 water supplies included in the study were significantly substandard or unfit for human consumption. Of these wells, 18% were recommended for further investigation and 5% were recommended for water treatment (iron and sulphur). It was indicated that new (more secure) wells should be drilled at the remaining locations.

- Well construction characteristics for new wells was investigated and specified by Thomson. The recommended well construction involved drilling deep wells (greater than 35 metres deep) with longer casing lengths (greater than 25 metres) in order to access a deep less vulnerable aquifer that would not be influenced by shallow contamination sources. The well remediation plan also involved proper abandonment of old wells. Thomson indicated that the drilling, casing and cement pressure grouting of new wells would permit adequate water supplies to be obtained below the identified shallow groundwater contamination.

- 80% of the 184 survey locations had sewage disposal systems which were malfunctioning. It was also found that lots in the village were too small to accommodate proper septic / tile bed systems. Thomson recommended installation of a communal sewage system for 113 homes in order to replace malfunctioning septic systems.

It is understood that the sewage system was constructed from 1989 through 1990 and that approximately 150 homes were connected to this system. In 1990, funding was received from the province for the implementation of the Private Services Grant Program. Under this program, an 85% grant from the Ministry of the Environment became available to property owners for the implementation of individual correction to wells and sewage systems as recommended in the Thomson report.

Based on information provided by the Project Engineer who worked on the Private Services Grant Program (Gorrell Resource Investigations), the following work was completed at / near the end of the grant program (work completed to May 31, 1993):

- Fifty-nine (59) new water supply wells were installed out of a total of seventy-seven (77) residences that were eligible for well replacement;

- One (1) well was abandoned out of a total of 8 that were identified for abandonment;

- Water treatment (iron and sulphur) was installed at 34 out of a total of 47 residences (based on water quality encountered after installation);

- No further investigation was conducted at additional well locations although further investigation was identified at 27 well locations; and,

- Overall, 159 work items were identified for the water supply portion of the program and 94 items were completed.

Geology

The geology of the study area was previously investigated as part of the Private Services Grant Program application in the 1980's (Thomson 1985). Information contained in this section draws from details provided in the Thompson Report and also considers additional information obtained from available well records.

Overburden in the area is composed of Covington Till which is characterised by a bouldery sandy clay. Overburden thickness throughout much of the study area is very limited with exposed bedrock and outcrops identified in some areas. Thompson (1985) reported that overburden ranges in thickness from 0 to 4 metres. To the south of the South Nation River a relatively thick marine layer is present exceeding 10 metres in thickness in some areas.

Underlying bedrock within the village typically consists of variably bedded dolostone of the Oxford Formation. The Oxford Formation is expected to range in thickness from 0 to greater than 35 metres with the upper few metres expected to be highly weathered and fractured.

The Oxford Formation is underlain by the March Formation which consists of interbedded grey limestone and sandstone. The two units have a transitional non-distinct boundary. The March formation has been reported to have a thickness of at least 25 metres.

The March formation is underlain by the Nepean Formation which consists of grey sandstone. The Nepean Formation was not fully penetrated as part of the previous investigations, so the thickness is not known.

Hydrogeology and Aquifer Vulnerability

The Oxford, March and Nepean Formations support viable aquifer units in the area (i.e. there are groundwater supplies suitable for domestic use in each of these formations). Shallow groundwater flow is expected to flow in a southeasterly direction from the village of Spencerville and towards discharge at the South Nation River, consistent with local topography.

The limited overburden and shallow fractured nature of the bedrock present in the village to the north of the South Nation River make the underlying bedrock aquifers, and particularly the shallow aquifer unit in the Oxford Formation, highly vulnerable to surface contamination. The presence of the thick marine clay layer in areas to the south of the Nation River make that area less vulnerable to surface contamination.

In general, groundwater supplies in shallow fractured bedrock aquifers are considered highly vulnerable to contamination due to rapid groundwater velocity and potential microorganism transport in these aquifers. Rainfall events can have a significant impact on groundwater quality by facilitating transportation of coliforms (and other microorganisms) from the surface and subsurface (Health Canada, 2020a).

Potential sources of surface / shallow contamination that can impact water quality in a sensitive setting include animal feces (pets, wild animals, birds), and contamination associated with surface water runoff (e.g. agricultural and urban runoff).
The Thompson Study (1985) indicated that water obtained from the Oxford Formation is often sulphurous and mineralised. During the well replacement program elevated iron and sulphur were also identified in the March/Nepean Formation.

Study Area

The ministry water quality survey was conducted within the village of Spencerville north of the South Nation River in an area approximately bounded by the river to the south, Cedar Street to the west, Spencer and Bennett Streets to the East and Goodin Road to the north. A single sample was also collected from a home located on Beverly Street located southwest of the village.

Fewer homes, larger lot sizes, and a less sensitive geological setting make the area located south of the South Nation River less vulnerable to contamination. For this reason, the study area was limited to those areas located north of the South Nation River.

In order to comply with personal privacy protection requirements, personal information (names and addresses) have not been provided in this report. Given this limitation and in order to still allow for spatial interpretation of the data, the study area has been broken up into three discussion areas (A, B, and C). Sample results have also been tabulated in this report according to area so that the individual sample result data are available for review without compromising privacy protection requirements (refer to Table 1 and 2 following report text).

