REPORT

Nestlé Waters Canada Aberfoyle Site

2020 Annual Monitoring Report

Submitted to:

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Key Facts for 2020 Operations at Aberfoyle

Key facts for the 2020 operations at Aberfoyle are summarized below.

1) Well TW3-80 continued to operate under the terms of Permit to Take Water (PTTW) 1381-95ATPY. Nestlé submitted an application for renewal of the permit to the Ministry of the Environment, Conservation and Parks (MECP), formerly the Ministry of the Environment and Climate Change (MOECC), in April 2016, more than 90 days prior to the expiration of the permit on July 31, 2016. In accordance with the Ontario Water Resources Act, Section 34.1 (6), Nestlé has continued to legally operate under the existing permit until a final review and decision is made regarding the renewal of the permit.

2) Nestlé has complied with all the conditions in the existing permit for the Aberfoyle well TW3-80.

3) Comprehensive annual monitoring reports are prepared for the Aberfoyle well (TW3-80) under the conditions of the PTTW that remain in effect.

4) No complaints arising from the taking of water authorized under this PTTW were received in 2020.

5) The total precipitation measured at the Environment Canada Kitchener/Waterloo (KW) Station in 2020 was about 24% below the long-term average.

6) The Grand River Low Water Response Team declared a Level 1 Low Water Condition for the entire Grand River Watershed, including Mill Creek, on July 9, 2020. The Level 1 Low Water Condition was removed on October 8, 2020. Nestlé Waters Canada complied with the request by the Grand River Conservation Authority for all water-users in the Grand River watershed to voluntarily limit water takings to 90% of their monthly maximum permitted volume during the Level 1 Condition.

7) TW3-80 pumps water from the Lower Bedrock Aquifer which is overlain by a Middle Bedrock Aquitard, an Upper Bedrock Aquifer and an overburden aquifer/aquitard.

8) The total volume of water taken in 2020 from TW3-80 was 582,221,219 L, approximately 44% of the permitted annual volume assuming continuous well operation. No water was taken from TW2-11 in 2020.

9) The daily water takings at TW3-80 ranged from 45 L to 2,871,783 L. The average daily water taking was 1,590,768 L. The maximum daily taking corresponded to less than 80% of the permitted maximum daily taking and on most days was substantially less than the maximum permitted daily taking.

10) The monthly water takings in 2020 from TW3-80 ranged from 34,531,690 L to 71,530,142 L. The monthly takings never exceeded 83,700,000 L; therefore, per Condition 4.5 of the PTTW, no data from multi-level piezometers MP6, MP12, MP11 and MW2 were required to be submitted to the MECP during the year.

11) The variations in water levels in TW3-80 are due mainly to short-term changes in the pumping rate and during 2020 were within the historical range of observed water levels. Ongoing pumping from TW3-80 has not led to a long-term water level decline in the well.

12) Water levels in the Lower Bedrock Aquifer around the property over both the short-term and long-term, are influenced mainly by pumping of TW3-80. The effects of long-term variability in pumping are observed more in the wells closer to TW3-80 where water level changes from year to year correlate with overall annual

water takings (i.e., increased water takings result in lower water levels). The influence of pumping decreases with distance away from the pumping well. Water levels recover when pumping rates are reduced, indicating that the water taking is sustainable. There is also some influence on the water levels from recharge and external influences, to varying degrees. Water levels measured within the Lower Bedrock Aquifer in 2020 were generally similar to the water levels in 2019. The water levels in the summer were slightly lower, but within the historical range measured at the wells.

13) Water levels in the Upper Bedrock Aquifer around the property are partly influenced from pumping at TW3-80 (i.e., there is hydraulic connection between the Upper Bedrock and Lower Bedrock Aquifers); however, the connection is limited (i.e., there is less response than in the Lower Bedrock Aquifer). The magnitude of influence varies based on distance from TW3-80 and existing hydrogeologic conditions, reflecting complexity in the subsurface and differences in permeability. While there is an influence on water levels in the Upper Bedrock Aquifer from pumping TW3-80, there are also seasonal and long-term trends in water levels that are reflective of recharge trends (i.e., lower water levels during years of below-average precipitation and higher water levels during years of above-average precipitation). Water levels measured in the Upper Bedrock Aquifer in 2020 were within the historical measured ranges, with some lower water levels observed in the summer in nearby wells relative to those in 2019.

14) Water levels in the overburden are affected both by natural events (recharge) and to a much lesser degree from pumping at TW3-80. The response to pumping in the overburden is muted compared to the responses in the Upper and Lower Bedrock Aquifers and only observed in the immediate vicinity of the pumping well. Water levels measured within the overburden in 2020 were within the historical measured ranges.

15) Water levels in mini-piezometers installed in the shallow subsurface have been similar over the past five years, with water levels generally increasing in the spring, declining through the summer, and then increasing in the fall. In addition to the seasonal trend, short-term changes (“spikes”) in water level in the shallow groundwater are influenced by individual precipitation events. Overall, the water levels are influenced primarily by precipitation events, which overwhelm any changes due to pumping from TW3-80.

16) Surface water levels in Aberfoyle Creek and Mill Creek fluctuate in response to natural events (i.e., precipitation, snow melt and evapotranspiration) with no measurable effects from changes in pumping from TW3-80. In general, surface water levels are higher in the winter/spring and lower in the summer and then increase slightly into the fall. “Spikes” in the water levels are related to precipitation events or spring melt.

17) Surface water flows in Aberfoyle Creek at the upstream end of the property (SW1) and downstream end of the property (SW2) have been similar to historic flows over the years. Stream flows are higher in the spring, following precipitation and melt events, and then decline through the summer with less variability in flow. The effects of pumping TW3-80 could not be detected in the surface water flows observed at SW1 and SW2 in 2020.

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1.0 INTRODUCTION

Nestlé Waters Canada (Nestlé) has retained Golder Associates Ltd. (Golder) to conduct the annual monitoring program and report preparation for the Nestlé Aberfoyle Site as required by Amended Permit To Take Water (PTTW) Number 1381-95ATPY issued by the Ministry of the Environment, Conservation and Parks (MECP), formerly the Ministry of the Environment and Climate Change (MOECC). The PTTW is included in Appendix A. The current PTTW was issued on December 19, 2013. The PTTW renewal application was submitted to the MECP in April 2016. The current PTTW expired on July 31, 2016, and in accordance with the Ontario Water Resources Act Section 34.1 (6), Nestlé continues to operate TW3-80 under the terms of the existing PTTW until a final review and decision is made regarding the renewal.

The location of the Aberfoyle Spring/Plant (Site) is shown on Figure 1.1. The PTTW authorizes water taking from two on-Site bedrock wells located on Lot 23, Concession 7, Geographic Township of Puslinch, Wellington County, Ontario. Water from TW3-80 is taken for the purpose of bottling water. Although it has not been used, water from TW2-11 is permitted for taking for miscellaneous purposes such as providing water to the on-Site pond for firefighting purposes.

The Aberfoyle bottling facility is located on a 46.75 hectare parcel owned by Nestlé approximately 5 km southeast of Guelph and 12 km northeast of Cambridge (Figure 1.1). The Aberfoyle facility consists of a bottling plant, warehouse, paved parking and access drives, ponds, and open fields, and is bordered by wooded areas, wetlands and aggregate operations.

A summary of the PTTW Conditions and where the information can be found in this report are outlined in Table 1:

Table 1: Permit To Take Water Conditions

Condition Number	Condition Description	Report Section
3.2, 3.3, 3.4	Identifies use, rates, time and total takings allowed.	3.1.1, 4.1, Appendix C
4.1	Maintain a daily record of all water takings including date, volume of water taken and rate at which it was taken.	Appendix C
4.2, 4.3, 4.6	Establish the specified groundwater and surface water monitoring programs including monitoring requirements and monitoring timing.	3.1.2, 3.1.3
4.4	Undertake wetland monitoring and redd surveys and submit results to Director.	Appendix H
4.5	If monthly water takings exceed 83,700,000 L, then multi-level piezometer data for selected wells must be submitted to the Director within 30 days of the end of the calendar month.	4.1
4.7	Notify the Director of monitoring locations that become inaccessible or abandoned and provide a recommendation for replacement.	3.1.2.1, 3.1.3.1, 3.1.4

Condition Number	Condition Description	Report Section
4.8	Prepare and submit an annual monitoring report to the Director, which presents and interprets the data collected under the conditions of the PTTW.	This report
4.9	Submit details of the bottling operations to the Director.	4.1
5.1	Notify the local District Office of any complaint arising from the taking of water and proposed action to rectify the complaint.	4.1
5.2	Supply water to anyone with a water supply (in effect prior to this taking) that has been negatively impacted.	Not applicable

Golder began monitoring at the Site in May 2014 on behalf of Nestlé. Prior to that time, monitoring was performed by Conestoga Rovers and Associates (CRA) and Nestlé. The MECP has requested that the reporting follow the same outline and presentation as previous reports. The reporting of the geologic characterization has been updated to be consistent with the updated interpretation developed by the Ontario Geological Survey (Brunton, 2008, 2009; Brunton and Brintnell, 2011) rather than the previous geologic nomenclature. At some well locations there were insufficient data to update to the new nomenclature. As such, the bedrock has been divided into three units based on both the old and new nomenclature: Upper Bedrock Aquifer, Middle Bedrock Aquitard and Lower Bedrock Aquifer (as described in detail below). Additional reporting (Golder et. al., 2019) has also been prepared separately and submitted to the MECP to satisfy the new hydrogeological study requirements (MECP, 2017) issued since the submission of the application for renewal of the PTTW.

The report is structured as follows:

- Section 1.0: Introduction including site location, history, and construction details for supply well TW3-80.
- Section 2.0: Regional setting including a description of topography, drainage, ecology, physiography, geology and hydrogeology.
- Section 3.0: Summary of 2020 field program including a description of field activities conducted in 2020.
- Section 4.0: Monitoring program results including a summary and analysis of the data collected in 2020.
- Section 5.0: Conclusions from the 2020 monitoring program.
- Section 6.0: Recommendations from the 2020 monitoring program.

1.1 Historical Summary

TW3-80 was constructed in April 1980 for an aquaculture (fish farming) operation. In December 2000, the Perrier Group of America, a Nestlé Company, purchased the property. Six consecutive PTTWs have been issued for TW3-80 since that time, allowing for water takings for bottling water purposes. Additional investigations have been conducted over the years to determine if there have been any negative impacts on the natural environment and ensure that the water taking by Nestlé is sustainable. These additional investigations have been requirements of previous permits and have been completed to the satisfaction of the MECP. Other than the on-going conditions of the PTTW, no additional studies were required in 2020.

Most recently, PTTW Number 1381-95ATPY was issued in December 2013, which also allows for water taking from TW2-11 for miscellaneous purposes (such as providing water to the on-Site pond for firefighting purposes) but not bottling water. The combined water taking from TW3-80 and TW2-11 is restricted to 3,600,000 L per day.

1.2 Construction Details for Supply Well TW3-80

The borehole log for TW3-80 is provided in Appendix B. The glacial overburden at the well is 14.6 m thick and consists of a silt till to a depth of 12.2 m below grade, and 2.4 m of fine-to-medium sand overlying bedrock. Any coarse-grain sediments at surface may have been removed in the past. The well was originally completed to a depth of 42.4 m below grade, 27.8 m into the bedrock.

Conestoga Rovers and Associates (CRA, 2014) interpreted the bedrock through which TW3-80 was drilled as consisting of the Guelph Formation dolostone (14.6 to 16.8 m) and the Amabel Formation (Eramosa Member and Unsubdivided Member) (16.8 to 42.4 m). Changes to the bedrock nomenclature have been made by the Ontario Geological Survey (OGS) (i.e., Brunton, 2008, 2009: Brunton and Brintnell, 2011). Based on the revised nomenclature, TW3-80 is interpreted to have been drilled through the Guelph, Eramosa, and Goat Island Formations and possibly into the Gasport Formation. The stratigraphy at TW3-80 is consistent with that of other wells in the area.

When TW3-80 was initially constructed in 1980, a 305 mm diameter steel casing was installed through the overburden and approximately 0.6 m into the top of rock to a depth of 15.2 m and cemented in place (CRA, 2014). The remainder of the well was completed as a 305 mm diameter open hole.

In 1999, the bottom 11.3 m of TW3-80 was sealed with gravel, bentonite grout, and a cement cap so that the well would pump water with more favourable natural water quality from within the Guelph to Goat Island/Gasport Formations. The revised finished depth is 31.1 m below grade.

To comply with Nestlé water well construction standards, a liner was installed in the well in 2002. A 250 mm diameter stainless steel liner was installed inside the 305 mm steel casing and grouted in place, to a depth of 28.4 m. The revised open interval of TW3-80 is now 28.4 m to 31.1 m below grade and only allows pumping from the Goat Island/Gasport Formations. A schematic of the well construction is included on Figure 1.2.

2.0 REGIONAL SETTING

The following sections provide a summary of the regional and local topography, drainage, physiography, and overburden and bedrock geology/hydrogeology for the Site.

2.1 Topography and Drainage

Regional topography is characterized by northeast-southwest trending bands of hummocky terrain (Chapman and Putnam, 1984). Locally, the Nestlé property is located in a relatively flat area between the Paris and Galt Moraines. Surface topography is shown on Figure 2.1. Within a 1 km radius of the Nestlé property, ground surface elevations typically range from 310 to 330 masl (metres above sea level) with the lows occurring along Aberfoyle Creek and Mill Creek. The streambed elevation of the portion of Aberfoyle Creek that traverses Nestlé's property is approximately 310.5 masl (+/- 1 m).

The Site is located within the Mill Creek Subwatershed (Figure 2.1) which forms part of the larger Grand River Watershed. Part of Mill Creek is located north of the Nestlé property and generally flows in a southwesterly direction within the study area. A tributary of Mill Creek, referred to as Aberfoyle Creek, flows through the Site, also in a southwesterly direction, and converges with Mill Creek west of the Nestlé property. Aberfoyle Creek is located approximately 150 m to the northwest of TW3-80 at its nearest point. Mill Creek and Aberfoyle Creek are shown on Figure 2.1 along with other surface water and wetland features, which are described below.

As shown on Figure 2.1 several ponds exist, both natural and man-made, within a 1 km radius of the Nestlé property. One such pond, referred to as the Aberfoyle Mill Pond, located east of and upstream from the Site, is created by a dam across Aberfoyle Creek. Some small on-Site ponds exist on the Nestlé property. Most of the other ponds in the area appear to be man-made and are off-line ponds (i.e., not connected to streams). Some of the ponds are the result of aggregate extraction below the water table.

In addition to the ponds in the area, several wetland areas are also present within a 1 km radius of the Nestlé property (Figure 2.1). Most of these wetlands are part of the Mill Creek Puslinch Wetland Complex and are considered provincially significant wetlands. Wetlands are present within the northwest part of the Nestlé property.

2.2 Ecological Setting

The northwestern half of the Nestlé property is in a natural condition and supports a diversity of forest and wetland habitats as well as a watercourse and fish habitat. Most of these habitats are relatively undisturbed and support a diverse range of flora and fauna, including some that are locally significant.

The wetland habitats along Aberfoyle Creek form part of the provincially significant Mill Creek Puslinch Wetland Complex.

Collectively, these natural features comprise part of an extensive natural heritage system of the headwaters of the Mill Creek watershed. This natural heritage system is recognized for its provincial, regional and local significance.

Aberfoyle Creek is a branch of Mill Creek that traverses the Nestlé property. Its confluence with Mill Creek is immediately downstream from the Nestlé property. Upstream of the Nestlé property, Aberfoyle Creek flows through a 10 hectare pond, created by a dam constructed in the 1860's to power a grist mill. Outflows from the pond are controlled by a series of weirs. Upstream of Mill Pond, Aberfoyle Creek is a cold-water stream that contains both Brook Trout (*Salvelinus fontinalis*) and Brown Trout (*Salmo trutta*). However, during the summer the water is warmed in the Mill Pond so that downstream from the pond, through the Nestlé property, the water temperature frequently exceeds the lethal temperature for these trout species. The most abundant fish species through the Nestlé property are cool-water species for which the water temperatures are suitable. Like the upper reaches of Aberfoyle Creek, Mill Creek is a cold-water stream that supports Brook Trout and Brown Trout.

2.3 Physiography

Chapman and Putnam (1984) define this physiographic region as the eastern limb of the Horseshoe Moraines. The existing landforms and most of the surficial soils in the area were created/deposited during the most recent glacial period, specifically the recession of the Lake Ontario ice lobe. During the recession of the Lake Ontario ice lobe, three distinct end moraines were formed in the area: the Paris Moraine, the Galt Moraine, and the Moffat

Moraine (Karrow, 1987). The Paris Moraine is situated to the north of the property and the Galt Moraine is situated to the south of the property. These moraines are primarily composed of silty to sandy till and form the major drainage divides for the Mill Creek subwatershed. The Nestlé property is situated mainly within an outwash gravel plain situated between the two moraines (Figure 2.2). The outwash gravel plain was likely formed by glacial meltwater associated with a halt in the ice retreat during the formation of the Galt Moraine.

2.4 Geology and Hydrogeology

The following sections provide a summary of the regional and local geology and hydrogeology. The regional interpretation is based on published mapping and information contained in the Mill Creek Subwatershed Study (CH2M Gore & Storrie, 1996). Detailed geologic information has also been obtained from logging of the stratigraphy by CRA at locations where monitoring wells were installed as part of previous field investigations. The bedrock interpretation has been updated to follow the revised nomenclature of the OGS (Brunton, 2008 and 2009, Brunton and Brintnell, 2011).

2.4.1 Overburden Geology

The overburden ranges in thickness from 15 m in low-lying areas of the subwatershed near Mill Creek and Aberfoyle Creek to 35 m along the crests of the Paris and Galt Moraines (Drift Thickness Map P.535, M.A., Vos, 1968; CH2M Gore & Storrie, 1996).

The surficial overburden geology, as mapped by the OGS is shown on Figure 2.2. The surficial overburden of the area is characterized by the following units:

- Outwash gravel;
- Ice-contact gravel: kames and eskers; and
- Stoney, sandy silt till (Wentworth Till).

Regionally, the Paris and Galt Moraines, located north and south of the property, respectively, consist of Wentworth Till. Karrow (1987) describes the till as a buff-coloured, stony, sandy silt till. Located between the moraines are younger outwash gravel deposits and ice-contact gravel deposits. Deposits along parts of Aberfoyle Creek and Mill Creek are mapped as peat and muck (organic deposits). There are no bedrock outcrops within the study area.

The coarse-grained deposits between the moraines generally overlie the Wentworth Till. In some areas, particularly the central part of the Mill Creek subwatershed, the till is not present, and the coarse-grained deposits are continuous to bedrock. The surficial coarse-grained deposits are thinner and separated from the bedrock by the underlying till in the upper and lower reaches of the Mill Creek subwatershed. The site is located within the upper half of the watershed. Occasional coarse-grained deposits exist at various depths as lenses or discontinuous layers within or between till units (CH2M Gore & Storrie, 1996). A gravel layer is also present immediately above the bedrock in some locations, including at TW3-80.

Locally, within a 1 km radius of the property, the overburden is typically 10 m to 30 m thick and consists mainly of outwash gravel or ice-contact gravel deposits. As previously discussed, these coarse-grained deposits are situated between the moraines and are elongated in a southwest to northeast direction. The Wentworth Till is mapped as the surficial deposit along the moraines to the southeast (approximately 500 m) and northwest (approximately 2 to 2.5 km) of TW3-80.

2.4.2 Bedrock Geology

The bedrock surface is somewhat irregular, but generally dips to the southwest. The bedrock elevation in the vicinity of the Nestlé property declines from approximately 306 masl northeast of the property (MW10-09) to 293 masl south of the property (MW16-12).

The regional bedrock geology is shown on Figure 2.3. As noted above, the bedrock nomenclature shown on Figure 2.3 has since been revised based on work by the OGS (Brunton, 2008 and 2009, Brunton and Brintnell, 2011). In general, the previous Guelph Formation is now divided into the Guelph Formation and the Eramosa Formation (Stone Road Member and Reformatory Quarry Member); the previous Eramosa Member of the Amabel Formation is now the Vinemount Member of the Eramosa Formation; and the previous Unsubdivided Member of the Amabel Formation is now divided into the Goat Island, Gasport and Irondequoit Formations. The bedrock hydrogeologic units underlying the property, which are relevant to the Nestlé water taking, are composed of limestone, dolostone and shale sequences and are summarized as follows (from oldest to youngest).

- **Cabot Head Formation:** The Cabot Head Formation, readily distinguished by its grey-green colour, is a non-calcareous shale with thin interbeds of sandstone and limestone. Due to its low hydraulic conductivity, the top of the Cabot Head Formation is interpreted to be the base of the active groundwater flow system.
- **Merritton Formation:** The Merritton Formation consists of a pinkish-brown, finely crystalline dolostone unit with dark shaley partings. This unit is relatively thin where present in the area.
- **Rockway Formation:** The Rockway Formation is a greenish-grey fine crystalline argillaceous dolostone with shaley partings (Brunton, 2008). The thickness of the Formation is fairly consistent and typically less than 2 m.
- **Irondequoit Formation:** This Formation is a thickly to medium-bedded crinoidal grainstone (Brunton, 2008). The unit has a fairly consistent thickness of approximately 3 m throughout the area.
- **Gasport Formation:** The Gasport Formation is a cross-bedded crinoidal grainstone-packstone with sequences of reef mound and coquina (shell bed) lithofacies. This unit has commonly been referred to as the Amabel Formation (Unsubdivided Member) in previous studies in the area (Turner, 1978). Wells in the vicinity of the Nestlé property are generally not drilled through the entire sequence. In and around the City of Guelph, the Formation generally varies in thickness from about 25 to over 70 m, and the upper sections of the reef mounds, the crinoidal grainstones and the coquina shell beds make this formation highly transmissive, where they are present (Golder, 2011).
- **Goat Island Formation:** The Goat Island Formation consists of two members; the lower Niagara Falls Member and the upper Ancaster Member. Based on the boreholes completed in the area, the Goat Island Formation is estimated to range in thickness from approximately 2 m to 15 m.
  - **Goat Island Formation** – Niagara Falls Member: The Niagara Falls Member is a finely crystalline and cross laminated crinoidal grainstone with small reef mounds.
  - **Goat Island Formation** – Ancaster Member: The Ancaster Member is a chert-rich, finely crystalline dolostone that is medium to ash grey in colour.

- **Eramosa Formation:** The Eramosa Formation consists of three members including, from oldest to youngest, the Vinemount Member, the Reformatory Quarry Member and the Stone Road Member.
  - **Eramosa Formation** – Vinemount Member: The Vinemount Member consists of thinly bedded, fine crystalline dolostone with shaley beds that give off a distinctive petroliferous odour when broken (Brunton, 2008). This dark grey to black dolostone unit was commonly identified in water well records as 'black shale' and mapped in previous studies in the City of Guelph as the Eramosa Member of the Amabel Formation. The shaley beds of this Formation significantly reduce the vertical permeability across this unit relative to the other Formations. The Vinemount Member ranges in thickness from approximately 4 m to 12 m in the area of the property.
  - **Eramosa Formation** – Reformatory Quarry Member: The Reformatory Quarry Member, is described by Brunton (2008) as light brown to cream coloured, pseudonodular, thickly bedded and coarsely crystalline dolostone. This unit is susceptible to karstification due to its uniform fine dolomite crystallinity (Brunton, 2008). This unit also often contains mud-rich and microbial mat-bearing lithofacies that may act as aquitard materials, reducing the vertical permeability across this unit.
  - **Eramosa Formation** – Stone Road Member: This cream coloured coarsely crystalline Upper Eramosa unit is not present in most of the area and can be difficult to distinguish from the Guelph Formation.
- **Guelph Formation:** The Guelph Formation is the upper bedrock unit in the study area and consists of medium to thickly bedded crinoidal grainstones and wackestones and reefal complexes (Brunton, 2008). The Guelph Formation is cream coloured and fossiliferous. The upper 0.3 m to 0.6 m is noted to be highly fractured and weathered. Based on data from borehole drilling, the Guelph Formation is typically less than 5 m thick in the vicinity of the property, which is thin relative to the regional scale thickness.

2.4.3 Hydrogeology

The interpretation and nomenclature for the bedrock formations has been revised (as indicated above); however, the interpretation of the hydrostratigraphy at the property and surrounding area has remained consistent. The hydrostratigraphy consists of the following from surface down:

- Overburden Aquifer/Aquitard;
- Upper Bedrock Aquifer (Guelph Formation, Reformatory Quarry Member of the Eramosa Formation);
- Middle Bedrock Aquitard (Vinemount Member of the Eramosa Formation and sometimes parts of the Reformatory Quarry Member of the Eramosa Formation and the Goat Island Formation); and
- Lower Bedrock Aquifer (Goat Island Formation and Gasport Formation).

The designations of aquifers and aquitards is a simplification of the hydrostratigraphy for conceptual purposes. In reality, the hydraulic properties of the bedrock are variable and at some locations of the hydraulic conductivity may be sufficiently small that locally a bedrock stratum act as an aquitard.

Two hydrostratigraphic cross-sections (A-A' and B-B') through the property are included on Figures 2.4 and 2.5 with the locations shown on Figure 2.2. Cross-section A-A' is oriented southwest to northeast roughly along Aberfoyle Creek and cross-section B-B' is oriented north to south through the property, crossing Aberfoyle Creek and including supply well TW3-80.

Based on the hydrostratigraphic interpretation around the property, the thickness of the hydrostratigraphic units is as follows: Overburden Aquifer/Aquitard – 7 to 35 m; Upper Bedrock Aquifer – 2 to 14 m; Middle Bedrock Aquitard – 4 to 12 m; and Lower Bedrock Aquifer – 46 to 58 m. As shown in cross-section A-A', TW3-80 is completed in the upper part of the Lower Bedrock Aquifer.

2.4.4 Groundwater Flow Under Non-Pumping Conditions

Non-pumping conditions have been observed prior to the start of pumping tests. In addition to the pumping tests, there are sometimes brief shutdowns during which water levels in the aquifers evolve towards non-pumping conditions. One such shutdown occurred in October 2010 for 3.4 days. CRA (2014) provided an interpretation of the non-pumping conditions in the overburden and bedrock groundwater levels, as discussed below and also compared to shutdowns that occurred in October 2004 and November 2006.

- The overburden water table interpretation is presented on Figure 2.6, which indicates that the direction of groundwater flow in the overburden is generally to the southwest, with local components of flow to the west and south toward Aberfoyle Creek. CRA (2014) indicates that this flow configuration was similar to the pattern observed for October 2004 and November 2006 shutdowns.
- The Upper Bedrock Aquifer interpretation is shown on Figure 2.7 with the groundwater flow direction identified in a southwest, south, and southeast direction, which is reported to be similar to the pattern observed for October 2004 and November 2006 shutdowns.
- The Lower Bedrock Aquifer interpretation is shown on Figure 2.8 with the groundwater flow direction to the southwest in the vicinity of supply well TW3-80, which is reported to be similar to the pattern observed for October 2004 and November 2006 shutdowns.

Groundwater in the Lower Bedrock Aquifer flows generally south in the direction of TW3-80. The Aberfoyle aquifer is interpreted to be recharged primarily within the northern portion of the Mill Creek subwatershed and the capture zone for TW3-80 is inferred to extend to the north-northeast of the well. The Lower Bedrock Aquifer extends beyond Aberfoyle to the southwest, and groundwater is inferred to discharge to the Grand River in the vicinity of Cambridge.

2.5 Source Water Protection

Since the passing of the Clean Water Act (2006), municipalities in Ontario have been required to develop source protection plans to protect their municipal sources of drinking water. These plans identify both water quality and water quantity risks to local drinking water sources and develop strategies to reduce or eliminate these risks. Potential and existing risks for a municipal source are identified within wellhead protection areas (WHPA). A WHPA is an area projected to ground surface that reflects the zone in an aquifer where groundwater is flowing to a municipal drinking water source (pumping well). These areas are defined to protect water quality. The Nestlé Aberfoyle property and well TW3-80 are located more than 2.6 km from the closest WHPAs, which include the City of Guelph WHPA to the northwest and the Freelton WHPA to the southeast and east in the Lake Ontario Basin. The closest City of Guelph wells are the Burke Well, which is located approximately 7 km away from TW3-80, and the Downey Well, which is more than 8 km away from TW3-80. The Freelton Wells are more than 10 km from TW3-80.

In addition to protecting water quality, water quantity is also a concern and is considered under Water Quantity Protection Plans. A Water Quantity Risk Assessment is completed to ensure that future water needs of a community can be met. It identifies existing and potential water quantity threats and future activities that may limit municipal water supplies. This is important because when more water is taken from an area than can be naturally replenished, water supplies are threatened, and water shortages are possible. The Aberfoyle property falls within a Water Quantity Protection Zone (WHPA-Q) for the City of Guelph municipal wells. The WHPA-Q zone for the City of Guelph has been assigned a significant risk level (Matrix Solutions, 2017). The Tier 3 Assessment scenarios predicted that the City's municipal wells can meet current needs. However, the assessment predicted that the City's Queensdale municipal well would be unable to meet projected increased future demands under normal climate conditions and during prolonged drought (Matrix Solutions, 2017). The Queensdale municipal well is located approximately 12 km northwest of TW3-80. There is also a high level of uncertainty with the results for the City's Arkell Well 1, which is located approximately 10 km north of TW3-80. It is for these reasons that the City's WHPA-Q has been assigned a significant risk level with respect to water quantity. The Source Protection Committee reviewed all existing water takings within the WHPA-Q to evaluate their contribution to water quantity stress in the area. The study showed that municipal wells have the greatest impact on themselves (i.e., pumping at a municipal well influences the water levels in other municipal wells). TW3-80 was not found to interfere with the municipal wells' ability to supply water (Matrix Solutions, 2018). TW3-80 is estimated to be responsible for 1% of the drawdown at the closest municipal well (Burke Well located approximately 7 km north-northeast of TW3-80) (Matrix Solutions, 2018). With a drawdown in the order of approximately 10.8 m at the Burke Well, pumping from TW3-80 is estimated to be responsible for approximately 0.1 m of the drawdown observed at the Burke Well.

3.0 SUMMARY OF 2020 FIELD PROGRAM

This section describes the field activities performed in 2020 associated with PTTW Number 1381-95ATPY (for TW3-80 and TW2-11).

3.1 Groundwater and Surface Water Monitoring Program

Groundwater and surface water monitoring was initiated in 2000 and has evolved over the years with the objectives to 1) characterize the existing hydrogeologic setting, and 2) document potential long-term changes to the groundwater and surface water resources in the area. The monitoring program includes measurement and record-keeping of water takings, groundwater levels, mini-piezometer levels, surface water levels, surface water flows and surface water temperatures. The monitoring program includes the following instrumentation, with the locations shown on Figures 3.1 through 3.3:

- Groundwater levels and pumping volumes in 2 production wells (although TW2-11 has never been used);
- Groundwater levels in 38 monitoring wells at 16 sites (13 consisting of multiple monitoring intervals) with monitors in the Lower Bedrock Aquifer, Upper Bedrock Aquifer, and overburden;
- Groundwater levels in 11 private wells (1 of the 11 is no longer monitored since 2018 due to access restrictions);
- Shallow groundwater levels in 9 mini-piezometers with a total of 18 monitors;
- Surface water levels at 7 stations (1 of the 7 is no longer monitored after it was destroyed in 2018);
- Stream flow at 2 locations; and
- Stream temperature at 6 locations.

3.1.1 Water Taking

Water taking from TW3-80 in 2020 is measured using a Krohne magnetic flow meter that is wired to an Allen Bradley industrial Programmable Logic Controller. The instantaneous flow and cumulative volume pumped are recorded every minute. The flow meter was calibrated on November 16, 2020 by Endress+Hauser.

The daily volumes taken from supply well TW3-80 in 2020 are provided in Appendix C. No water was taken from TW2-11 in 2020.

3.1.2 Groundwater Monitoring Program

Groundwater levels have been measured at various locations for varying periods of time on-Site and off-Site since December 1980. Following the purchase of the Site by the Perrier Group of America, a monitoring program was initiated in December 2000. Modifications to the monitoring program have been made over time as a result of PTTW requirements, well abandonments, physical inaccessibility to wells, and changes in property ownership. In 2018, a homeowner requested that monitoring be discontinued at their well (see Section 3.1.4). During the 2020 monitoring period, none of the wells required as part of the monitoring program became inaccessible. Previous wells that have been decommissioned or are no longer part of the monitoring program are shown on Figure 3.4. All the existing monitoring locations and the decommissioned or unused wells are shown on Figure 3.5.

The monitoring locations for the 2020 groundwater monitoring program are shown on Figures 3.1 and 3.2 and are summarized as follows:

Overburden Monitors

- MW2D-07, MW2E-07, MW4C-07, MW10A-09, TW1-93, TW1-99, MW-S, PCC-S, PCC-I

Bedrock Monitors

Upper Bedrock Aquifer Monitors

- MW2C-07, MW4B-07, MW6B-08, MW7B-08, MW8B-08, MW10B-09, MW14B-11, MW14C-11, MW15B-12, MW16B-12, MW17B-12, MW18B-12, MW-D, MW-I, PCC-D, 8 MLL (67-08317), 2 Brock Road North, 58 Brock Road South, 7404 Road 34 (67-07589), Y well

Middle Bedrock Aquitard Monitors

- MW2B-07, I (67-07389)

Lower Bedrock Aquifer Monitors

- TW3-80 (Production Well), TW2-11, MW2A-07, MW4A-07, MW6A-08, MW7A-08, MW8A-08, MW10C-09, MW10D-09, MW14A-11, MW15A-12, MW16A-12, MW17A-12, MW18A-12, Fireflow, B (67-07383), M1 (67-13755), PW5 Meadows of Aberfoyle (67-1197), 67-08740, W2 (no longer monitored since August 2018)

Some private wells are open across multiple bedrock units (for example private wells with a finished depth in the Lower Bedrock Aquifer are typically open across the Upper and Lower Bedrock Aquifers). Wells constructed in this manner have been grouped with the lowermost unit in which they are installed. It should be noted that water levels measured in wells open to multiple aquifer units represent average water levels that are not representative of the levels in any of the individual aquifer units. In addition, these wells may represent a potential pathway for contaminants in the shallow groundwater system to move into the deeper strata. None of the wells that Nestlé owns are open across multiple aquifer units.

Water levels are measured at all locations during the third week of each month. Where required by the PTTW, dataloggers are used to record water levels at 60-minute intervals and downloaded monthly. The groundwater levels measured in 2020 are presented in Appendix D.

3.1.2.1 Missing Data

The following table provides a list and description of missing data from the 2020 groundwater monitoring. In some wells (e.g., PCC), the water level is close to surface and can become frozen in the winter. Other issues include blockage in the access tubes, active wasp nests and health and safety restrictions due to COVID. With the exception of the COVID restrictions, the other issues were temporary and have been resolved.

Table 2: Missing Groundwater Data from the 2020 Monitoring

Monitoring Location	Missing Data	Comment
MW8A-08	Manual water level in February (transducer downloaded)	Frozen
8 Maple Leaf Lane	Manual water level in February and November	Frozen in February and access tube blocked in November
PCC-D	Manual water level in February (transducer downloaded)	Frozen
MOE#6708740	Manual water level in September	Wasp nest
Private Well "I"	Manual water level in March through December	Well is in house and could not enter house due to health and safety restrictions (COVID)

3.1.3 Surface Water Monitoring Program

The monitoring locations for the 2020 surface water monitoring program are shown on Figure 3.3 and are summarized as follows:

Surface Water Levels

Measurement of surface water levels was initiated in December 2001 as part of Nestlé's monthly monitoring program. In 2020, surface water levels were measured at the following locations:

- Aberfoyle Creek:
  - SW1 - located within the upstream part of the Nestlé property;
  - SW2 - located within the downstream part of the Nestlé property; and
  - SW3 - located at Gilmour Road, upstream of the Nestlé property.
- Mill Creek:
  - SW4 - located on Mill Creek at Maple Leaf Lane, upstream of the confluence with Aberfoyle Creek; and

  - SW5 - located on Mill Creek at McLean Road, downstream of the Nestlé property.
- Ponds:
  - SW9 - located in the Dufferin Aggregates owned pond located southeast of the Nestlé property (destroyed in 2018); and
  - SW10 - located in the Dufferin Aggregates owned pond at the entrance to the Nestlé property.

Water levels are measured at all locations during the third week of each month using a water level meter. At SW1 and SW2, dataloggers are used to record water levels at 60-minute intervals, which are also downloaded once a month. The surface water levels for 2020 are presented in Appendix E.

Stream Flow

Measurement of stream flow was initiated in December 2001 as part of Nestlé's monthly monitoring program. Stream flow is measured at SW1 (upstream part of Nestlé property) and SW2 (downstream part of Nestlé property) in Aberfoyle Creek during the third week of each month. Stream flows are measured at SW1 and SW2 to monitor for changes that could be attributed to pumping at TW3-80. In 2020, stream flow velocities were measured using a Hach electromagnetic flow meter and the stream flows were calculated using the cross-sectional area-velocity method. The stream flow calculations for 2020 are presented in Appendix F.

In addition, the monthly surface water elevations ("stage") and stream flow measurements ("discharge") collected in 2020 were used to update and/or re-establish the stage-discharge relationships (rating curves) at SW1 and SW2. The rating curves were used to infer continuous records of stream flow from the continuous water level measurements at SW1 and SW2.

Mini-Piezometers

Mini-piezometers were initially installed in 2004 with additional mini-piezometers being installed since that time. In 2020, water levels were measured in mini-piezometers at ten locations, each containing a shallow and a deep monitor (see locations on Figure 3.3). The mini-piezometer nests are located along Aberfoyle Creek upstream of the Nestlé property to Mill Creek downstream of the confluence of the two creeks as follows.

- MP11S-08/D-04
- MP1-16S/D (installed April 2016 – currently not part of existing PTTW)
- MP16S/D-08
- MP6S-08/D-04
- MP12S/D-04
- MP14S/D-07
- MP8S/D-04
- MP19S/D-12
- MP17S/D-11
- MP18S/D-11

Water levels are measured and dataloggers downloaded at all locations during the third week of each month. Dataloggers are used to record water levels at 60-minute intervals. The water levels measured in 2020 are presented in Appendix E.

Temperature

Measurement of surface water temperature began in 2005. In 2020, surface water temperature was measured at six locations along Aberfoyle Creek. The most upstream location is situated at Brock Road with the remainder of the sites located on the Nestlé property downstream of Brock Road. Beginning upstream and moving downstream, the stream temperature sites are as follows (see locations on Figure 3.3).

- ST6-08
- ST1-05
- ST2-05
- ST3-05
- ST4-05
- ST5-05

The dataloggers are located at the sediment-water interface with temperature data measured and logged at 30-minute intervals using Stowaway Tidbit® dataloggers or HOBO Tidbit MX dataloggers. Two dataloggers are installed at each site. Air temperature is also measured in a shaded area at ST1-05 at 30-minute intervals.

C. Portt and Associates Ltd. (2011) conducted a review of the appropriateness of the methodology for the temperature monitoring program. The report was approved by the MECP in October 2011 and recommendations from the report were implemented by CRA at that time and continued by Golder since May 2014. The temperature data are analyzed by C. Portt and Associates using ThermoStat software. A report on the surface water temperature is included as Appendix G.

3.1.3.1 Missing Data

The following table provides a list and description of missing data from the 2020 surface water monitoring. Some of the missing data are technically not missing but rather are due to winter conditions. The water levels in the mini-piezometers are close to surface and can become frozen in the winter. Slow moving water in the creeks can also become frozen in the winter. The water level is not necessarily representative of the actual water level under these frozen winter conditions. Other issues included access restrictions due to bridge construction or bridge stability. The issues were temporary and have been resolved.

Table 3: Missing Surface Water Data from the 2020 Monitoring

Monitoring Location	Missing Data	Comment
MP1-16D (not part of PTTW)	Not missing but frozen	Frozen in January, February and March
MP6S-08/D-04	Not missing but frozen	Frozen in January and February

Monitoring Location	Missing Data	Comment
MP8S/D-04	Not missing but frozen	Frozen in January and February (S only)
MP11D-04	Not missing but frozen	Frozen in January and February
MP12S/D-04	Not missing but frozen	Frozen in January, February, March (D only) and April (D only)
MP14S/D-07	Not missing but frozen	Frozen in January, February and March (D only)
MP16S/D-08	Not missing but frozen	Frozen in January and February
MP17S/D-11	Not missing but frozen	Frozen in January and February
MP18S/D-11	Not missing but frozen	Frozen in January and February
MP19S/D-12	Not missing but frozen	Frozen in January and March (D only)
SW1	Not missing but frozen	Frozen in January
SW5	Manual measurement	Bridge under construction in September
SW10	Not missing but frozen	Frozen in January and February

3.1.4 Notification Regarding Locations Which Become Inaccessible

A list of the wells that have become inaccessible and removed from the monitoring program, along with replacements that were recommended, are provided in the following table.

Table 4: Inaccessible Monitors

Monitoring Location	Reason for Inaccessibility	Action recommended by Nestlé	Documented in Letter to MECP (Appendix J)
SW9	In April 2018 the station was destroyed when part of the aggregate wash pond was filled in	No additional station to be established since the pond levels vary due to aggregate operations and nearby SW10 can be used for monitoring in the same area	April 30, 2018
W2	In August 2018 the landowner notified Nestlé that they would no longer like their well monitored	Install a monitoring well on a neighbouring property	August 9, 2018

3.2 Biological Monitoring

Biological monitoring undertaken on the Nestlé Waters Canada Aberfoyle property in 2020 was completed in accordance with the requirements of the PTTW for the site and under the guidance of recommendations provided in the 2019 Biological Monitoring Report (Beacon Environmental, 2020). Monitoring of terrestrial resources (vegetation and wildlife) was completed by Beacon Environmental and monitoring of aquatic resources (salmonid redd survey reaches of Aberfoyle Creek) was completed by C. Portt and Associates. The findings of the 2020 Biological Monitoring Program are presented in the 2020 Biological Monitoring Program Report (Beacon Environmental, 2021) which is included in Appendix H.

3.3 Surveying

No surveying needed to be conducted in 2020.

3.4 Precipitation

In 2020, precipitation data were obtained from Environment Canada from the Kitchener/Waterloo (KW) Station, which is an automated Nav Canada station that reports total daily precipitation over the entire year. When data are missing from the station, the gap is filled in using data from the Elora RCS meteorological station. Precipitation records were also previously obtained from the Waterloo Wellington Station; however, precipitation has not been recorded at the station since April 2017. Environment Canada does not calculate 30-year annual average climate conditions (climate normal) for the Kitchener Waterloo Station and as such the climate normal from the Waterloo Wellington Station continues to be used for comparison.

The following table provides a summary of the annual precipitation. The annual 30-year average (1981-2010) precipitation from the Waterloo Wellington Station (closest station to the KW station with 30-year average data) is 916.5 mm. The total precipitation measured in 2020 was 697.6 mm, which is approximately 24% below the average. Following a couple years of near-average precipitation in 2016 and 2017, the total precipitation in the last three years (2018, 2019 and 2020) has been below the long-term average. Annual precipitation is also shown graphically on Figure 3.6 along with the 30-year average.

To assess the variability in precipitation locally, the total precipitation at the KW Station has been compared to the total precipitation recorded at the University of Waterloo. Annual precipitation at the University of Waterloo in 2020 totalled 950.9 mm or close to the average.

Table 5: Annual Precipitation

Year	Precipitation (mm)	% Difference from Average
2008	1304.7	42.3
2009	964.9	5.3
2010	833.1	-9.1
2011	1081	17.9
2012	770.6	-15.9
2013	1088.6	18.8

Year	Precipitation (mm)	% Difference from Average
2014	973.8	6.3
2015	795.8	-13.2
2016	931.9	1.7
2017	949.4	3.6
2018	807.1	-11.9
2019	740.0	-19.3
2020	697.6	-23.9
Average (1981-2010)	916.5	

The monthly precipitation for 2020 is included in Table 6. With the exception of January and August, the remaining months were below average conditions. This is different than the description provided by the University of Waterloo indicating average conditions were experienced from February to December (email from weather@uwaterloo.ca).

Table 6: Monthly Precipitation in 2020

Month	Precipitation (mm)	Average (mm)	% Difference from Average
January	78.8	65.2	20.9
February	23.1	54.9	-57.9
March	53.9	61.0	-11.6
April	39.6	74.5	-46.8
May	45.0	82.3	-45.3
June	36.4	82.4	-55.8
July	81.0	98.6	-17.8
August	95.0	83.9	13.2
September	70.6	87.8	-19.6
October	64.2	67.4	-4.7
November	60.0	87.1	-31.1

Month	Precipitation (mm)	Average (mm)	% Difference from Average
December	50.0	71.2	-29.8

It is noted that in 2017, Nestlé benefited from an exchange with the consulting hydrogeologist for Puslinch Township regarding the assessment of precipitation data from stations in the general area of the Aberfoyle facilities (memorandum prepared by Harden Environmental Services Inc. for Puslinch Township, May 12, 2017). It is recognized that there are differences between the amounts of precipitation recorded at the different stations. It is impossible to obtain a perfectly representative estimate of the annual precipitation over the full extent of the area of contribution for the Nestlé Aberfoyle well. What is most important is that adopting a consistent approach from year to year allows an assessment of the differences with respect to long-term average conditions (30-year climate normals). An analysis of precipitation trends was conducted to see if there is a correlation with water level trends. We note that the actual influence on water levels (groundwater) would be due to recharge and not total precipitation, and that recharge is controlled by more than just precipitation. However, in the absence of detailed recharge data in the area, the use of precipitation totals allows for some comparison of long-term trends in water levels, particularly in the shallow monitors (overburden and mini-piezometers).

For the 2018 Annual Report, an independent soil water balance analysis was conducted to estimate annual average infiltration rates over the region surrounding TW3-80. The SWB code of the United States Geological Survey was applied (Westenbroek et al., 2010) with the records of precipitation data compiled for the Annual Monitoring Report for 2008-2018. The results of the analysis suggested that the annual average infiltration is about 17% of the annual precipitation. The analysis was updated with the 2019 and 2020 climate data and the estimated annual infiltration is consistent with the trends inferred from the 2008-2018 analyses. The estimated annual infiltration for 2020 is lower than estimated for previous years, which reflects the fact that the reported annual precipitation for 2020 for the KW Station is the lowest over the period from 2008 to 2020. The updated analyses are documented in a technical memorandum included in Appendix I.

4.0 MONITORING PROGRAM RESULTS

4.1 Water Taking for TW3-80 and TW2-11

Water taking at the Nestlé Aberfoyle Site in 2020 continues to be governed by PTTW 1381-95ATPY, which permits water to be taken from two wells as outlined in Table 7.

Table 7: Permitted Water Takings at Aberfoyle

Source	Maximum Rate	Maximum Number of Hours of Water Taking per Day	Maximum Daily Water Taking	Maximum Number of Days of Water Taking per Year
TW3-80	2,500 L/min	24	3,600,000 L	365
TW2-11	475 L/min	24	684,000 L	365
Total			3,600,000 L	

The daily water takings for 2020 are tabulated in Table C1 in Appendix C. The daily water taking at TW3-80 ranged from 45 L to 2,871,783 L. The average daily taking was 1,590,768 L. During 2020, the instantaneous flow rates and the daily takings were always below the limits of the PTTW (i.e., less than 2,500 L/min and 3,600,000 L, respectively).

The total volume of water taken each year from 2001 to 2020 is presented on Figure 4.1. The total volume of water taken in 2020 from TW3-80 was 582,221,219 L. In 2020, the total volume taken was approximately 44% of the permitted volume. The total pumping from TW3-80 in 2020 was similar to the total annual water taking in 2019. Since 2002, the groundwater taking has ranged from approximately 43% to 67% of the permitted taking.

The monthly water takings for the past 5 years are presented on Figure 4.2. The monthly water takings in 2020 from TW3-80 ranged from 34,531,690 L in December to 71,530,142 L in August. In 2020, the monthly water takings generally increased during the first half of the year (with the exception of the low water takings in April and May), with the peak water taking in August, and then decreased during the remainder of the year. In general, the monthly water taking amounts and trends over the year were similar in 2019 and 2020.

The Grand River Low Water Response Team declared a Level 1 Low Water Condition for the entire Grand River Watershed, including Mill Creek, on July 9, 2020. The Level 1 Low Water Condition was removed on October 8, 2020. Nestlé Waters Canada complied with the request by the Grand River Conservation Authority for all water-users in the Grand River watershed to voluntarily limit water takings to 90% of their monthly maximum permitted volume during the Level 1 Condition. Nestlé's water takings were below 80% of the permitted daily amount during the low-water condition.

Condition 4.5 of the PTTW indicates that if the monthly amount of water taken exceeds 83,700,000 L, then multi-level piezometer (MP6, MP12, MP11 and MW2) data shall be submitted to the MECP. The monthly threshold of 83,700,000 L represents 75% of the permitted monthly water taking, based on a 31-day month. As shown on Figure 4.2, the monthly water takings in 2020 were less than the 83,700,000 L threshold; therefore, no multi-level piezometer data were submitted to the MECP during the year.

No water was taken from TW2-11 in 2020.

Condition 4.9 of the PTTW requires details of the bottling operations such as location and name of facilities where water is delivered in bulk containers, if bulk water is containerized at the receiving location, the size of the containers into which the water is transferred, and total volume of water transported in bulk to each remote facility. Nestlé has indicated that no water was shipped in bulk (container greater than 20 litres) in 2020.

As per Condition 5.1, Nestlé has indicated that no complaints arising from the taking of water authorized under this PTTW were received in 2020.

4.2 Groundwater Monitoring Program

The groundwater levels measured manually in 2020 at the monitoring wells are tabulated in Table D1 in Appendix D. Hydrographs with the manual or transducer water level data are also included in Appendix D. In addition to the water levels, the hydrographs include the daily pumping volumes at TW3-80 and daily precipitation as recorded at the Waterloo Wellington or Kitchener Waterloo meteorological stations prior to April 2017 and from the Kitchener Waterloo station after April 2017 (as described in Section 3.4, with missing data filled in from other nearby stations).

4.2.1 TW3-80

Water levels and average daily pumping rates for TW3-80, along with daily precipitation, from 2016 through 2020 are shown on Figure D1a (Appendix D).

Water levels measured in 2020 at TW3-80 range from approximately 297.5 to 312.5 masl (or approximately 18.9 to 3.9 m below ground surface) under pumping and non-pumping conditions, respectively. These variations in water levels are mainly due to changes in the pumping rate and are within the historical range of water levels observed at TW3-80. An analysis of monthly-average water levels at TW3-80 versus average pumping at TW3-80 was undertaken to assess how pumping water levels are related to pumping rates. A linear regression of the data indicates that pumping rate accounts for approximately 90% of the variation in water levels in TW3-80. A technical memorandum on the analysis is included in Appendix I.

Operation records of TW3-80 indicate that the well is seldom shut-down for significant periods of time and, consequently, there are few fully recovered non-pumping water levels available. Based on previous shutdowns, CRA (2014) indicates that the non-pumping water levels are approximately 311 to 313 masl or 5.4 to 3.4 m below ground surface. The estimated non-pumping water levels (partially recovered conditions following shutdown of the pump) observed in 2020 range from approximately 306.5 to 312.5 masl. The water levels are similar to the non-pumping water levels observed since September 2018 and higher than the previous three years (2016 through 2018) when the water takings were higher. It should be noted that non-pumping water levels do not represent “true” conditions that would be observed if there was no pumping at TW3-80 for an extended period. Instead, they represent partially recovered conditions, with the amount of recovery dependent on the average pumping rate before the pumping stopped, how much time has elapsed before pumping resumes and whether there is a background (seasonal) trend in the water levels. The results of the analysis presented in Appendix I suggest that the fully recovered non-pumping level in TW3-80 is about 313.4 m.

The pumping levels in 2020 range from approximately 298 to 307 masl. Based on a static water level of 313 masl, the estimated drawdown at the well in 2020 ranged from approximately 6 to 15 m. The total available drawdown to the top of the pump intake is about 20.7 m (based on a static water elevation of 313 masl and a top of pump intake elevation of 292.3 masl). Referring to Figure 1.2, the top of the Lower Bedrock Aquifer is at an elevation of approximately 292.3 masl. The pumping levels in 2020 ranged from about 6 to 15 m above the top of the aquifer; confirming that the aquifer has remained under confined conditions in 2020.

The records of average monthly water levels, monthly withdrawals and monthly precipitation between 2005 and 2020 are shown on the hydrograph for TW3-80 (Figure D1b). The hydrograph extends back to 2005 to include the period of increased pumping up to 2008. The data provide important insights into the performance of the well and the long-term sustainability of pumping. The water levels and pumping volumes can be categorized into four periods with a year of transition between each period as follows: 2005 through 2007 when pumping rates were higher and water levels were lower; 2009 through 2013 when pumping rates were lower and water levels were higher; 2015 through 2017, when pumping rates were higher and water levels were lower; and 2019 to present, when pumping rates have been lower and water levels higher. In general, the water level changes in TW3-80 correspond to the changes in the overall water taking from the well (i.e., lower water levels during periods of higher water takings (e.g., 2007) and higher water levels during periods of lower water takings (e.g., 2011)). Overall, the water levels respond to pumping as expected and the on-going groundwater taking at TW3-80 has not led to a long-term declining trend in the TW3-80 water levels. The capacity of the well has not changed through time.

4.2.2 Lower Bedrock Aquifer

The regional groundwater potentiometric surface in the Lower Bedrock Aquifer is shown on Figure 4.3. The potentiometric surface was prepared based on the water levels measured during the August 20, 2020 monthly monitoring event. This represents a time when the highest pumping volumes were recorded at TW3-80 and monthly precipitation was also high. A review of the potentiometric surface on August 20, 2020, indicates groundwater flow toward TW3-80 from the northeast, north and northwest. The greater hydraulic connection with the area toward MW7-08 is evident in the potentiometric surface under pumping conditions. It is estimated that the water elevation contours resume back to the regional southerly flow pattern approximately 1.5 km south of the Site.

Hydrographs for wells completed in the Lower Bedrock Aquifer are included on Figures D2 through D17 in Appendix D. It should be noted that private wells installed in the Lower Bedrock Aquifer are constructed as open-hole installations and are therefore also open through the Upper Bedrock Aquifer and the Middle Bedrock Aquitard. The water levels in these wells represent an "average" water level and do not provide a reliable measure of water levels specific for any of the individual aquifer units across which the well is open.

The findings from a review of the hydrographs of wells completed in the Lower Bedrock Aquifer, specifically with continuous water level data from dataloggers, are summarized below.

- Water levels measured within this aquifer at the beginning and end of 2020 are generally similar to the water levels measured in 2019. The water levels measured in the summer of 2020 were lower than summer water levels in 2019 but similar to water levels in previous years when the pumping at TW3-80 was higher. The water levels in 2020 are within the historical range measured at the wells.

- Water levels in portions of the Lower Bedrock Aquifer near TW3-80 are influenced by short-term fluctuations in TW3-80 pumping. The short-term pumping effects are evident with the water levels fluctuating in response to daily changes in pumping rates and are observed in monitoring wells closest to TW3-80 (e.g., MW2A-07 and MW4A-07). In comparison, wells located further away (upgradient – MW6A-08, MW8A-08, MW10C-09 and MW10D-09; downgradient – MW15A-12, MW16A-12 and MW17A-12) show only minor differences between the daily high and low water levels.

- Water levels in the Lower Bedrock Aquifer are also influenced by longer term trends in the TW3-80 pumping. The long-term pumping effects are evident in the wells closer to TW3-80 where water level changes from year to year correlate with overall annual water takings (i.e., increased water takings result in lower average water levels). During periods of reduced pumping, the water levels recover with no long-term increasing or decreasing trends. These effects of variations in total annual pumping decrease with distance from TW3-80, as can be seen by comparing the hydrographs for MW2A-07 against hydrographs for wells further from TW3-80 (e.g., MW8A-08, MW15A-12 and MW16A-12). This is evident with the observed rise in water levels since September 2018, which correlates with an overall decrease in pumping at TW3-80. The long-term water level trend in the monitoring wells further away from TW3-80 indicate that there is no increasing or decreasing trend over the last five years.

- An exception to these trends is at MW7A-08 (located approximately 1,050 m north of TW3-80) where there appears to be a stronger hydraulic connection with TW3-80 compared to the connection between TW3-80 and MW14A-11 (located approximately 750 m northwest of TW3-80) and TW3-80 and MW18A-12 (located approximately 750 m southwest of TW3-80). This may also indicate that the zone of influence extends further upgradient toward MW7-08, as opposed to downgradient toward MW18-12. This interpreted hydraulic connection is consistent with previous years.

- Another exception to these trends is at MW10C/D-09 (located approximately 1,230 m north east of TW3-80) and at MW16A-12 (located approximately 1,650 m south of TW3-80), where the water levels remain lower from the summer to the end of the year. This is consistent with previous years where the water levels at these locations start to rise in January. These wells are located further away from TW3-80 and may be influenced by external sources.
- Water levels in the Lower Bedrock Aquifer show some correlation with conditions in the shallower subsurface. During the spring, shallow groundwater levels are greatest and the water levels in some wells (MW6A-08, MW8A-08, MW10C/D-09, MW15A-12, and MW16A-12) are stable or on increasing trends while pumping is increasing.

In summary, the water levels in the on-site monitoring wells in the Lower Bedrock Aquifer are influenced primarily by pumping at TW3-80. The effects of pumping at TW3-80 diminish with distance away from the well, and beyond about a kilometre water levels are predominantly affected by other influences. In addition, water levels recover when pumping rates are reduced, as has been observed since September 2018.

4.2.3 Middle Bedrock Aquitard

Hydrographs for wells completed in the Middle Bedrock Aquitard are included on Figure D18 in Appendix D. Two wells are monitored within this unit, including one monitoring well (MW2B-07) that is sealed within the Middle Bedrock Aquitard but close to the top of the Lower Bedrock Aquifer, and one private well (“I”), that like other private wells is constructed as an open hole that is also open to the Upper Bedrock Aquifer. Since private well “I” is completed partially within the upper aquifer, it is not considered a true Middle Bedrock Aquitard monitoring well and is not representative of Middle Bedrock Aquitard conditions. Previously, monitoring well MW14B-11 was also considered to be situated within the Eramosa Aquitard; however, with the recent re-interpretation of aquifer/aquitard units, MW14B-11, which is located in the Reformatory Quarry Member of the Eramosa Formation is now considered to be located within the Upper Bedrock Aquifer.

The results of a review of the hydrographs of wells completed in the Middle Bedrock Aquitard, specifically with continuous water level data from dataloggers, are summarized below.

- Water levels measured within this aquitard in 2020 are similar to the water levels measured in 2019 and higher than water levels observed during the previous three years (2016 through 2018). The water levels are within the historical range measured at the wells.
- The water levels in MW2B-07 follow a similar trend as the water levels in the Lower Bedrock Aquifer from year to year and respond to pumping at TW3-80. The water levels show a response to pumping and non-pumping. This is consistent with the interpretation that the bottom of the screen is only 2 m above the contact between the Middle Bedrock Aquitard and the Lower Bedrock Aquifer.
- Water levels at “I” were only measured in January and February in 2020. Water levels were not measured after this time due to a restriction to not enter the house during the pandemic. The manual water level measurements recorded in the past at “I” suggest that the well responds similar to MW2B-07 or as a Lower Bedrock Aquifer monitoring well.

4.2.4 Upper Bedrock Aquifer

The regional groundwater potentiometric surface in the Upper Bedrock Aquifer is shown on Figure 4.4. The potentiometric surface was prepared based on the water levels measured during the August 20, 2020 monthly monitoring event. This represents a time when the highest pumping volumes were recorded at TW3-80 and monthly precipitation was also high. A review of the potentiometric surface on August 20, 2020, indicates groundwater flow toward TW3-80 from the northeast, north and northwest. The greater hydraulic connection with the area toward MW7-08 is evident in the potentiometric surface under pumping conditions.

Hydrographs for wells completed in the Upper Bedrock Aquifer are included on Figures D19 through D29 in Appendix D.

The findings from a review of the hydrographs of wells completed in the Upper Bedrock Aquifer, specifically with continuous water level data from dataloggers, are summarized below.

- Water levels measured in the Upper Bedrock Aquifer in 2020 are within the historical measured ranges. Water levels were generally stable through the winter and then declined into the summer. Water levels in the downgradient wells generally stabilized during the second half of the year while the water levels in the other wells increased through the fall.
- Water levels in the Upper Bedrock Aquifer around the Site show some effects of pumping at TW3-80 (i.e., there is hydraulic connection between the Lower Bedrock and Upper Bedrock Aquifers); however, the connection is limited (i.e., less response than in the Lower Bedrock Aquifer). The extent of influence varies based on distance from TW3-80 and existing hydrogeologic conditions (i.e., complexity in the subsurface geologic structure and properties).
- The relationship between the long-term average pumping rates and water levels (i.e., higher water levels during periods of decreased pumping since September 2018) is only observed in the monitoring wells on the property (e.g., MW2C-07 and MWI/D) and MW7B-08 (upgradient).
- Typically, wells further away from TW3-80 show less effect from pumping, although this is not always the case. The greatest influence from pumping is observed at MW2C-07 and MW7B-08. There appears to be a stronger hydraulic connection between TW3-80 and MW7B-08 (located approximately 1,050 m north of TW3-80) compared to the connection between TW3-80 and MW4B-07 (located approximately 330 m northwest of TW3-80). This is also consistent with previous years and points to complexity in the subsurface.
- While there is an influence on water levels in the Upper Bedrock Aquifer from pumping TW3-80, there are also long-term water level fluctuations that are reflective of recharge (i.e., lower water levels during years of below-average precipitation and higher water levels during years of above-average precipitation).
- There are also seasonal influences observed in the water levels in the Upper Bedrock Aquifer. For example, there is a rise in water levels or stable water levels measured in the wells within the Upper Bedrock Aquifer in the spring due to spring recharge. Recharge to the aquifer has more of an effect than pumping during this period of time (i.e., the changes in water level are more reflective of the wet spring/dry summer and fall compared to the total pumping). There are also short-term fluctuations in water levels that reflect changes in barometric pressure.

In summary, the water levels in the on-site monitoring wells in the Upper Bedrock Aquifer are influenced by pumping at TW3-80 but to a lesser degree than water levels in the Lower Bedrock Aquifer due to a lower permeability bedrock layer that exists between the two aquifers. There is also an influence on water levels reflective of recharge. The long-term monitoring data, which show that water levels recover when pumping rates are reduced is consistent with the interpretation that the water taking is sustainable.

4.2.5 Overburden

The potentiometric surface of the overburden plotted in Figure 4.5 is also based on water levels measured on August 20, 2020, during the month of highest pumping. A review of the potentiometric surface on August 20, 2020, indicates that groundwater flow is generally in a southerly direction with potentially some flow towards Aberfoyle Creek. We note that there is both lateral and vertical flow in the overburden. An interpretation of the lateral flow in the overburden is shown in Figure 4.5, while vertical gradients in the shallow overburden along the creek are discussed below. Shallow groundwater flow directions are more variable locally than the deeper bedrock flow systems as they are more influenced by topography and interactions with surface features.

Hydrographs for wells completed in the overburden are included on Figures D30 through D34 in Appendix D. The intermediate and deep overburden wells are installed in the till, in sand and gravel within or below the till, or deep within the surficial sand and gravel aquifer. Shallow overburden wells are typically installed in the upper portion of the surficial sand gravel.

Findings from a review of the hydrographs of wells completed in the overburden are summarized below.

- Water levels measured within the overburden during the first half of 2020 are similar to water levels measured in 2019. Water levels measured in the second half of 2020 are lower than those measured in 2019 but within the historical measured ranges. There is no significant overall increasing or decreasing trend.
- Water levels were generally stable through the winter and then declined into the summer. Water levels in MWC-07 and TW1-99 generally stabilized during the second half of the year while the water levels in the other wells increased through the fall.
- Water levels in the overburden are affected by natural events (recharge), and to a lesser degree by pumping at TW3-80. The response to pumping in the overburden is muted compared to the response in Upper and Lower Bedrock Aquifers but for monitoring wells immediately adjacent to TW3-80 there is a correlation with long-term variations in pumping.

In summary, the water levels in the overburden are influenced by natural events and to a lesser degree, pumping at TW3-80. The influence of pumping on water levels in the overburden is less than the influence of pumping on water levels in both the Upper and Lower Bedrock Aquifers. There are no long-term declining trends in the overburden water levels. The fact that water levels recover when pumping rates are reduced and there are no long-term declining trends is a line of evidence that the water taking is sustainable.

4.2.6 Vertical Gradients

Vertical gradients between the Lower Bedrock Aquifer and the Upper Bedrock Aquifer are plotted on Figures D35 through D45 in Appendix D; the gradients are inferred from multi-level monitoring wells completed in both units.

Note that a positive gradient is calculated when the water level in the upper aquifer exceeds the level in the lower aquifer. Under these conditions, the mean direction of vertical groundwater flow is downwards.

In general, based on a review of the graphs for the multi-level monitoring well locations, a dampened response in the Upper Bedrock Aquifer relative to the response in the Lower Bedrock Aquifer is evident. At locations where the positive gradient increases when pumping increases, this is due to the fact that water levels in the Lower Bedrock Aquifer respond more to pumping than do the water levels in the Upper Bedrock Aquifer.

A description of the gradients at the Site is as follows:

- MW2A/C-07 – positive gradient (potential downward flow) that increases with increased pumping. There are brief periods in 2020 and other years when the gradient is reversed, coinciding with reduced pumping. The positive gradient has decreased since September 2018 which corresponds with the decrease in pumping over the same time period. However, the increased positive gradient is observed during the summer months in 2020 when pumping from TW3-80 increased. The long-term gradient trend correlates with the long-term pumping trend (i.e., increased pumping results in an increasing positive gradient). Seasonal changes in vertical gradient are also evident and correspond to the seasonal changes in pumping (i.e., higher pumping during the summer months). Daily changes in the vertical gradient are greater than at wells further away from TW3-80.
- MW4A/C-07 – positive gradient (potential downward flow) that increases with increased pumping. The positive gradient has decreased since September 2018 which corresponds with the decrease in pumping over the same time period. The long-term gradient trends and seasonal changes in vertical gradient are also evident and similar to those observed at MW2-07. The daily changes in the vertical gradient are less than at MW2-07.
- MW6A/B-08 – positive gradient (potential downward flow) that has been relatively consistent since 2016 with a slight decrease since September 2018 correlating to the decrease in pumping over the same time period. Changes in pumping during each year are not evident in the gradient (i.e., increased pumping during the summer does not result in an increased positive gradient), however the decrease in pumping in April/May is evident in the gradient. The increased gradient since the second half of 2016 was due to a temporary drop in the water level at MW6A-08 following purging of the well for sampling.
- MW7A/B-08 – positive gradient (potential downward flow) that increases with increased pumping. There is a daily fluctuation in the positive gradient that relates to the daily pumping at TW3-80. There is some correlation between the long-term change in the gradient and the long-term changes in pumping of TW3-80 (i.e., the decreased pumping since September 2018 has resulted in a decrease in the positive gradient), however, not as much compared to MW2-07.
- MW8A/B-08 – negative gradient (potential upward flow) that occasionally reverses to a positive gradient (potential downward flow) mainly during the summer. Since September 2018 the gradient has been negative with the exception of some positive gradients during the summer of 2020 when pumping from TW3-80 increased. There was also a brief reversal in the gradient in January 2019 when the water levels in MW8A-08 declined; however, the water levels subsequently recovered.
- MW10B/C-09 – positive gradient (potential downward flow) that does not change with seasonal pumping fluctuations. The gradient has been consistent over the past five years.
- MW14A/C-11 – positive gradient (potential downward flow) that increases with increased pumping and correlates with the long-term pumping trend. Seasonal changes in vertical gradient are also evident and

correspond to the seasonal changes in pumping. The positive gradient has decreased since September 2018 when pumping was less.

- MW15A/B-12 – negative gradient (potential upward flow) that does not change with increased pumping.
- MW16A/B-12 – positive gradient (potential downward flow) with minor changes related to seasonal changes in pumping.
- MW17A/B-12 – positive gradient (potential downward flow) that reverses to a negative gradient (potential upward flow) during times of decreased pumping (i.e. April/May 2020 and end of 2020). Seasonal changes in vertical gradient are also evident and correspond to the seasonal changes in pumping.
- MW18A/B-12 – positive gradient (potential downward flow) that reverses to a negative gradient (potential upward flow) during times of decreased pumping. In 2019 and 2020 the gradient was mainly negative with positive gradients occurring during times of increased pumping. Seasonal changes in vertical gradient are also evident and correspond to the seasonal changes in pumping. There have been more negative gradients since the reduction in pumping in September 2018.

Most of the area around TW3-80 is characterized by positive gradients (downward flow) in the bedrock. A negative gradient (upward flow) is present at wells further away from TW3-80 (i.e., MW15-12 to the west and MW8-08 to the north). Over the past five years, a negative gradient (upward flow) is also present at MW2-07, MW17-12 and MW18-12 when pumping at TW3-80 is lower.

4.3 Surface Water Monitoring Program

The surface water monitoring program includes measurement of mini-piezometer and surface water levels, surface water flows and surface water temperatures. The surface water levels measured in 2020 are presented in Appendix E along with hydrographs of the water levels and the surface water flows are tabulated and graphed in Appendix F. The hydrographs also include the daily pumping volumes at TW3-80 and daily precipitation as recorded at the Waterloo Wellington or Kitchener Waterloo meteorological stations (with missing data filled in from other nearby stations). Surface water temperatures are discussed in Section 4.3.4 and Appendix G.

4.3.1 Mini-Piezometer Water Levels

Hydrographs for the mini-piezometer locations are presented on Figures E1 through E10 in Appendix E with the "a" figures including data for the last 5 years (2016 through 2020) and the "b" figures including data for 2020.

The findings from a review of the hydrographs for the mini-piezometers are summarized below.

- The MP11 mini-piezometer nest located at the Nestlé Gilmour Road property is considered to represent background conditions (i.e., conditions along Aberfoyle Creek that are beyond any influence of pumping TW3-80). However, the water level changes at this location are more subtle or muted than at other locations. This may be due to the fact that the nest is constructed in organic material on the bank beside the stream (as opposed to in the stream for the other mini-piezometer nests) and the nest is located on a tributary of Aberfoyle Creek (as opposed to the main branch of Aberfoyle Creek). A new mini-piezometer nest (MP1-16) was installed in Aberfoyle Creek in April 2016, in the general vicinity of the MP11 nest to monitor background conditions upstream of the Site. The location of MP1-16 is more representative of shallow groundwater conditions near the creek than the MP11 nest. In 2018, the casing at MP1-16 was extended so that the mini-piezometer doesn't flow (when not frozen). For the 2020 analysis, MP1-16 is considered to represent background conditions.

- The variation in water levels at MP1-16 over 2020 was approximately 0.8 m in both the shallow and deep piezometers, mainly due to significant increase in water levels in January following a precipitation/snowmelt event. In 2020 the water levels generally decreased following the event in January and then increased in March, declined into the summer, and then increased in the fall. These changes in water level are influenced by natural seasonal patterns. The potential for vertical flow at the MP1-16 nest is consistently upwards in 2020, similar to previous years (i.e., as shown in Figure E1a/b, water levels in MP1-16D exceed those in MP1-16S).
- There are six mini-piezometer nests situated on the Nestlé property (MP16, MP6, MP12, MP14, MP8, MP19) and two located downstream of the confluence of Aberfoyle Creek and Mill Creek (MP17, MP18). These mini-piezometer nests, located upgradient and downgradient of TW3-80, showed fluctuations of approximately 0.5 m to 1.0 m during 2020. The fluctuation and trend in water levels at the mini-piezometers was similar to those observed at MP1-16. The similarity in water levels indicates that changes in water levels correspond more with natural events rather than changes in pumping in TW3-80 and as such are mainly due to precipitation, snow melt and evaporation.
- Water levels measured in the mini-piezometers in 2020 are within the ranges measured over the past five years.
- The water levels have generally increased in the spring, declined through the summer, and then increased in the fall. In 2020, the water levels measured in the summer were less than the water levels measured in the summer of 2019.
- In addition to the seasonal trends, short-term changes (“spikes”) in water level in the shallow groundwater reflect the influence of precipitation.

Shallow gradients observed in the mini-piezometers are shown on Figures E11a, b, c, and d. Beginning upstream and moving downstream, the vertical gradients are as follows:

- MP1-16 – strong negative gradient (potential upward flow). There are several short-term decreases in the negative gradient caused by rapidly rising surface water elevations following precipitation events.
- MP11 – strong negative gradient (potential upward flow) that changes seasonally with decreased gradient in the summer.
- MP16 – weak negative gradient (potential upward flow) during the first half of the year followed by a weak positive gradient (potential downward flow) during the second half of the year.
- MP6 – weak negative gradient (potential upward flow) with no gradient in the fall.
- MP12 – weak negative gradient (potential upward flow) during the entire year with the exception of a reversal to a week positive gradient (potential downward flow) in August.
- MP14 – strong negative gradient (potential upward flow) during the entire year.
- MP8 – weak negative gradient (potential upward flow) during the entire year except in the summer when the gradient is reversed to a weak positive gradient (potential downward flow) with the exception of the significant precipitation event at the beginning of August.

- MP19 – weak negative gradient (potential upward flow) during the entire year except in the summer when the gradient is reversed to a weak positive gradient (potential downward flow).
- MP17 – weak positive gradient (potential downward flow) and weak negative gradient (potential upward flow) during the first half of the year and then a weak positive gradient (potential downward flow) during the second half of the year.
- MP18 – weak negative gradient (potential upward flow) during the first half of the year and then a weak positive gradient (potential downward flow) during the second half of the year.

The water levels in the mini-piezometers on August 20, 2020 are plotted on Figure 4.6 which is during the month of highest pumping. Review of the water levels on August 20, 2020 indicates that there is a strong negative gradient (potential upward flow) at MP1-16 located upstream of Aberfoyle Mill Pond. There is essentially no gradient at the three piezometers (MP16, MP6, MP12) upgradient of TW3-80 and then a strong negative gradient at MP14 near the middle of the property. There is no gradient at the downstream end of the property (MP8). Weak positive gradients are observed at MP17 and MP18 located downgradient of the confluence of Aberfoyle Creek and Mill Creek. These gradients are similar to those observed in the past with no measurable influence with well pumping.

4.3.2 Surface Water Levels

Hydrographs for the surface water level monitoring locations are included on Figures E12 through E18 in Appendix E with the “a” figures including data for the last 5 years (2016 through 2020) and the “b” figures including data for 2020.

A review of the hydrographs for the surface water level monitoring locations indicates the following:

- Generally surface water levels have been higher in the winter/spring and lower in the summer and then have increased slightly into the fall.
- Surface water levels in the creeks fluctuate in response to precipitation, snow melt and evapotranspiration with no measurable effects from pumping at the current rates.
- In general, surface water levels at the off-Site stations (SW3, SW4 and SW5) were similar throughout the year, with higher water levels observed in the winter/spring and lower water levels in the summer. The water levels are within the range over the past five years with the exception of a low water level measurement at SW5 in October which may be due to the bridge construction at the creek crossing that occurred in September or from below-average precipitation.
- Surface water levels at the on-Site stations (SW1 and SW2) generally follow similar trends, with higher water levels in the spring followed by lower water levels in the summer and higher water levels again in the fall (although generally lower than those in the spring). The low water levels in the summer of 2020 at SW1 are lower than the low water levels in the summer of 2019 but within the historic range observed at the station. The low water levels in the summer of 2020 at SW2 are similar to the low water levels in the summer of 2019. Similar to the changes in 2019, these low levels are attributed to two factors: a decrease in precipitation and changes to the channel geometry that occurred in July/August 2019. “Spikes” in the water levels are related to precipitation events or spring melt. The changes in water levels at SW1 and SW2 are due to natural events (i.e., precipitation, snow melt and evaporation) which is confirmed by the fact that water levels at SW2 are decreasing while overall pumping from TW3-80 has also been decreasing.

- Water levels are no longer measured at SW9 since it was destroyed in April 2018 when part of the pond was filled in.
- Water levels at SW10 are measured in a pond on the neighbouring property. This pond may represent water table conditions. In 2020, the water levels generally rose through May and then declined for the remainder of the year. It is our understanding that operations at the aggregate pit commenced in 2016 and aggregate washing of the sand and gravel may be occurring. The changes in water levels are likely due to a combination of seasonal changes and potentially to aggregate operations.

The water levels at the surface water stations on August 20, 2020 are included on Figure 4.6, during the month of highest pumping. Review of the water levels on August 20, 2020 indicates that surface water features varied in elevation from approximately 317.32 masl at SW3 to 307.22 masl at SW5 with surface water levels across the Site ranging from 311.35 masl (SW1) to 310.21 masl (SW2).

It is important to note that the stream flow provides a more reliable data set for investigating the potential impacts of pumping compared to an analysis of stream water levels, which can be affected by channel geometry. An analysis of stream flow is presented in the following section.

4.3.3 Surface Water Flow

The monthly stream flow data collected in 2020 are summarized in Appendix F. Stream flow has been measured at SW1 and SW2 since December 2001. SW1 is located along Aberfoyle Creek near the upstream part of the property while SW2 is located along Aberfoyle Creek near the downstream part of the property.

Stage-discharge curves were developed for SW1 and SW2 which show the relationship between surface water elevation (stage) and stream flow (discharge). The stage-discharge relationships at surface water stations SW1 and SW2 were updated and reassessed to account for the 2020 measured water levels and flow rates. Due to changing stream conditions, individual stage-discharge curves sometimes need to be created for individual years or a series of years. This is done because a review of the discrete flow and water level measurement results indicates that the hydraulic controls at the gauging stations have changed subtly. The stream geometry appears to have changed in the winter resulting in the need for new stage-discharge curves for SW1 and SW2. The changes are due to removal of dead trees upstream of SW1 and changes from the rehabilitation conducted by the Mill Creek Rangers near SW2. New stage-discharge curves were developed to represent continuous flows in 2020 at SW1 and SW2 to provide a better fit to the data. Stage-discharge curves were developed by estimating the level at which zero flow would occur (i.e., y0) at each station. This was estimated using the available low-flow measurements collected over the monitoring period. Historical data were included for comparison and to include measured data over a larger range of stream discharge conditions. Power functions were used to develop a best fit curve for the measured data at each station. Data outliers were evaluated with a lower confidence due to suspected winter conditions or measurement error. The updated stage-discharge curves for SW1 and SW2 are presented on Figures F1 and F2, respectively.

Graphs of estimated stream flow at SW1 and SW2, along with pumping rates and precipitation, are presented on Figure F3 in Appendix F with the “a” figure including data for the last 5 years (2016 through 2020) and the “b” figure including data for 2020. The updated stage-discharge relationship was used to estimate stream flow from the continuous water level elevation data in 2020. It should be noted that historically there are a few occasions (i.e., January 2020) when flow was estimated at SW1 and SW2 for stream elevations outside of the observed stage-discharge curve relationship (typically flows exceeding approximately 1,200 L/s).

Review of the flow data indicates the following:

- In 2020, stream flow measured in the field (during monthly monitoring) at SW1 ranged from 41.8 L/s (September) to 284.9 L/s (March) and at SW2 stream flow ranged from 29.5 L/s (September) to 309.8 L/s (March).
- The trends in surface water flow at SW1 and SW2 over the year are similar. This is consistent with previous years.
- In 2020, stream flow was higher in the spring following precipitation and melt events and then declined through the summer with less variability in flow. The stream flow rose from October to the end of the year. There was also an increase in flow in January following a precipitation/melt event.
- With the exception of the high flows in January (estimated from the stage-discharge curves), the 2020 stream flows at SW1 and SW2 were within the historical range over the past five years.
- The calculated flows, using the rating curves, indicate that flow in the creek was similar or higher at SW1 than SW2 during the spring freshet, possibly due to ice or debris blockage at SW1 that artificially increase the water levels.
- A review of the manual measurements indicates that flow at SW2 was slightly less than flow at SW1 during seven months of the year. Flow measurement error is typically in the range of +/- 15% (see for example Harmel et al., 2006) and attributed to simplified representation of the cross section shape, point velocity measurements and flow meter thresholds. With the exception of the flow in September, the observed difference in flow during this period is within the range of potential flow measurement error.

It was noted in CRA (2014) that pumping tests conducted in 2004, 2007, and 2010 indicated that surface water flow at SW1 and SW2 was not measurably affected by pumping. The on-going monitoring confirms this conclusion and shows that the stream flows are influenced primarily by precipitation events and fluctuate seasonally.

4.3.4 Surface Water Temperature

Surface water temperature was monitored at six stations across the Nestlé property.

The average daily water and air temperature data for 2016 through 2020 are shown on Figure G1a and for 2020 on Figure G1b. Review of the data indicates the following:

- The seasonal trend in stream temperature levels in 2020 is similar to previous years.
- Average daily ambient air temperature ranged from -13.1ºC to 25.4ºC in 2020.
- Average daily surface water temperature ranged from 0.2ºC to 29.6ºC at the upstream end of the property and from 0ºC to 26.8ºC at the downstream end of the property. Surface water temperatures generally decrease, across the Site, moving downstream.
- Ambient air temperature significantly influences stream temperature as seen by the strong correlation between the two. The correlation is not evident during the winter months when air temperature typically drops below 0ºC and surface water temperature remains relatively constant around 0ºC.

The surface water temperature data were provided to C. Portt and Associates, and the results were incorporated in their report, which is also included in Appendix G.

The mill pond on Aberfoyle Creek has a major influence on the temperature of the creek and its fish community. During the summer, the water in the mill pond, upstream from Brock Road, becomes warm and, as a consequence, the creek is warm through the Nestlé property. In the C. Portt and Associates report it is concluded that:

> *In 2020, mean summer (June – August) air temperature and water temperatures were the highest in the period 2007 – 2020. The overall pattern of water temperature suitabilities for the fish species found in the Aberfoyle Branch of Mill Creek from Brock Road downstream through the Nestle property in 2020 are consistent with previous years. Water temperatures during the June 1 – August 31 period are usually too warm for coldwater species such as brook trout and brown trout and too cold for warmwater species such as largemouth bass. The water temperatures during this period are most favourable for species such as common shiner that have intermediate thermal requirements. During the summer, the water in the mill pond upstream from Brock Road becomes warm and, although the creek temperature decreases with distance downstream, it frequently exceeds the ultimate upper incipient lethal temperature for brook trout and brown trout at the furthest downstream temperature monitoring site.*
>
> *The relationships between air temperature and water temperature were consistent with those observed in previous years.*

4.4 Biological Monitoring Program

In the 2020 Biological Monitoring Report (Beacon Environmental, 2021) it is concluded that:

> *In summary, the findings suggest that there have not been any significant changes to the various terrestrial and aquatic parameters being monitored on the Aberfoyle property. Species richness, abundance, and distribution are generally within the range expected and attributable to natural variation and succession. The subject property continues to support high quality terrestrial and wetland habitats that support a diverse range of native wildlife.*

The report also includes recommendations for continued biological monitoring in 2021. Details are included in the report which can be found in Appendix H.

5.0 CONCLUSIONS

The following conclusions are provided based on the results of the 2020 monitoring program.

1) Nestlé has complied with the conditions in the existing permit for the Aberfoyle wells TW3-80 and TW2-11.

2) TW3-80 and TW2-11 operated in accordance with the pumping limits outlined in the PTTW. The daily water taking at TW3-80 in 2020 ranged from 45 L to 2,871,783 L. The average daily taking in 2020 was 1,590,768 L. The total volume of water taken in 2020 from TW3-80 was 582,221,219 L or 44% of the permitted volume. No water was taken from TW2-11 in 2020.

3) The interpreted non-pumping water levels in TW3-80, which obtains water from the Lower Bedrock Aquifer, ranged from approximately 306.5 to 312.5 masl in 2020 and the interpreted water levels under variable pumping conditions ranged from approximately 298 to 307 masl. The drawdown at the well ranged from approximately 15 m to 6 m in 2020. At all times the water level in TW3-80 remained above the top of the Lower Bedrock Aquifer. Historical and current records indicate that long-term water levels generally correlate with the monthly pumping volumes (i.e., higher water levels during months of lower pumping and lower water levels during months of higher pumping). When pumping stopped briefly in 2020 water levels in TW3-80 approached fully recovered non-pumping levels.

4) The trends of water level variations within the Lower Bedrock Aquifer are stable with nearby monitoring wells in the Lower Bedrock Aquifer fluctuating in response to variations in pumping at TW3-80. The groundwater taking from TW3-80 has not led to a long-term declining trend in the aquifer water levels. Average water levels in the aquifer in 2020 that are influenced by the pumping at TW3-80 have increased due to the overall decrease in pumping since September 2018.

5) The Middle Bedrock Aquitard limits the effect of pumping on overlying units (indicating semi-confined conditions). Unacceptable impacts (i.e., long-term declining trends) to the Upper Bedrock Aquifer and overburden aquifer have not been observed. The water levels in the Upper Bedrock Aquifer and overburden aquifer show seasonal trends that are reflective of spring melt and precipitation.

6) Surface water levels fluctuate in response to precipitation, snow melt and evapotranspiration.

7) The water taking does not hinder the ability of the water resource to support existing natural functions of the ecosystem. The withdrawal does not result in physical and ecological impacts to the adjacent Mill Creek and Aberfoyle wetlands.