Area A includes those properties located West of Cherry Street (for those properties located south of Centre Street) and Ryan Street (for those properties located on the north side of Centre Street). Area B includes those properties located east of Cherry Street and South of Centre Street. Area C includes those properties located east of Ryan Street and North of Centre Street.

The study area and discussion areas are identified on Figure 1.

Sampling Survey Details - August 24, 2020

Ministry staff conducted sampling of eight (8) selected private domestic wells located in proximity to the four-plex property located at 32 David Street. This initial effort was undertaken to determine any potential influence on groundwater quality related to the construction of the four-plex property as described in the “Purpose” section of this report. The selected wells were all located in Area A. The water well supplies at all eight (8) locations were sampled and analysed for Total Coliforms and Escherichia Coli. Samples from six (6) of the well supplies were also submitted for the analysis of additional “general chemistry” parameters to provide a better understanding of the general water quality conditions and to assist in identifying a potential source of the bacterial contamination. The additional parameters included nutrients, biological oxygen demand, cations, and organic carbon. These parameters can also provide additional evidence when determining potential fecal (sewage) or non-fecal sources of contamination. Attempts were made to collect samples prior to any treatment where possible.

In addition to the conventional water quality analysis described above, samples were also collected from six (6) well locations (the same six wells discussed above) for bacteroides analysis using a molecular PCR method. Bacteroides are the most prolific bacteria found in the gut of warm-blooded animals and show host specificity in the DNA profile. Bacteroides do not, in and of themselves, generally represent a human health risk and the molecular method detects only genetic material and does not provide information as to whether the bacteria are living. However, the presence of bacteroides at high concentrations in a water sample confirms that the water was recently/previously contaminated by a fecal source of contamination. Genetic differences have also been identified in bacteroides from different host organisms and molecular methods have been developed to determine the host source of the bacteroides detected (e.g. human or bovine). The bacteroides analysis conducted in this study quantified the general bacteroides counts present and determined the proportion of which (if any) originated from a human or bovine source.

All of the analysis was conducted at the ministry's accredited laboratory in Etobicoke, Ontario. The analysis of Total Coliforms and Escherichia Coli were completed using membrane filtration.

Well surveys and inspections were conducted by ministry staff at the time of sampling.

<u>Sampling Survey Details - August 31, 2020</u>

A second and more robust sampling program was completed on August 31, 2020. The intent of the second sampling survey was to further assess well water quality conditions more broadly across the village and to determine potential causes / influences. A total of seventy-six (76) samples were collected from seventy-three (73) properties. Two samples were collected at three (3) of the locations. The samples were collected by ministry staff (61 samples), township staff (6 samples), and village residents (6 samples). The properties sampled were located in areas A (34 locations), B (23 locations), and C (15 locations) as well as one (1) additional location west of the village on Beverly Street.

Samples collected on August 31, 2020 were analysed for general bacterial quality (Total Coliforms and Escherichia Coli). Due to laboratory capacity constraints samples were submitted to and analysed by both the Ministry's laboratory in Etobicoke (44 samples) and the Public Health Ontario (PHO) lab in Kingston (32 Samples). Those samples submitted to the PHO lab were analysed using membrane filtration while those samples submitted to the ministry laboratory were analysed using the accredited Colilert® Quanti-Tray method. The Colilert® method provides the advantage that it supresses the growth of background non-coliform bacteria that can prevent quantification of coliform bacteria when using traditional membrane filtration methods and large amounts of non-coliform environmental bacteria is present.

Well surveys and inspections were completed for those locations sampled by ministry staff.

Sampling Results - August 24, 2020

The results of sampling conducted on August 24, 2020 are provided in Table 1. The address of each sampling location has been encoded to ensure privacy protection of participants.

The most common parameters analysed to assess the bacterial quality and potability of private drinking water are for Total Coliforms and Escherichia Coli. Coliform bacteria are widely distributed in water, soil, and vegetation. Because Total Coliforms are present in both fecal and non-fecal environments, they are not good indicators of fecal contamination (Health Canada 2020). Health Canada does not consider Total Coliforms a risk to human health. However, high coliform counts in groundwater indicate that the groundwater may be vulnerable to contamination from the surrounding environment. Escherichia Coli has historically been used as the definitive indicator of recent fecal contamination of water; although it is now accepted that Escherichia Coli is predominantly of fecal origin but is not exclusively fecal. Health Canada (2020b) states that some strains of Escherichia Coli exist as non-fecal naturalized members of the microbial community.

For the purpose of this report bacterial water quality results in excess of the Ontario Drinking Water Standards will be used to define an “adverse” (or “unsafe”) drinking water result. The Ontario Drinking Water Standard (ODWS) for both Total Coliforms and Escherichia Coli are not detectible (i.e. 0 counts per 100 mL) and are health related standards.

The results of the bacterial analysis indicated that all eight (8) of the samples were adverse and unsafe for human consumption. Six (6) of the eight (8) samples were reported as “no data overgrown target” (“NDOGT”) indicating that the samples were overgrown with background bacteria found in the environment and/or target organisms, and target organisms (Total Coliforms and/or Escherichia Coli) were identifiable.

With respect to the further general chemistry analysis conducted at six (6) of the eight (8) locations, the results were generally consistent with those expected in a bedrock setting of this type (limestone / sandstone aquifer units). Notably, hardness exceeded the ODWS operational guideline and sodium exceeded the local medical officer of health notification level in five (5) of the six (6) samples. These results are expected to be reflective of natural background water quality conditions, with the exception of those samples collected from location A2 which are suspected to have been collected following water softening. Nutrient concentrations and other general chemistry parameters were within background ranges and did not provide any indication of sewage / other impact.