8) The water taking does not prevent other water users from continuing their established pattern of use. The groundwater withdrawal from TW3-80 does not interfere with existing municipal uses or private uses. There have been no well interference complaints at Aberfoyle due to the water taking from TW3-80.

9) No irreversible impacts have been observed due to pumping of the aquifer or deterioration of groundwater quantity or quality on neighbouring properties.

10) Based on the monitoring data collected, the 2020 water takings from TW3-80 are sustainable.

6.0 RECOMMENDATIONS

It is recommended that the existing monitoring program be kept in place with the following changes:

1) Production Well changes

   a. Nestlé has indicated that they will no longer require water taking from TW2-11. In addition, the Fireflow well is no longer used because a surface water pond is used for fire suppression. Nestlé would like to decommission the Fireflow well. A review of the monitoring network and data indicates that TW2-11 provides similar water level response to the Fireflow well and is close enough that it could replace the Fireflow well for monitoring purposes. The Fireflow well should be decommissioned following regulated abandonment procedures, so that the well will not act as a potential pathway. The Fireflow well should then be replaced by TW2-11 for monitoring.

2) Surface Water Monitoring changes

a. SW9 was used to monitor water levels in a pond used by the aggregate extraction industry on the property south of the site. The pond is used for water taking and therefore its level is not a meaningful measure with respect to the potential influence of pumping TW3-80 on the pond. SW9 was destroyed when part of the pond was filled in and it is recommended that SW9 not be replaced and be removed from the monitoring conditions.

b. SW10 is also used to monitor water levels in a pond on the property south of the site that is used for aggregate extraction. There has been no influence in the water levels at the pond from pumping TW3-80. SW10 should be removed from the monitoring conditions.

3) Mini-piezometer changes

a. The mini-piezometer nest MP11 is used as background monitoring. Due to concerns about the location of MP11 (i.e., not in main branch of Aberfoyle Creek and not within the creek), in 2016 a mini-piezometer nest (MP1-16) was installed in the main branch of Aberfoyle Creek, within the creek itself. Moving forward, MP1-16 should be used for monitoring background conditions and MP11 should be removed from the monitoring conditions.

b. The mini-piezometer nests MP17S/D and MP18S/D are both located downstream of the confluence of Aberfoyle Creek and Mill Creek west of the Nestlé property. The monitoring points provide similar data and do not show any influence from pumping TW3-80. MP18S/D should be removed from the monitoring conditions.

c. MP19S/D is located outside of Aberfoyle Creek and does not show any influence from pumping TW3-80. MP8S/D is located in Aberfoyle Creek and close to MP19S/D and provides sufficient monitoring data in the area. MP19S/D should be removed from the monitoring conditions.

4) Overburden Monitoring Well changes

a. TW1-99 is located near MW2-07 and TW3-80. The monitoring well provides similar data to the nearby MW2-07 monitoring well, which is a multi-level well with monitoring points in both the overburden and bedrock. Monitoring at TW1-99 should be discontinued as monitoring at MW2-07 provides sufficient coverage for the area.

b. TW1-93 is located near MW-S and both wells provide similar data. Monitoring at TW1-93 should be discontinued as monitoring at MW-S provides sufficient coverage for the area.

5) Bedrock Private Well changes

The monitoring program has been on-going since 2000, with more detailed monitoring occurring since 2008. No impacts to private wells or the surrounding aquifer have been observed. In addition, the monitoring data from these private wells are often influenced by pumping at the private wells themselves. Based on this, we suggest that monitoring of the private wells (as outlined below) be replaced with dedicated monitoring wells.

a. Discontinue monitoring at M1 and W2, which are private wells completed in the Lower Bedrock Aquifer. The owner of W2 does not want to be part of the monitoring program. A new monitoring well (MW21-18 (SWP BH1)) has been completed on the northeast corner of the Nestlé property.

The new monitoring point in the Lower Bedrock Aquifer at this location can effectively replace monitoring at M1 and W2.

b. Discontinue monitoring at 8 Maple Leaf Lane, Private Well “I” (50 Brock Road), 58 Brock Road and MOE WWR #67-08740 (27 Old Brock Road). A new monitoring well (MW20-19 (SWP BH3)) has been completed at the Aberfoyle School. Monitoring points in both the Upper Bedrock and Lower Bedrock Aquifers at this location can effectively replace monitoring at the four noted wells.

c. Discontinue monitoring at MOE WWR #67-07589 (7404 County Road 34), Private Well “B” (7425 County Road 34) and 2 Brock Road. A new monitoring well (MW19-18 (SWP BH2)) has been completed at the Township Office. Monitoring points in both the Upper Bedrock and Lower Bedrock Aquifers at this location can effectively replace the monitoring at the three noted wells.

6) The PTTW should be updated with the following administrative changes

a. MW1A-04 should be removed from continuous monitoring of groundwater levels at bedrock wells as it has been decommissioned and replaced with MW10B-09, which is in the permit.

b. Private well “J” should be removed from monthly monitoring of groundwater levels in bedrock and replaced with Private well “I” as previously indicated by CRA (note that this well is recommended to be replaced with a dedicated monitoring well and neither Private Well “I” or “J” should be included on the permit).

c. MP17S/D-12 and MP18S/D-12 should be renamed MP17S/D-11 and MP18S/D-11 (note that MP18S/D is recommended to be removed from the monitoring program).

d. MW-I should be removed from the list of continuous monitoring overburden wells and added to the list of continuous monitoring bedrock wells.

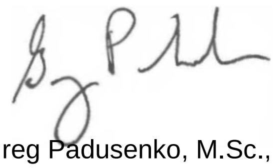
7) The frequency interval for monitoring certain terrestrial resource parameters as part of the biological monitoring program should be reduced as there is very little variation observed from year to year. Proposed changes are as follows:

a. Frequency of breeding bird and turtle surveys should be reduced from annually to once every two (2) years; and.

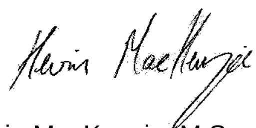
b. Vegetation plot monitoring frequency should be reduced to once every five (5) years.

Signature Page

Golder Associates Ltd.



Greg Padusenko, M.Sc., P.Eng., P.Geo.
Hydrogeologist



Kevin MacKenzie, M.Sc., P.Eng.
Senior Hydrologist, Principal

John Piersol, M.Sc., P.Geo.
Senior Hydrogeologist, Associate

GRP/JAP/KM/ll

https://golderassociates.sharepoint.com/sites/139500/project files/6 deliverables/aberfoyle/2020 annual report/final/20449101 fnl rpt 2021mar23 2020 aberfoyle report.docx

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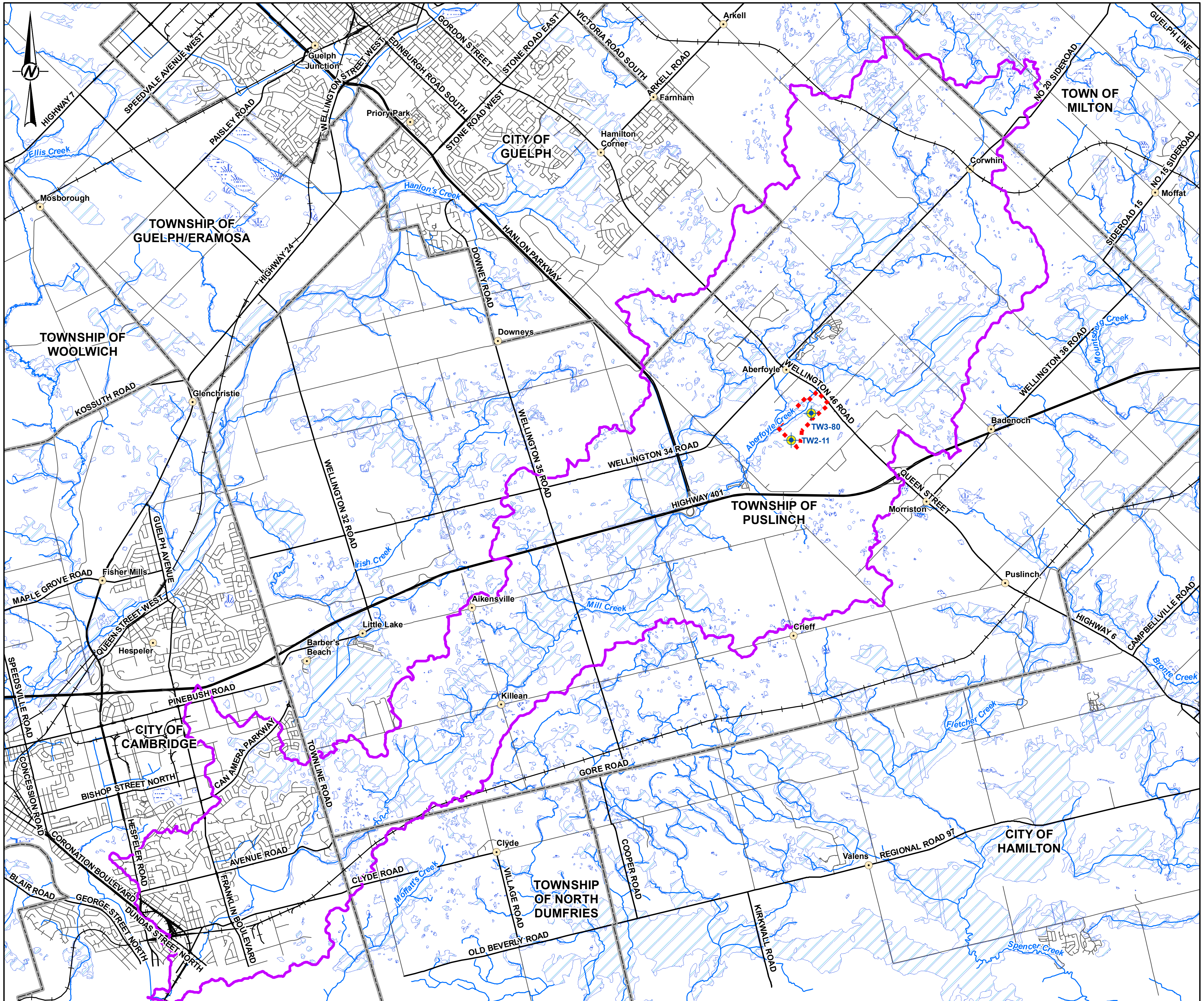
FIGURES

Figures 1.1 to 4.6



LEGEND

- Nestle Production Well
- City / Town
- Main Road /Highway
- Local Road
- Railway
- Watercourse
- Waterbody
- Wetland
- Provincially Significant Wetland
- Municipal Boundary
- Property Boundary
- Mill Creek Sub-Watershed

0 2 4 6

Kilometres

1:80,000

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
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CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
SITE LOCATION

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
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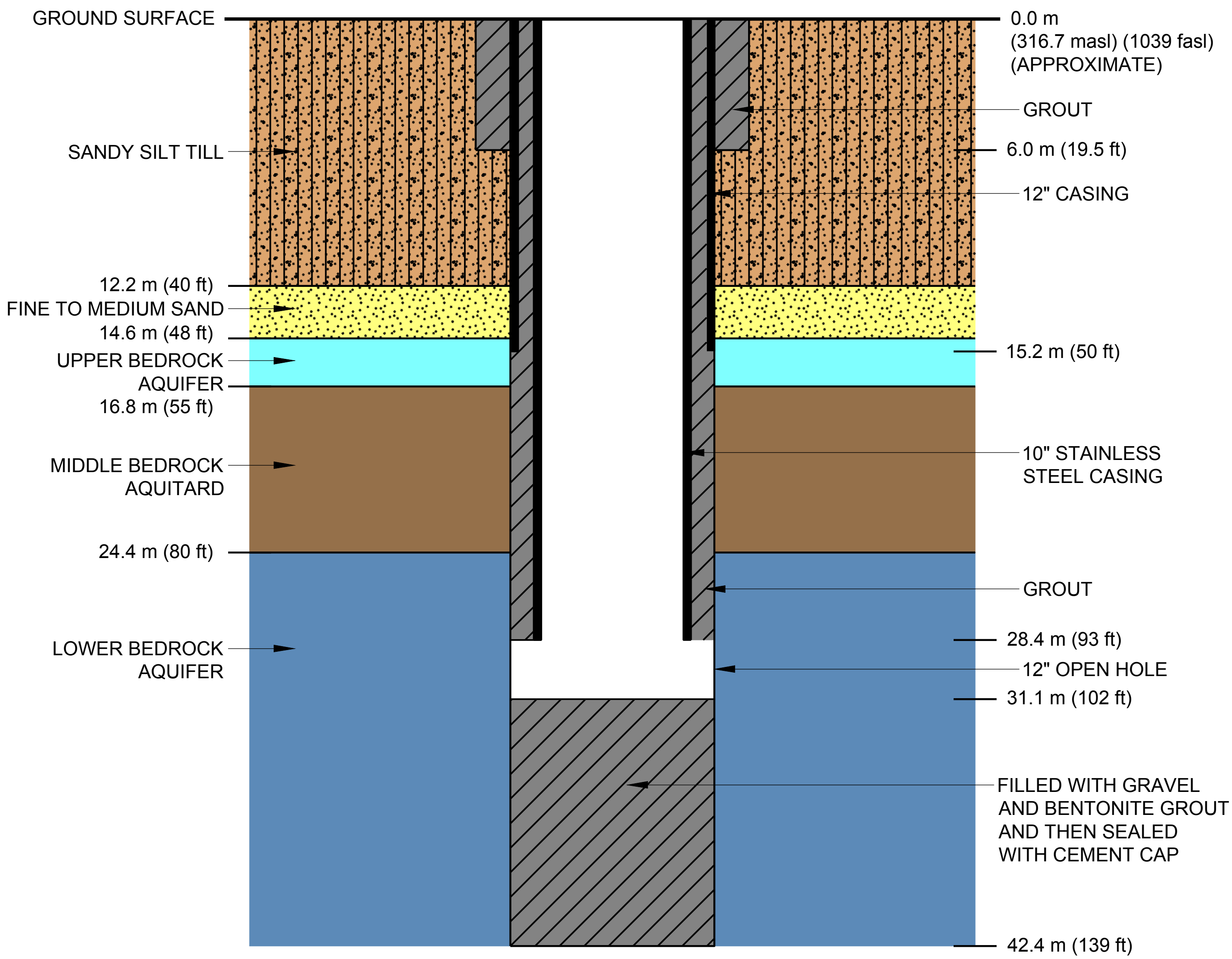


CLIENT	PROJECT
NESTLE WATERS CANADA	2020 ANNUAL REPORT

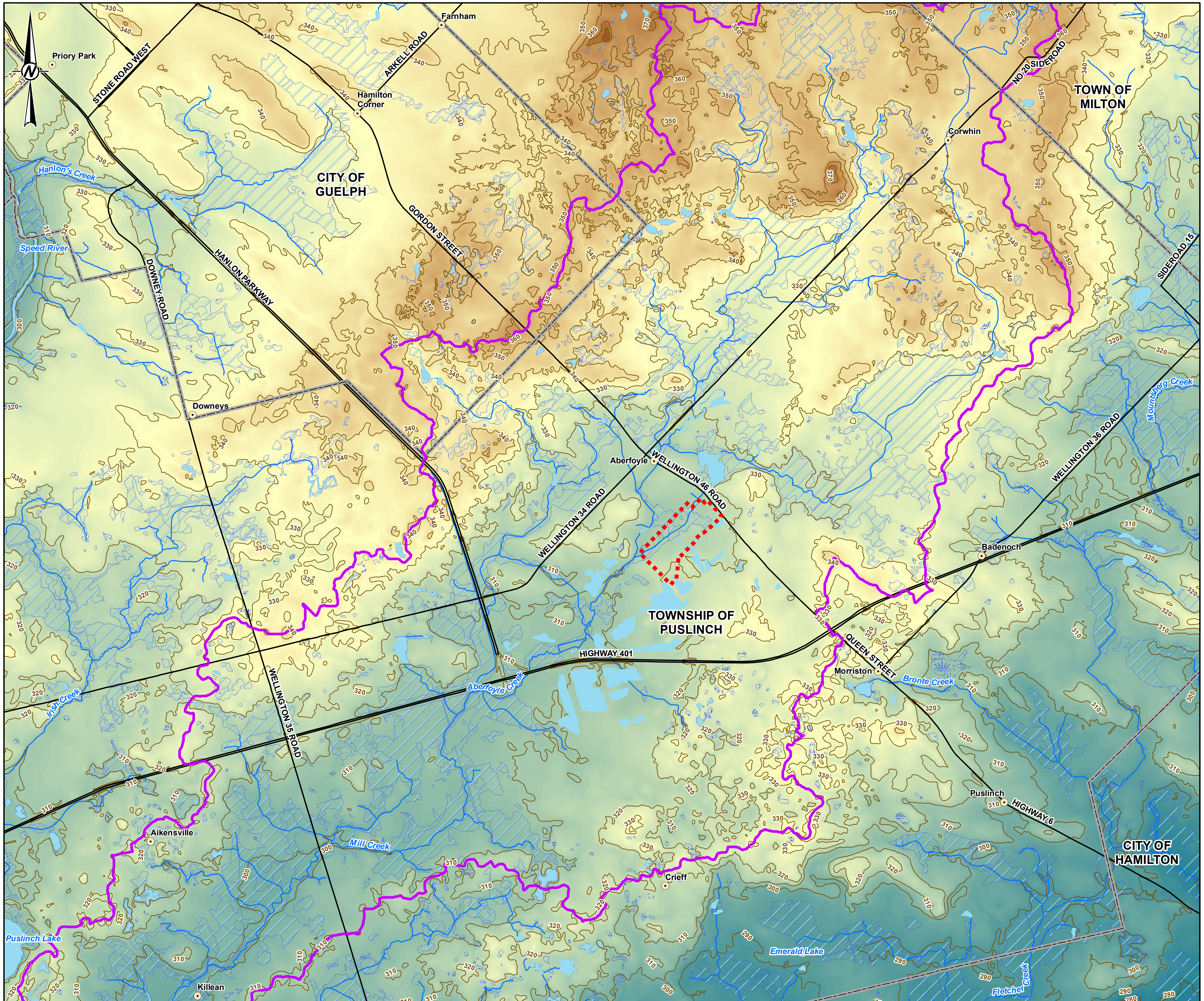
CONSULTANT: GOLDER

YYYY-MM-DD	2021-02-02
PREPARED	SA/DD
DESIGN	MR
REVIEW	GP
APPROVED	GP

TITLE

ABERFOYLE TW3-80 SCHEMATIC

PROJECT No.	PHASE	Rev.	FIGURE
20449101		A	1.2



LEGEND

- City / Town
- Topographic Elevation Contour (masl)
- Main Road /Highway
- Watercourse
- Waterbody
- Wetland
- Provincially Significant Wetland
- Mill Creek Sub-Watershed
- Municipal Boundary
- Property Boundary

Value

High : 385.707

Low : 278.55

0 1 2 3 4
Kilometres
1:50,000

REFERENCE(S)

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CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
TOPOGRAPHY AND DRAINAGE

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	**2.1**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm 0

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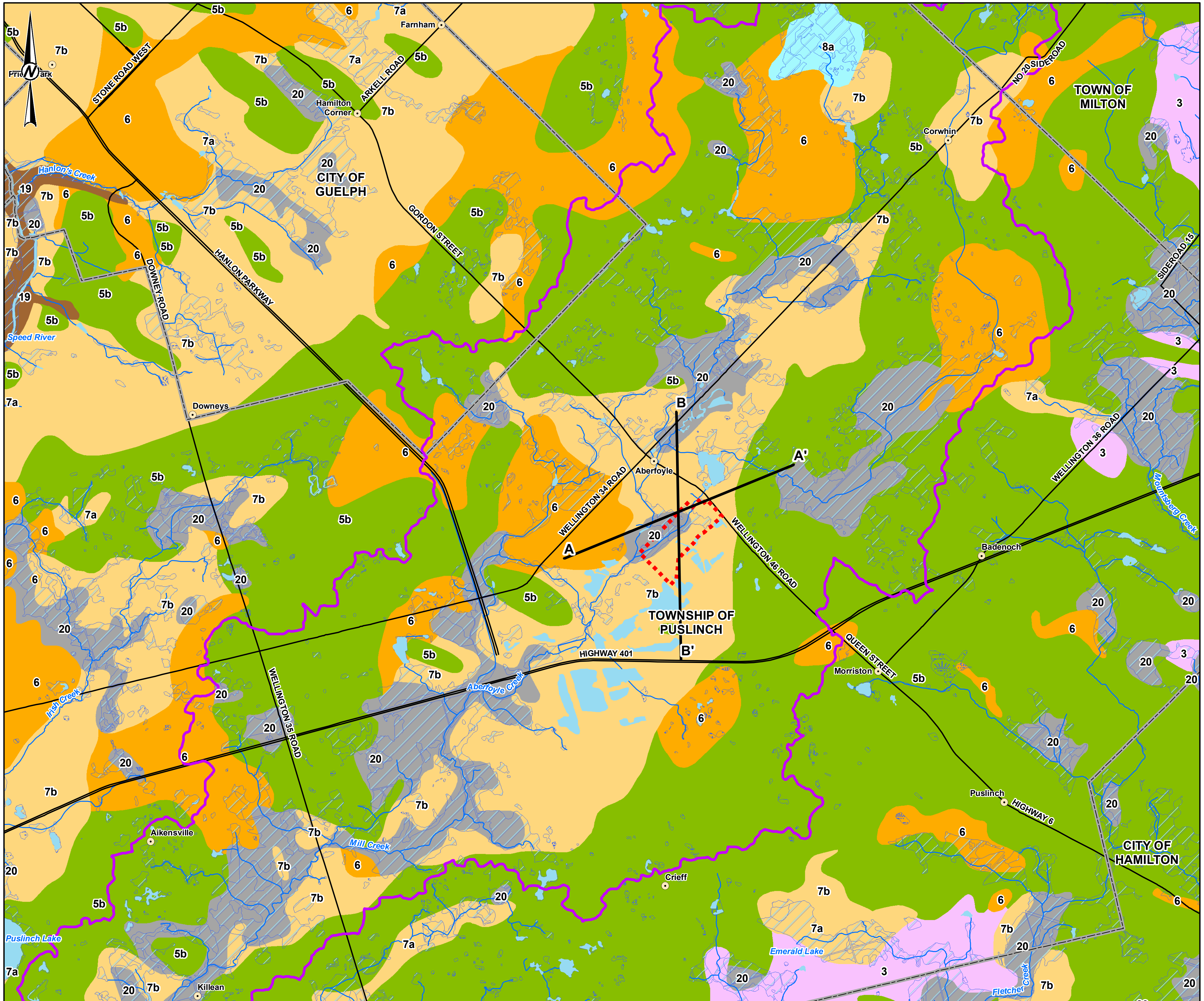

LEGEND

- City / Town
- Cross-Section Location
- Main Road /Highway
- Watercourse
- Waterbody
- Wetland
- Provincially Significant Wetland
- Mill Creek Sub-Watershed
- Municipal Boundary
- Property Boundary
- 3: Paleozoic bedrock
- 5b: Stone-poor, carbonate-derived silty to sandy till
- 6: Ice-contact stratified deposits
- 7a: Sandy deposits
- 7b: Gravelly deposits
- 8a: Massive-well laminated
- 19: Modern alluvial deposits
- 20: Organic deposits

0 1 2 3 4
Kilometres
1:50,000

REFERENCE(S)
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CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
REGIONAL QUATERNARY GEOLOGY

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
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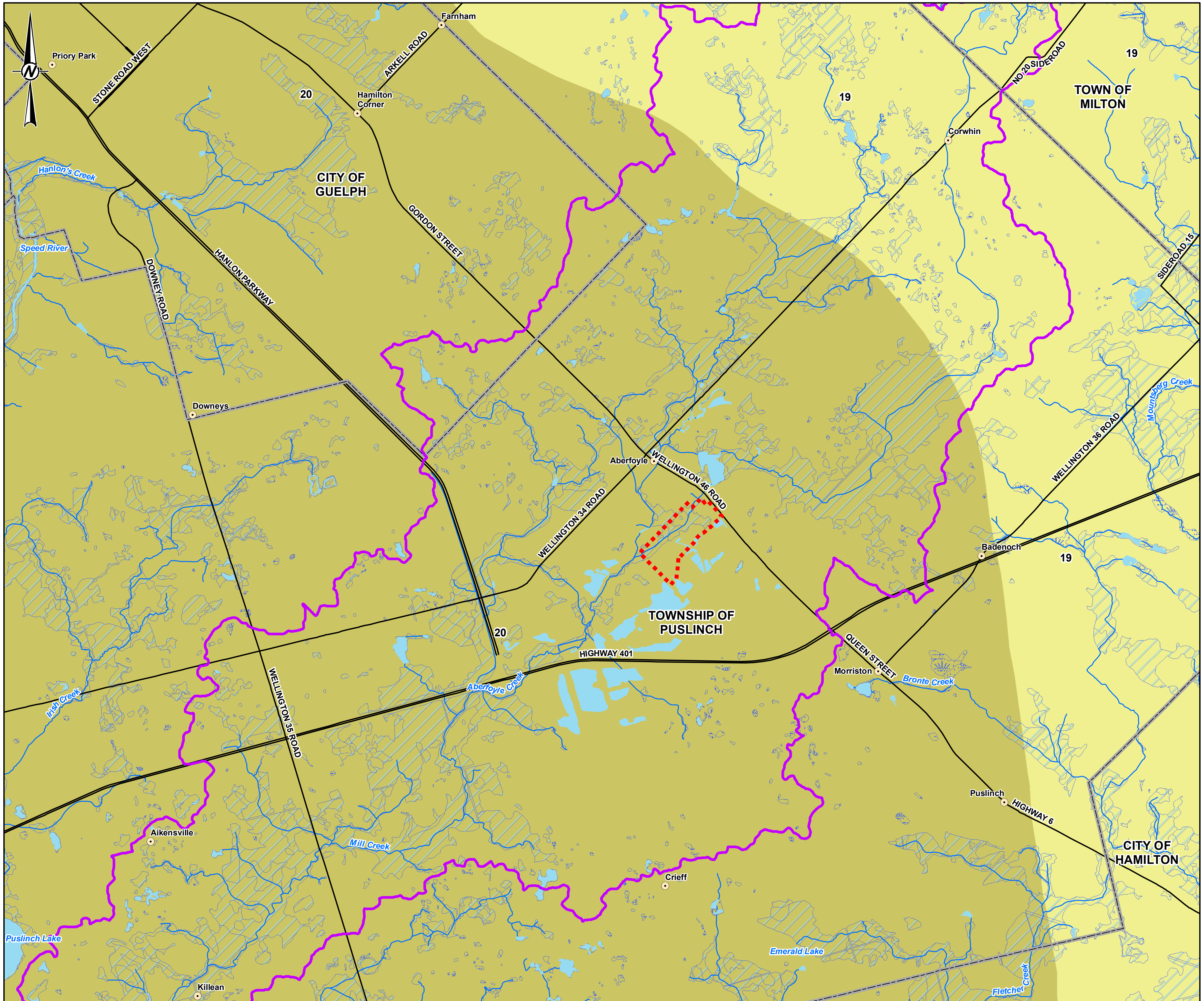

LEGEND

- City / Town
- Main Road /Highway
- Watercourse
- Waterbody
- Wetland
- Provincially Significant Wetland
- Mill Creek Sub-Watershed
- Municipal Boundary
- Property Boundary
- 20: Guelph - dolostone; thick-bedded, crinoidal, locally biohermal; locally bituminous (Eramosa Mb)
- 19: Amabel - dolostone, limestone, argillaceous dolostone; locally cherty; locally bituminous (Eramosa Mb)

0 1 2 3 4

1:50,000 Kilometres

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
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CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

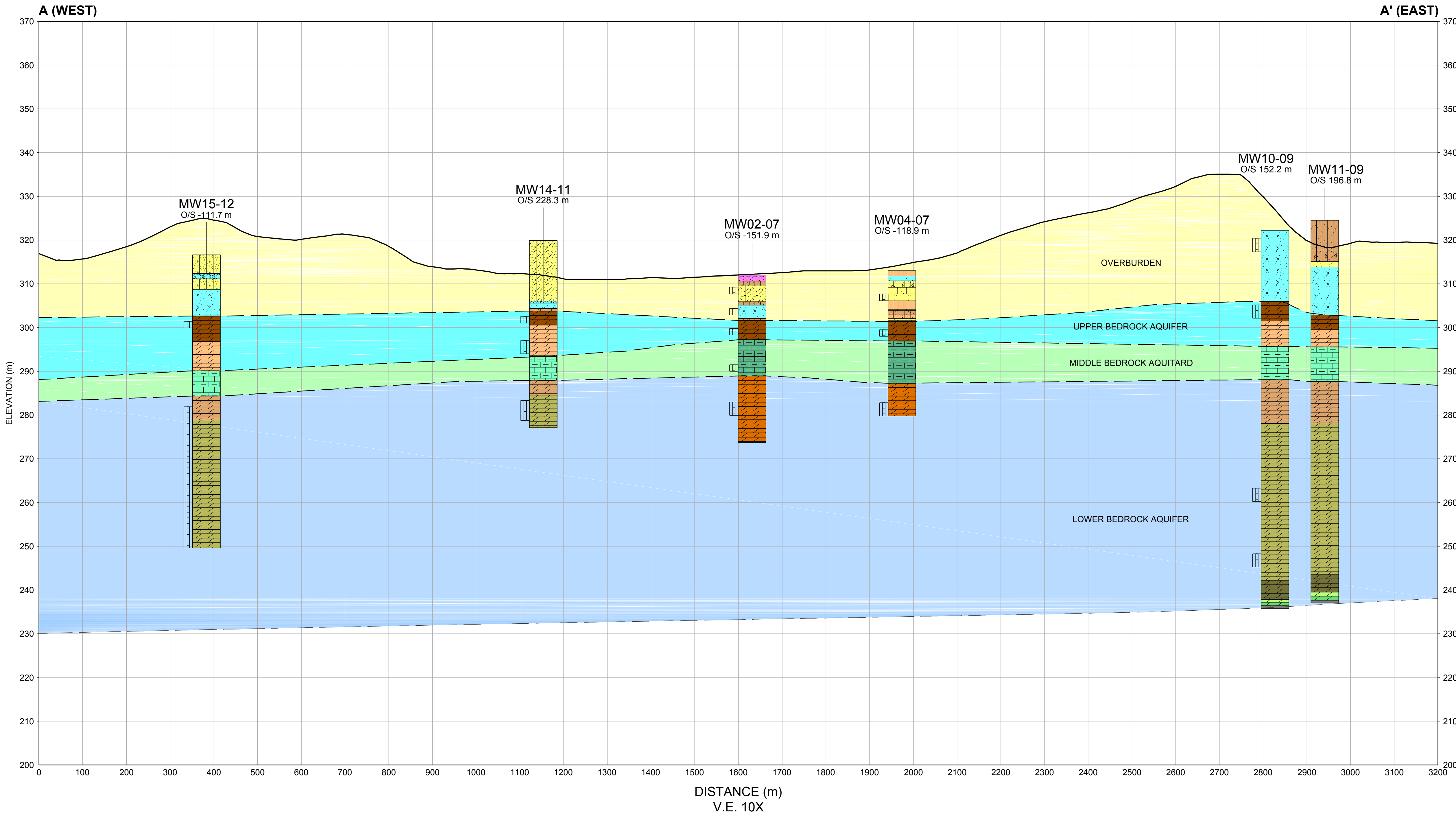
TITLE
REGIONAL BEDROCK GEOLOGY

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	2.3



LEGEND

OVERBURDEN	BEDROCK (OLD)	BEDROCK (NEW)
SAND	GUELPH	GUELPH
SILTY SAND	ERAMOSA	REFORMATORY QUARRY
SILTY SAND TILL	AMABEL	VINEMOUNT
SANDY SILT	BEDROCK	GOAT ISLAND
SANDY SILT TILL		GASPORT
SILT		IRONDEQUOIT
SILT TILL		ROCKWAY
TOPSOIL		MERRITTON
SAND AND GRAVEL		CABOT HEAD
GRAVEL AND SILT		

0 25 50
1:1,000 VERTICAL METRES

0 250 500
1:10,000 HORIZONTAL METRES

CLIENT
NESTLE WATERS CANADA

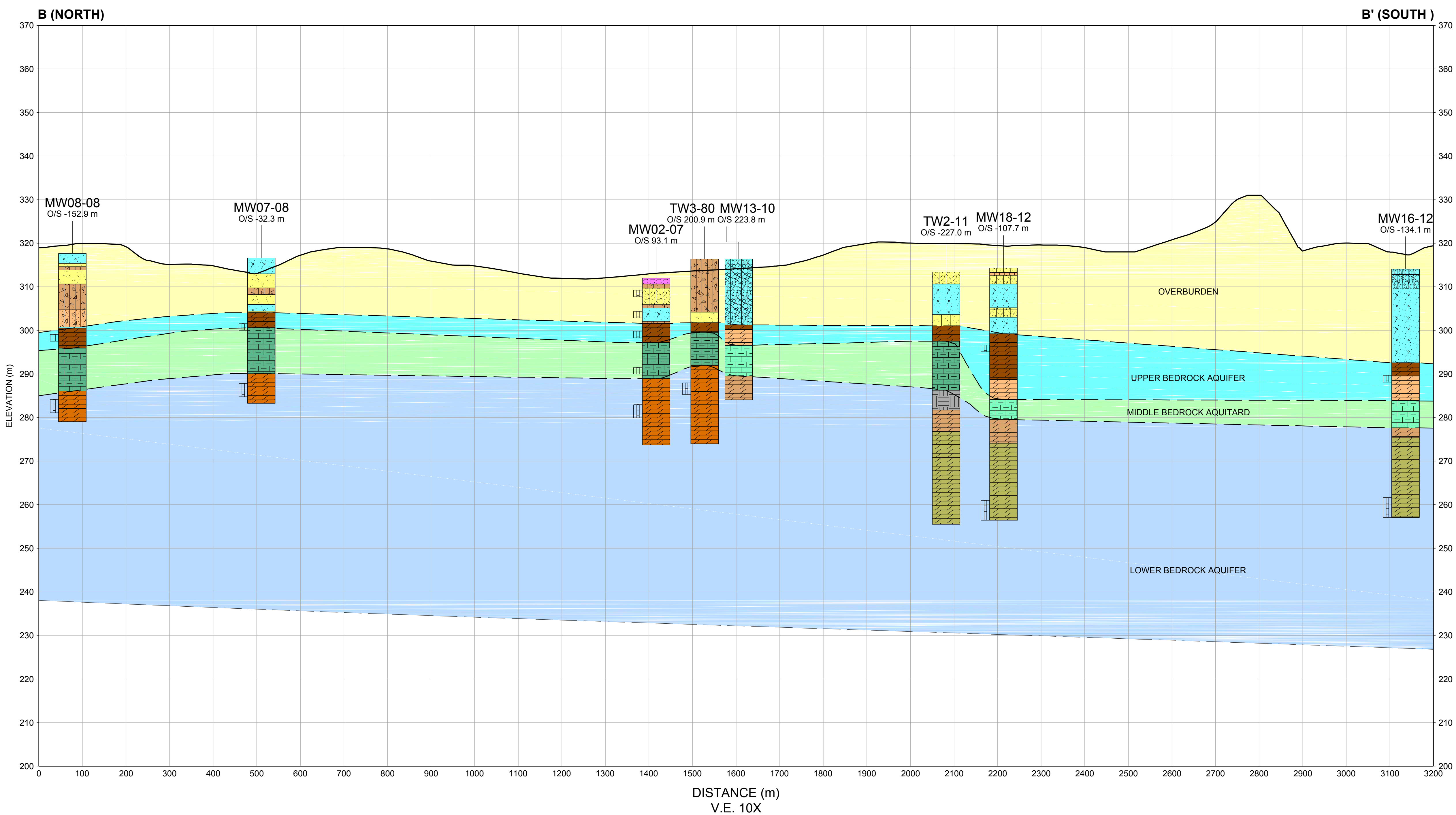
PROJECT
2020 ANNUAL REPORT

TITLE
CROSS SECTION A-A'

CONSULTANT
GOLDER

YYYY-MM-DD	2021-02-02
DESIGNED	
PREPARED	SA/DD
REVIEWED	GP
APPROVED	JP

PROJECT NO. 20449101 | PHASE | REV. A | FIGURE 2.4



LEGEND

OVERBURDEN
- SAND
- SILTY SAND
- SILTY SAND TILL
- SANDY SILT
- SANDY SILT TILL
- SILT
- SILT TILL
- TOPSOIL
- SAND AND GRAVEL
- GRAVEL AND SILT

BEDROCK (OLD)
- GUELPH
- ERAMOSA
- AMABEL
- BEDROCK

BEDROCK (NEW)
- GUELPH
- REFORMATORY QUARRY
- VINEMOUNT
- GOAT ISLAND
- GASPORT
- IRONDEQUOIT
- ROCKWAY
- MERRITTON
- CABOT HEAD

0 25 50
1:1,000 VERTICAL METRES

0 250 500
1:10,000 HORIZONTAL METRES

CLIENT	NESTLE WATERS CANADA
PROJECT	2020 ANNUAL REPORT
TITLE	**CROSS SECTION B - B'**
CONSULTANT	GOLDER
YYYY-MM-DD	2021-02-02
DESIGNED	
PREPARED	SA/DD
REVIEWED	GP
APPROVED	JP
PROJECT NO.	20449101
PHASE	
REV.	A
FIGURE	2.5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25 mm

LEGEND

- Production Well
- Monitoring Well (Bedrock)
- Monitoring Well (Overburden)
- Private Well (Bedrock)
- Piezometer
- Surface Water Station
- Surface Water Temperature Station
- Water Level Elevation Contour (Oct. 12, 2010)
- Watercourse
- Property Boundary

0 200 400 600 800 1,000

1:12,500 METERS

REFERENCE(S)
BASE DATA - MNR LIO, OBTAINED 2013
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CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
OVERBURDEN AND SURFACE WATER ELEVATIONS (NON-PUMPING CONDITION OCTOBER 2010)

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	2.6

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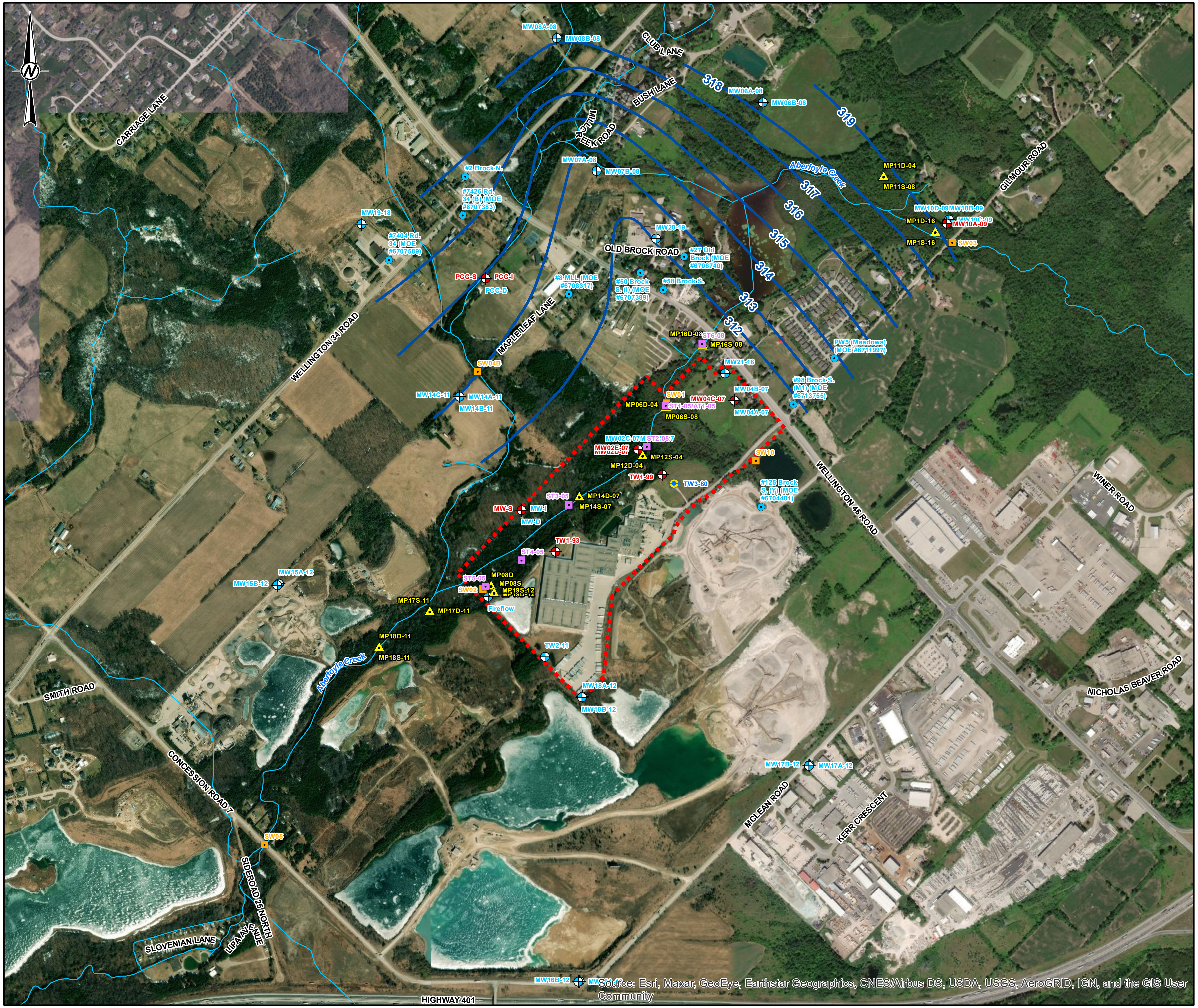

LEGEND

- Monitoring Well (Bedrock)
- Monitoring Well (Overburden)
- Production Well
- Private Well (Bedrock)
- Piezometer
- Surface Water Station
- Surface Water Temperature Station
- Water Level Elevation Contour (Oct. 12, 2010)
- Watercourse
- Property Boundary

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
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CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
POTENTIOMETRIC SURFACE OF UPPER BEDROCK AQUIFER (NON-PUMPING CONDITION OCTOBER 2010)

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	2.7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

25mm

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LEGEND

- Production Well
- Monitoring Well (Bedrock)
- Monitoring Well (Overburden)
- Private Well (Bedrock)
- Piezometer
- Surface Water Station
- Surface Water Temperature Station
- Water Level Elevation Contour (Oct. 12, 2010)
- Watercourse
- Property Boundary

0 200 400 600 800 1,000

1:12,500 METERS

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
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CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
POTENTIOMETRIC SURFACE OF LOWER BEDROCK AQUIFER (NON-PUMPING CONDITION OCTOBER 2010)

CONSULTANT

GOLDER

YYYY-MM-DD	2019-01-18
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	2.8

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

LEGEND

- Production Well
- Monitoring Well (Bedrock)
- Private Well (Bedrock)
- Private Well (not monitored)
- Watercourse
- Property Boundary

0 200 400 600 800 1,000

1:12,500 METERS

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
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CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
2020 BEDROCK MONITORING LOCATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	3.1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

S:\Clients\Nestle\Aberfoyle\99_PROJ\1311550250_Monitoring\40_PROD\0019_2018_Annual_Report\1311550250-0019-CH-0011.mxd

LEGEND

- Production Well
- Monitoring Well (Overburden)
- Watercourse
- Property Boundary

0 200 400 600 800 1,000

1:12,500 METERS

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2013
PROJECTION: UTM NAD83 ZONE 17
WATERCOURSES PRODUCED USING INFORMATION UNDER LICENSE WITH THE GRAND RIVER CONSERVATION AUTHORITY © GRAND RIVER CONSERVATION AUTHORITY, 2014
PROPERTY BOUNDARY OBTAINED FROM CRA, NOVEMBER 2014.

CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
2020 OVERBURDEN MONITORING LOCATIONS

CONSULTANT
GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	**3.2**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

LEGEND

- Production Well
- Piezometer
- Surface Water Station
- Surface Water Temperature Station
- Surface Water Station (Destroyed)
- Watercourse
- Property Boundary

0 200 400 600 800 1,000

1:12,500 METERS

REFERENCE(S)
BASE DATA - MNR LIO, OBTAINED 2013
PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM
ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2013
PROJECTION: UTM NAD83 ZONE 17
WATERCOURSES PRODUCED USING INFORMATION UNDER LICENSE WITH THE GRAND RIVER CONSERVATION AUTHORITY © GRAND RIVER CONSERVATION AUTHORITY, 2014
PROPERTY BOUNDARY OBTAINED FROM CRA, NOVEMBER 2014.

CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
2020 SURFACE WATER MONITORING LOCATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	3.3

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

S:\Clients\Nestle\Aberfoyle\99_PROJ\1311520250-0019_2018_Annual_Report\1311520250-0019-CH-0013.mxd

LEGEND

Production Well

Well Status as of December 2020

Decommissioned

Watercourse

Property Boundary

0 100 200 300 400 500

1:12,500 METERS

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2013
PROJECTION: UTM NAD83 ZONE 17
WATERCOURSES PRODUCED USING INFORMATION UNDER LICENSE WITH THE GRAND RIVER CONSERVATION AUTHORITY © GRAND RIVER CONSERVATION AUTHORITY, 2014
PROPERTY BOUNDARY OBTAINED FROM CRA, NOVEMBER 2014.

CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
UNUSED OR DECOMMISSIONED WELLS

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	3.4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

25mm

LEGEND

- Production Well
- Monitoring Well (Bedrock)
- Monitoring Well (Overburden)
- Private Well (Bedrock)
- Private Well (Not Monitored)
- Piezometer
- Surface Water Station
- Surface Water Temperature Station
- Surface Water Station (Destroyed)

Well Status as of December 2020

- Decommissioned
- Watercourse
- Property Boundary

0 200 400 600 800

1:12,500 METERS

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2013
PROJECTION: UTM NAD83 ZONE 17
WATERCOURSES PRODUCED USING INFORMATION UNDER LICENSE WITH THE GRAND RIVER CONSERVATION AUTHORITY © GRAND RIVER CONSERVATION AUTHORITY, 2014
PROPERTY BOUNDARY OBTAINED FROM CRA, NOVEMBER 2014.

CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
WELL LOCATIONS

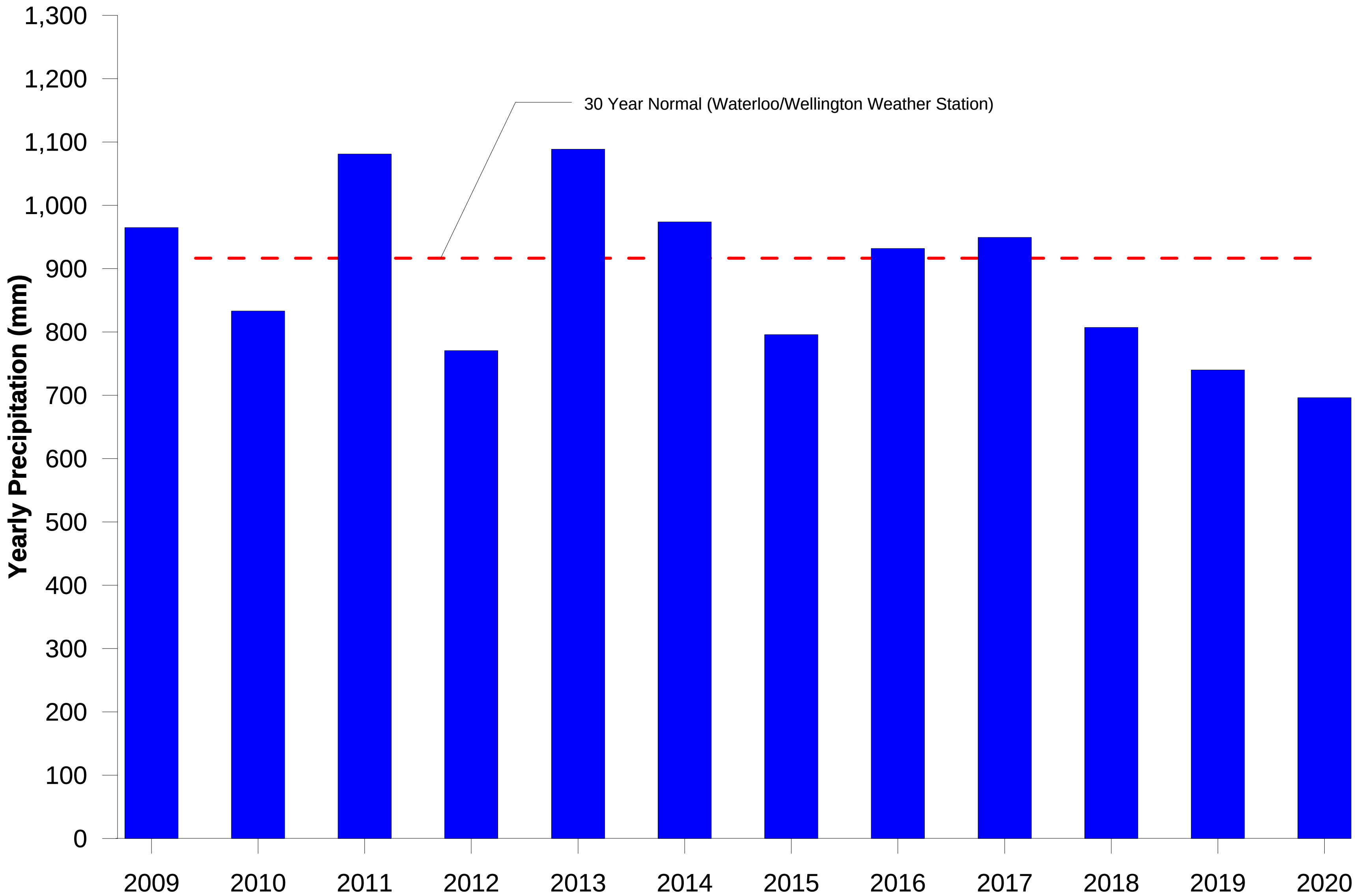
CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449109	0019	1.0	3.5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm



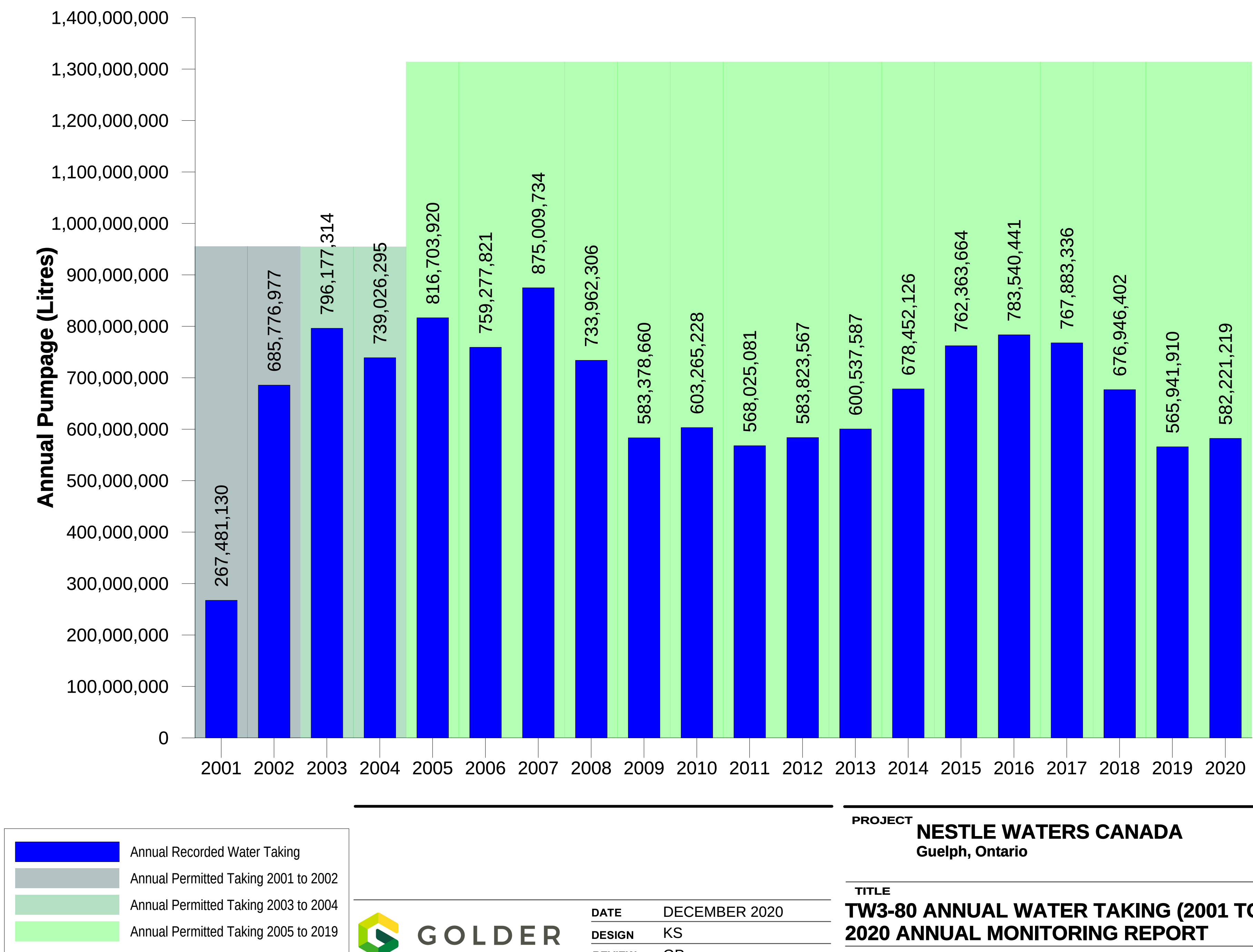
GOLDER

DATE	DECEMBER 2020
DESIGN	SK
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Guelph, Ontario

TITLE
HISTORICAL YEARLY PRECIPITATION (2009 TO 2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	3.6



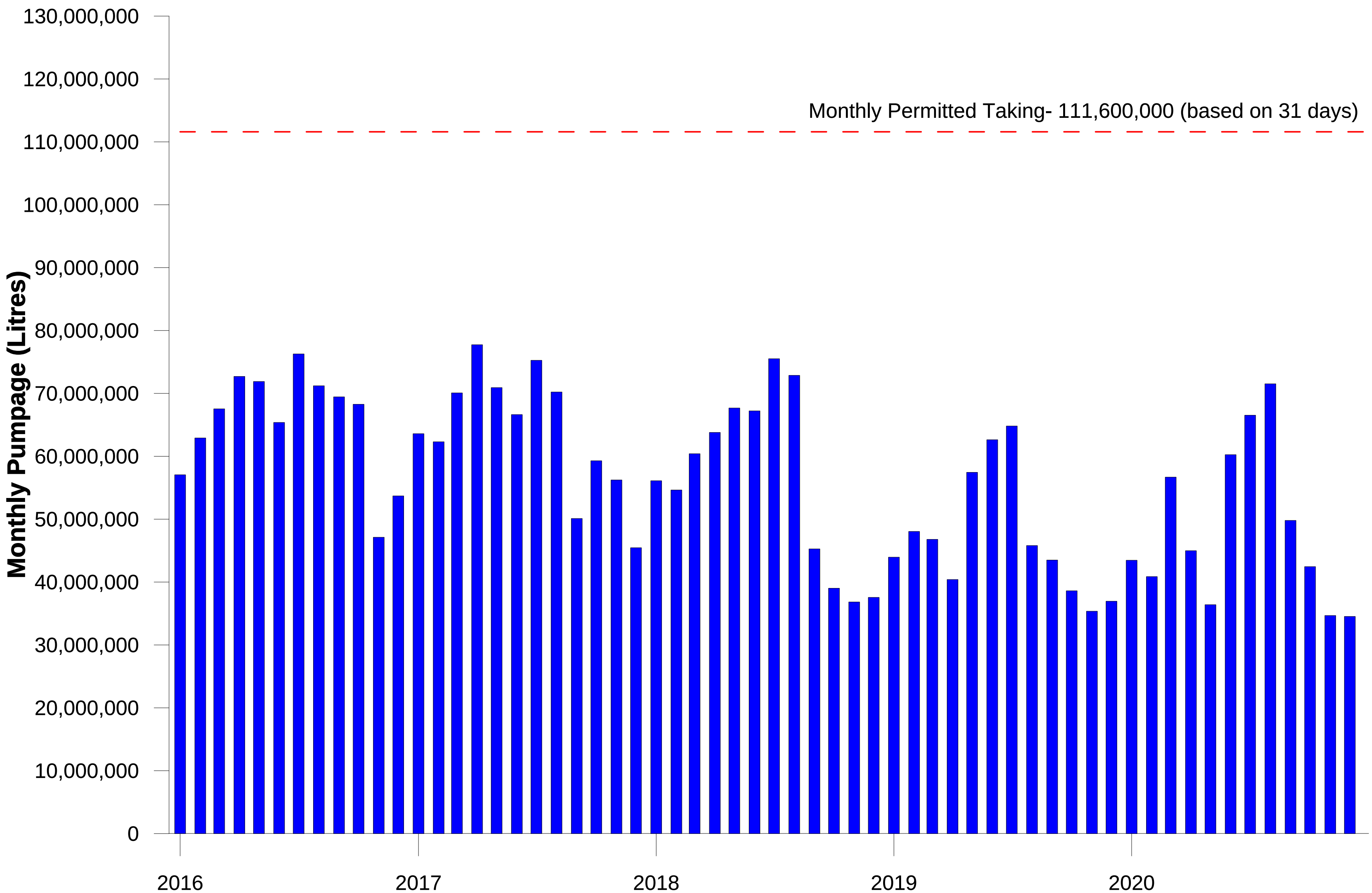
GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Guelph, Ontario

TITLE
TW3-80 ANNUAL WATER TAKING (2001 TO 2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	4.1



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Guelph, Ontario

TITLE
TW3-80 MONTHLY WATER TAKING (2016 TO 2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	4.2

LEGEND

- Production Well
- Monitoring Well (Bedrock)
- Private Well (Bedrock)
- Watercourse
- 311.5 Water Level Elevation (August 20, 2020)
- Water Elevation Contour (masl)
- Inferred Water Elevation Contour
- Property Boundary

0 200 400 600 800 1,000

1:12,500 METERS

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2013
PROJECTION: UTM NAD83 ZONE 17
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PROPERTY BOUNDARY OBTAINED FROM CRA, NOVEMBER 2014.

CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
POTENTIOMETRIC SURFACE OF LOWER BEDROCK AQUIFER (AUGUST 2020)

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	**4.3**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

LEGEND

- Production Well
- Monitoring Well (Bedrock)
- Private Well (Bedrock)
- Watercourse
- Water Elevation Contour (masl)
- 311.5 Water Level Elevation (August 20, 2020)
- Property Boundary

0 200 400 600 800 1,000

1:12,500 METERS

REFERENCE(S)
BASE DATA - MNR LIO, OBTAINED 2013
PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2013
PROJECTION: UTM NAD83 ZONE 17
WATERCOURSES PRODUCED USING INFORMATION UNDER LICENSE WITH THE GRAND RIVER CONSERVATION AUTHORITY © GRAND RIVER CONSERVATION AUTHORITY, 2014
PROPERTY BOUNDARY OBTAINED FROM CRA, NOVEMBER 2014.

CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
POTENTIOMETRIC SURFACE OF UPPER BEDROCK AQUIFER (AUGUST 2020)

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-05
DESIGNED	JMC
PREPARED	PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	4.4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

LEGEND

- Production Well
- Monitoring Well (Overburden)
- Watercourse
- Water Elevation Contour (masl)
- 311.4 Water Level Elevation (August 20, 2020)
- Property Boundary

0 200 400 600 800 1,000

1:12,500 METERS

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2013
PROJECTION: UTM NAD83 ZONE 17
WATERCOURSES PRODUCED USING INFORMATION UNDER LICENSE WITH THE GRAND RIVER CONSERVATION AUTHORITY © GRAND RIVER CONSERVATION AUTHORITY, 2014
PROPERTY BOUNDARY OBTAINED FROM CRA, NOVEMBER 2014.

CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
POTENTIOMETRIC SURFACE OF OVERBURDEN (AUGUST 2020)

CONSULTANT

GOLDER

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	4.5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

S:\Clients\Nestle\Aberfoyle\99_PROJ\1311520250_Monitoring\40_PROD\0013_2017_Annual_Report_Final\1311520250-0013-CH-0019.mxd

LEGEND

- Production Well
- Piezometer
- Surface Water Station
- Watercourse
- 311.5 Water Level Elevation (August 20, 2020)
- Property Boundary

0 200 400 600 800 1,000

1:12,500 METERS

REFERENCE(S)

BASE DATA - MNR LIO, OBTAINED 2013
PRODUCED BY GOLDER ASSOCIATES LTD UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES, © QUEENS PRINTER 2013
PROJECTION: UTM NAD83 ZONE 17
WATERCOURSES PRODUCED USING INFORMATION UNDER LICENSE WITH THE GRAND RIVER CONSERVATION AUTHORITY © GRAND RIVER CONSERVATION AUTHORITY, 2014
PROPERTY BOUNDARY OBTAINED FROM CRA, NOVEMBER 2014.

CLIENT
NESTLE WATERS CANADA

PROJECT
2020 ANNUAL REPORT

TITLE
SURFACE WATER ELEVATIONS (AUGUST 2020)

CONSULTANT

YYYY-MM-DD	2021-01-25
DESIGNED	JMC
PREPARED	JMC/PR
REVIEWED	GP
APPROVED	JP

PROJECT NO.	CONTROL	REV.	FIGURE
20449101	0019	1.0	**4.6**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

25mm

0

APPENDIX A

Permit To Take Water Number 1381-95ATPY

Ministry of the Environment
West-Central Region
Technical Support Section
12th Floor
119 King St W
Hamilton ON L8P 4Y7
Fax: (905)521-7820
Tel: (905) 521-7640

Ministère de l'Environnement
Direction régionale du Centre-Ouest
Secteur du Soutien Technique
12e étage
119 rue King W
Hamilton ON L8P 4Y7
Télécopieur: (905)521-7820
Tél:(905) 521-7640

Ontario

December 19, 2013

Nestle Canada Inc.
101 Brock Road S.
Puslinch, Ontario
N1H 6H9

Dear Sir/Madam:

RE: Lot 23, Concession 7
Geographic Township of Puslinch
City of Guelph
Wellington County
Permit Number 1381-95ATPY

Please find attached a Permit to Take Water which authorizes the withdrawal of water in accordance with the application for this Permit to Take Water, dated December 3, 2012 and signed by Don DeMarco.

This Permit expires on July 31, 2016. Authorized rates and amounts are indicated on Table A. This Permit cancels and replaces Permit Number 1763-8FXR29, issued on April 29, 2011.

Ontario Regulation 387/04 (Water Taking) requires all water takers to report daily water taking amounts to the Water Taking Reporting System (WTRS) electronic database: http://www.ene.gov.on.ca/envision/water/pttw.htm . Daily water taking must be reported on a calendar year basis. If no water is taken, then a "no taking" report must be entered. Please consult the Regulation and Section 4 of this Permit for monitoring requirements.

If you have questions about reporting requirements, please call the WTRS Help Desk at 416-235-6322 (toll free: 1-877-344-2011) or by email, WTRSHelpdesk@ontario.ca . It is preferred that you submit your data directly and electronically to the WTRS. Where this is impracticable, please use the Water Taking Submission Form *(included as Appendix C of the Technical Bulletin: Permit To Take Water (PTTW)-Monitoring and Reporting of Water Takings),* which can be downloaded from the above website, and fax your completed forms to 416-235-6549 or mail them to: Water User Reporting Section, 125 Resources Rd. Toronto, ON M9P 3V6.

Please also note Condition 1.4 specifically indicates that this Permit is not transferable to another party. Any queries regarding a change in owner/operator should be made to the Permit to Take Water Evaluator at the above address.

Take notice that in issuing this Permit, terms and conditions pertaining to the taking of water and to the results of the taking have been imposed. The terms and conditions have been designed to allow for the development of water resources, while providing reasonable protection to existing water uses and users.

Yours truly,

Carl Slater
Director, Section 34, Ontario Water Resources Act
West Central Region

File Storage Number: AP28 PUNE

AMENDED PERMIT TO TAKE WATER
Ground Water
NUMBER 1381-95ATPY

Pursuant to Section 34 of the Ontario Water Resources Act, R.S.O. 1990 this Permit To Take Water is hereby issued to:

Nestle Canada Inc.
101 Brock Road S.
Puslinch, Ontario N1H 6H9

For the water taking from: Two bedrock wells (TW3-80 and TW2-11)

Located at: Lot 23, Concession 7, Geographic Township of Puslinch
Guelph, County of Wellington

For the purposes of this Permit, and the terms and conditions specified below, the following definitions apply:

DEFINITIONS

(a) "Director" means any person appointed in writing as a Director pursuant to section 5 of the OWRA for the purposes of section 34, OWRA.

(b) "Provincial Officer" means any person designated in writing by the Minister as a Provincial Officer pursuant to section 5 of the OWRA.

(c) "Ministry" means Ontario Ministry of the Environment.

(d) "District Office" means the Guelph District Office.

(e) "Permit" means this Permit to Take Water No. 1381-95ATPY including its Schedules, if any, issued in accordance with Section 34 of the OWRA.

(f) "Permit Holder" means Nestle Canada Inc..

(g) "OWRA " means the *Ontario Water Resources Act*, R.S.O. 1990, c. O. 40, as amended.

You are hereby notified that this Permit is issued subject to the terms and conditions outlined below:

<u>TERMS AND CONDITIONS</u>

1. Compliance with Permit

1.1 Except where modified by this Permit, the water taking shall be in accordance with the application for this Permit To Take Water, dated December 3, 2012 and signed by Don DeMarco, and all Schedules included in this Permit.

1.2 The Permit Holder shall ensure that any person authorized by the Permit Holder to take water under this Permit is provided with a copy of this Permit and shall take all reasonable measures to ensure that any such person complies with the conditions of this Permit.

1.3 Any person authorized by the Permit Holder to take water under this Permit shall comply with the conditions of this Permit.

1.4 This Permit is not transferable to another person.

1.5 This Permit provides the Permit Holder with permission to take water in accordance with the conditions of this Permit, up to the date of the expiry of this Permit. This Permit does not constitute a legal right, vested or otherwise, to a water allocation, and the issuance of this Permit does not guarantee that, upon its expiry, it will be renewed.

1.6 The Permit Holder shall keep this Permit available at all times at or near the site of the taking, and shall produce this Permit immediately for inspection by a Provincial Officer upon his or her request.

1.7 The Permit Holder shall report any changes of address to the Director within thirty days of any such change. The Permit Holder shall report any change of ownership of the property for which this Permit is issued within thirty days of any such change. A change in ownership in the property shall cause this Permit to be cancelled.

2. General Conditions and Interpretation

2.1 Inspections
The Permit Holder must forthwith, upon presentation of credentials, permit a Provincial Officer to carry out any and all inspections authorized by the OWRA, the *Environmental Protection Act*, R.S.O. 1990, the *Pesticides Act*, R.S.O. 1990, or the *Safe Drinking Water Act*, S. O. 2002.

2.2 Other Approvals
The issuance of, and compliance with this Permit, does not:

(a) relieve the Permit Holder or any other person from any obligation to comply with any other applicable legal requirements, including the provisions of the *Ontario Water Resources Act*, and the *Environmental Protection Act*, and any regulations made thereunder; or

(b) limit in any way any authority of the Ministry, a Director, or a Provincial Officer, including the authority to require certain steps be taken or to require the Permit Holder to furnish any further information related to this Permit.

2.3 Information

The receipt of any information by the Ministry, the failure of the Ministry to take any action or require any person to take any action in relation to the information, or the failure of a Provincial Officer to prosecute any person in relation to the information, shall not be construed as:

(a) an approval, waiver or justification by the Ministry of any act or omission of any person that contravenes this Permit or other legal requirement; or

(b) acceptance by the Ministry of the information's completeness or accuracy.

2.4 Rights of Action

The issuance of, and compliance with this Permit shall not be construed as precluding or limiting any legal claims or rights of action that any person, including the Crown in right of Ontario or any agency thereof, has or may have against the Permit Holder, its officers, employees, agents, and contractors.

2.5 Severability

The requirements of this Permit are severable. If any requirements of this Permit, or the application of any requirements of this Permit to any circumstance, is held invalid or unenforceable, the application of such requirements to other circumstances and the remainder of this Permit shall not be affected thereby.

2.6 Conflicts

Where there is a conflict between a provision of any submitted document referred to in this Permit, including its Schedules, and the conditions of this Permit, the conditions in this Permit shall take precedence.

3. Water Takings Authorized by This Permit

3.1 **Expiry**

This Permit expires on **July 31, 2016**. No water shall be taken under authority of this Permit after the expiry date.

3.2 Amounts of Taking Permitted

The Permit Holder shall only take water from the source, during the periods and at the rates and amounts of taking specified in Table A. Water takings are authorized only for the purposes specified in Table A.

Table A

	Source Name / Description:	Source: Type:	Taking Specific Purpose:	Taking Major Category:	Max. Taken per Minute (litres):	Max. Num. of Hrs Taken per Day:	Max. Taken per Day (litres):	Max. Num. of Days Taken per Year:	Zone/ Easting/ Northing:
1	Well TW3-80	Well Drilled	Bottled Water	Commercial	2,500	24	3,600,000	365	17 569053 4812797
2	Well TW2-11	Well Drilled	Other - Miscellaneous	Miscellaneous	475	24	684,000	365	17 568638 4812238
						Total Taking:	3,600,000		

3.3 For greater certainty, Source Name Well TW2-11 in Table A shall not be used for bottled water and shall be used for miscellaneous purposes such as providing water to the on site pond for fire fighting purposes.

3.4 For greater certainty, the total amount of water taken for the combination of sources in Table A shall not exceed 3,600,000 litres per day.

4. Monitoring

4.1 Under section 9 of O. Reg. 387/04, and as authorized by subsection 34(6) of the *Ontario Water Resources Act* , the Permit Holder shall, on each day water is taken under the authorization of this Permit, record the date, the volume of water taken on that date and the rate at which it was taken. The daily volume of water taken shall be measured by a flow meter or calculated in accordance with the method described in the application for this Permit, or as otherwise accepted by the Director. A separate record shall be maintained for each source. The Permit Holder shall keep all records required by this condition current and available at or near the site of the taking and shall produce the records immediately for inspection by a Provincial Officer upon his or her request. The Permit Holder, unless otherwise required by the Director, shall submit, on or before March 31st in every year, the records required by this condition to the ministry’s Water Taking Reporting System.

4.2 The Permit Holder shall establish the following groundwater monitoring program for the duration of the Permit:

Bedrock Wells

(i) Continuous monitoring of groundwater levels in the following wells:

- TW3-80 (67-07290)
- MW2A/B/C-07
- MW4A/B-07
- Fireflow (67-14195)
- MW-D (67-11936)
- MW1A-04
- PCC-D (67-11650)
- MW10B/C/D-09
- MW6A/B-08

- MW7A/B-08
- MW8A/B-08
- TW2-11
- MW14A/B/C-11
- MW15A/B-12
- MW16A/B-12
- MW17A/B-12
- MW18A/B-12

(ii) Monthly monitoring of groundwater levels at the following private wells (if the owner permits):

- Private well MOE WWR #67-08740
- Private well at 2 Brock Road
- Private well MOE WWR #67-07589
- Private well MOE WWR #67-08317 also known as 8 Maple Lane Well
- Private well at 58 Brock Road
- Private well "B"
- Private well "M1"
- Private well "Y" MOE WWR #67-09669
- Private well "J"
- Meadows of Aberfoyle well #PW5 (67-1197)
- Private Well "W2" (67-13335)

Overburden Wells

(iii) Continuous monitoring of groundwater levels in the following wells:

- TW1-93 (67-11283)
- TW1-99 (67-12929)
- MW-S/I
- PCC S/I
- MW2D/E-07
- MW4C-07
- MW10A-09

4.3 The Permit Holder shall establish the following surface water monitoring program for the duration of the Permit:

Surface Water Levels

(i) Continuous monitoring of water levels at the following locations:

- SW1
- SW2

(ii) Monthly monitoring of water levels at the following locations:

- SW3
- SW4
- SW5
- SW9
- SW10

Stream Flow
(iii) Monthly monitoring of flow, encompassing a range of flow conditions, and the development of a stage-discharge curve at the following surface water locations:

- SW1
- SW2

Multi-level Piezometers
(iv) Continuous monitoring of multi-level piezometers at the following locations:

- MP16S/D-08
- MP6S-08/D -04
- MP12S/D-04
- MP14S/D-07
- MP8S/D-04
- MP11S-08/D-04
- MP17S/D-12
- MP18S/D-12
- MP19S/D-12

Temperature
(v) Continuous monitoring of temperature at the sediment-water interface at the following locations:

- ST6-08
- ST1-05/AT-01
- ST2-05
- ST3-05
- ST4-05
- ST5-05

4.4 The Permit Holder shall undertake wetland monitoring and redd surveys as recommended in "2010 Biological Monitoring Program Final Report" by C. Portt and Associates dated January 28, 2011. Results from the wetland and redd surveys shall be submitted to the Director as a part of the annual monitoring report required under Condition 4.8.

4.5 The Permit Holder shall determine the total amount of water taken for each calendar month. If the monthly amount exceeds 83,700,000 L, the Permit Holder shall submit multi-level piezometer data in a letter report to the Director within 30 days of the end of the calendar month for the following monitoring locations:

- MP6S-08/D-04
- MP12S/D-04
- MP11S-08/D-04
- MW2-D/E

4.6 Continuous monitoring shall be datalogged at 60 minute intervals and downloaded monthly, however, the daily minimum water levels can be used to evaluate the water level variation with respect to pumping to improve the data handling and presentation. Monthly groundwater monitoring shall be conducted in the same week each calendar month.

4.7 The Permit Holder shall identify to the Director in writing, within 15 days of any monthly monitoring event, any monitoring locations identified in Conditions 4.2 and 4.3 which become inaccessible and/or abandoned along with a recommendation for replacement monitoring locations. Upon approval of the Director the monitoring program shall be appropriately modified.

4.8 The Permit Holder shall submit to the Director, an annual monitoring report which present and interprets the monitoring data to be collected under the Terms and Conditions of this Permit. This report shall be prepared, signed and stamped by a licensed professional geoscientist or a licensed professional engineer specializing in hydrogeology who shall take responsibility for its accuracy. Surface water impact assessment shall be conducted by a qualified surface water scientist who shall co-sign the report as responsibility for the accuracy of the surface water portion. The report shall be submitted to the Director by March 31 of each calendar year and include monitoring data for the 12 month period ending December 31 of the previous year.

4.9 The Permit Holder shall submit to the Director as part of the annual monitoring report, details of the bottling operations involved with water taking under this Permit to Take Water to indicate compliance with OWRA Section 34.3. These details shall include:

- Location and name of the facilities to which water is delivered in bulk containers greater than 20 L from this source,
- If the bulk water is containerized at the receiving location,
- The size of container(s) into which the water is transferred at the receiving location, and
- Total volume of the water transported in bulk in each calendar year to each remote facility.

5. Impacts of the Water Taking

5.1 Notification

The Permit Holder shall immediately notify the local District Office of any complaint arising from the taking of water authorized under this Permit and shall report any action which has been taken or is proposed with regard to such complaint. The Permit Holder shall immediately notify the local District Office if the taking of water is observed to have any significant impact on the surrounding waters. After hours, calls shall be directed to the Ministry's Spills Action Centre at 1-800-268-6060.

5.2 For Groundwater Takings

If the taking of water is observed to cause any negative impact to other water supplies obtained from any adequate sources that were in use prior to initial issuance of a Permit for this water taking, the Permit Holder shall take such action necessary to make available to those affected, a supply of water equivalent in quantity and quality to their normal takings, or shall compensate such persons for their reasonable costs of so doing, or shall reduce the rate and amount of taking to prevent or alleviate the observed negative impact. Pending permanent restoration of the affected supplies, the Permit Holder shall provide, to those affected, temporary water supplies adequate to meet their normal requirements, or shall compensate such persons for their reasonable costs of doing so.

If permanent interference is caused by the water taking, the Permit Holder shall restore the water supplies of those permanently affected.

6. Director May Amend Permit

The Director may amend this Permit by letter requiring the Permit Holder to suspend or reduce the taking to an amount or threshold specified by the Director in the letter. The suspension or reduction in taking shall be effective immediately and may be revoked at any time upon notification by the Director. This condition does not affect your right to appeal the suspension or reduction in taking to the Environmental Review Tribunal under the *Ontario Water Resources Act* , Section 100 (4).

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is included to ensure that the conditions in this Permit are complied with and can be enforced.

2. Condition 2 is included to clarify the legal interpretation of aspects of this Permit.

3. Conditions 3 through 6 are included to protect the quality of the natural environment so as to safeguard the ecosystem and human health and foster efficient use and conservation of waters. These conditions allow for the beneficial use of waters while ensuring the fair sharing, conservation and sustainable use of the waters of Ontario. The conditions also specify the water takings that are authorized by this Permit and the scope of this Permit.

In accordance with Section 100 of the Ontario Water Resources Act, R.S.O. 1990, you may by written notice served upon me, the Environmental Review Tribunal and the Environmental Commissioner, ***Environmental Bill of Rights****, R.S.O. 1993, Chapter 28, within 15 days after receipt of this Notice, require a hearing by the Tribunal. The Environmental Commissioner will place notice of your appeal on the Environmental Registry. Section 101 of the Ontario Water Resources Act, as amended provides that the Notice requiring a hearing shall state:*

1. The portions of the Permit or each term or condition in the Permit in respect of which the hearing is required, and;
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

In addition to these legal requirements, the Notice should also include:

3. The name of the appellant;
4. The address of the appellant;
5. The Permit to Take Water number;
6. The date of the Permit to Take Water;
7. The name of the Director;
8. The municipality within which the works are located;

This notice must be served upon:

The Secretary
Environmental Review Tribunal
655 Bay Street, 15th Floor
Toronto ON
M5G 1E5
Fax: (416) 314-4506
Email:
ERTTribunalsecretary@ontario.ca

AND

The Environmental Commissioner
1075 Bay Street
6th Floor, Suite 605
Toronto, Ontario M5S 2W5

AND

The Director, Section 34
Ministry of the Environment
12th Floor
119 King St W
Hamilton ON L8P 4Y7
Fax: (905)521-7820

Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal:

by telephone at (416) 314-4600 ***by fax at (416) 314-4506*** ***by e-mail at www.ert.gov.on.ca***

This instrument is subject to Section 38 of the ***Environmental Bill of Rights*** *that allows residents of Ontario to seek leave to appeal the decision on this instrument. Residents of Ontario may seek to appeal for 15 days from the date this decision is placed on the Environmental Registry. By accessing the Environmental Registry, you can determine when the leave to appeal period ends.*

This Permit cancels and replaces Permit Number 1763-8FXR29, issued on 2011/04/29.

Dated at Hamilton this 19th day of December, 2013.

Carl Slater
Director, Section 34
Ontario Water Resources Act , R.S.O. 1990

Schedule A

This Schedule "A" forms part of Permit To Take Water 1381-95ATPY, dated December 19, 2013.

Ministry of the Environment and Climate Change
West Central Region

119 King Street West
12th Floor
Hamilton, Ontario L8P 4Y7
Tel.: 905 521-7640
Fax: 905 521-7820

Ministère de l'Environnement et de l'Action en matière de changement climatique
Direction régionale du Centre-Ouest

119 rue King Ouest
12e étage
Hamilton (Ontario) L8P 4Y7
Tél. : 905 521-7640
Téléc. : 905 521-7820

Ontario

February 5, 2015

Nestle Canada Inc.
101 Brock Road S.
Puslinch, Ontario
N1H 6H9

Attention: Ms. Andreanne Simard

Dear Ms. Simard:

RE: Request for short term pumping rate change for well sanitization
Permit to Take Water 1381-95ATPY

NOTICE

Pursuant to s. 100, Ontario Water Resources Act, R.S.O. 1990, c. O.40 as amended, I am issuing notice that, as Director of Section 34 of the Ontario Water Resources Act, I am exercising my discretion to amend Permit to Take Water 1381-95ATPY condition 3.5. All other terms and conditions of Permit to Take Water 1381-95ATPY shall continue in force.

In an email dated November 27, 2014, Ms. Simard, requested the sanitation Notice issued on December 20, 2013 be applicable for all years remaining on the permit.

This Notice supersedes the Notice issued December 20, 2013. Condition 3.5 is hereby revoked and replaced as follows:

3.5 Notwithstanding Table A, the maximum pumping of water extracted from Source TW3-80 may be increased to 2575 litres per minute (680 U.S. gallons per minute) annually, or as needed, for the sole purpose of sanitization of the well. The maximum amount of water taken shall not exceed 3,600,000 litres/day.

This Notice now forms part of the current permit and must be attached to the original Permit to Take Water, if available. If the original is no longer available, this letter must be kept attached to a certified copy of the Permit to Take Water.

Any change in circumstances related to this permit should be reported promptly to a Director.

It is your responsibility to ensure that any person taking water under the authority of this permit is familiar with and complies with the terms and conditions.

In accordance with Section 100 of the *Ontario Water Resources Act,* *R.S.O. 1990, you may by written notice served upon me, the Environmental Review Tribunal and the Environmental Commissioner,* ***Environmental Bill of Rights,*** *R.S.O. 1993, Chapter 28, within 15 days after receipt of this Notice, require a hearing by the Tribunal. The Environmental Commissioner will place notice of your appeal on the Environmental Registry. Section 101 of the* *Ontario Water Resources Act,* *as amended provides that the Notice requiring a hearing shall state:*

1. The portions of the Permit or each term or condition in the Permit in respect of which the hearing is required, and;
2. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

In addition to these legal requirements, the Notice should also include:

3. The name of the appellant;
4. The address of the appellant;
5. The Permit to Take Water number;
6. The date of the Permit to Take Water;
7. The name of the Director;
8. The municipality within which the works are located;

This notice must be served upon:

The Secretary *Environmental Review Tribunal* *2300 Yonge Street, Suite 1700* *Toronto, Ontario M4P 1E4*	*AND*	*The Director, Section 34* *Ministry of the Environment* *12th Floor* *119 King St W* *Hamilton ON L8P 4Y7* *Fax: (905)521-7820*

Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal:

by telephone at (416) 314-4600 ***by fax at (416) 314-4506*** ***by e-mail at www.ert.gov.on.ca***

Yours truly,

Dan Dobrin

Director, Section 34, Ontario Water Resources Act
West Central Region

File Storage Number: AP28 PUNE

APPENDIX B

TW3-80 Borehole Log

Attachment 2

Project Name: ABERFOYLE FISHERIES
Job No. 979-653
Client: CUSTOM AGGREGATE
Borehole Type: 12" Ø Cable Tool
Location: Pit No. 1, Aberfoyle

Borehole No. TW3-80
Date Completed April 14/80
Geologist/Engineer A.V.N.
Elevation 1040.90, top of casing

Depth (Elev.)	Stratigraphy	Profile: Description & Remarks	Sample: Number / Type / Blows/Foot	Penetration Test Blows/Foot (20 40 60 80)	Piezometer or Standpipe Installation
0 (1039)		(316.7 m amsl) Brown clayey-silt till containing some sand and small gravel (304.5 m amsl)			12" Ø steel casing to rock grouted to 20' from surface
40					
45		fine - medium sand (303.0 m amsl)			
48		fine sand matrix w/sand and gravel (302.1 m amsl)			12" Ø Drive shoe seated into rock
		Eramosa member of the Guelph formation * Black dolomite slightly crystalline solid (292.3 m amsl)			
80 (959)		Saw Wiarton formation of the Amabel Group light - medium grey dolomite slightly crystalline fractured water bearing zone (274.3 m amsl)			12" Ø Open hole in rock
139 (900)		N.B. Static level, 11.42 ft. below top of casing on April 15/80 ELEV. = 1029.48			

FIGURE 2.3

* Based on driller's log, Guelph Fm. interpreted to occur from El. 302.1 to 299.9 m amsl.
Eramosa from 299.9 to 292.3 m amsl.

Conestoga - Rovers & Associates

Ministry of the Environment
Ontario

TW #3/80

The Ontario Water Resources Act
WATER WELL RECORD

MOE # 67-07290

County or District	Township, Borough, City, Town, Village	Con., Block, Tract, Survey, Etc.	Lot
Wellington	Puslinch	Con 7	23, 2

Owner	Address	Date Completed
Elliott, Mr. John	R.R. #3, Guelph, Ontario.	14 Apr. 8

LOG OF OVERBURDEN AND BEDROCK MATERIALS

General Colour	Most Common Material	Other Materials	General Description	Depth - From	Depth - To
Brown	Clay	Stones		0	20
Brown	" sand	Gravels		20	47
M. Br.		Rock		47	55
D. Br.		Rock		55	75
Black		Rock		75	85
M. Br.		Rock		85	95
Grey & Br.		Rock		95	135
D. Grey		Rock		135	139
	TW #3/80	Total Depth			139

12" shoe

WATER RECORD

Water Found at Feet	Kind of Water
55	Fresh
93	Fresh
130	Fresh

CASING & OPEN HOLE RECORD

Inside Diam.	Material	Wall Thickness	Depth From	Depth To
12"	Steel	.250	0	48
12	Open hole		48	139

PLUGGING & SEALING RECORD

Depth Set At - From	To	Material and Type
102	118	Cement
118	130	Bentonite Grout
130	139	Limestone Gravel

PUMPING TEST

Pump; Pumping rate 1200 GPM; Duration of pumping 24 hours
Static level 11' 6"; Water level end of pumping 50 ft; Water levels during: 11' 6"
Recommended pump type: Deep; Recommended pumping rate 1200 GPM; Recommended pump setting 100 ft

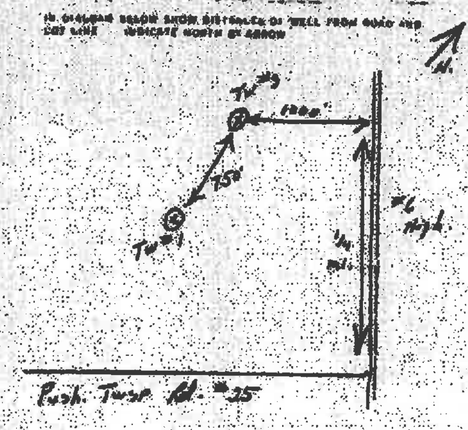
FINAL STATUS OF WELL
Water supply

WATER USE
Commercial

METHOD OF DRILLING
Cable tool

LOCATION OF WELL

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



Push. Twsp. Rd. #35

CONTRACTOR

Name of Well Contractor	Licence Number
Graham Well Drilling Ltd.	2936

Address: Guelph, Ont.

Name of Well Technician: J. Hawkins 22w

Signature of Contractor; Submission Date: 30 Apr. 80

CONTRACTOR'S COPY

APPENDIX C

TW3-80 Water Taking

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Jan-20	113,399	80	429,261	302
2-Jan-20	307,796	215	1,165,134	814
3-Jan-20	413,310	289	1,564,549	1,095
4-Jan-20	485,519	339	1,837,887	1,284
5-Jan-20	483,213	338	1,829,161	1,278
6-Jan-20	335,980	236	1,271,821	892
7-Jan-20	276,741	191	1,047,579	724
8-Jan-20	241,754	169	915,139	640
9-Jan-20	282,709	197	1,070,168	744
10-Jan-20	315,406	219	1,193,943	827
11-Jan-20	212,377	147	803,933	556
12-Jan-20	451,350	317	1,708,545	1,199
13-Jan-20	529,278	371	2,003,533	1,403
14-Jan-20	547,213	382	2,071,424	1,445
15-Jan-20	449,056	312	1,699,862	1,179
16-Jan-20	338,925	235	1,282,970	890
17-Jan-20	340,546	235	1,289,107	889
18-Jan-20	313,114	217	1,185,266	820
19-Jan-20	463,424	324	1,754,249	1,226
20-Jan-20	441,527	307	1,671,361	1,164
21-Jan-20	365,367	255	1,383,065	964
22-Jan-20	289,236	303	1,094,875	1,149
23-Jan-20	213,494	147	808,161	558
24-Jan-20	352,698	245	1,335,106	929
25-Jan-20	324,829	227	1,229,610	859
26-Jan-20	346,568	241	1,311,903	911
27-Jan-20	426,913	298	1,616,041	1,128
28-Jan-20	516,657	359	1,955,760	1,359
29-Jan-20	505,503	352	1,913,535	1,331
30-Jan-20	476,668	332	1,804,382	1,257
31-Jan-20	323,263	224	1,223,681	848

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Feb-20	344,963	242	1,305,825	915
2-Feb-20	324,952	226	1,230,075	854
3-Feb-20	368,923	257	1,396,524	973
4-Feb-20	456,441	316	1,727,817	1,197
5-Feb-20	432,883	302	1,638,638	1,144
6-Feb-20	470,793	329	1,782,146	1,244
7-Feb-20	450,358	314	1,704,790	1,188
8-Feb-20	382,067	265	1,446,281	1,003
9-Feb-20	350,277	242	1,325,940	918
10-Feb-20	304,296	211	1,151,885	799
11-Feb-20	439,327	307	1,663,032	1,160
12-Feb-20	305,881	212	1,157,885	803
13-Feb-20	303,563	212	1,149,111	802
14-Feb-20	435,822	305	1,649,766	1,153
15-Feb-20	355,240	246	1,344,728	931
16-Feb-20	288,077	202	1,090,488	764
17-Feb-20	277,042	192	1,048,717	726
18-Feb-20	347,859	244	1,316,790	922
19-Feb-20	280,995	195	1,063,681	737
20-Feb-20	353,395	247	1,337,744	936
21-Feb-20	434,734	302	1,645,646	1,143
22-Feb-20	400,886	281	1,517,518	1,063
23-Feb-20	449,178	313	1,700,323	1,183
24-Feb-20	273,119	189	1,033,866	715
25-Feb-20	189,047	132	715,621	500
26-Feb-20	504,596	351	1,910,102	1,330
27-Feb-20	222,435	155	842,009	588
28-Feb-20	529,573	368	2,004,650	1,392
29-Feb-20	519,686	361	1,967,226	1,365

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Mar-20	528,040	368	1,998,849	1,395
2-Mar-20	462,855	321	1,752,098	1,216
3-Mar-20	343,771	239	1,301,315	903
4-Mar-20	448,597	311	1,698,125	1,179
5-Mar-20	407,258	285	1,541,637	1,078
6-Mar-20	383,100	267	1,450,189	1,009
7-Mar-20	485,878	353	1,839,249	1,336
8-Mar-20	490,566	340	1,856,995	1,289
9-Mar-20	490,696	343	1,857,484	1,298
10-Mar-20	476,221	330	1,802,690	1,249
11-Mar-20	494,807	345	1,873,048	1,306
12-Mar-20	455,588	317	1,724,589	1,199
13-Mar-20	440,448	306	1,667,275	1,158
14-Mar-20	476,343	333	1,803,153	1,260
15-Mar-20	490,512	341	1,856,790	1,291
16-Mar-20	453,343	317	1,716,088	1,202
17-Mar-20	491,173	344	1,859,290	1,302
18-Mar-20	567,009	395	2,146,362	1,495
19-Mar-20	535,917	372	2,028,665	1,409
20-Mar-20	485,303	337	1,837,072	1,277
21-Mar-20	447,872	312	1,695,378	1,182
22-Mar-20	515,360	363	1,950,850	1,374
23-Mar-20	493,314	346	1,867,396	1,309
24-Mar-20	556,994	388	2,108,452	1,467
25-Mar-20	523,172	365	1,980,422	1,382
26-Mar-20	543,950	375	2,059,075	1,418
27-Mar-20	585,480	406	2,216,280	1,536
28-Mar-20	538,477	375	2,038,356	1,420
29-Mar-20	567,210	394	2,147,122	1,492
30-Mar-20	337,069	234	1,275,945	886
31-Mar-20	458,367	320	1,735,108	1,210

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Apr-20	461,552	323	1,747,163	1,222
2-Apr-20	579,012	403	2,191,797	1,525
3-Apr-20	538,140	377	2,037,082	1,426
4-Apr-20	477,610	332	1,807,949	1,258
5-Apr-20	530,891	369	2,009,641	1,397
6-Apr-20	344,320	238	1,303,393	901
7-Apr-20	378,748	263	1,433,717	995
8-Apr-20	320,217	269	1,212,154	1,018
9-Apr-20	411,736	333	1,558,590	1,262
10-Apr-20	532,845	371	2,017,037	1,406
11-Apr-20	582,694	405	2,205,736	1,533
12-Apr-20	529,384	368	2,003,934	1,394
13-Apr-20	449,584	311	1,701,861	1,177
14-Apr-20	353,901	246	1,339,659	931
15-Apr-20	483,910	337	1,831,798	1,277
16-Apr-20	517,494	363	1,958,927	1,373
17-Apr-20	443,234	310	1,677,822	1,173
18-Apr-20	504,156	351	1,908,437	1,329
19-Apr-20	433,341	301	1,640,375	1,139
20-Apr-20	327,582	228	1,240,031	862
21-Apr-20	306,619	214	1,160,679	809
22-Apr-20	409,312	282	1,549,413	1,069
23-Apr-20	273,285	190	1,034,496	719
24-Apr-20	306,493	212	1,160,200	803
25-Apr-20	296,961	206	1,124,118	780
26-Apr-20	287,482	199	1,088,236	754
27-Apr-20	305,590	212	1,156,785	801
28-Apr-20	184,404	128	698,044	485
29-Apr-20	274,514	190	1,039,149	720
30-Apr-20	39,350	29	148,957	108

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-May-20	29,637	22	112,189	83
2-May-20	33,744	26	127,734	98
3-May-20	52,228	38	197,705	142
4-May-20	99,357	70	376,105	265
5-May-20	216,318	150	818,851	568
6-May-20	274,392	192	1,038,687	725
7-May-20	274,585	190	1,039,417	721
8-May-20	305,961	213	1,158,189	805
9-May-20	279,002	195	1,056,137	737
10-May-20	298,558	208	1,130,164	787
11-May-20	285,984	199	1,082,568	752
12-May-20	304,462	211	1,152,512	801
13-May-20	433,710	302	1,641,769	1,143
14-May-20	301,215	209	1,140,222	793
15-May-20	284,417	198	1,076,634	748
16-May-20	340,535	235	1,289,066	891
17-May-20	120,155	84	454,835	318
18-May-20	73,581	52	278,534	198
19-May-20	287,623	201	1,088,769	761
20-May-20	454,137	316	1,719,094	1,197
21-May-20	500,020	347	1,892,779	1,314
22-May-20	408,596	285	1,546,702	1,077
23-May-20	405,045	281	1,533,260	1,065
24-May-20	394,855	273	1,494,688	1,035
25-May-20	419,882	293	1,589,426	1,111
26-May-20	403,843	282	1,528,710	1,069
27-May-20	471,633	325	1,785,325	1,230
28-May-20	510,819	356	1,933,659	1,348
29-May-20	507,332	353	1,920,460	1,338
30-May-20	441,412	306	1,670,925	1,159
31-May-20	403,054	285	1,525,723	1,079

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Jun-20	401,729	280	1,520,708	1,059
2-Jun-20	352,844	243	1,335,658	919
3-Jun-20	526,301	368	1,992,265	1,392
4-Jun-20	532,187	373	2,014,547	1,411
5-Jun-20	523,466	367	1,981,535	1,390
6-Jun-20	551,461	383	2,087,506	1,450
7-Jun-20	524,020	365	1,983,632	1,382
8-Jun-20	484,560	337	1,834,258	1,274
9-Jun-20	496,786	348	1,880,539	1,316
10-Jun-20	498,890	349	1,888,502	1,321
11-Jun-20	413,603	288	1,565,658	1,088
12-Jun-20	558,946	388	2,115,841	1,468
13-Jun-20	573,038	401	2,169,183	1,517
14-Jun-20	599,695	416	2,270,090	1,574
15-Jun-20	475,003	332	1,798,080	1,257
16-Jun-20	516,181	360	1,953,958	1,362
17-Jun-20	510,486	355	1,932,399	1,345
18-Jun-20	561,792	391	2,126,613	1,479
19-Jun-20	600,661	419	2,273,748	1,585
20-Jun-20	604,837	421	2,289,555	1,592
21-Jun-20	598,601	415	2,265,950	1,572
22-Jun-20	549,286	383	2,079,271	1,448
23-Jun-20	549,062	382	2,078,426	1,447
24-Jun-20	578,128	402	2,188,453	1,523
25-Jun-20	501,973	349	1,900,174	1,321
26-Jun-20	595,932	414	2,255,846	1,568
27-Jun-20	579,711	403	2,194,442	1,525
28-Jun-20	600,646	418	2,273,691	1,583
29-Jun-20	530,103	369	2,006,655	1,398
30-Jun-20	529,723	369	2,005,217	1,398

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Jul-20	500,829	349	1,895,844	1,319
2-Jul-20	420,520	294	1,591,842	1,112
3-Jul-20	449,651	316	1,702,115	1,196
4-Jul-20	388,332	272	1,469,997	1,028
5-Jul-20	452,312	315	1,712,185	1,192
6-Jul-20	518,794	362	1,963,849	1,370
7-Jul-20	587,334	411	2,223,299	1,554
8-Jul-20	635,869	445	2,407,025	1,686
9-Jul-20	602,870	420	2,282,109	1,588
10-Jul-20	668,916	464	2,532,120	1,755
11-Jul-20	606,067	422	2,294,214	1,598
12-Jul-20	666,360	462	2,522,444	1,750
13-Jul-20	514,364	359	1,947,078	1,357
14-Jul-20	533,639	374	2,020,041	1,416
15-Jul-20	597,104	420	2,260,284	1,591
16-Jul-20	622,062	432	2,354,758	1,636
17-Jul-20	552,775	385	2,092,481	1,457
18-Jul-20	580,924	405	2,199,034	1,535
19-Jul-20	524,022	366	1,983,636	1,384
20-Jul-20	582,680	407	2,205,681	1,540
21-Jul-20	556,738	387	2,107,480	1,465
22-Jul-20	539,172	352	2,040,985	1,333
23-Jul-20	539,172	374	2,040,985	1,417
24-Jul-20	667,411	463	2,526,426	1,754
25-Jul-20	554,569	385	2,099,271	1,458
26-Jul-20	632,785	439	2,395,350	1,663
27-Jul-20	625,504	434	2,367,787	1,644
28-Jul-20	620,538	464	2,348,989	1,755
29-Jul-20	617,488	429	2,337,446	1,623
30-Jul-20	590,327	411	2,234,630	1,556
31-Jul-20	626,684	435	2,372,257	1,646

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Aug-20	632,449	439	2,394,080	1,662
2-Aug-20	411,512	431	1,557,741	1,630
3-Aug-20	527,230	369	1,995,782	1,397
4-Aug-20	578,254	401	2,188,927	1,518
5-Aug-20	578,977	403	2,191,665	1,526
6-Aug-20	624,333	434	2,363,355	1,644
7-Aug-20	705,202	486	2,669,479	1,841
8-Aug-20	711,512	491	2,693,365	1,858
9-Aug-20	658,064	456	2,491,041	1,727
10-Aug-20	580,261	403	2,196,526	1,525
11-Aug-20	549,923	383	2,081,683	1,449
12-Aug-20	602,818	418	2,281,912	1,582
13-Aug-20	625,312	433	2,367,062	1,638
14-Aug-20	674,991	466	2,555,119	1,766
15-Aug-20	758,645	531	2,871,783	2,009
16-Aug-20	723,349	502	2,738,174	1,900
17-Aug-20	611,671	425	2,315,425	1,609
18-Aug-20	577,571	401	2,186,344	1,520
19-Aug-20	625,794	436	2,368,887	1,649
20-Aug-20	611,024	424	2,312,975	1,606
21-Aug-20	622,363	433	2,355,898	1,638
22-Aug-20	588,944	410	2,229,394	1,554
23-Aug-20	610,439	424	2,310,764	1,605
24-Aug-20	599,993	417	2,271,221	1,577
25-Aug-20	444,242	308	1,681,639	1,167
26-Aug-20	550,653	384	2,084,446	1,453
27-Aug-20	604,590	419	2,288,621	1,587
28-Aug-20	678,493	473	2,568,375	1,789
29-Aug-20	587,154	407	2,222,617	1,542
30-Aug-20	610,376	425	2,310,523	1,610
31-Aug-20	630,135	439	2,385,318	1,660

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Sep-20	603,825	420	2,285,727	1,590
2-Sep-20	503,035	348	1,904,193	1,318
3-Sep-20	324,795	224	1,229,481	848
4-Sep-20	413,622	288	1,565,728	1,091
5-Sep-20	478,820	332	1,812,530	1,257
6-Sep-20	478,487	332	1,811,268	1,258
7-Sep-20	482,807	334	1,827,622	1,265
8-Sep-20	418,730	292	1,585,067	1,105
9-Sep-20	524,052	364	1,983,751	1,379
10-Sep-20	404,017	280	1,529,370	1,061
11-Sep-20	386,623	268	1,463,528	1,015
12-Sep-20	433,849	303	1,642,298	1,147
13-Sep-20	399,546	270	1,512,444	1,021
14-Sep-20	346,917	241	1,313,224	912
15-Sep-20	445,662	309	1,687,014	1,172
16-Sep-20	430,939	299	1,631,281	1,133
17-Sep-20	428,598	298	1,622,419	1,127
18-Sep-20	431,193	299	1,632,242	1,134
19-Sep-20	452,501	314	1,712,902	1,190
20-Sep-20	458,378	318	1,735,149	1,205
21-Sep-20	415,638	289	1,573,360	1,093
22-Sep-20	397,643	276	1,505,242	1,045
23-Sep-20	436,153	303	1,651,018	1,147
24-Sep-20	488,992	340	1,851,035	1,285
25-Sep-20	595,304	413	2,253,470	1,565
26-Sep-20	615,074	427	2,328,307	1,617
27-Sep-20	150,542	105	569,863	396
28-Sep-20	367,346	255	1,390,555	966
29-Sep-20	402,957	280	1,525,356	1,059
30-Sep-20	441,540	307	1,671,411	1,161

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Oct-20	381,813	265	1,445,320	1,004
2-Oct-20	394,952	274	1,495,056	1,038
3-Oct-20	346,136	240	1,310,266	910
4-Oct-20	386,691	269	1,463,783	1,017
5-Oct-20	333,531	232	1,262,551	877
6-Oct-20	354,432	246	1,341,671	932
7-Oct-20	368,808	256	1,396,091	970
8-Oct-20	375,894	261	1,422,912	988
9-Oct-20	430,000	299	1,627,726	1,130
10-Oct-20	471,573	327	1,785,098	1,240
11-Oct-20	369,343	256	1,398,116	971
12-Oct-20	127,863	89	484,015	336
13-Oct-20	358,682	249	1,357,760	943
14-Oct-20	435,450	302	1,648,357	1,145
15-Oct-20	332,057	231	1,256,974	873
16-Oct-20	329,993	229	1,249,160	867
17-Oct-20	451,519	314	1,709,184	1,187
18-Oct-20	485,285	337	1,837,004	1,276
19-Oct-20	367,485	255	1,391,080	966
20-Oct-20	538,335	374	2,037,819	1,415
21-Oct-20	258,019	179	976,706	678
22-Oct-20	337,851	235	1,278,905	888
23-Oct-20	334,025	232	1,264,422	878
24-Oct-20	315,318	219	1,193,607	829
25-Oct-20	346,997	241	1,313,526	912
26-Oct-20	312,116	217	1,181,488	820
27-Oct-20	236,959	165	896,985	623
28-Oct-20	311,565	216	1,179,403	819
29-Oct-20	370,195	257	1,401,338	973
30-Oct-20	375,979	261	1,423,236	988
31-Oct-20	377,879	262	1,430,428	993

TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	**Volume** (US gpd)	**Average Flow Rate Over Time Taken** (US gpm)	**Volume** (L/day)	**Average Flow Rate Over Time Taken** (L/min)
1-Nov-20	368,658	256	1,395,520	969
2-Nov-20	380,915	265	1,441,919	1,001
3-Nov-20	470,977	327	1,782,842	1,238
4-Nov-20	578,325	402	2,189,199	1,520
5-Nov-20	486,006	338	1,839,732	1,278
6-Nov-20	380,777	264	1,441,396	1,001
7-Nov-20	385,752	268	1,460,229	1,014
8-Nov-20	325,414	226	1,231,827	855
9-Nov-20	47,482	33	179,737	125
10-Nov-20	258,838	180	979,810	680
11-Nov-20	559,976	389	2,119,737	1,472
12-Nov-20	527,759	366	1,997,784	1,387
13-Nov-20	610,920	424	2,312,583	1,606
14-Nov-20	360,681	250	1,365,324	948
15-Nov-20	383,134	266	1,450,321	1,007
16-Nov-20	302,264	210	1,144,193	795
17-Nov-20	289,931	201	1,097,508	762
18-Nov-20	359,600	250	1,361,232	945
19-Nov-20	429,649	298	1,626,398	1,129
20-Nov-20	394,422	274	1,493,050	1,037
21-Nov-20	382,817	266	1,449,120	1,006
22-Nov-20	92,114	64	348,688	242
23-Nov-20	12	0	45	0
24-Nov-20	123,127	86	466,086	324
25-Nov-20	29,451	20	111,485	77
26-Nov-20	90,261	63	341,676	237
27-Nov-20	106,946	74	404,834	281
28-Nov-20	57,094	40	216,125	150
29-Nov-20	149,988	104	567,767	394
30-Nov-20	229,602	159	869,137	604

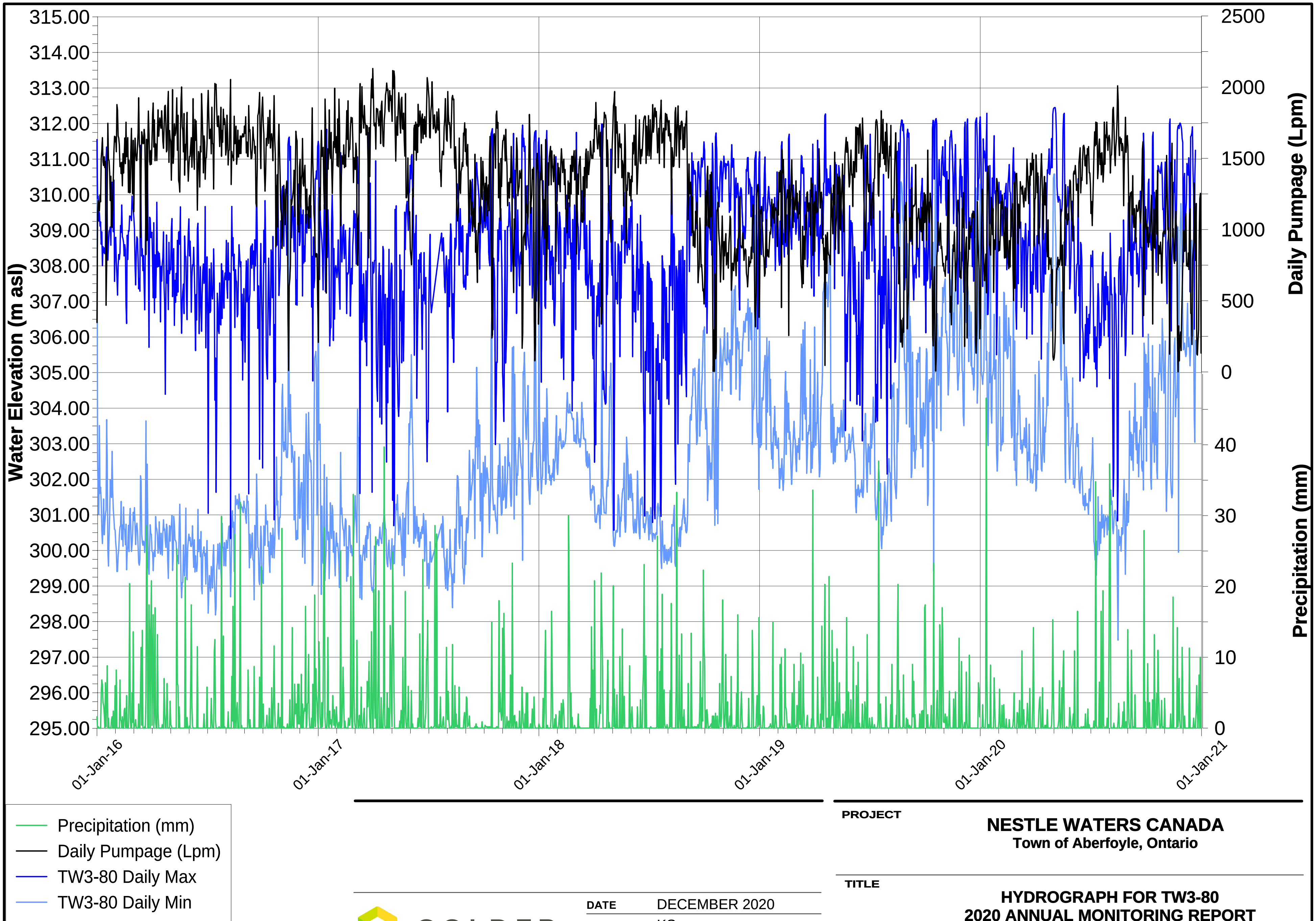
TABLE C1
TW3-80 DAILY WATER TAKING
NESTLE WATERS CANADA
ABERFOYLE, ONTARIO

Date	Volume (US gpd)	Average Flow Rate Over Time Taken (US gpm)	Volume (L/day)	Average Flow Rate Over Time Taken (L/min)
1-Dec-20	302,987	210	1,146,929	796
2-Dec-20	377,612	262	1,429,415	993
3-Dec-20	377,612	262	1,429,415	993
4-Dec-20	321,985	224	1,218,846	846
5-Dec-20	405,363	282	1,534,465	1,066
6-Dec-20	423,672	294	1,603,772	1,114
7-Dec-20	283,276	197	1,072,316	745
8-Dec-20	289,308	201	1,095,148	761
9-Dec-20	281,681	196	1,066,278	740
10-Dec-20	317,817	221	1,203,066	835
11-Dec-20	273,612	190	1,035,734	719
12-Dec-20	421,035	292	1,593,792	1,107
13-Dec-20	435,750	303	1,649,491	1,145
14-Dec-20	156,326	109	591,760	411
15-Dec-20	155,806	108	589,789	410
16-Dec-20	73,229	51	277,200	193
17-Dec-20	299,253	208	1,132,793	787
18-Dec-20	321,689	223	1,217,727	846
19-Dec-20	346,476	241	1,311,553	911
20-Dec-20	505,003	351	1,911,642	1,328
21-Dec-20	362,415	252	1,371,891	953
22-Dec-20	297,860	207	1,127,524	783
23-Dec-20	450,221	313	1,704,271	1,184
24-Dec-20	51,298	33	194,185	126
25-Dec-20	42,529	31	160,988	119
26-Dec-20	84,311	59	319,152	224
27-Dec-20	111,071	79	420,447	297
28-Dec-20	362,712	253	1,373,014	957
29-Dec-20	463,784	322	1,755,614	1,218
30-Dec-20	476,635	331	1,804,259	1,254
31-Dec-20	49,985	35	189,214	132

Notes:
1. All volumes measured with a flow meter and recorded on a datalogger.

APPENDIX D

Groundwater Level Monitoring



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

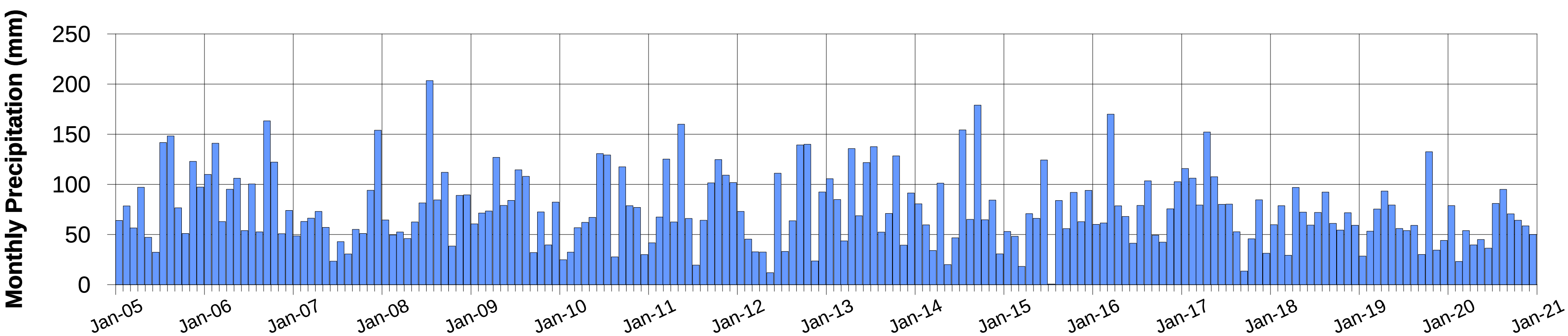
PROJECT

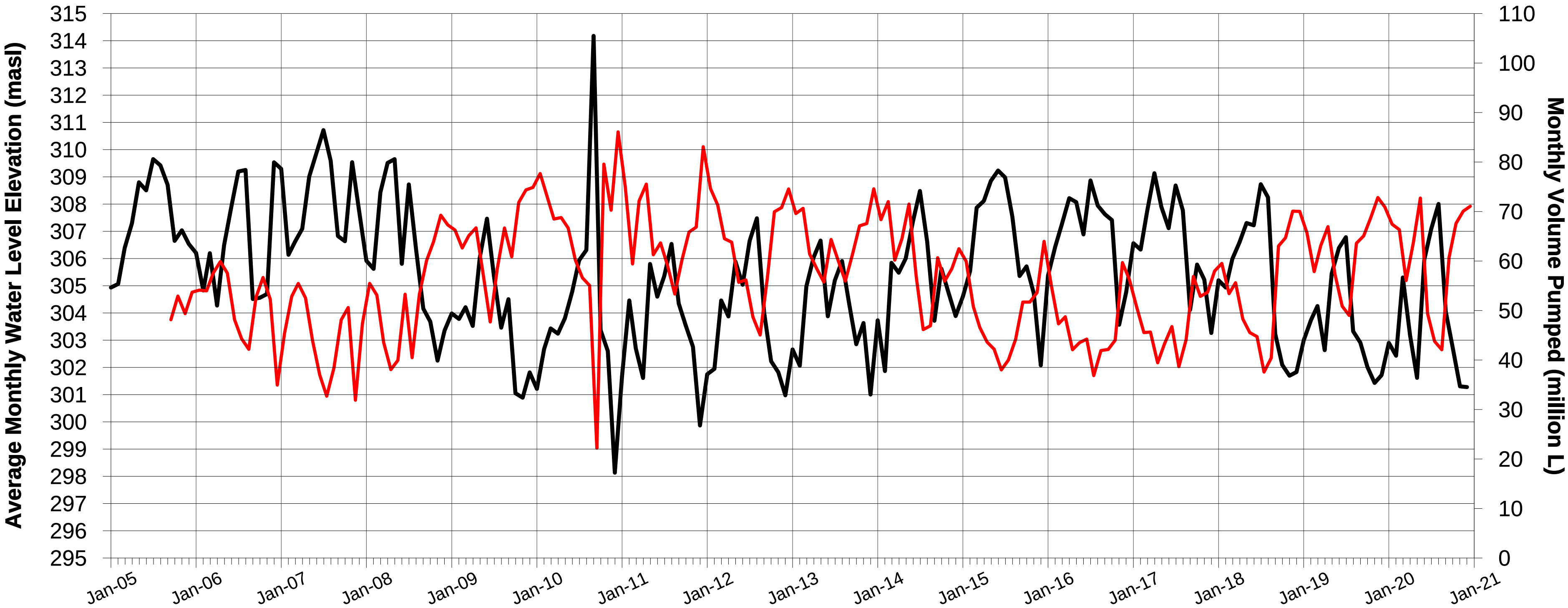
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

HYDROGRAPH FOR TW3-80
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D1a





GOLDER

DATE	December 2020
DESIGN	KJ
REVIEW	GP
APPROVED	GP

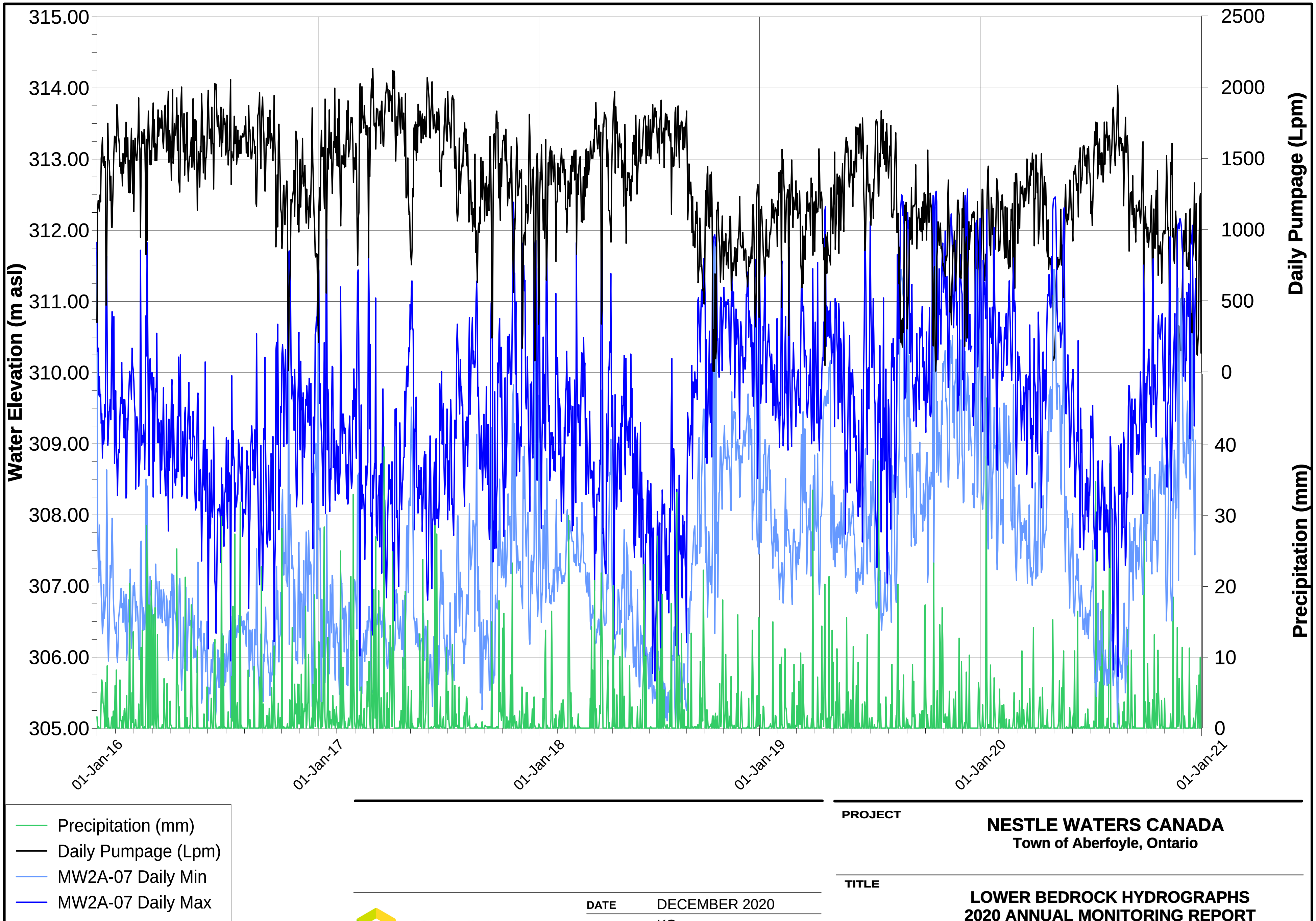
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

AVERAGE MONTHLY WATER LEVELS TW3-80
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D1b



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA

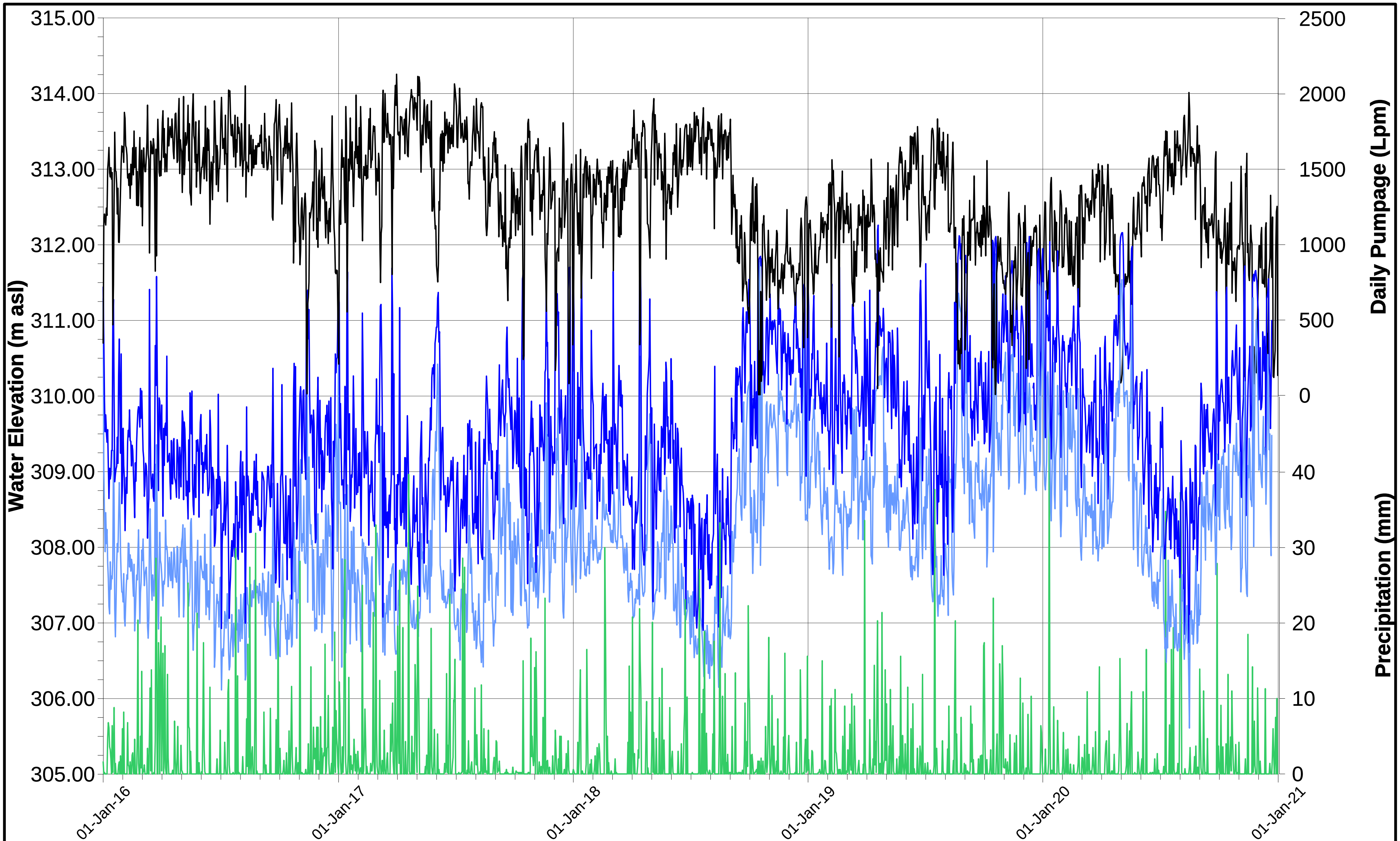
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS

2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D2



DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

GOLDER

PROJECT

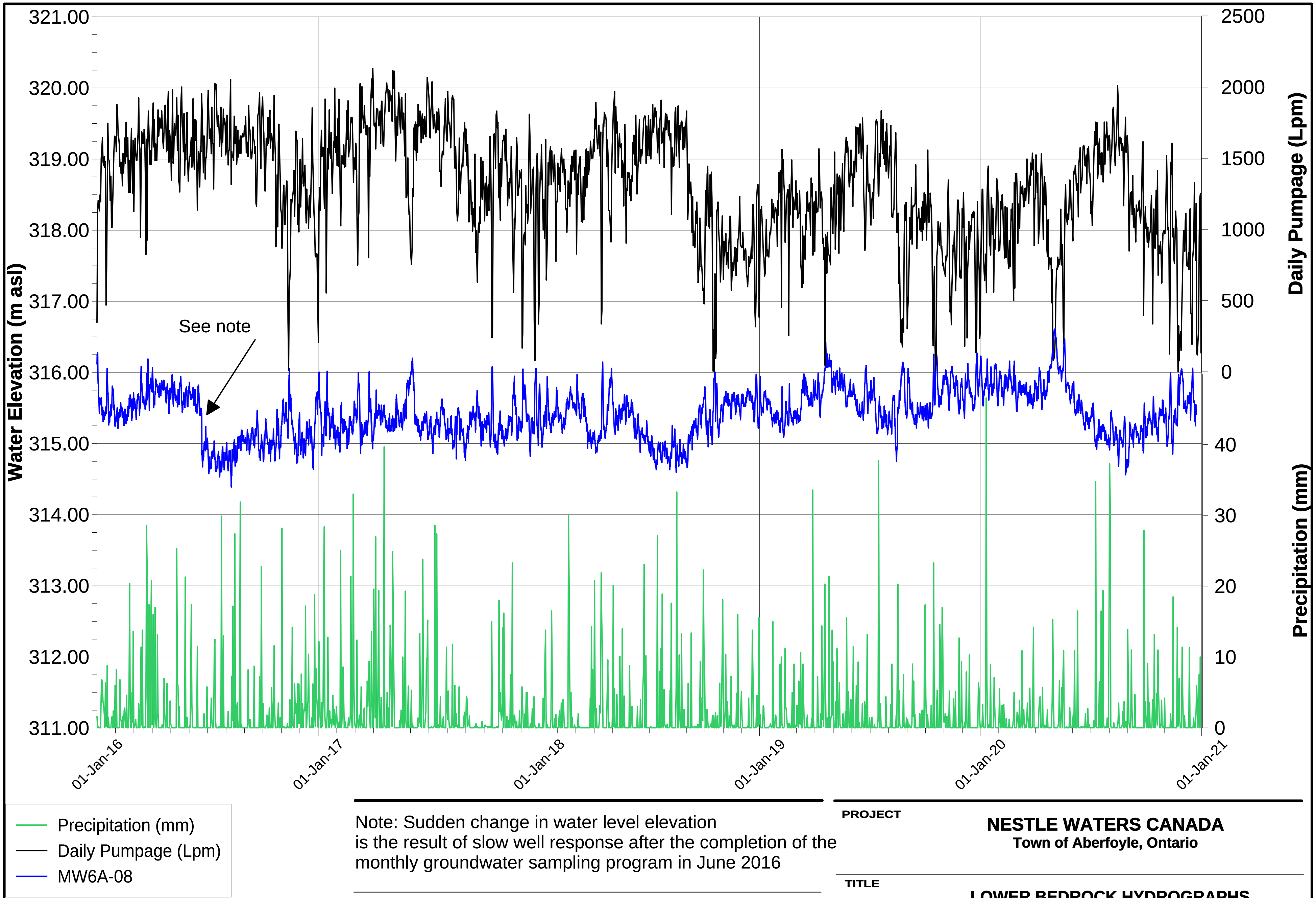
NESTLE WATERS CANADA

Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D3



Note: Sudden change in water level elevation is the result of slow well response after the completion of the monthly groundwater sampling program in June 2016