The general counts of bacteroides identified in the samples were extremely low (maximum 19 counts/100mL). Low numbers of bacteroides (such as those identified) indicate that the bacterial contamination identified is not the result of a recent or significant fecal source. The percentage of the bacteroides attributed to human and bovine sources were both 0%; however, it should be noted that speciation results should be interpreted with caution when the general bacteroides counts are low (i.e. <1,000 counts/100mL) as indicated in the laboratory method.

<u>Sample Results - August 31, 2020</u>

The results of sampling conducted on August 31, 2020 are provided in Table 2. The address of each sampling location has been encoded to ensure privacy protection of participants.

Forty-six (46) of seventy-six (76) samples (61%) and forty-five (45) of seventy-three (73) locations (62%) indicated adverse water quality and unsafe for human consumption based on the presence of Total Coliforms and in some cases Escherichia Coli. Four (4) of the samples were reported as NDOGT. Escherichia Coli was identified in seventeen (17) of the seventy-six (76) samples and the maximum number of Escherichia Coli enumerated in a sample was 16 counts/100mL.

Of the three (3) locations where two (2) samples were collected, two (2) of the locations (A33 and B10) showed agreement between the samples in terms of being safe or adverse; while the sample from a third location (B1) showed disagreement between the two samples (i.e. one was adverse, and one was safe). This finding is not unexpected given that the samples were collected by different people, likely from different sampling locations, and at different times. The adverse sample also had only one (1) Total Coliform and one (1) Escherichia Coli detected indicating that the water quality is near the detection limit of the method. For the purposes of this assessment location B1 has been considered as adverse.

Comparison with previous (August 24, 2020) results:

Seven (7) of the eight (8) locations sampled on August 24, 2020 (all of which were adverse) were re-sampled on August 31, 2020. Five (5) of the seven (7) locations were adverse based on samples collected on August 31, 2020.

Groundwater quality is expected to change over time and the variation in the results at these locations is not unexpected. Further discussion of groundwater variation is provided in the discussion section.

Area Assessment:

The following proportion of locations were identified as adverse in each of the study areas:

Area A = 26 of 35 (74%)
Area B = 11 of 23 (48%)
Area C = 8 of 15 (53%)

The results indicate that adverse water quality was identified throughout the village and adverse results were not limited to a particular area. The range in proportion of adverse results (48% to 74%) may be related to factors such as well construction, the presence of contaminant sources and surface water infiltration. These factors will be discussed further below.

Well Construction:

Well records could only be obtained / verified for ten (10) of the seventy-three (73) locations included in the current survey, and unfortunately very few of the wells replaced as part of the well replacement program conducted in the early 1990's have well records available in the ministry's well record database. The ministry's survey did not include the removal of well cap and measurement of well depth / casing length. This would be a major undertaking and the intent of the ministry's sampling survey was to identify water quality conditions across the village in order to determine potential sources of adverse groundwater quality. Further work to correlate well depth and casing length with sample results would provide further insight into the role of well construction on the protection of the water supply. Only one (1) of the ten (10) well records obtained for locations sampled as part of this survey was replaced as part of the Private Services Grant Program and the remaining nine (9) well records are for wells installed since 2001. These remaining wells conformed to the requirements of the Wells Regulation but did not follow the recommendations from the Thomson Report (1985) which recommended wells be cased and grouted to a significantly greater depth.

Many of the well owners interviewed had very little information related to their well construction with approximate well depth and year of construction being the most commonly provided information. Only nine (9) of the well owners indicated that their wells were replaced as part of the well replacement program conducted in the early 1990's.

For those nine (9) wells indicated to have been replaced as part of the 1990's well replacement program it can be assumed with reasonable confidence that these wells have been cased and grouted to depths in excess of 25 metres (80 feet). These wells represent a small portion of the wells replaced as part of the well replacement program (refer to background section above); however, these wells can provide preliminary evidence to assess the influence of deep wells with longer (grouted) casing length as recommended in the Thompson Report (1985). Only two (2) of nine (9) locations (22%) in this subset of wells had adverse water quality reported, suggesting that deeper wells with longer well casing lengths (as recommended in the Thompson Report (1985)) provide enhanced protection from surface / near surface contamination.

As a comparison, the results from the remaining nine (9) well locations where well records are available and the casing/grouting depths ranged from 6 to 9 metres (20 to 30 feet), six (6) of the nine (9) locations (67%) had adverse water quality results. These 9 wells appear to have been constructed in accordance with the Wells Regulation.

Without more complete information related to the depth of casing and grouting and depth to water bearing zones it is not possible to further assess the role of well construction details on bacterial water quality.

Well Survey & Inspection Details

Well surveys and inspections were completed at sixty-seven (67) wells.

Twenty-two (22) of the wells examined or 33% have casing heights extending above the ground surface less than the current requirement 40 centimetres (cm) in Wells Regulation.

Twenty-three (23) of the wells examined or 34% are topped with an older-style non-vermin proof cap enabling the entry of spiders, earwigs and other insects and other foreign materials inside of the well.