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

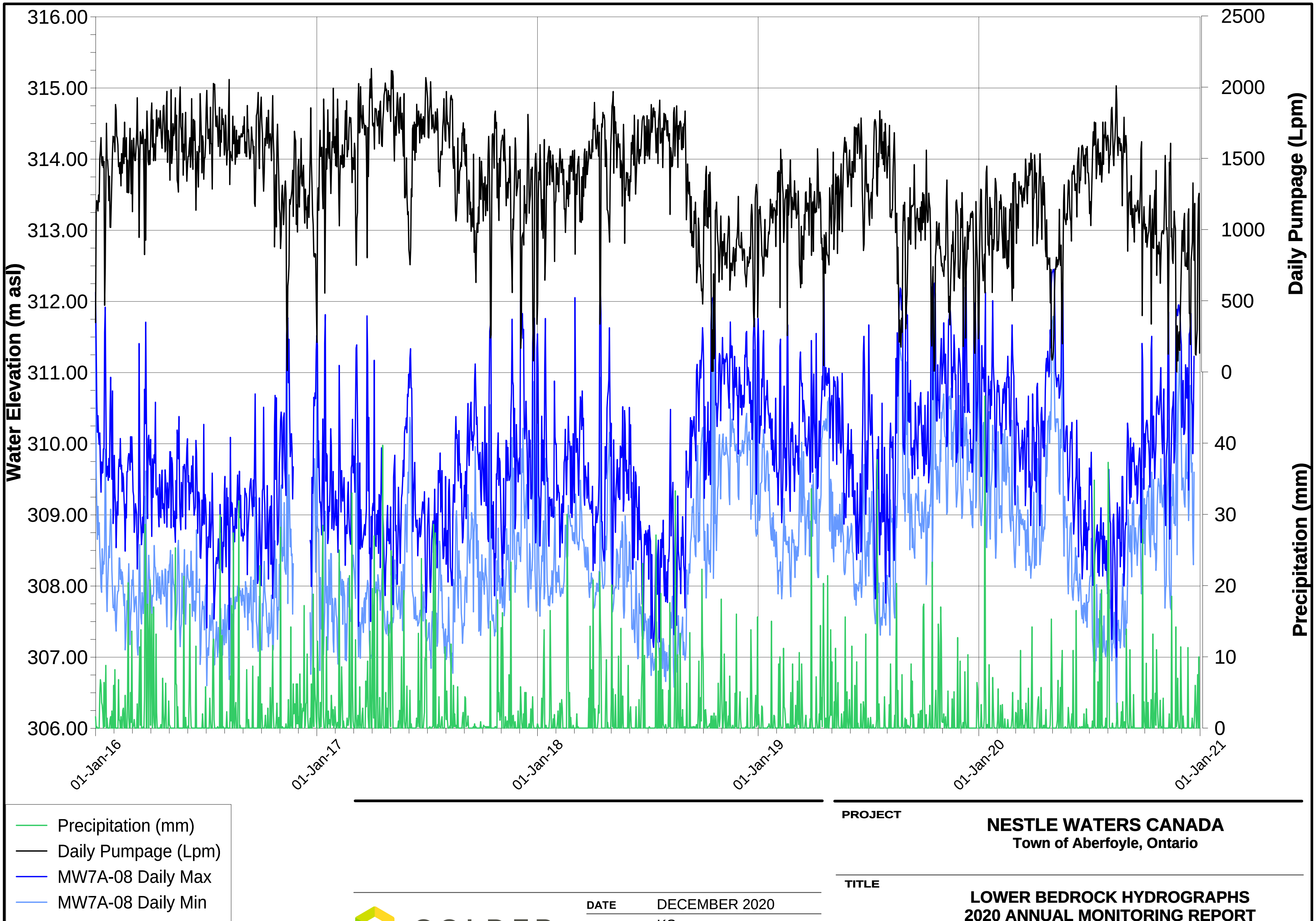
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D4



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA

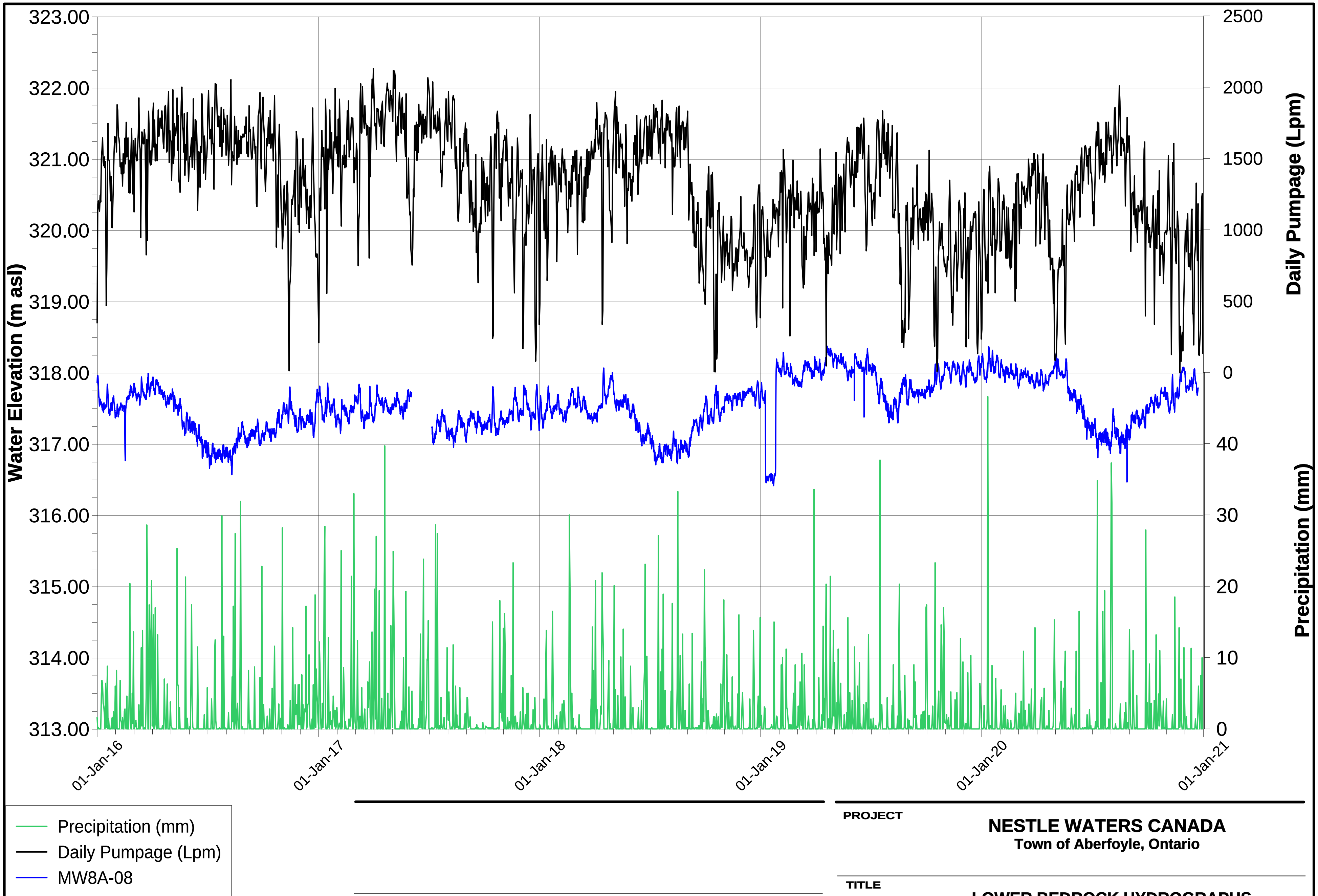
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS

2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D5



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

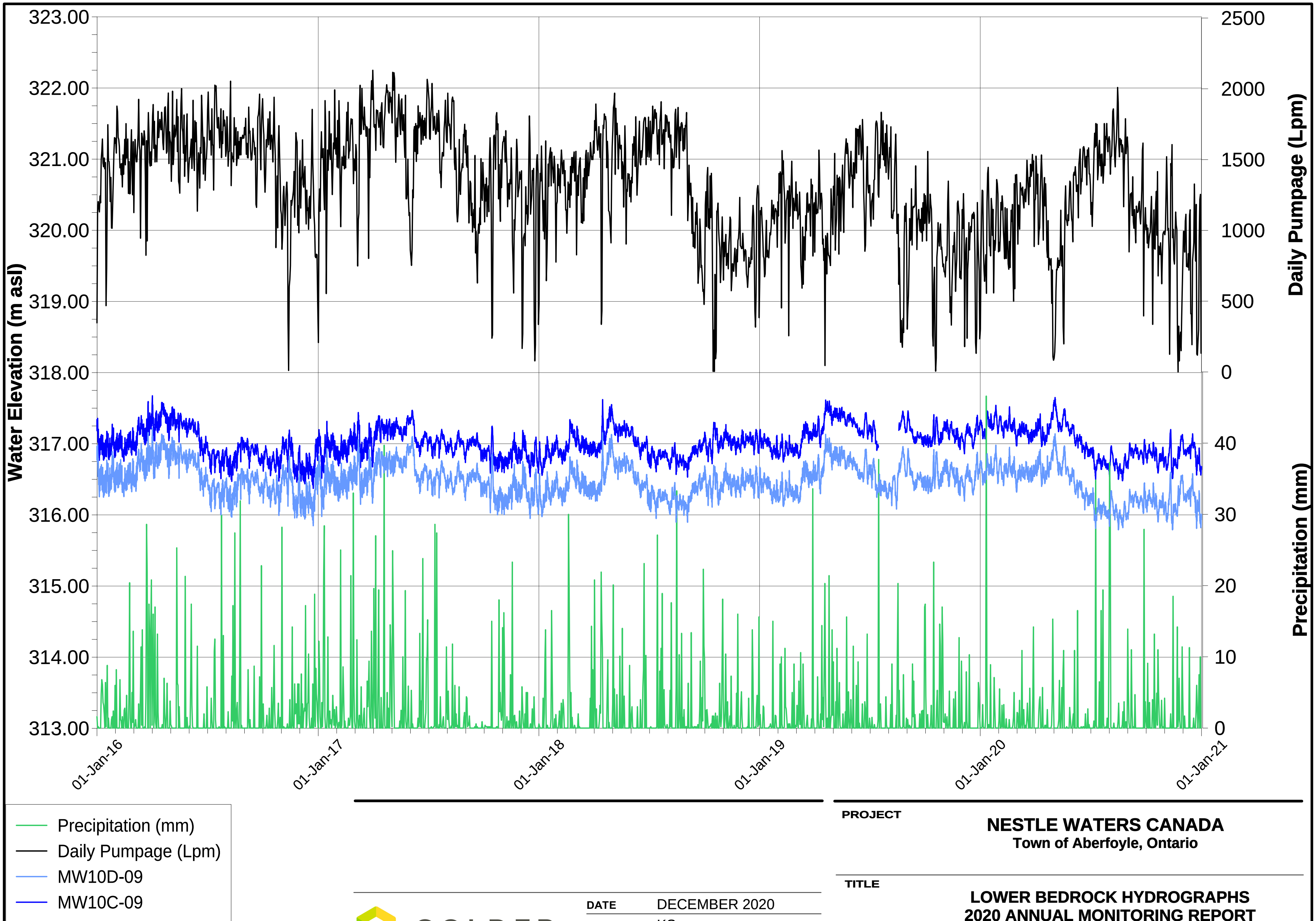
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D6



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
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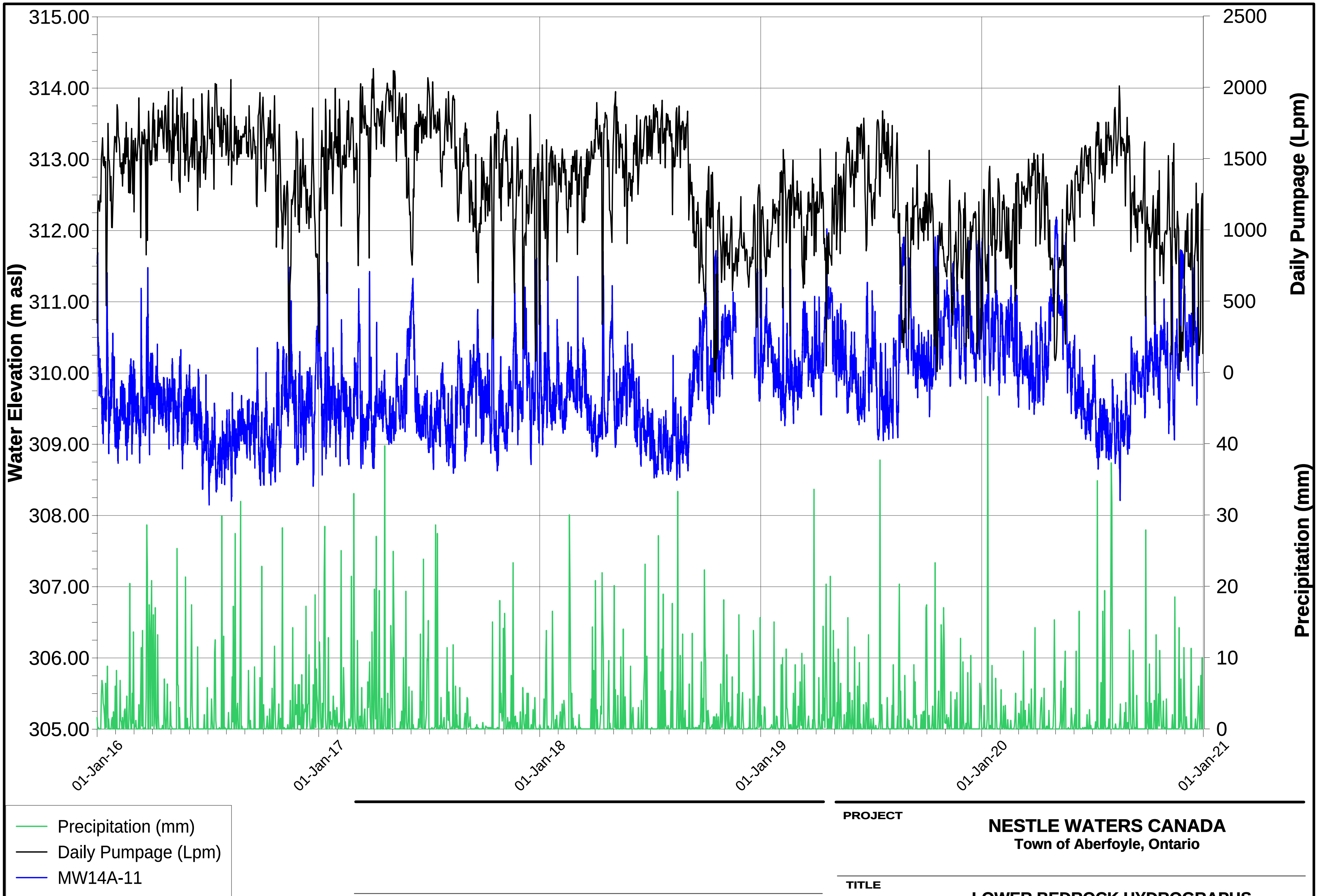


GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

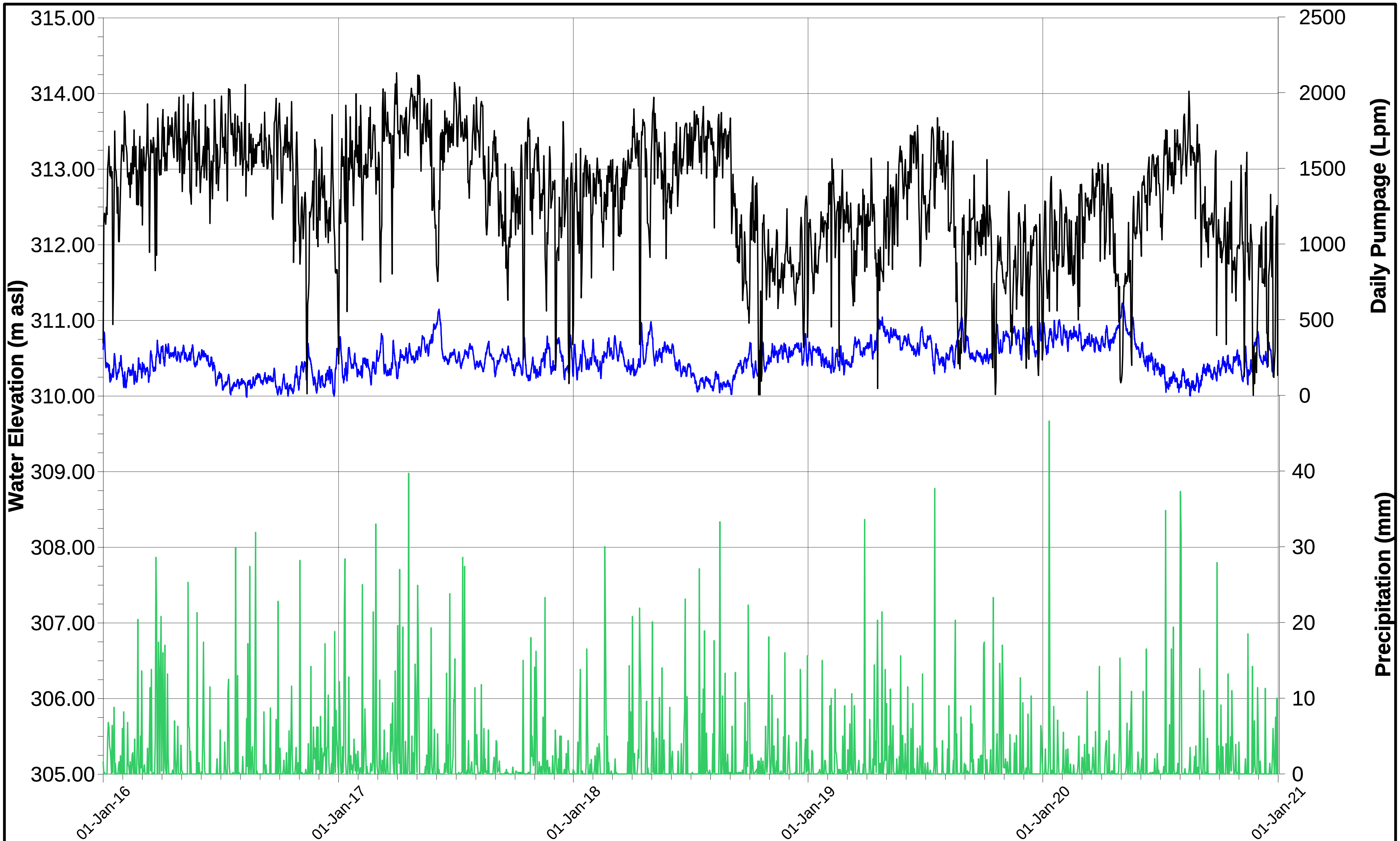
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D8



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

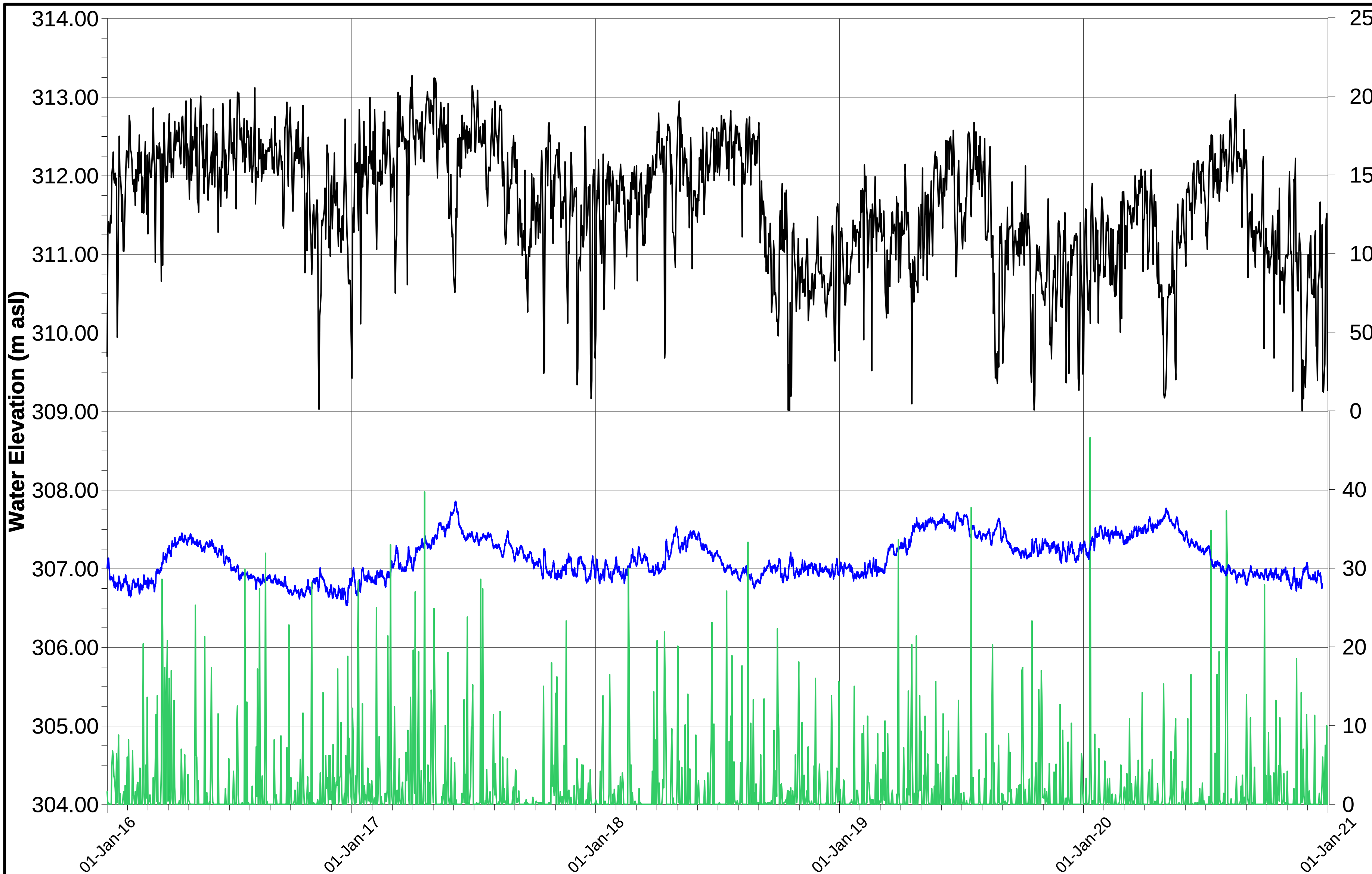
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D9



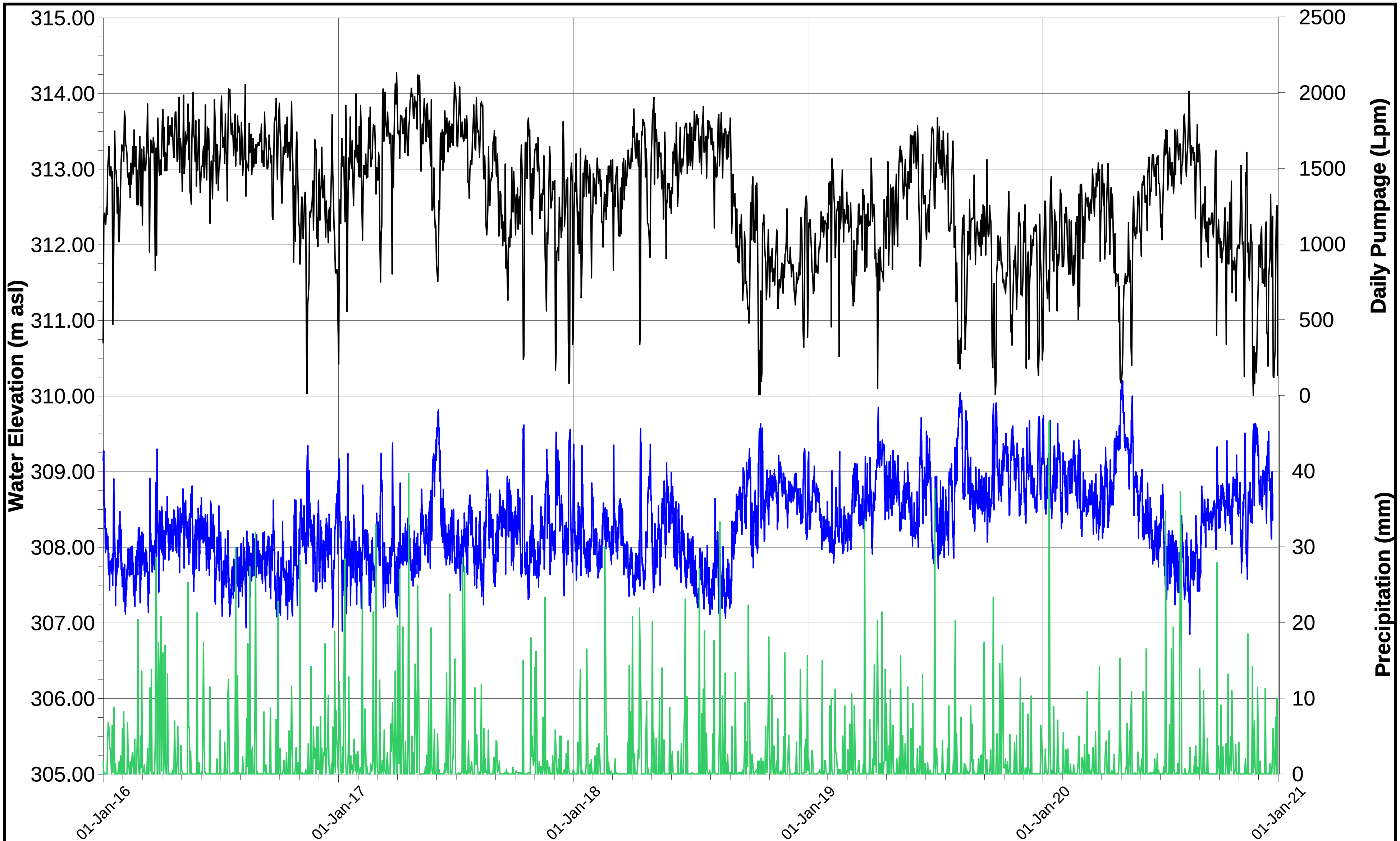
DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

GOLDER

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D10



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

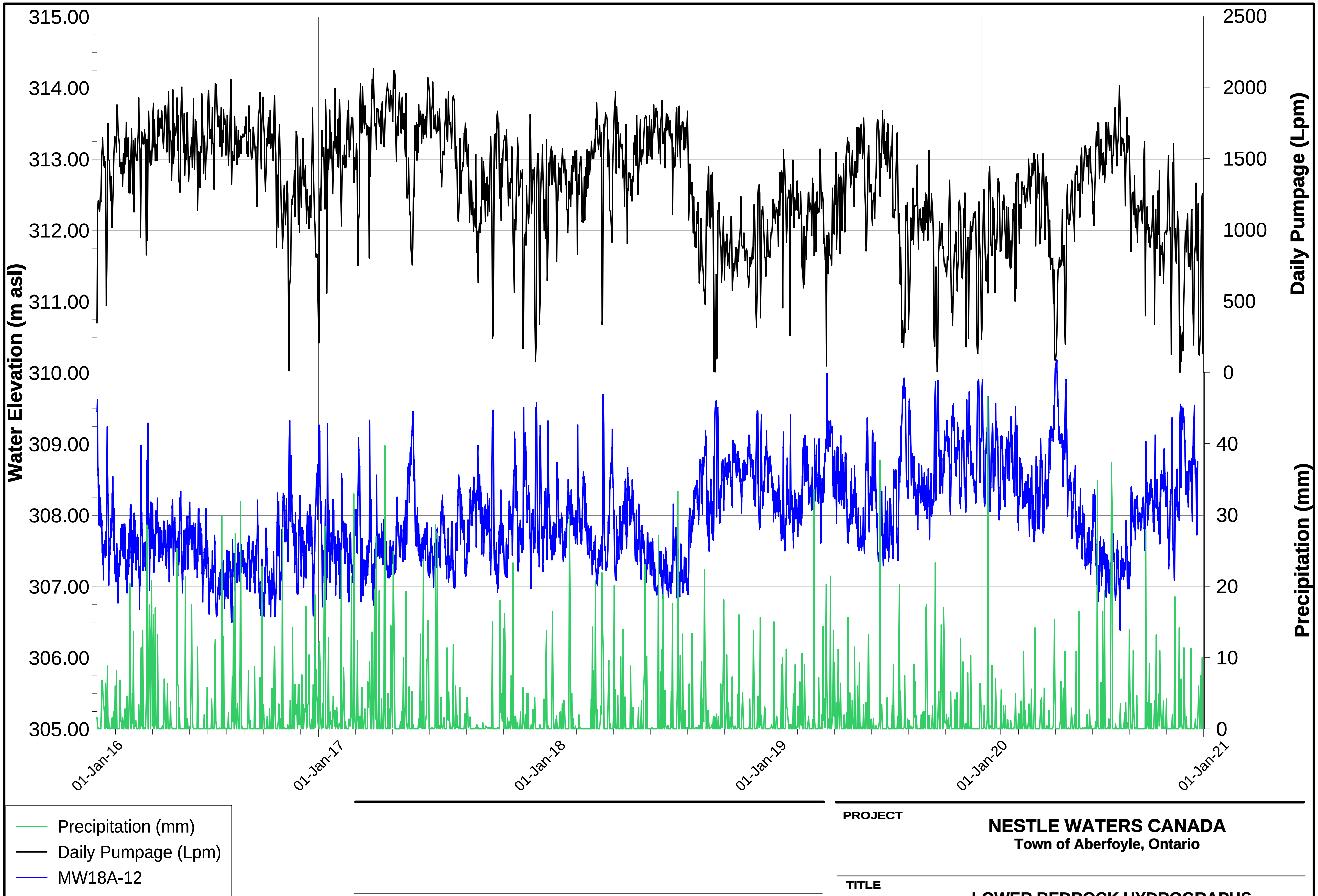
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D11



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

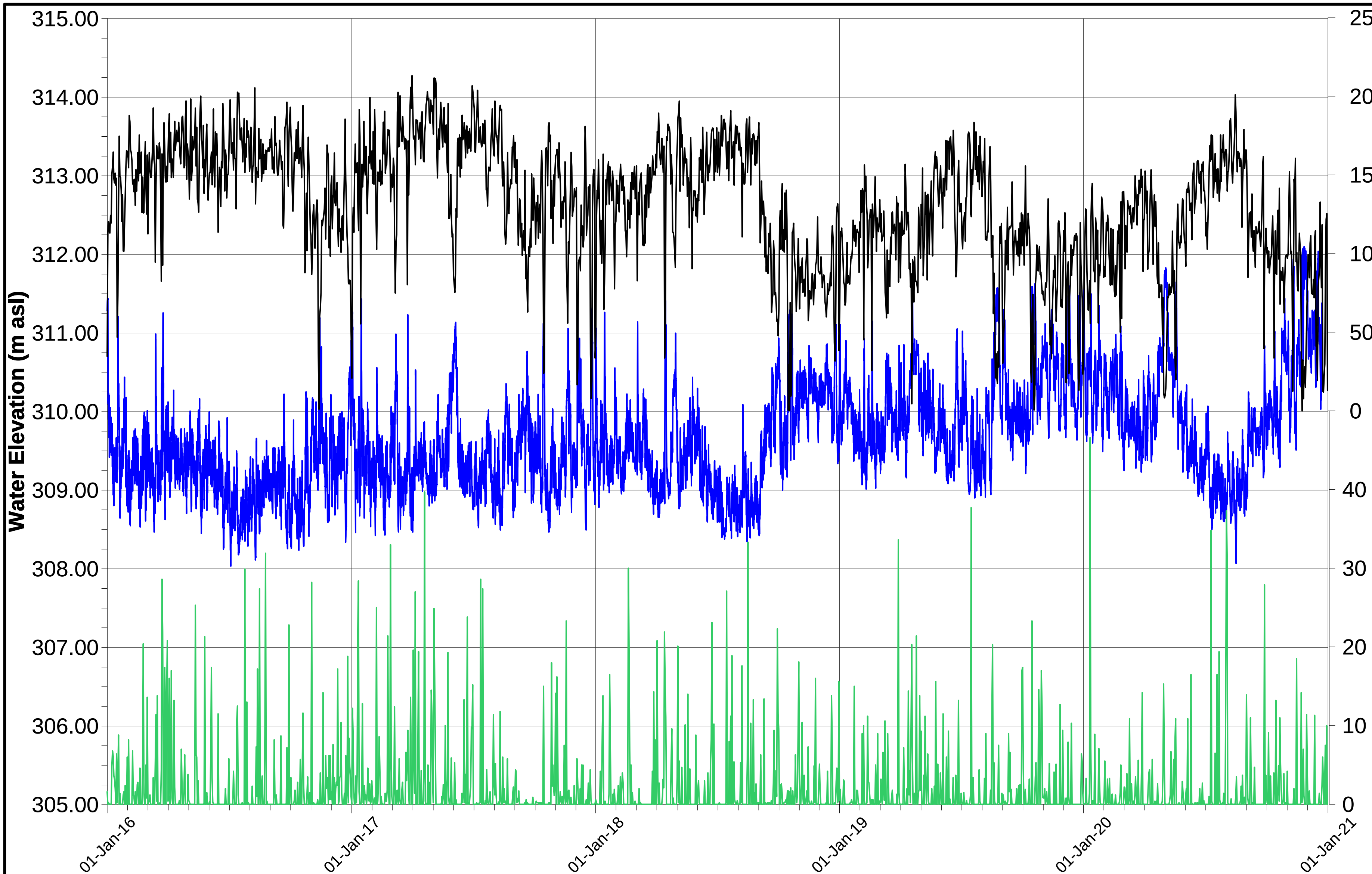
NESTLE WATERS CANADA

Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D12



Precipitation (mm)
Daily Pumpage (Lpm)
TW2-11

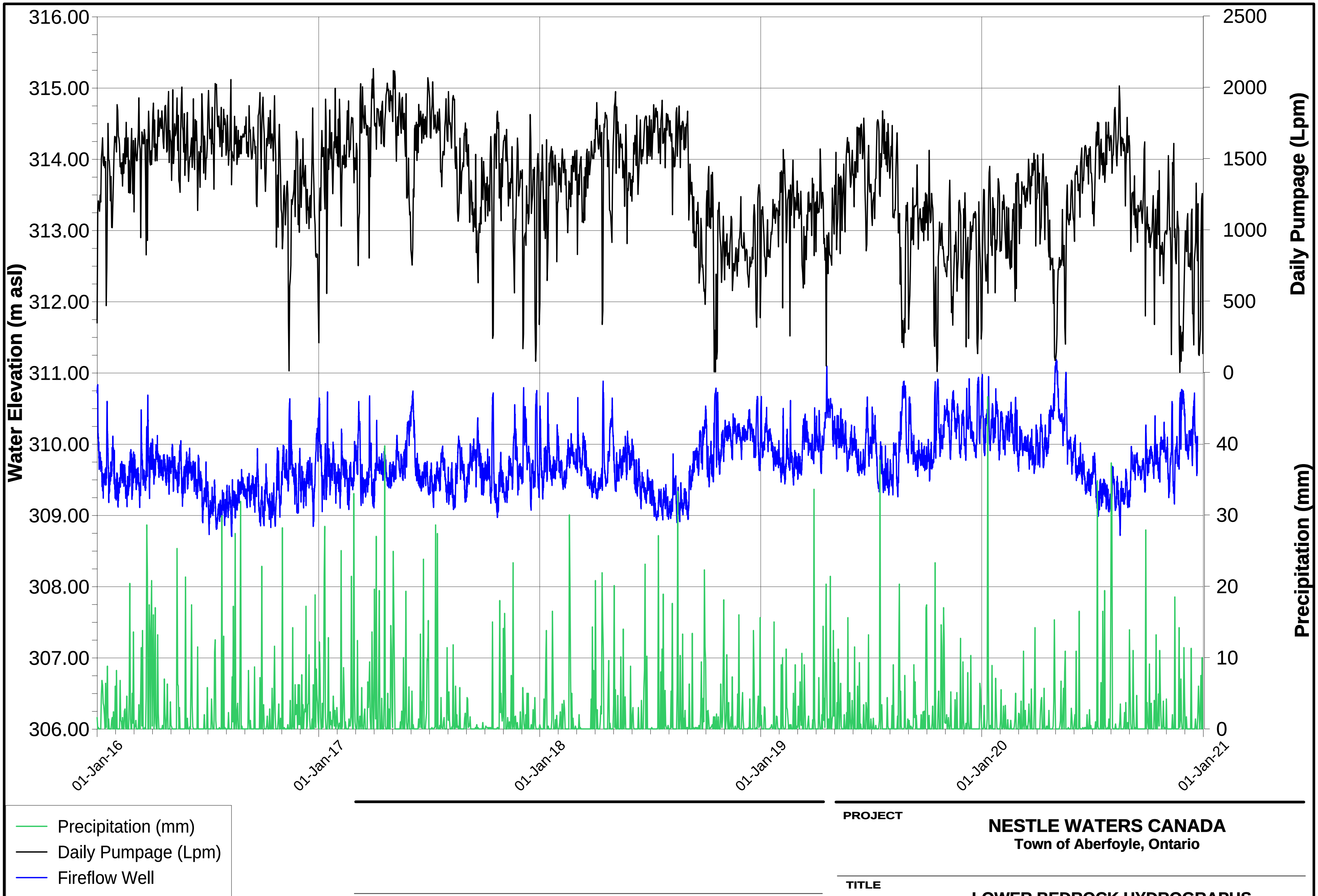
GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D13



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

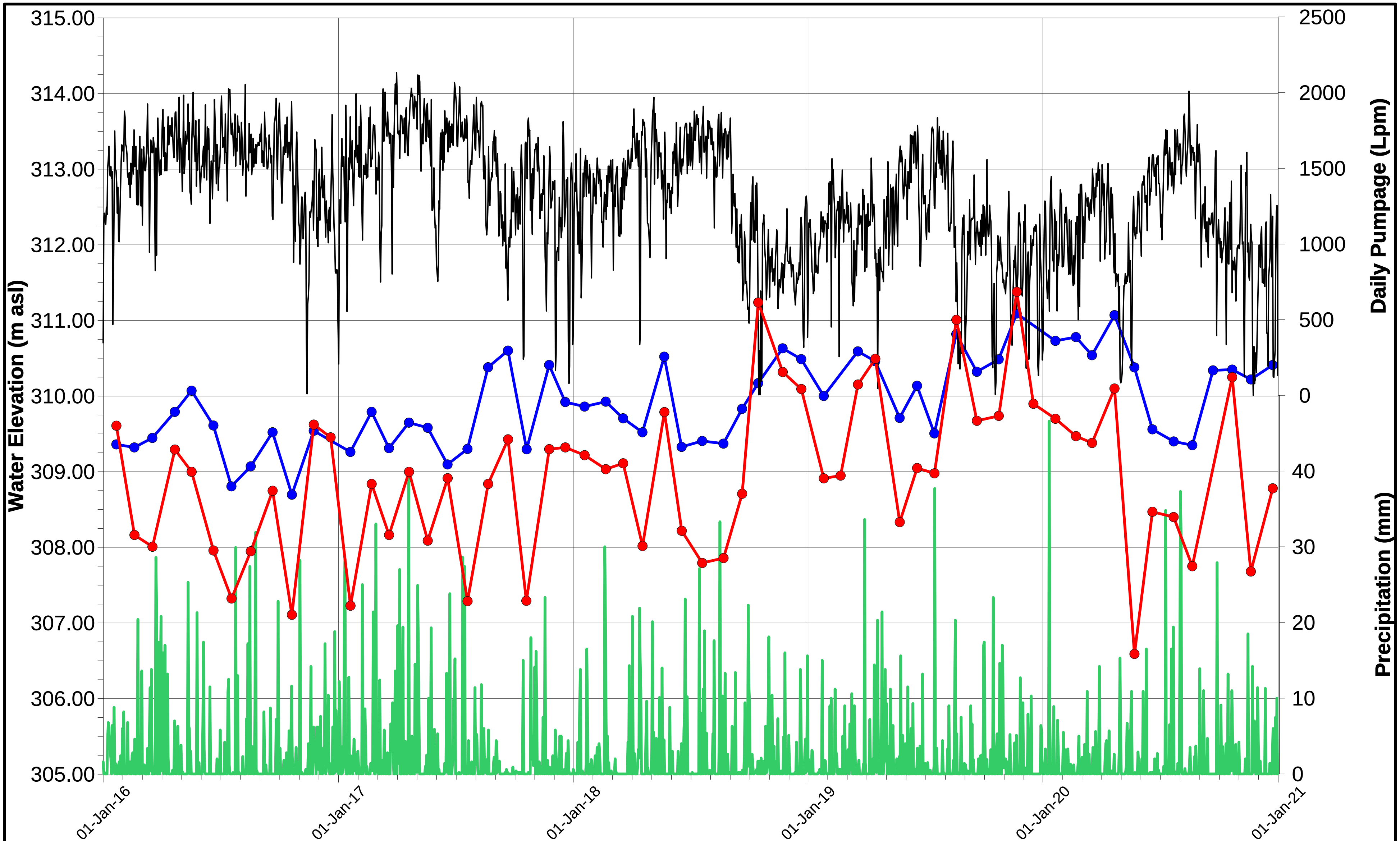
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D14



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

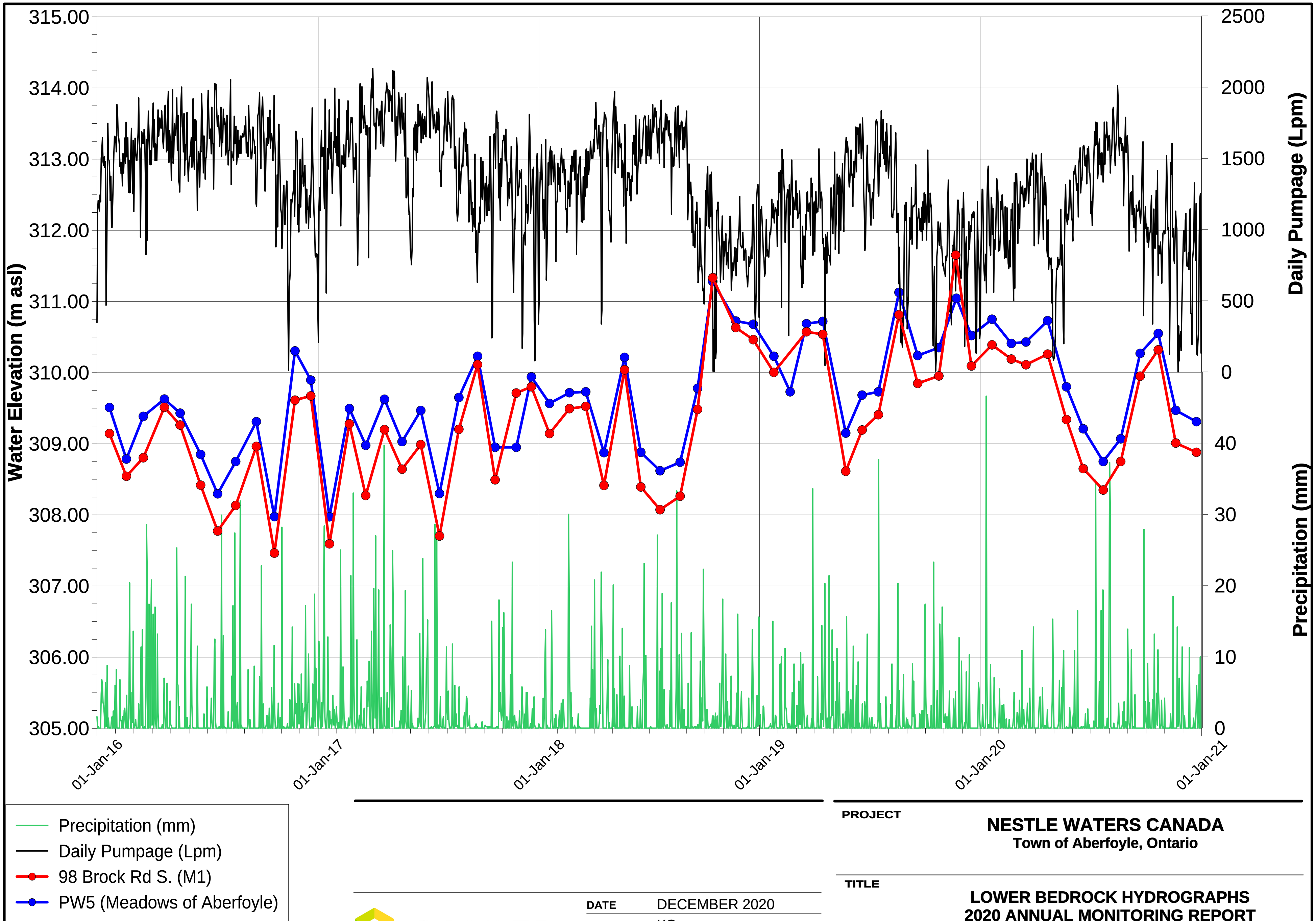
NESTLE WATERS CANADA

Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D15



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

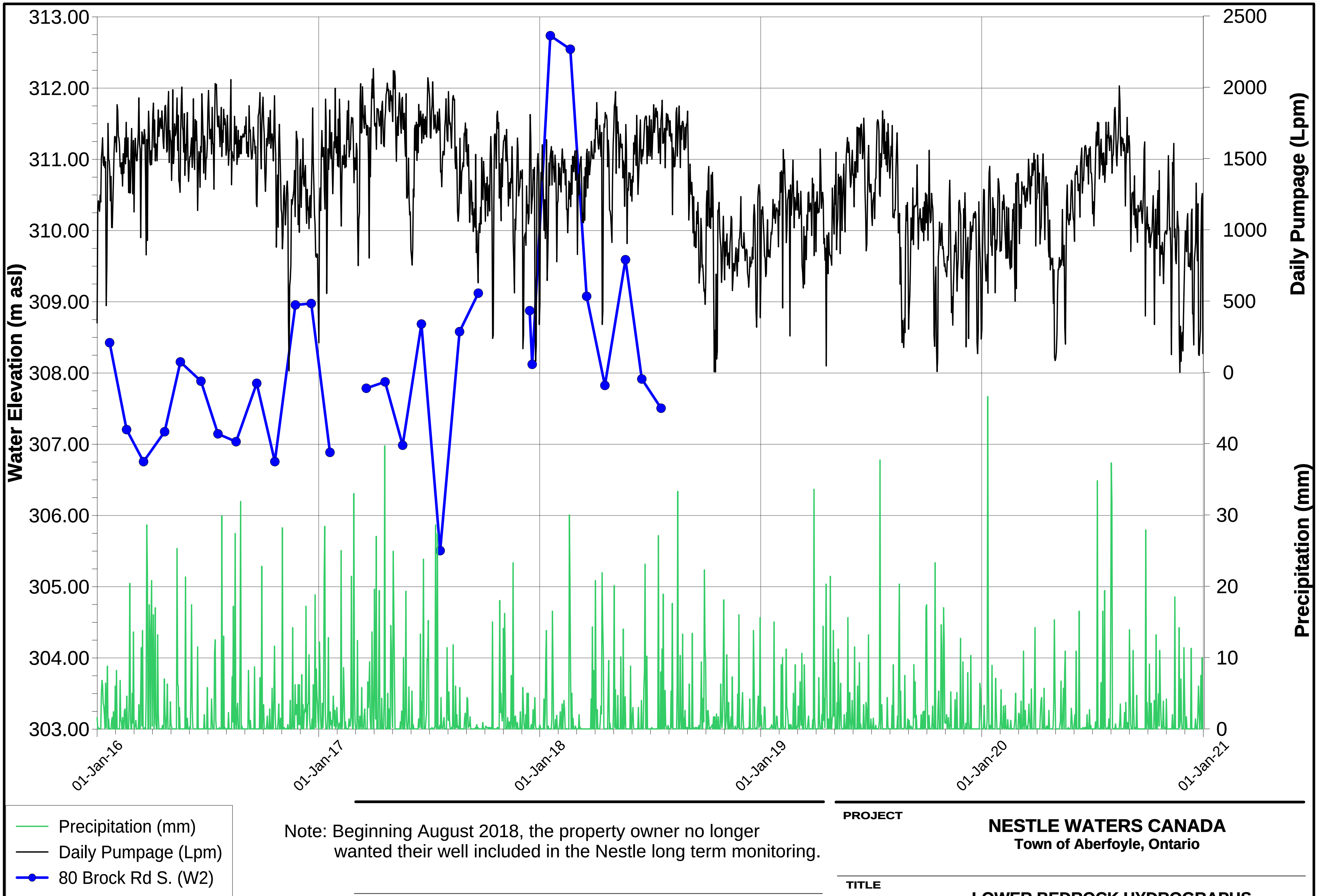
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D16



Note: Beginning August 2018, the property owner no longer wanted their well included in the Nestle long term monitoring.