The well heads of nine (9) wells or 13% of the wells examined were confirmed by the well owners to be located (buried or in well pits) below grade. Up to sixteen (16) or 24% of the wells examined were not visible above ground and may be buried or located in wells pits that are not being properly maintained to prevent the collection of surface water around or in the well.

Nine (9) of the wells examined or 13 % are located within gardens or have large shrubbery planted around the well casing. Planting flowers, shrubs or trees around the wellhead is discouraged as the roots can compromise the annular seal protecting the well allowing surface water to enter the well. The wells located within shrubbery are also difficult to access for maintenance.

Three (3) of the wells examined or 4% had decorative structures/objects (wishing wells, bottomless steel milk can) placed over the well casings. Such structures are discouraged as they trap moisture contributing to accelerated corrosion of the exterior of the well casing.

Three (3) of the wells examined or 4% have damaged/compromised vermin-proof well caps as a result of missing screens from the vent holes, lack of a threaded blank to seal the recess for submersible pump electrical wiring and conduit and a cracked well cap. Damaged/compromised well caps allow the entry of spiders, earwigs and other insects and other foreign materials inside of the well.

One (1) well examined has a casing extension with a noticeable lean (i.e. is not perpendicular) suggesting the casing extension was not securely fastened to the original well casing below ground, potentially enabling surface water/run-off or other foreign materials to enter the well.

The ground around twenty-four (24) wells of the wells examined or 36% have little or no slope away from the well to direct surface water away from the well. The ground around some of those wells slope slightly toward the wells.

Seven (7) of the wells examined or 10% were noted to have obvious/possible sources of contamination near the well. Sources of contamination includes a firepit, chicken coop, dogs being penned or fenced in the vicinity of wells and a well being located beneath a driveway. In one of the locations where there was clear evidence of dogs being present in the backyard the ground sloped directly toward the drilled well and there were depressions/holes in the yard and near the well casing. Well owners need to vigilant in ensuring dog feces are cleaned up routinely and without delay, with the cleaning of chicken coops where they exist, the removal of charcoal and ash from firepits and fluids leaking from parked vehicles.

A number of wells were noted to have some degree of corrosion on the exterior of the well casing from slight to significant pitting and flaking of the metal. Corrosion of the exterior of the well casing can be slowed by carefully painting the well casing with a suitable ‘rust’ paint being careful not to spill paint on the ground in the vicinity of the well.

Additional Activities

Additional activities were also undertaken by the Township in response to concerns raised by residents.

In response to concerns raised with respect to the four (4) drinking water wells installed at the four-plex property recently constructed on David Street, the township hired the services of an environmental consultant (Jp2g) to complete a hydrogeological assessment of the wells on the fourplex property and to assess any potential impacts the wells may create to interfere with local groundwater quality or quantity. The completed activities included sampling in accordance with ministry Guideline D-5-5 and the completion of pumping tests on two of the wells. The details and findings of the study are expected to be provided in a forthcoming report provided by Jp2g on behalf of the township. The results indicated that the wells were not impacted by bacterial contamination at the time of sampling and adequate yield (quantity) exists to supply the four supply wells and use of the four (4) wells is not expected to result in inter-well interference or interference with other existing wells in the village.

In response to concerns from residents that adverse water quality results in the area may be related to a sewer defect which occurred when the sewer lines for the four-plex property were connected to the sewer network, the township completed camera inspections along portions of the sewer network along David Street and Charles Street. The inspections did not identify any issues with the four-plex sewer connections; however, two defects were identified in the sewer lines along Charles Street. The defects included an area of root infiltration and an improperly sealed gasket at a lateral connection. The township subsequently excavated the identified areas to inspect and repair the defects. The township indicates that no indications of sewage leakage were identified at either of the two defect locations. Following the completion of the sewer repairs the Township completed additional sewer inspection work in various areas of the village and no further issues were identified. These findings are consistent with the ministry’s survey sample results which indicate that contamination is widespread and does not appear to be related to a significant point source of fecal contamination (e.g. sewer line breakage).

<u>Discussion & Conclusions</u>

1) The results from the August 31, 2020 survey identified a prevalence of adverse water quality results (62% of the sampled locations) and found that the presence of adverse water quality was not limited to particular areas of the village (adverse results ranged from 48% to 74% in the three discussion areas). These results indicate that the adverse water quality identified is not from those activities conducted at 32 David Street nor do they appear to be related to any other point sources of contamination (i.e. municipal sewage system). These conclusions are further supported by the supplementary analysis (general chemistry and bacteroides analyses) conducted at selected wells.

2) Based on the available results and information it appears that the identified adverse water quality results are the result of the highly vulnerable geological setting. The shallow bedrock unit is highly vulnerable to contamination from at / near surface due to the highly fractured nature of the shallow bedrock and the lack of overlying low-permeability soils which would afford some attenuation of contaminants. This conclusion is consistent with the findings of the hydrogeological assessment previously conducted by Thompson (1985). In general, groundwater supplies in shallow fractured bedrock aquifers are considered highly vulnerable to contamination due to rapid groundwater velocity and potential microorganism transport in these aquifers. Limited contaminant attenuation is expected in this setting.

3) While the municipal sewer system is not suspected to be responsible for the adverse microbial water quality results currently identified throughout the village, the vulnerable setting make it is essential that the sewer system is proactively maintained, and any maintenance activities are completed so that sewage is not released to the surface or subsurface. Any release from the sewer system would represent a significant heath risk to nearby groundwater users. Groundwater in the village is also highly susceptible to other forms of contamination if a spill or leak were to occur (e.g. fuel tanks, animal feces, agricultural and urban runoff).

4) Groundwater quality is expected to vary over time and the results of the current assessment are reflective of the water quality present in each well at the time that the sampling was conducted. Groundwater quality variations can be especially significant in highly vulnerable settings and are typically correlated with weather events (e.g. rainfall events). Rainfall events can have a significant impact on groundwater quality by facilitating transportation of bacteria (and other contaminants) from the surface and subsurface. Precipitation levels were generally well below normal over much of the summer with intermittent high precipitation storm events occurring as shown in the attached plot of precipitation recorded at the Environment Canada Brockville Weather Station. This weather station may not be totally reflective of precipitation in Spencerville but is the closest station with data available. The heavy rainfall events have likely contributed to the identified adverse water quality identified in the village over this period and during the completed study. It is noted that significant rainfall

occurred in the days prior to the sampling conducted by the ministry. Sampling would need to be conducted on multiple occasions over a period of time in order to better understand the variation of water quality.

5) Well construction can greatly influence the vulnerability of drinking water wells to surface / near-surface contamination. In a vulnerable setting, such as the Spencerville area, the most important well construction details are the well depth and the depth to which the well is cased and grouted. The Thomson Report (1985) identified that a deep well drilled and cased into a less vulnerable aquifer would provide the best protection for individual well water quality. This recommendation is effective because the deeper aquifer is naturally isolated from shallower aquifers and contamination (the deep aquifer is less vulnerable) and the long, grouted well casing prevents / limits a pathway for contamination to reach the deep water producing zone. Wells that are cased and grouted to greater depths are expected to be less vulnerable to surface contamination however this reduced vulnerability depends on the absence of natural vertical rock fractures and other pathways (e.g. nearby deep wells with shallow casing) which may allow for contaminants to migrate to depth. The hydrogeological study conducted by Thompson (1985) recognised the importance of casing and grouting depth and recommended that wells in the village be cased and grouted to minimum depths ranging from 25 metres (75 feet) to 32 metres (104 feet). The results of the current study indicate that the longer casing and grouting depths recommended by Thompson (1985) (which greatly exceed requirements in the Wells Regulation) likely reduces the vulnerability of a well to surface contamination; however, this construction does not appear to be entirely protective (2 of 9 deep wells appear to show bacterial contamination). Overall, the data available from the current study provides evidence to suggest that deeper grouted and cased wells provide significant protection in comparison to those constructed in accordance with the minimum regulatory requirements (6 metres / 19.7 feet). This is also consistent with the hydrogeological setting in the Spencerville area (a deep and relatively less vulnerable aquifer is present). Additional assessment (well depth and casing length assessment) and sampling of existing wells located in the village would be required to better characterise the ability of deeply cased and grouted wells to prevent adverse water quality impacts.

6) Numerous well maintenance issues were identified by the well inspections completed by ministry staff. The most common deficiencies identified included: absence of vermin proof caps; buried well casings; poor or improper ground sloping around well casings; placed in gardens or shrubs; and, insufficient casing stick ups. Known fecal contamination sources (animal feces) were also identified in proximity to a number of the wells inspected. Well maintenance and known contamination sources have the potential to result in adverse water quality in a particular well.

7) The presence of poorly constructed and/or maintained wells and those wells cased/grouted to shallow depths and extending into the deeper aquifers have the potential to provide a pathway for shallow groundwater contamination to migrate to the deeper bedrock aquifer units. However, these preferential pathways are not well understood. Additional study would be required to determine the role

and significance of this mechanism and may be difficult to determine. This would involve a detailed assessment and inventory of wells in Spencerville.

Recommendations

1) Well owners are ultimately responsible for taking those actions required to maintain their wells and to ensure the water obtained from their well is potable. Well owners should consider the following actions:

    a. It is recommended that well owners frequently test the quality of water obtained from their wells. Well owners should consult with the local health unit with respect to a recommended testing frequency (https://healthunit.org/health-information/drinking-water/).

    b. Given the vulnerable setting in Spencerville, well owners should consider the installation of a water treatment system to address any bacterial water quality impacts. The local health unit and a water treatment specialist should be consulted with respect to the need and technical requirements for a particular location based on water quality results for that location.

    c. For those well owners with substandard well construction or maintenance issues (i.e. buried well heads, improper caps, etc.) strong consideration should be given to addressing these issues. Residents should consult guidance provided on the ministry website with respect to required and recommended well maintenance (https://www.ontario.ca/page/well-regulation-well-maintenance-technical-bulletin). A licensed well technician may also be hired to assess deficiencies and to address any identified deficiencies.

    d. Well owners with wells not conforming to the recommendations provided by Thompson (1985) and with chronic adverse water quality issues could also consider obtaining the services of a licensed well contractor to replace their existing well with one that is cased into the deeper less vulnerable aquifer. It should be noted that this recommendation is not a guarantee that potable water will be obtained; however, it would be expected to reduce the vulnerability (magnitude and frequency of adverse water quality) of the water supply and those recommendations provide above should still be followed. It should also be noted that the deeper bedrock units may produce water with elevated concentrations of iron and/or sulphur and additional treatment may be required to address them.