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

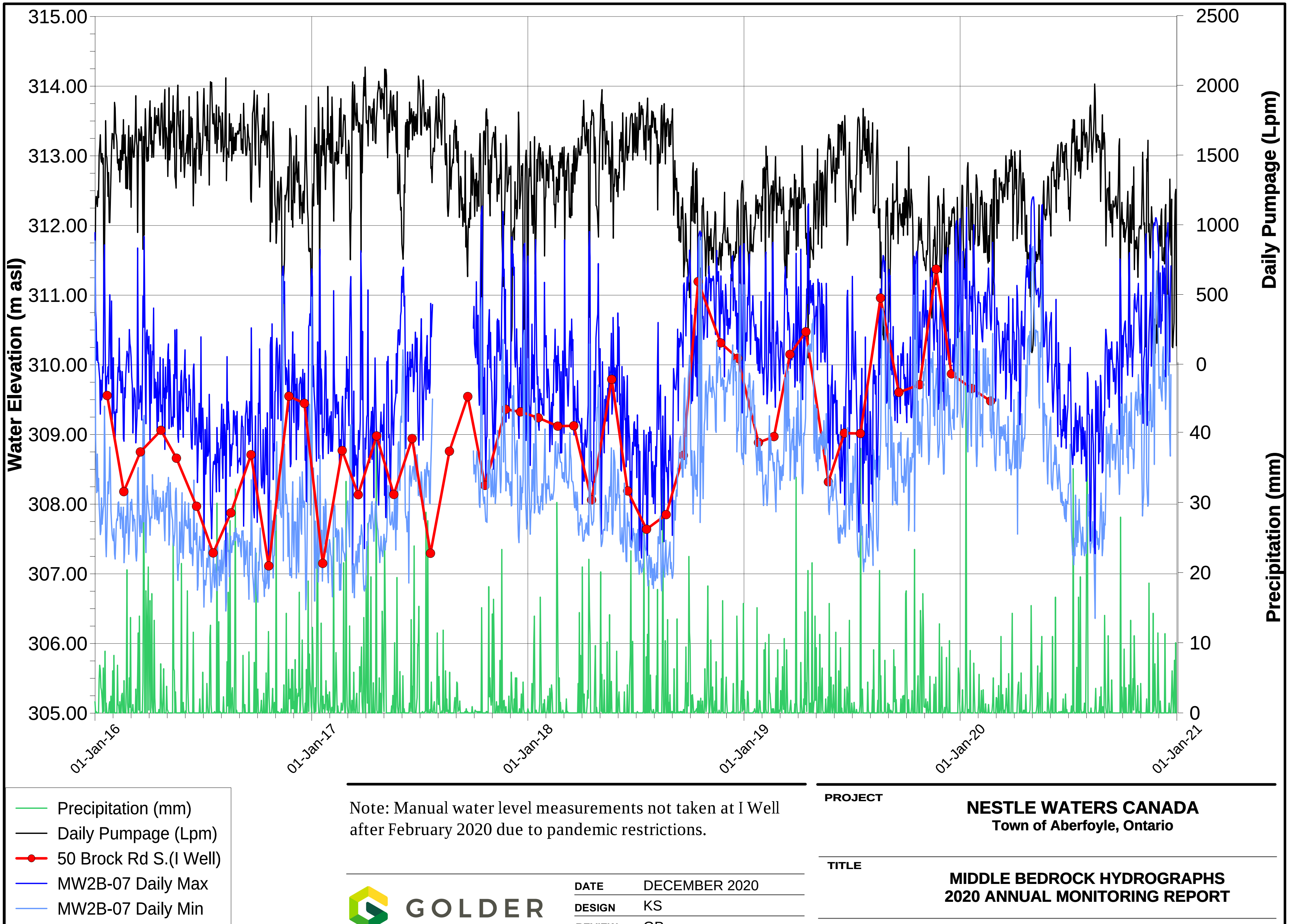
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

LOWER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D17



Note: Manual water level measurements not taken at I Well after February 2020 due to pandemic restrictions.

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

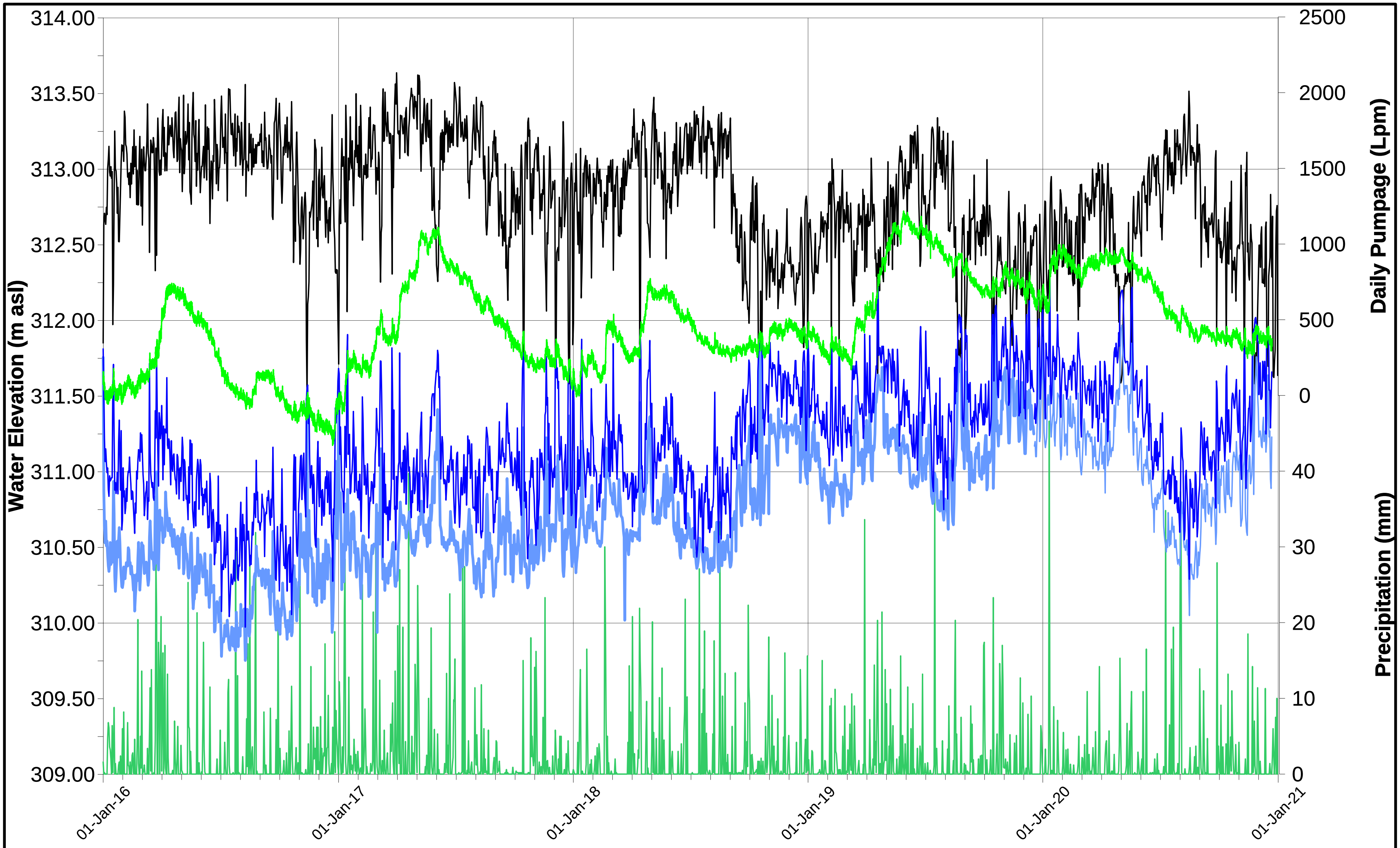
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MIDDLE BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D18



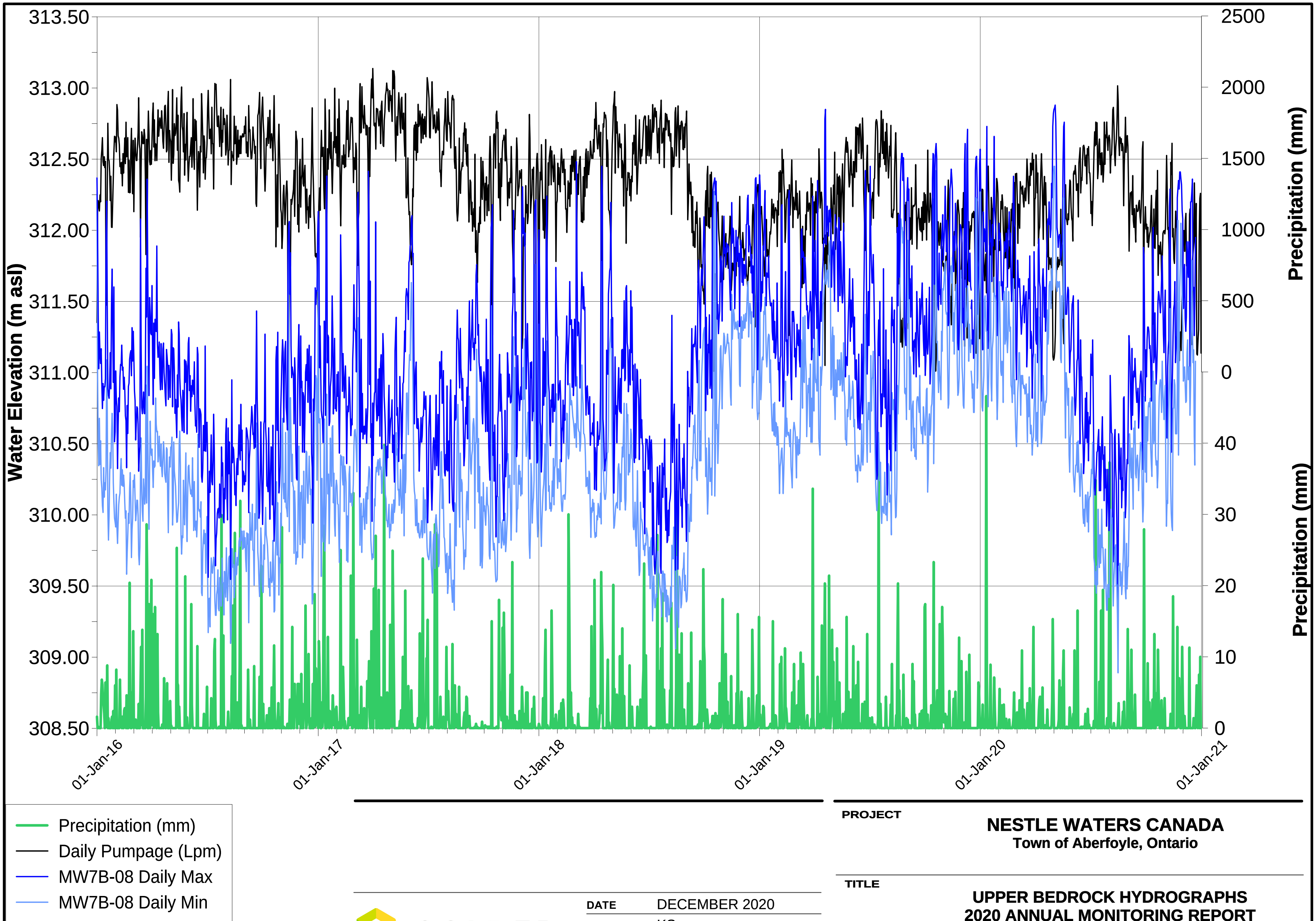
GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D19



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

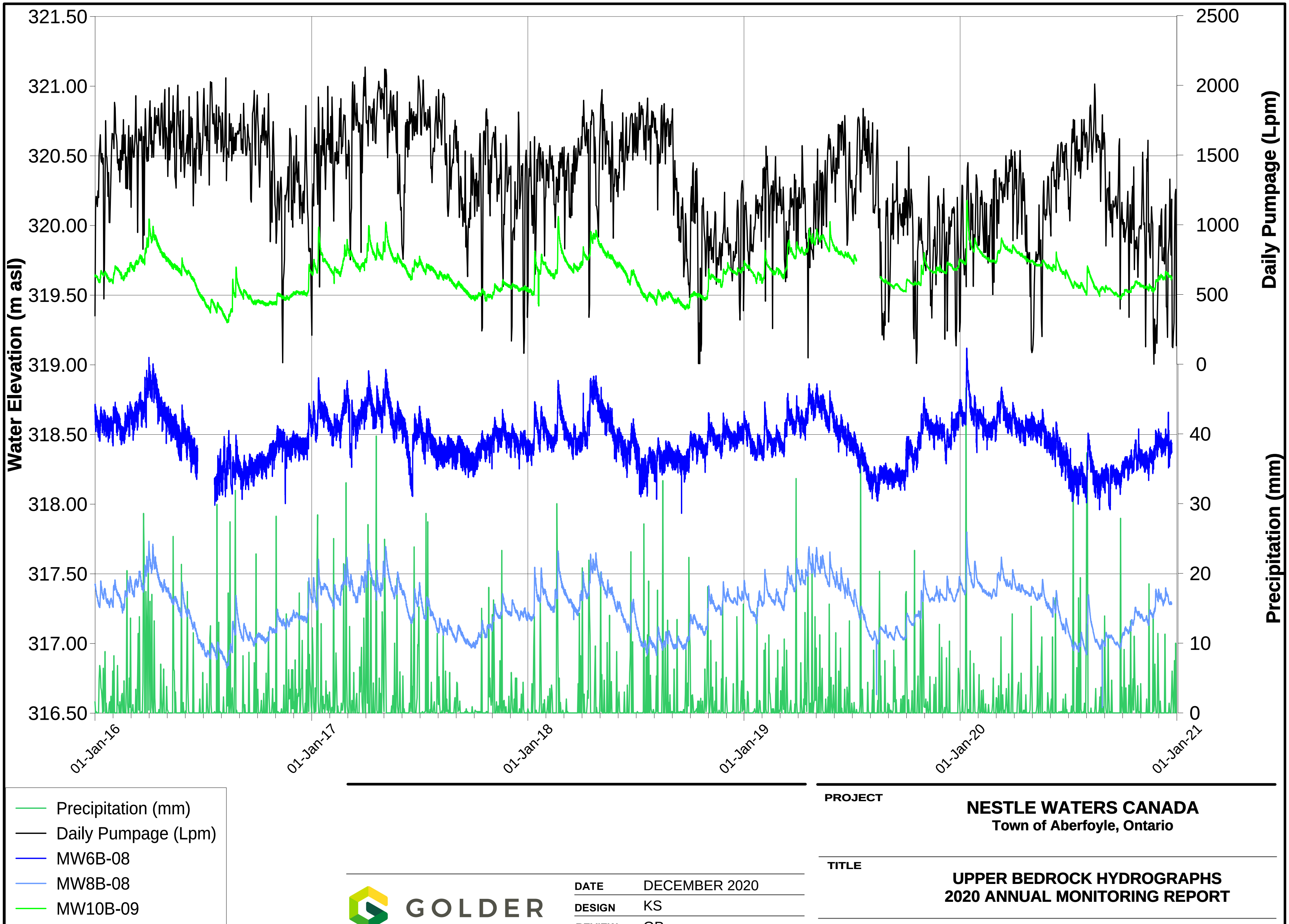
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D20



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

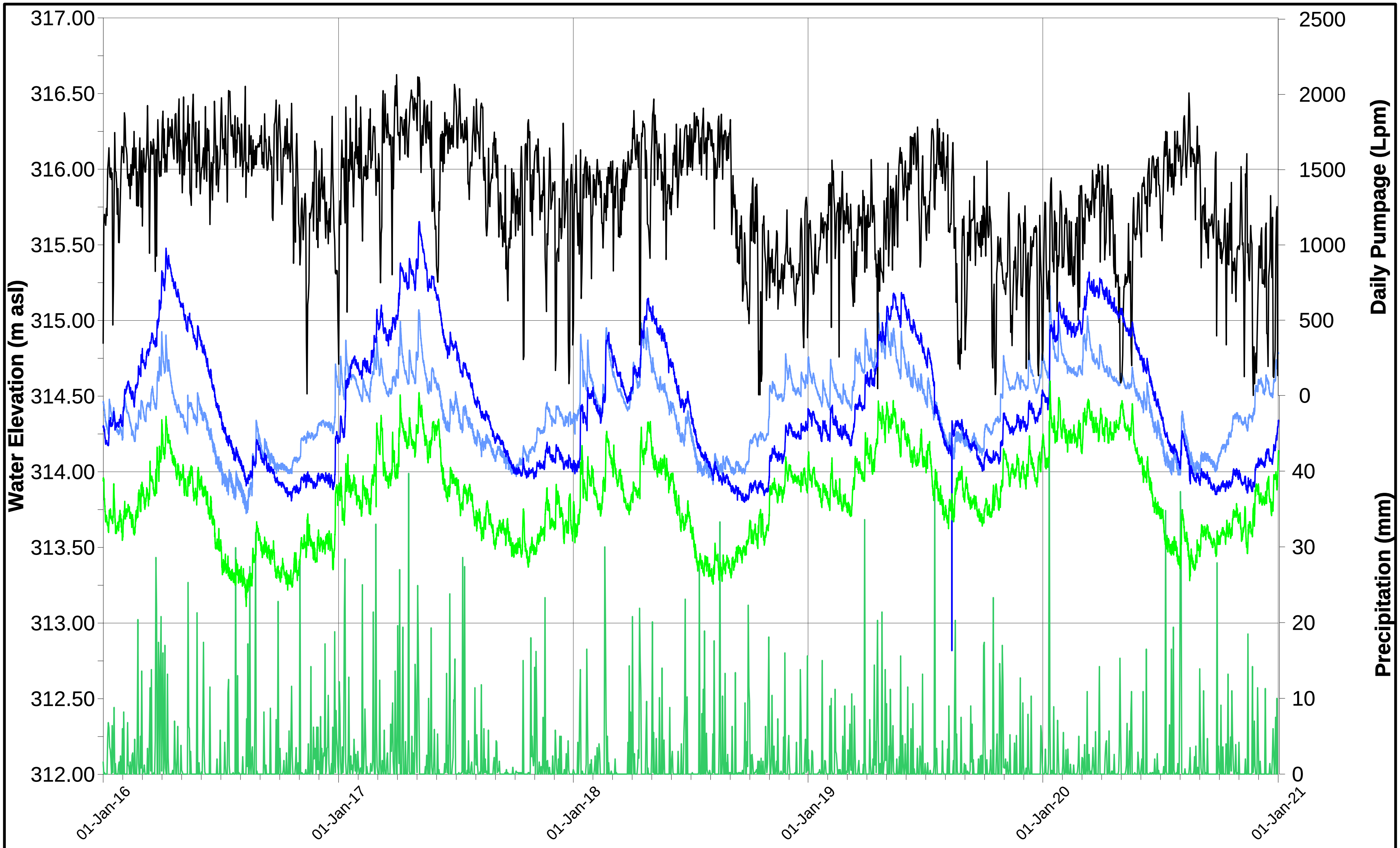
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D21



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

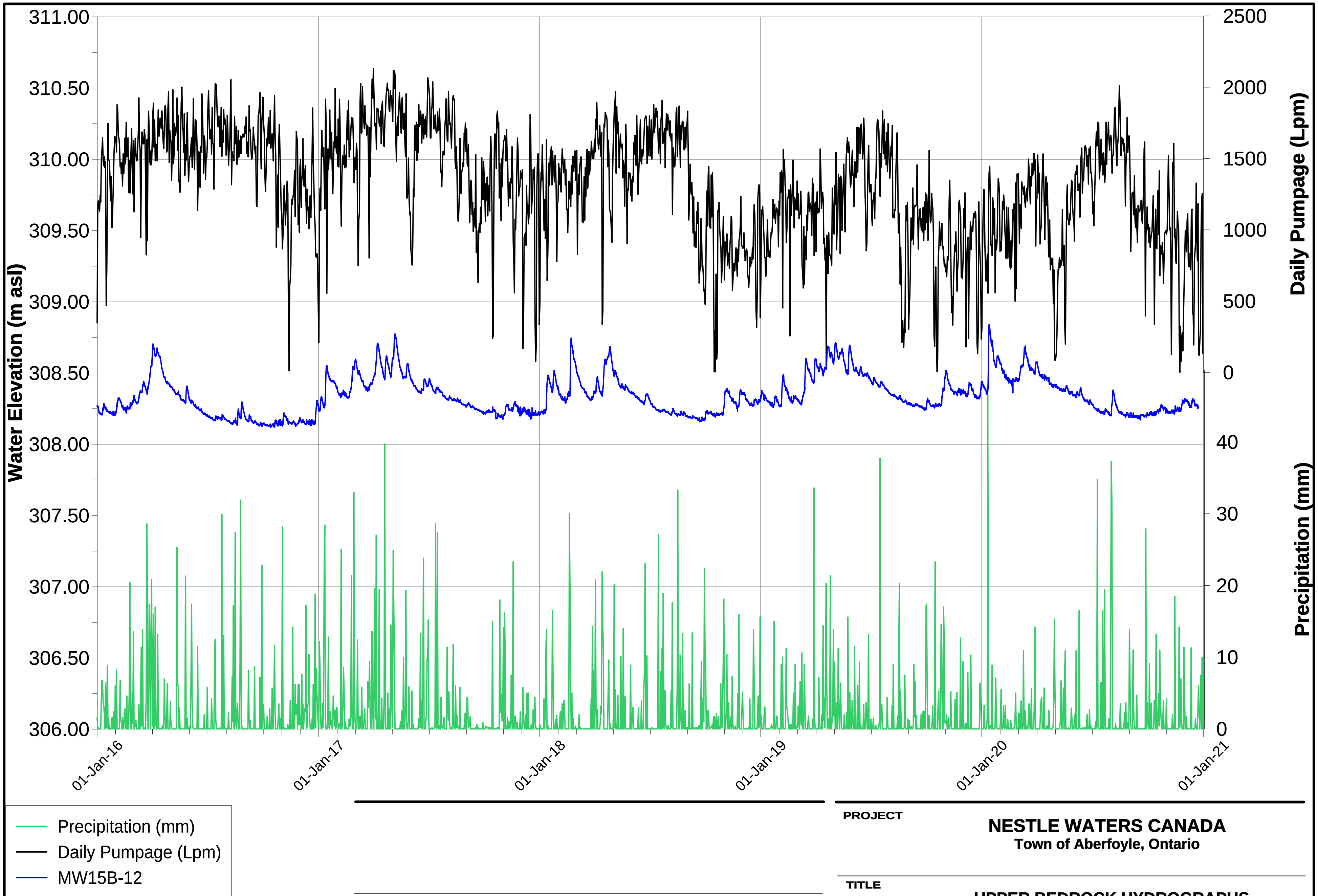
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D22



PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

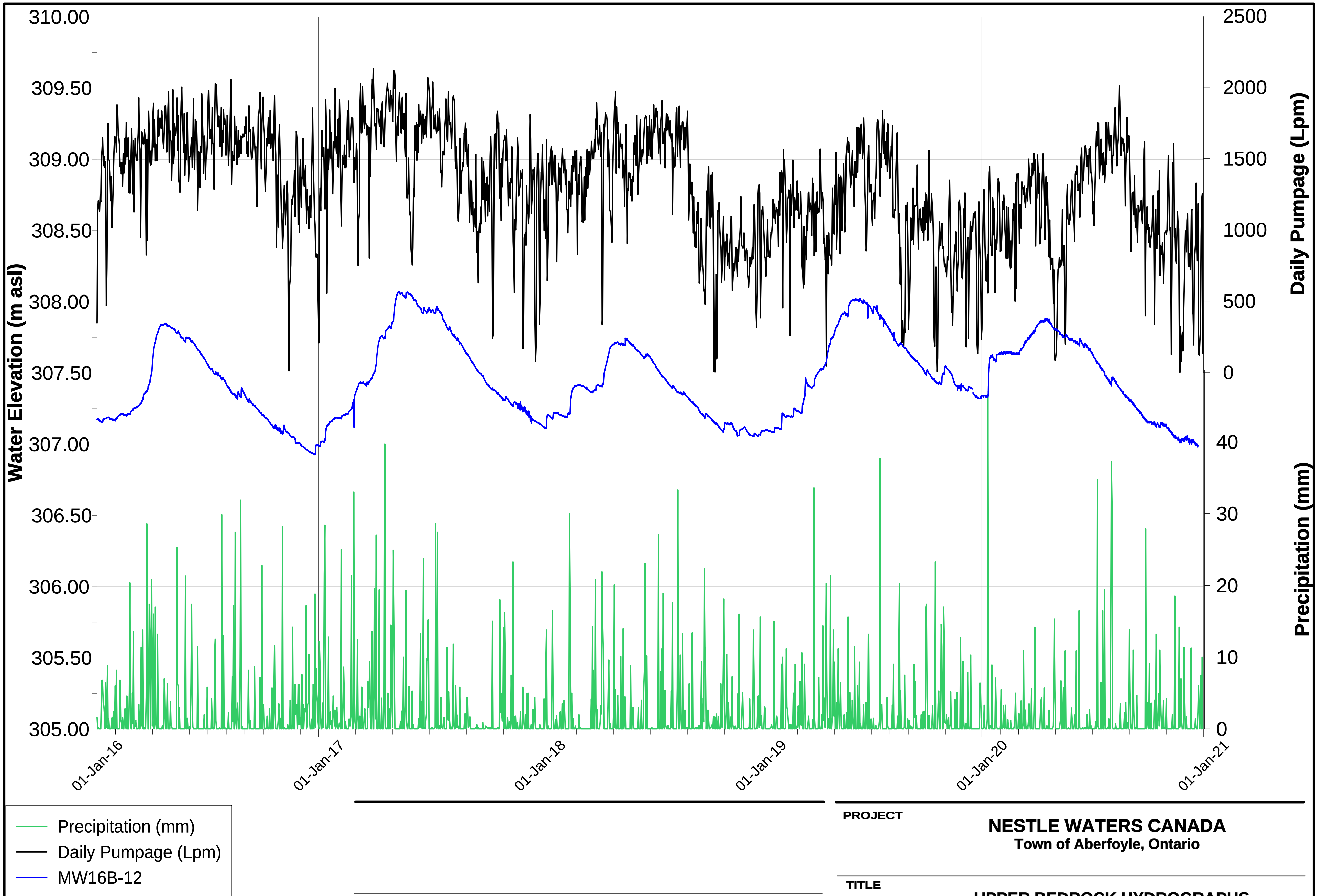
TITLE

UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D23



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

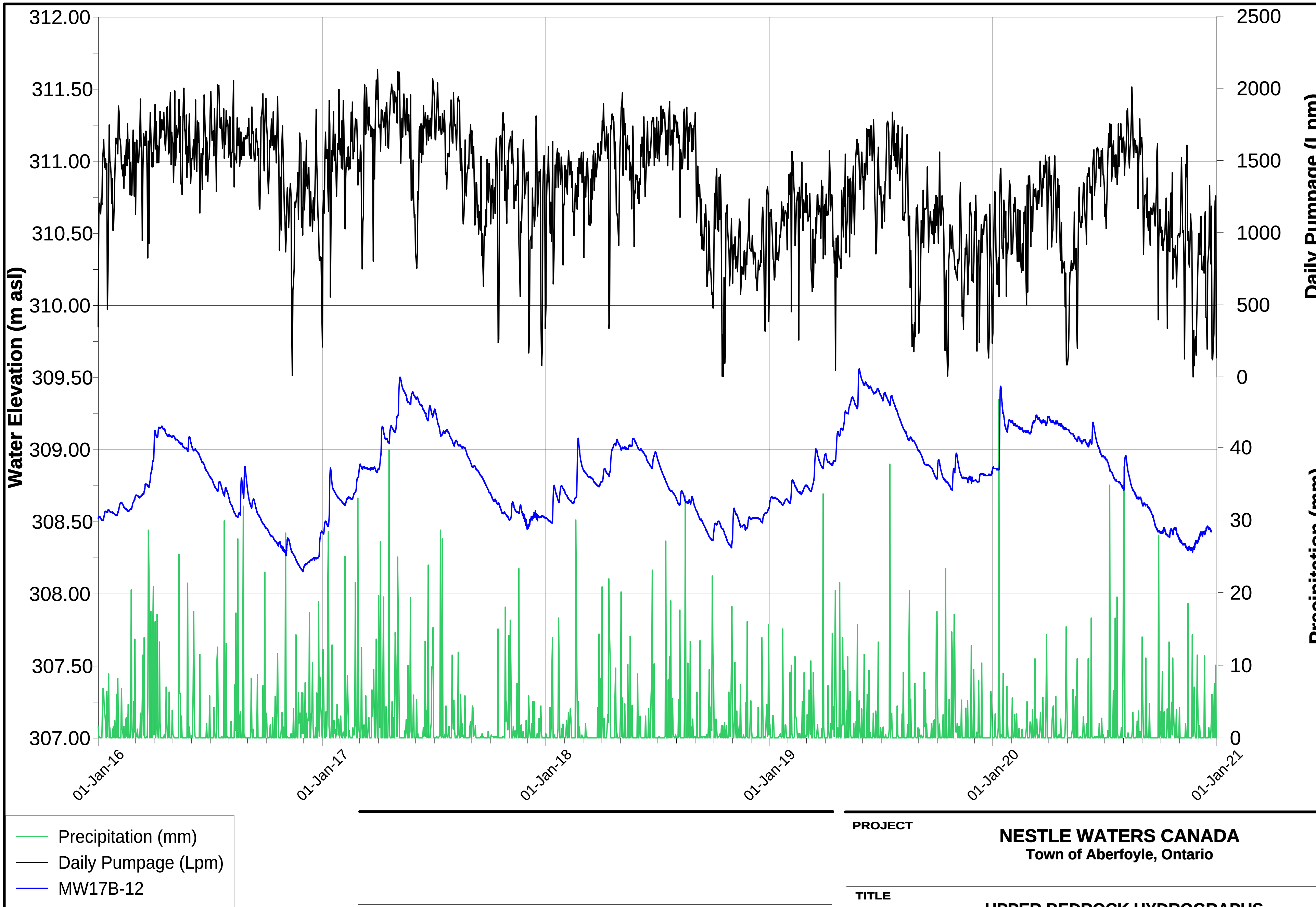
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D24



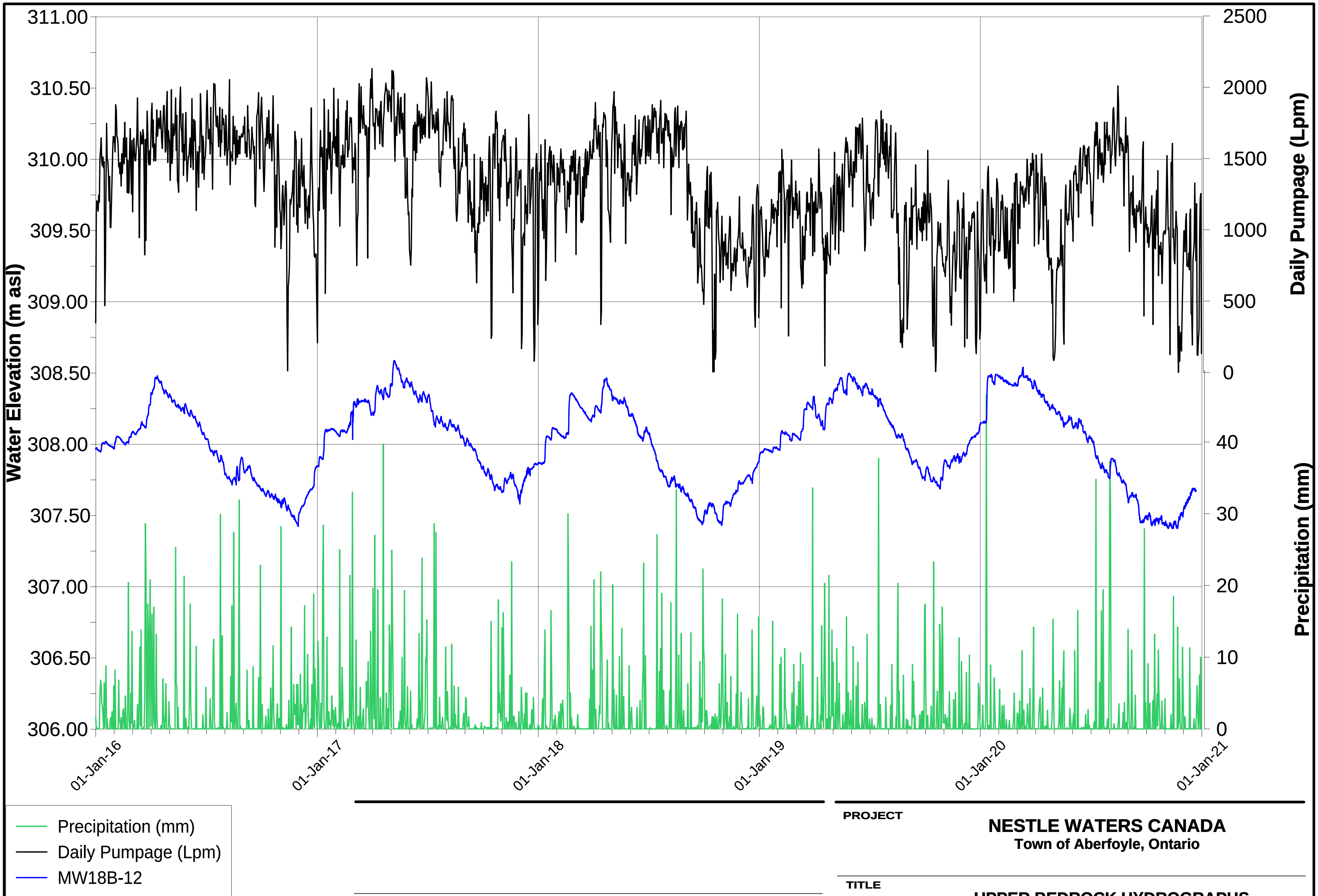
GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D25



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

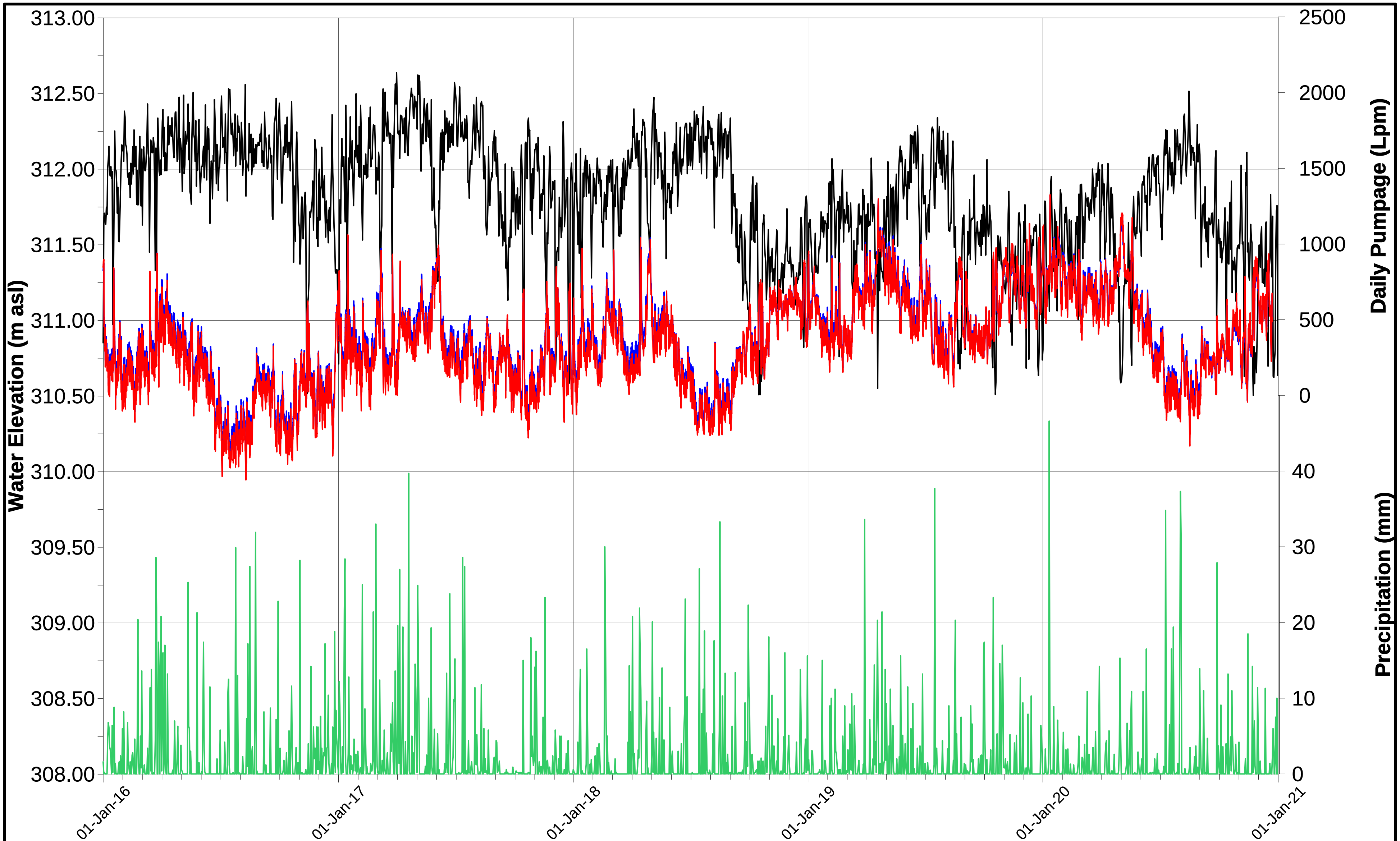
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D26