2) The need for a comprehensive maintenance and spill contingency plan should be considered with respect to the municipal sewer system.

3) Given the inherent vulnerability of groundwater in the village and the prevalence of adverse water quality identified in drinking water wells located across the village, the township may consider the need to undertake a robust study of well water quality. An appropriate study should assess the spatial and temporal variations in water quality obtained from residential wells located in the village and should include a detailed assessment of well construction details. Based on

the findings of future more comprehensive study the township may wish to consider if municipal actions are warranted with respect to water supply in the community, such as: the need to install a municipal source-protected water supply; the need for a by-law or other mechanism that would ensure that appropriate well construction and/or treatment is placed on future development; and, consideration of an ongoing education and notification program that would ensure that village residents are aware of the groundwater vulnerability and risk of adverse water quality in the village.

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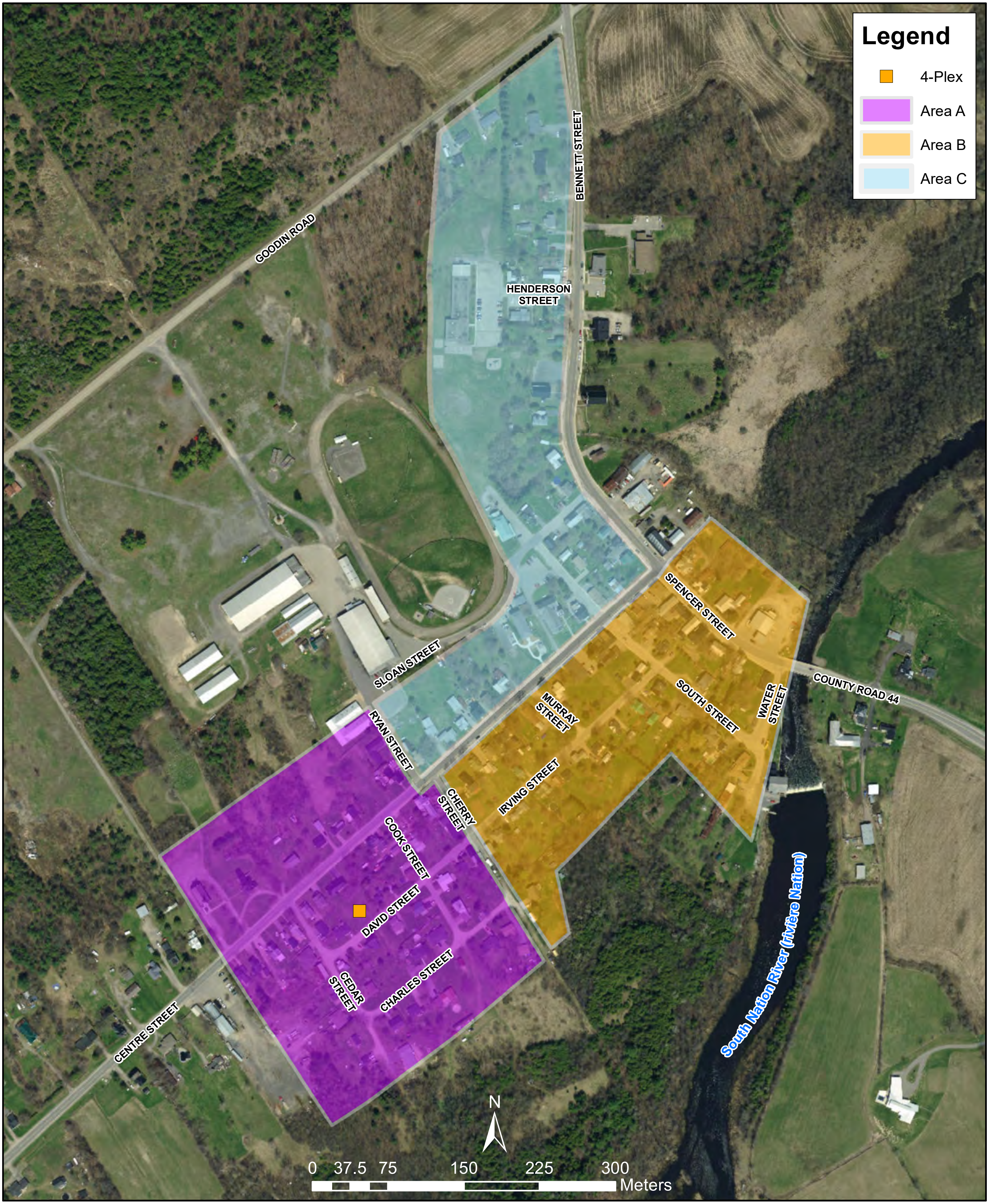
Health Canada (2020a) Guidelines for Canadian Drinking Water Quality: Guideline Technical Document - Total Coliforms”

Health Canada (2020b) Guidelines for Canadian Drinking Water Quality: Guideline Technical Document - Escherichia coli”

Ontario

Figure 1 – Study Area

Ministry of the Environment, Conservation and Parks



UTM Zone 18 (NAD 1983)
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Table 1 – Water quality results for samples collected August 24, 2020.

Parameter	Units	ODWS Standard	ODWS Type	Sample Location							
				A1	A2	A3	A4	A5	A6	A7	A8
Chloride	mg/L	250	AO	48.6	69.6	65.1	76.2			121	5.5
Calcium	mg/L			79.2	0.85	91.4	84.6			101	74.6
Magnesium	mg/L			28.6	0.26	30.6	29.1			34.8	27.6
Sodium	mg/L	200 / 20	AO / MAC*	**33.2**	**188**	**42**	**40.4**			**48.6**	3.32
Potassium	Mg/L			2.14	0.10	1.72	1.47			1.85	1.66
Hardness	mg/L	80-100	OG	**316**	3.2	**354**	**331**			**395**	**300**
Conductivity	µS/cm			747	804	835	808			977	557
pH				7.78	7.81	7.77	7.84			7.84	7.91
Alkalinity	mg/L as CaCO3	30-500	OG	285	258	297	266			274	272
Nitrogen: Ammonia + ammonium	mg/L			0.040	0.036	0.034	0.033			0.031	0.057
Nitrogen: Nitrite	mg/L	1	AMC	0.002	0.006	0.004	0.002			0.004	0.002
Nitrogen: nitrate + nitrite	mg/L	10	MAC	2.17	4.36	1.54	2.62			1.57	0.04
Phosphorus: Phosphate	mg/L			0.0109	0.0306	0.0094	0.0141			0.0092	0.0091
Dissolved Organic Carbon	mg/L	5	AO	1.6	2.1	1.2	1.6			1.2	0.9
Dissolved Inorganic Carbon	mg/L			73.3	67.3	77.9	70.2			71.2	69.2
Reactive Silicate	mg/L			2.60	2.34	2.24	2.20			2.24	3.06
Biological Oxygen Demand	Mg/L as O_2			<1	<1	<1	<1			<1	<1
Total Coliform	# /100mL	0	MAC	**NDOGT**	**NDOGT**	**NDOGT**	**NDOGT**	**NDOGT**	**6**	**65**	**NDOGT**
Total Coliform Background	# /100mL			**NDOGT**	**NDOGT**	**NDOGT**	**NDOGT**	**NDOGT**	**10**	**200**	**NDOGT**
Escherichia Coli	# /100mL	0	MAC	**NDOGT**	**NDOGT**	**NDOGT**	**NDOGT**	**NDOGT**	**0**	**1**	**NDOGT**
Bacteroides – General	# /100mL			19	7	<5	7			4	10
Bacteroides – Human	%			0	0	0	0			0	0
Bacteroides - Bovine	%			0	0	0	0			0	0

NDOGT = No Data; Over Grown; Target Identified

ODWS = Ontario Drinking Water Standard

ODWS MAC of 20mg/L for sodium is a local medical officer of health notification level for persons on sodium restricted diets.

ODWS exceedances are **highlighted and in bold**

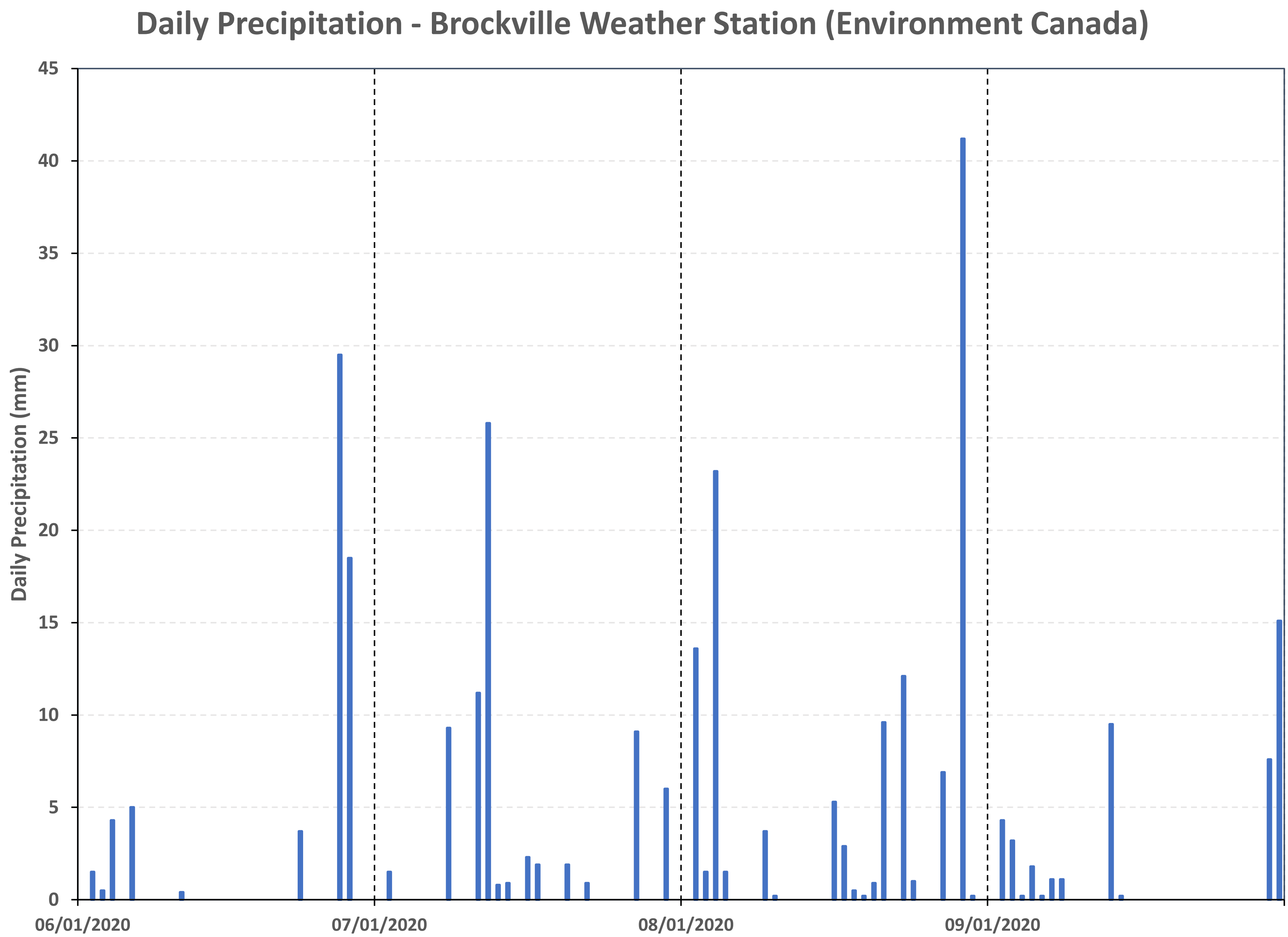
Table 2 – Drinking Water Sample Details and Results from August 31, 2020

Location No.	Total Coliform	E. Coli	Collected By	Laboratory
A1	27.1	1	MECP	MECP
A2	>200.5	5.3	MECP	MECP
A3	>200.5	<1	MECP	MECP
A4	>200.5	1	MECP	MECP
A5	>200.5	<1	MECP	MECP
A8	<1	<1	MECP	MECP
A9	<1	<1	MECP	MECP
A9	2	<1	MECP	MECP
A10	>200.5	<1	MECP	MECP
A11	47.8	1	MECP	MECP
A12	<1	<1	MECP	MECP
A13	0	0	MECP	PHO
A14	6	4	MECP	PHO
A15	17	13	MECP	PHO
A16	<1	<1	MECP	MECP
A17	0	0	RESIDENT	PHO
A18	>200.5	1	MECP	MECP
A19	4.2	<1	MECP	MECP
A20	1	<1	MECP	MECP
A21	34.4	1	MECP	MECP
A22	2	0	MECP	MECP
A23	0	0	MECP	PHO
A24	9	0	MECP	PHO
A25	20	16	MECP	PHO
A26	109.1	6.4	MECP	PHO
A27	19.2	<1	MECP	MECP
A28	<1	<1	MECP	MECP
A29	>200.5	1	MECP	MECP
A30	<1	<1	MECP	MECP
A31	>200.5	2	MECP	MECP
A32	165.2	1	MECP	MECP
A33	7	0	MECP	PHO
	NDOGT		RESIDENT	PHO
A34	165.2	<1	MECP	MECP
A35	118.4	<1	MECP	MECP
B1	<1	<1	MECP	MECP
	1	1	MECP	PHO
B2	1	0	MECP	PHO
B3	>200.5	<1	MECP	MECP
B4	<1	<1	MECP	MECP
B5	<1	<1	MECP	MECP
B6	>200.5	1	MECP	MECP
B7	NDOGT		RESIDENT	PHO

Table 2 – Drinking Water Sample Details and Results from August 31, 2020

B8	<1	<1	MECP	MECP
B9	34.4	<1	MECP	MECP
B10	<1	<1	MECP	MECP
	0	0	RESIDENT	PHO
B11	<1	<1	MECP	MECP
B12	<1	<1	MECP	MECP
B13	<1	<1	MECP	MECP
B14	<1	<1	MECP	MECP
B15	9	1	MECP	PHO
B16	56	<1	MECP	MECP
B17	<1	<1	MECP	MECP
B18	3.1	<1	MECP	MECP
B19	>200.5	<1	MECP	MECP
B20	0	0	MECP	PHO
B21	165.2	2	MECP	MECP
B22	<1	<1	MECP	MECP
B23	0	0	MECP	PHO
C1	9	0	TOWNSHIP	PHO
C2	0	0	TOWNSHIP	PHO
C3	0	0	TOWNSHIP	PHO
C4	15	0	TOWNSHIP	PHO
C5	0	0	TOWNSHIP	PHO
C6	25	0	RESIDENT	PHO
C7	0	0	TOWNSHIP	PHO
C8	>200.5	<1	MECP	MECP
C9	0	0	MECP	PHO
C10	NDOGT		RESIDENT	PHO
C11	1	0	TOWNSHIP	PHO
C12	NDOGT		MECP	PHO
C13	1	1	TOWNSHIP	PHO
C14	0	0	MECP	PHO
C15	0	0	TOWNSHIP	PHO
BEVERLY	10	0	TOWNSHIP	PHO

MECP = Ministry of the Environment, Conservation, and Parks
PHO = Public Health Ontario
NDOGT = No Data, Overgrown, Target Organisms Identified
* Those samples submitted to the PHO laboratory are report in counts/100mL
* Those samples submitted to the MECP laboratory are reported in most probable number (MPN) / 100 mL
* Adverse water quality results (i.e. exceedances of the Ontario Drinking Water Standards) are highlighted



Daily Precipitation - Brockville Weather Station (Environment Canada)
Daily Precipitation (mm)
45
40
35
30
25
20
15
10
5
0
06/01/2020
07/01/2020
08/01/2020
09/01/2020