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA

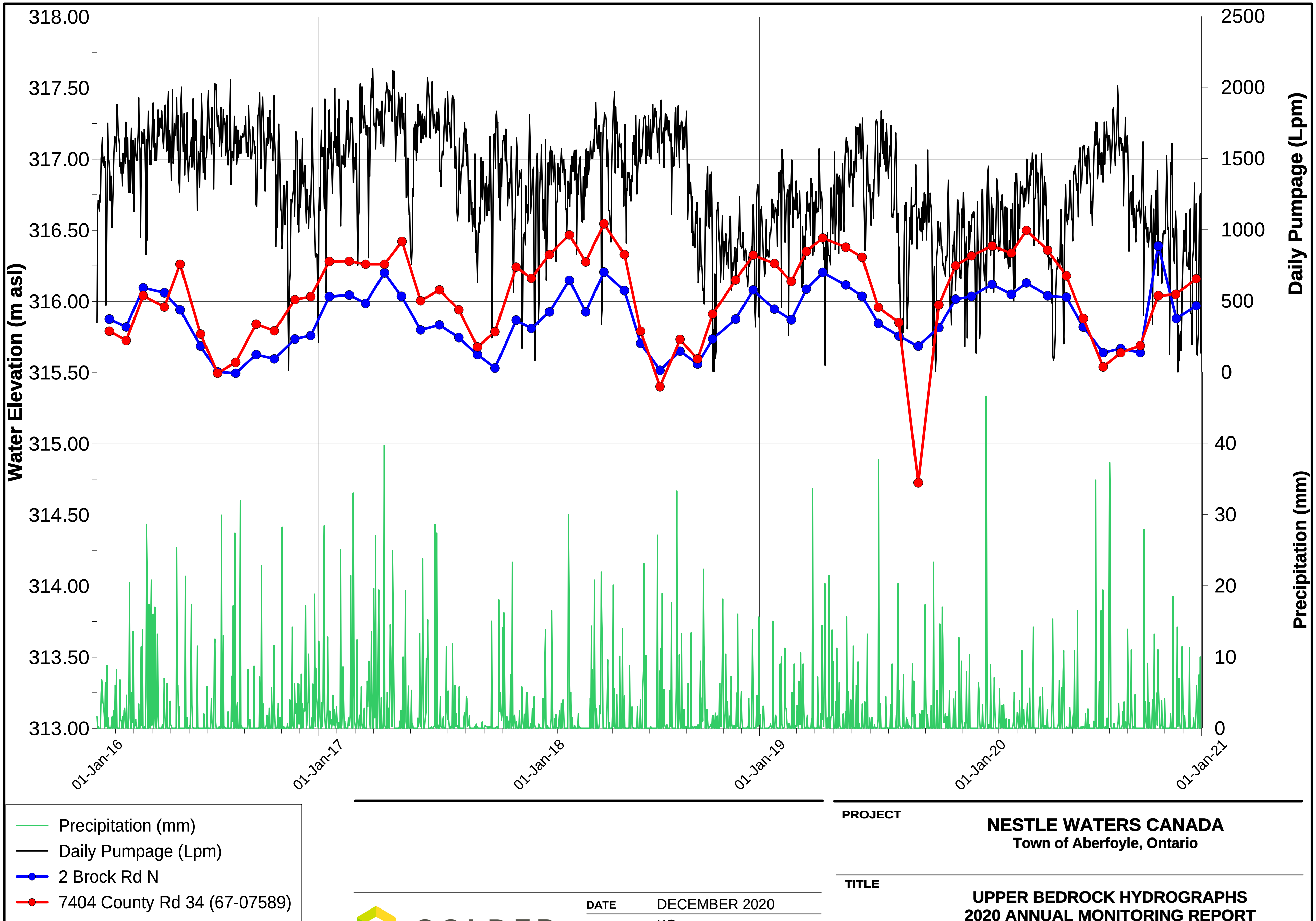
Town of Aberfoyle, Ontario

TITLE

UPPER BEDROCK HYDROGRAPHS

2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D27



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

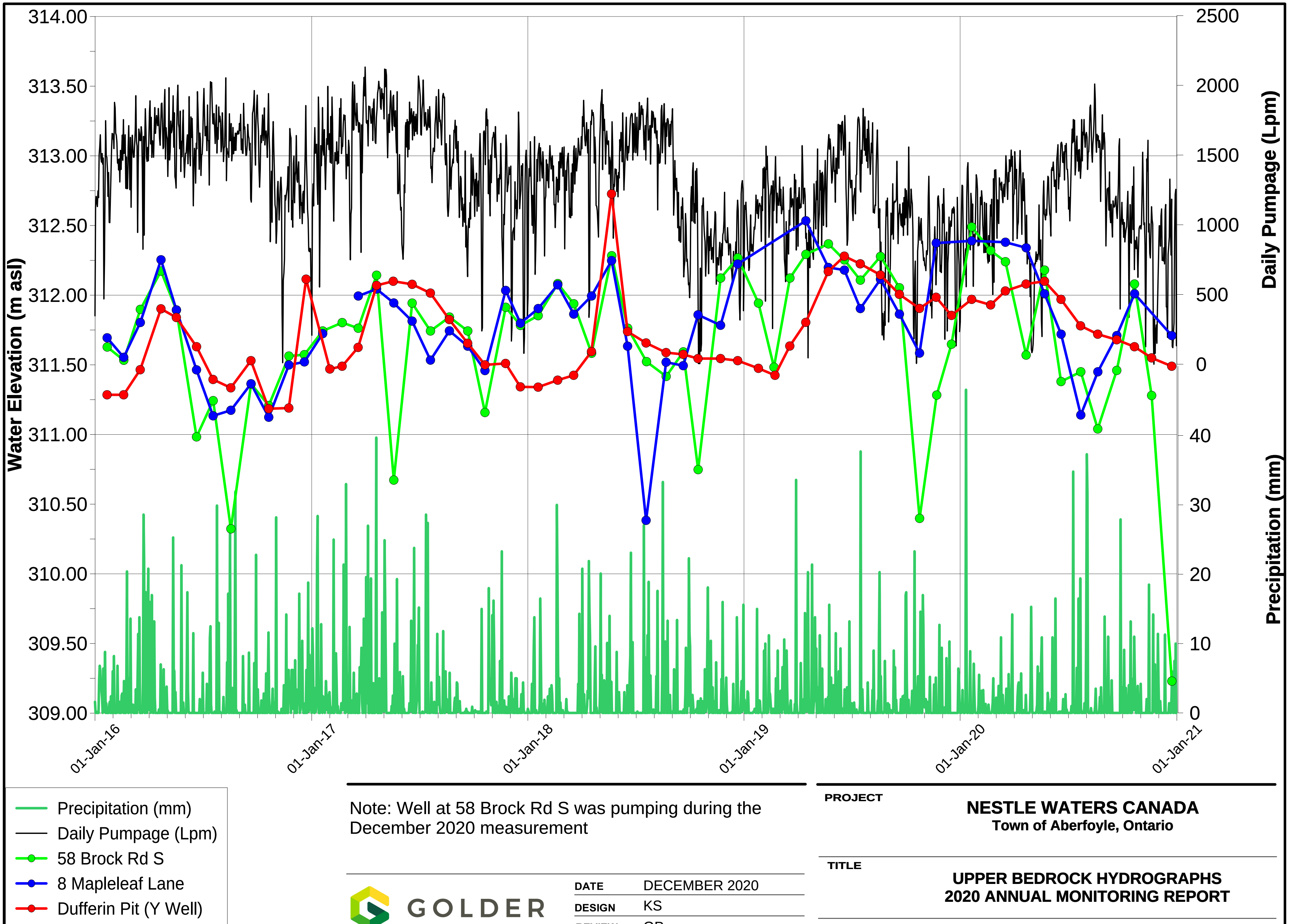
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D28



Note: Well at 58 Brock Rd S was pumping during the December 2020 measurement

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

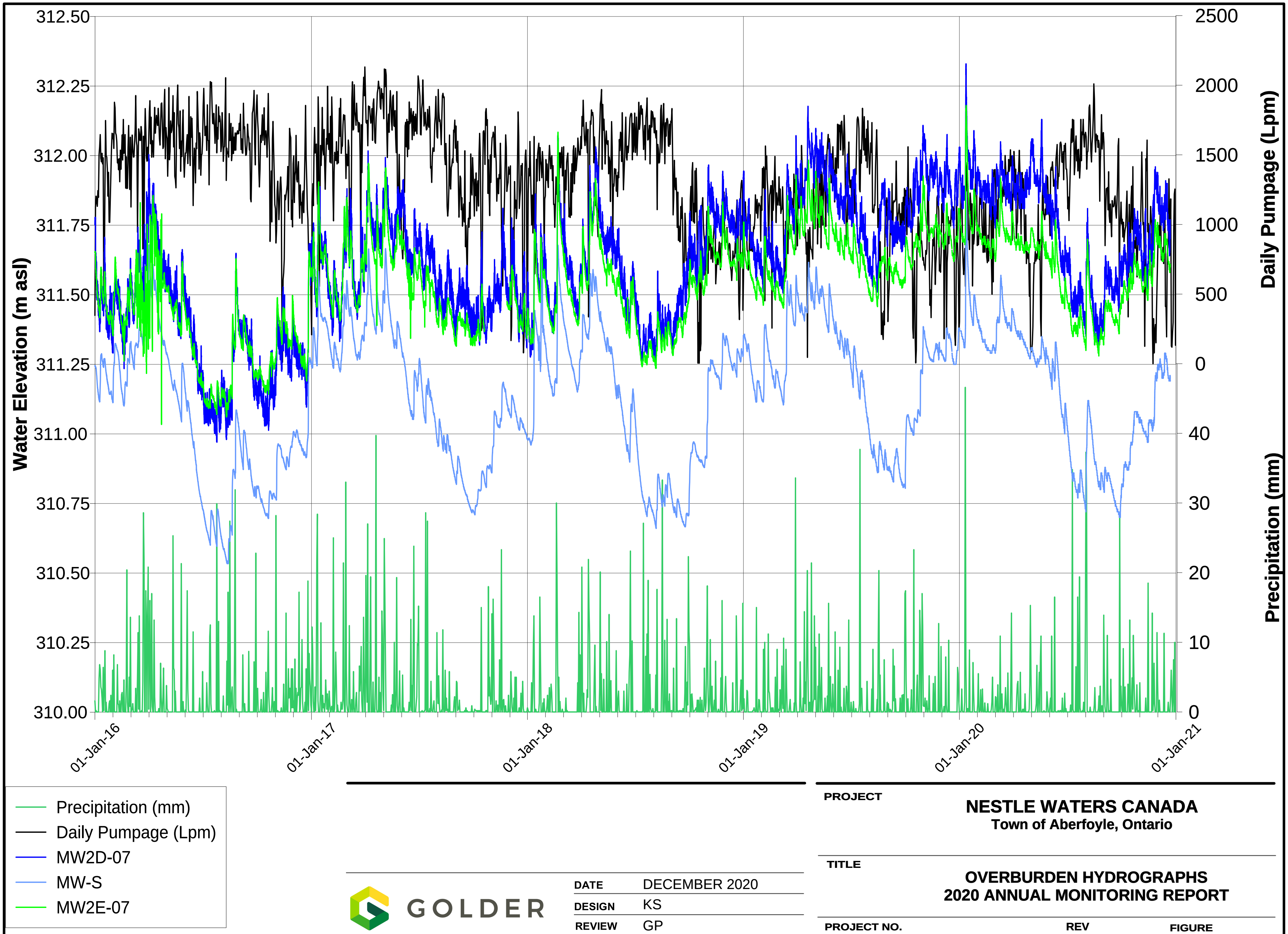
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

UPPER BEDROCK HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D29



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

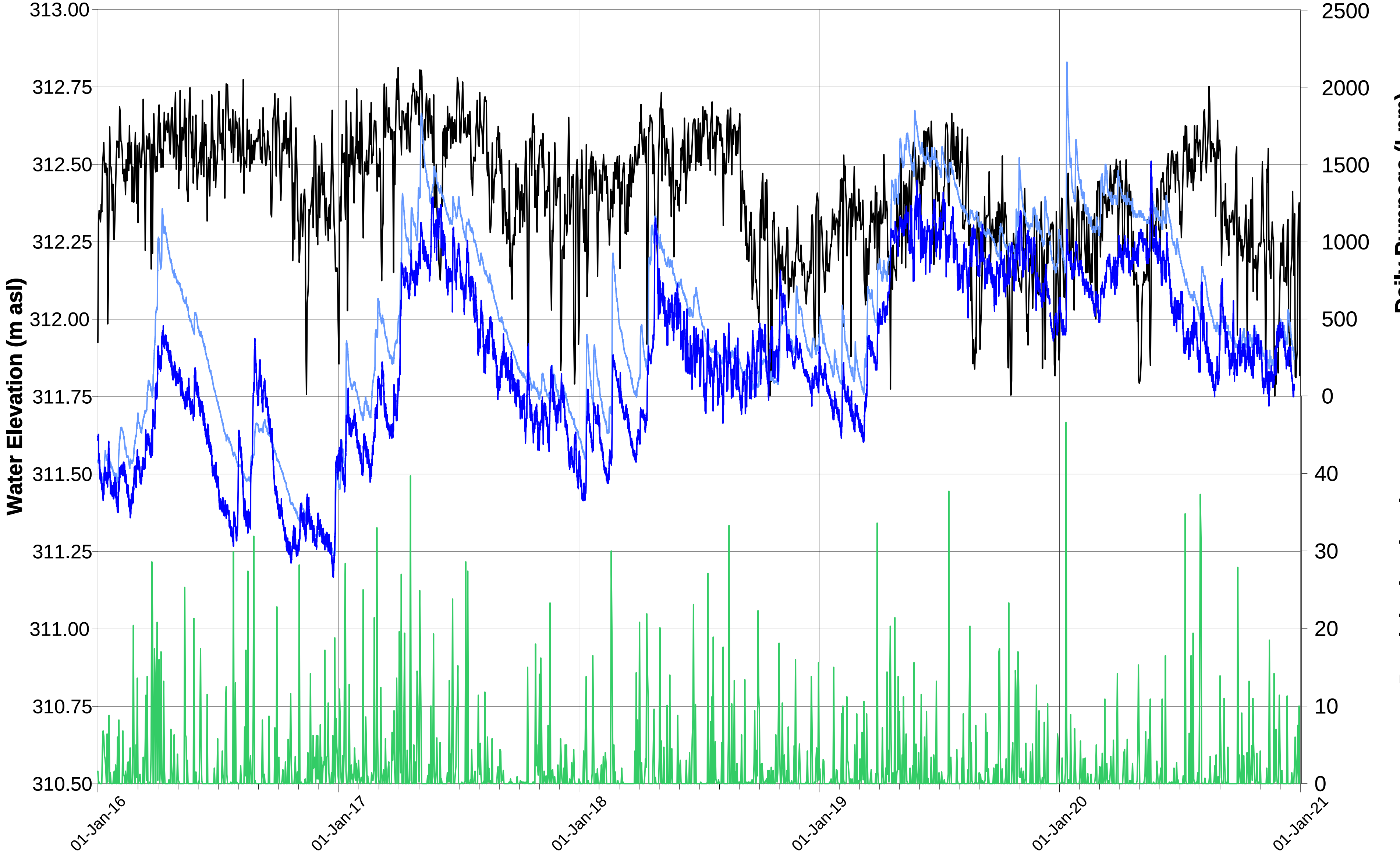
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

OVERBURDEN HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D30



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

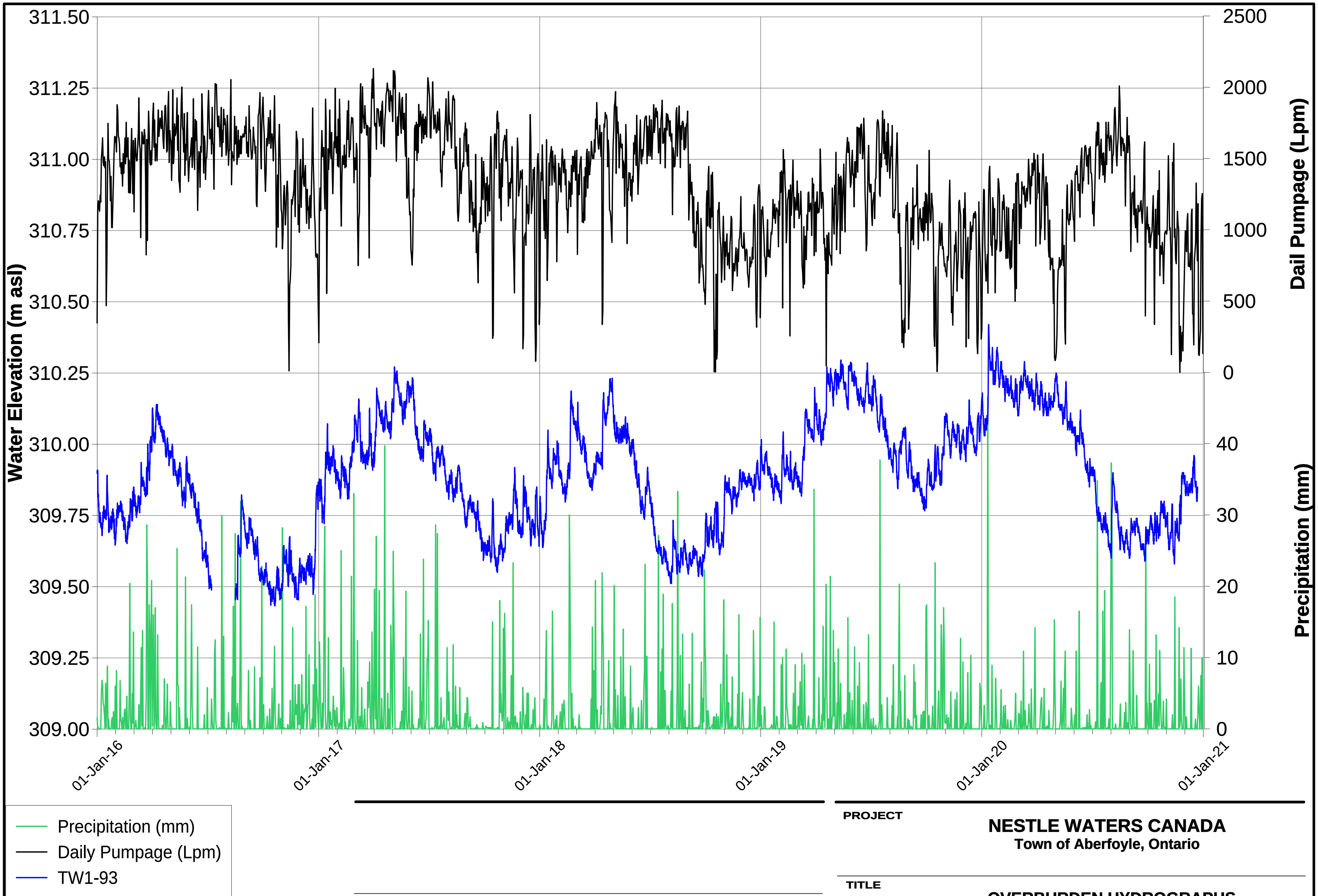
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

OVERBURDEN HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D31



DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

GOLDER

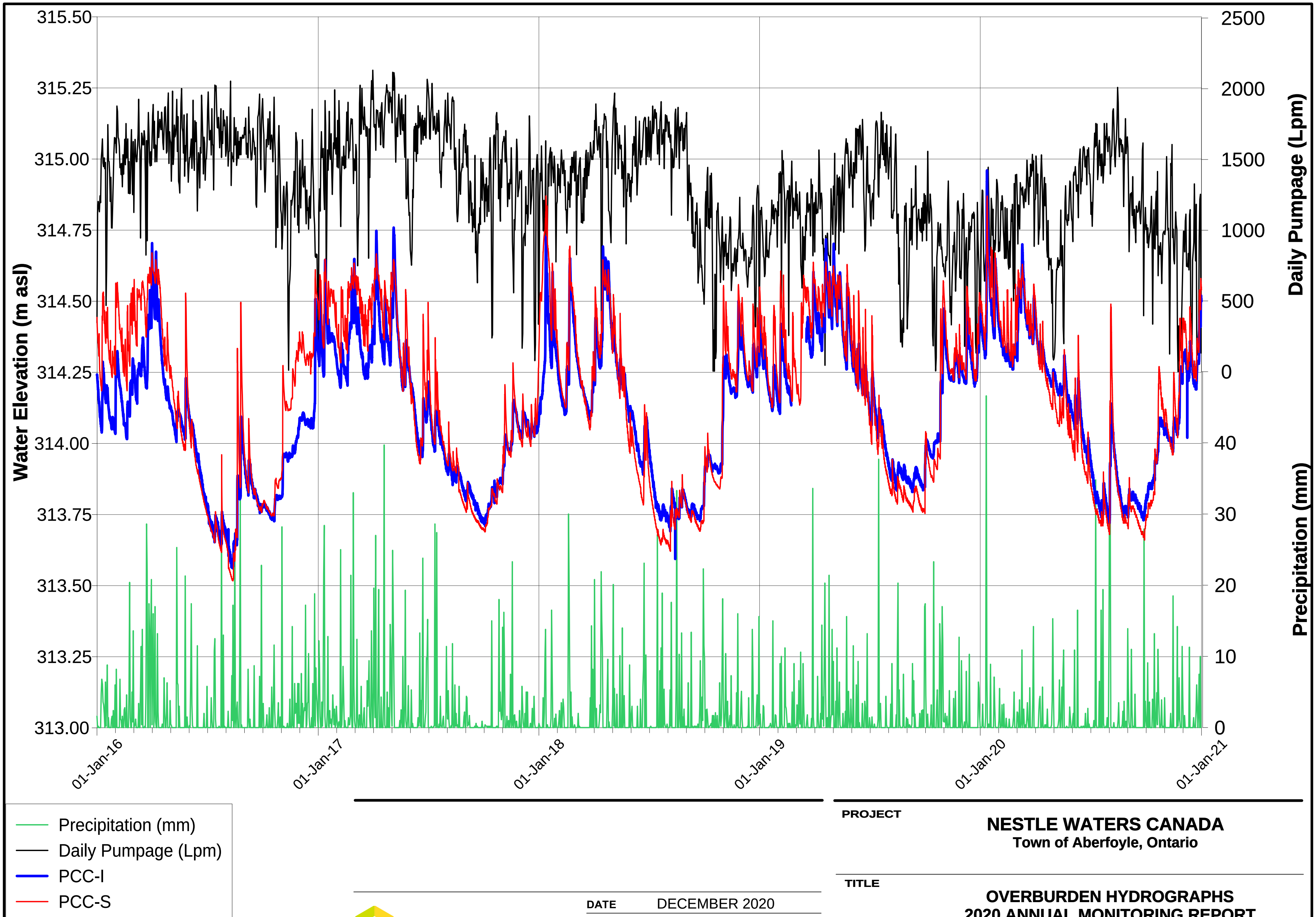
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

OVERBURDEN HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D32



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

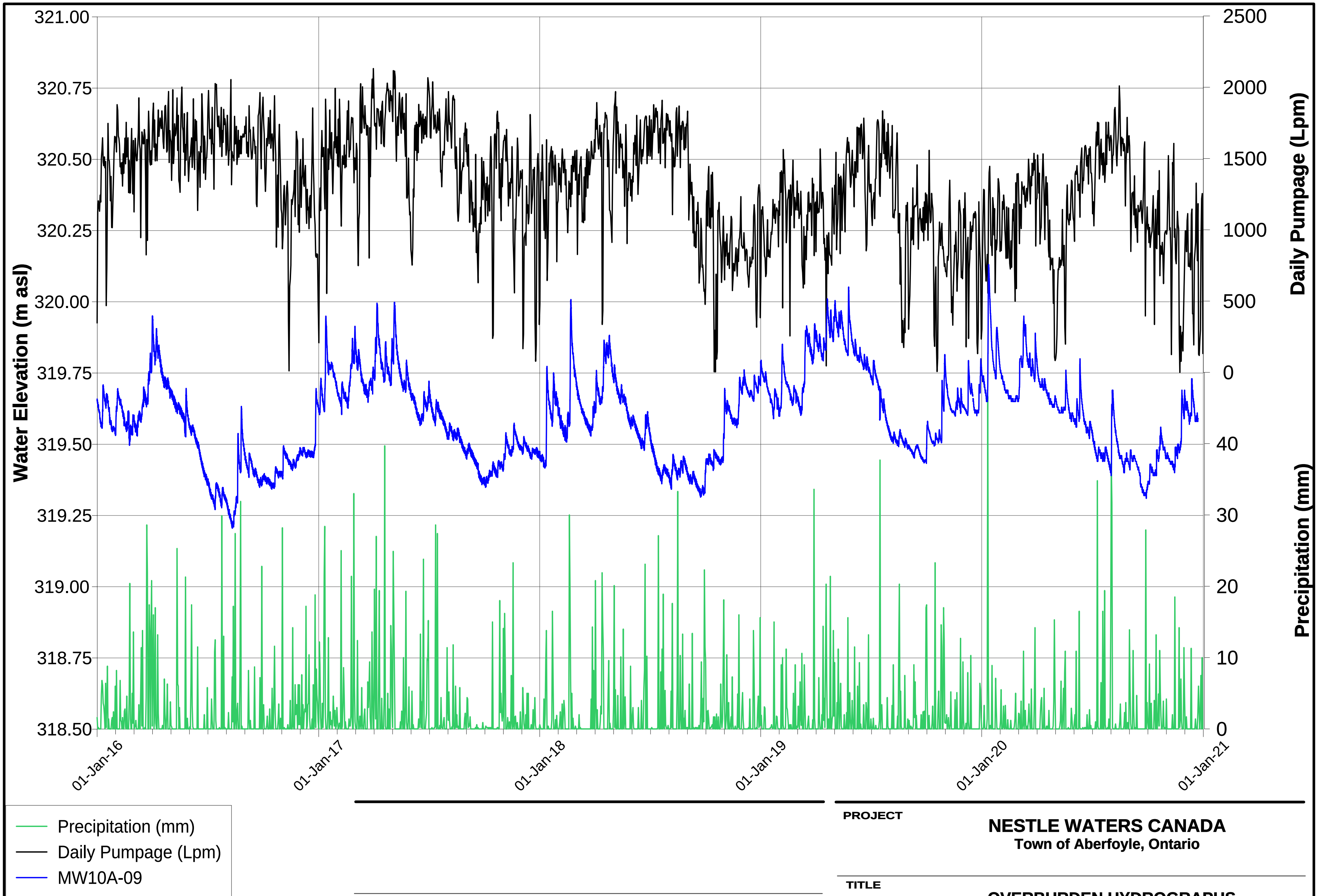
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

OVERBURDEN HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D33



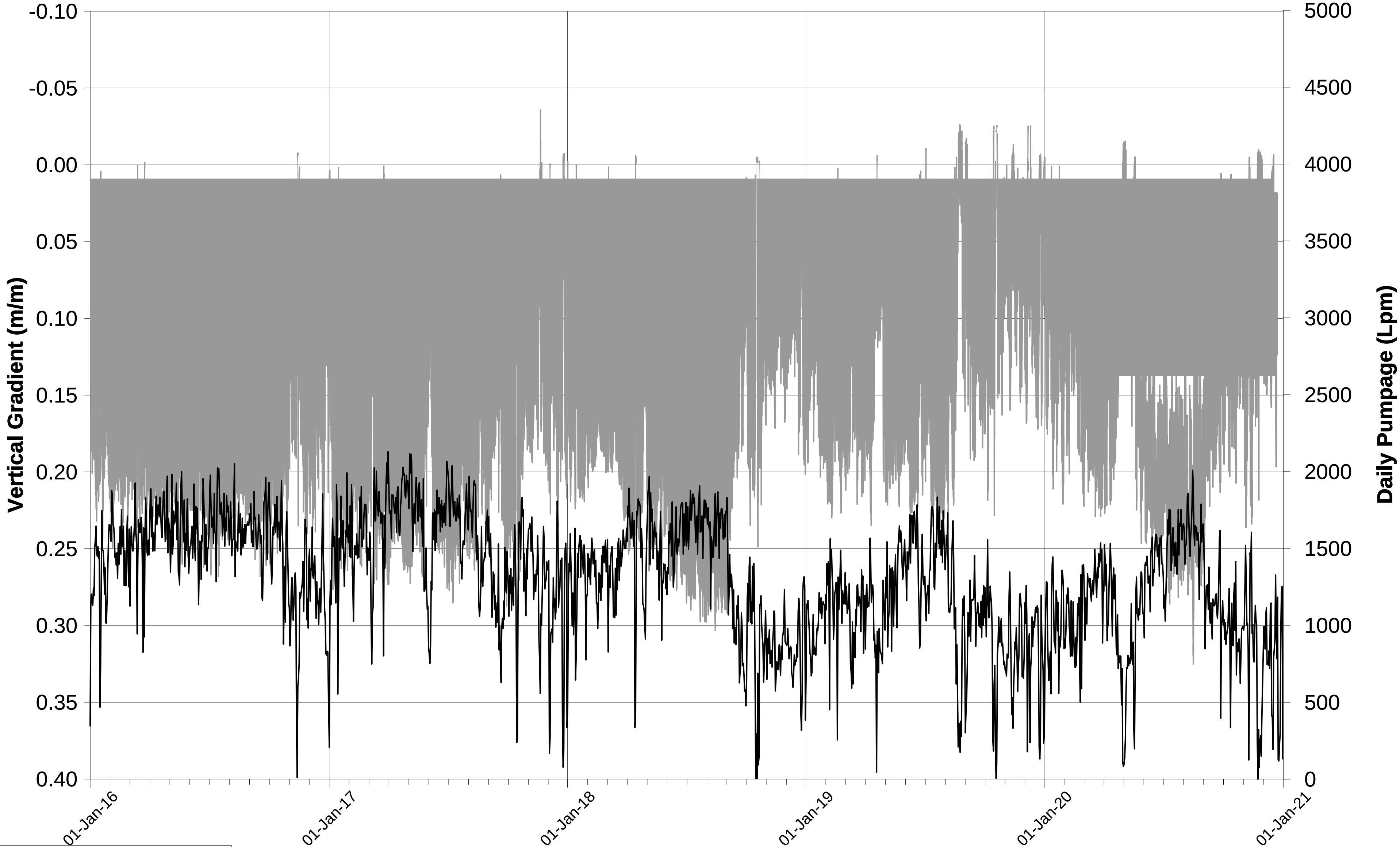
GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
OVERBURDEN HYDROGRAPHS
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D34



Note: Vertical gradient between MW2C-07 and MW2A-07

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

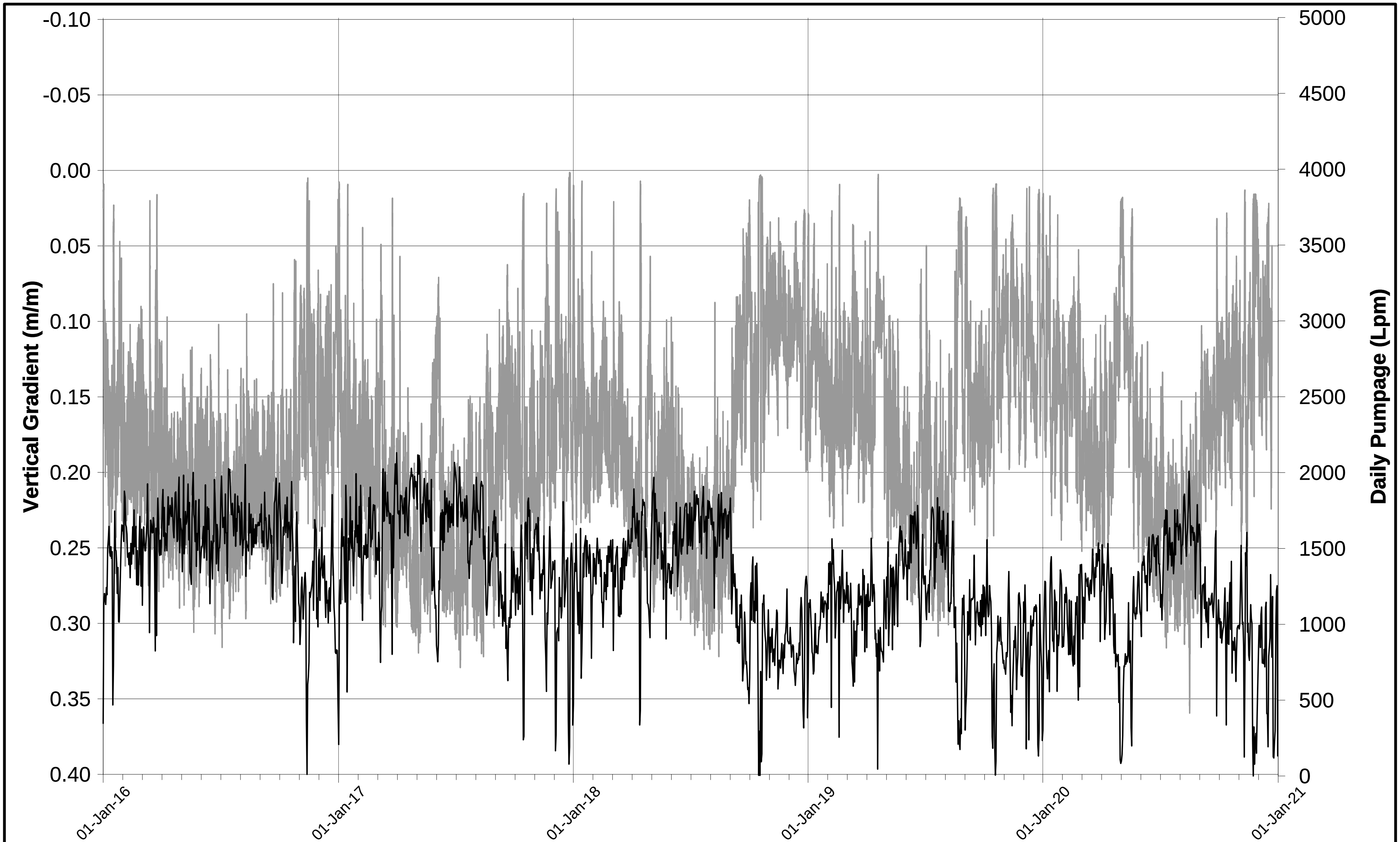
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW2 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D35



Daily Pumpage (Lpm)
Vertical Gradient (m/m)

Note: Vertical gradient between MW4B-07 and MW4A-07

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

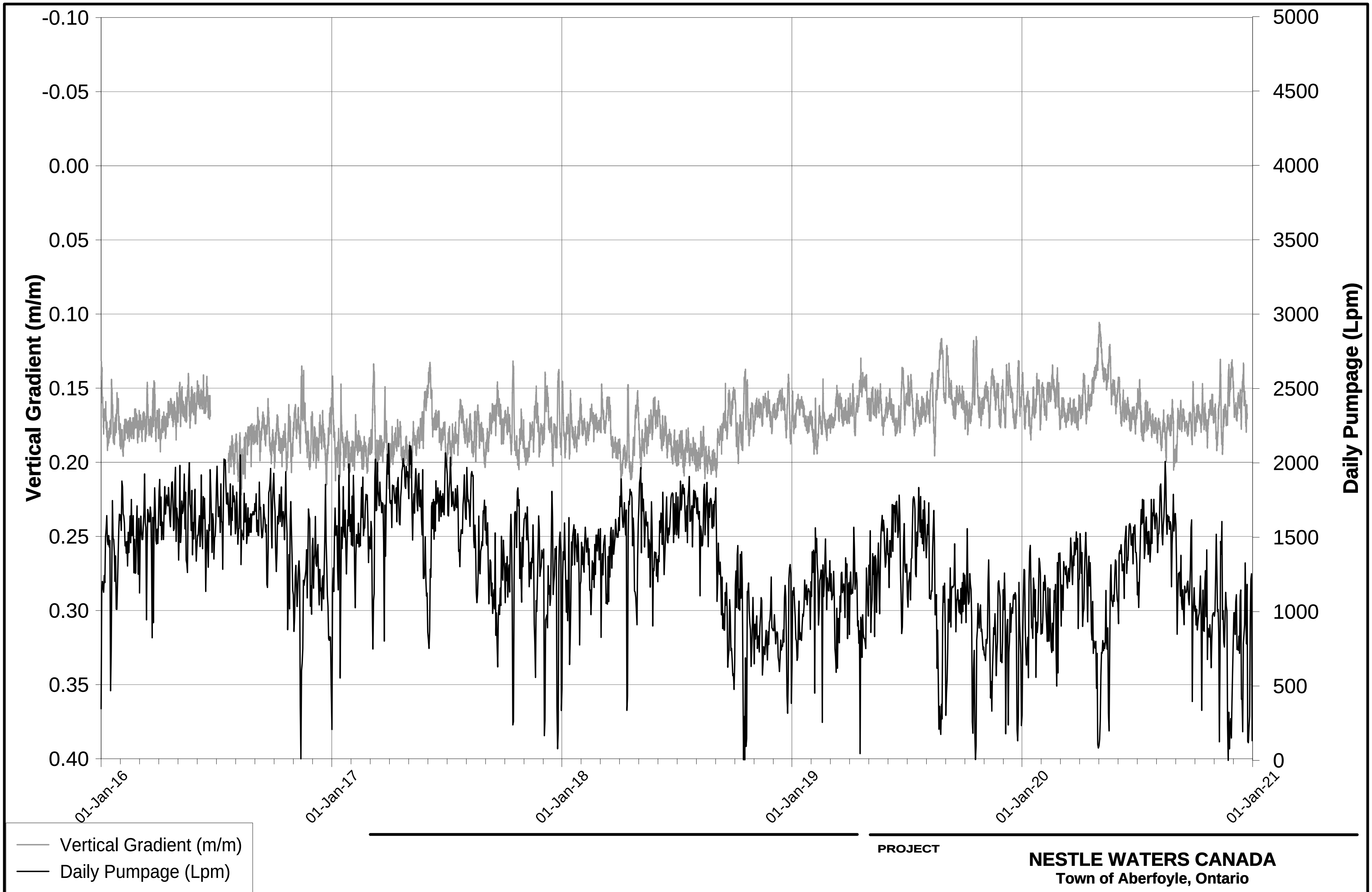
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW4 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D36

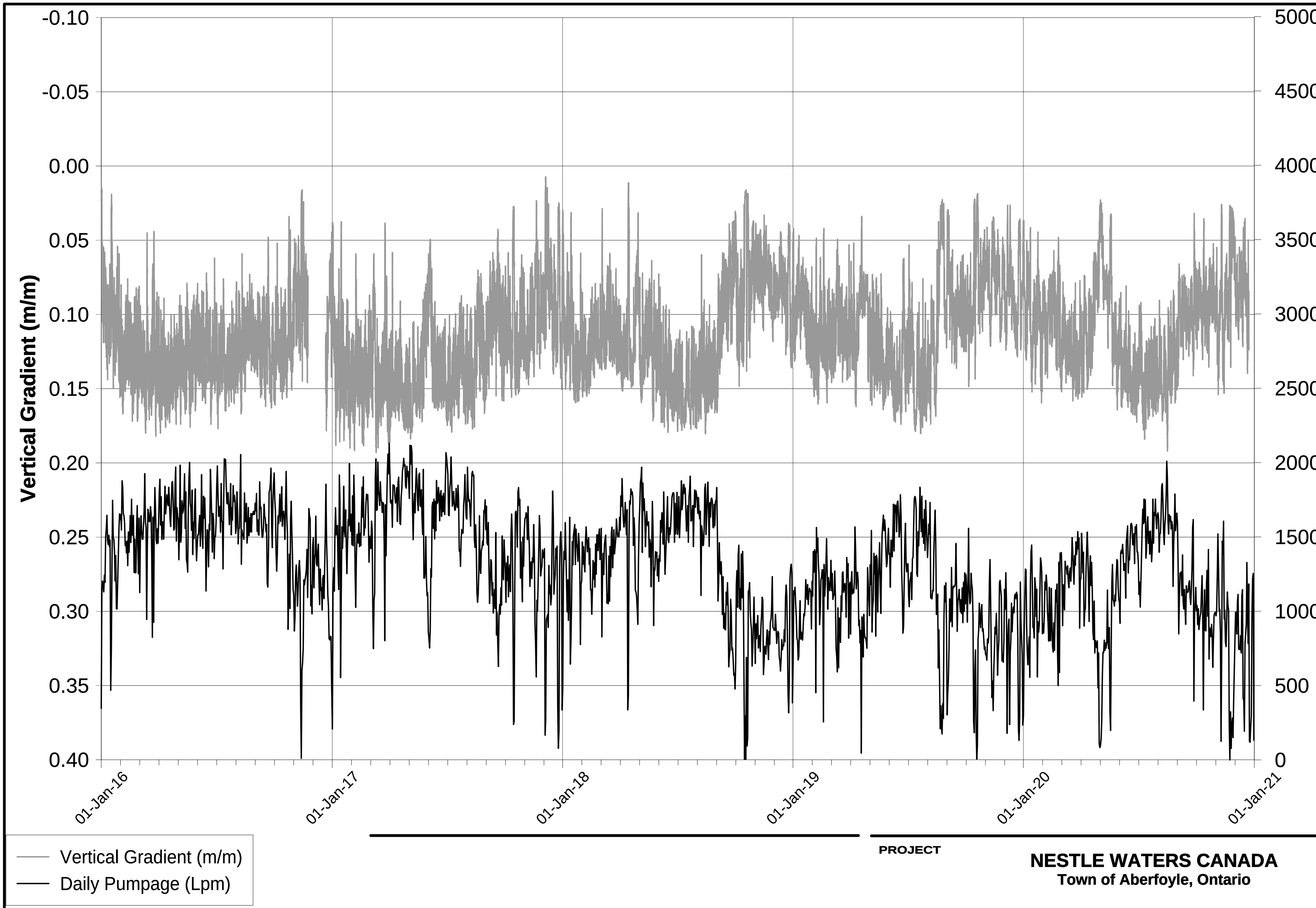


PROJECT	**NESTLE WATERS CANADA** **Town of Aberfoyle, Ontario**
TITLE	**MW6 VERTICAL GRADIENT** **2020 ANNUAL MONITORING REPORT**

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D37



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

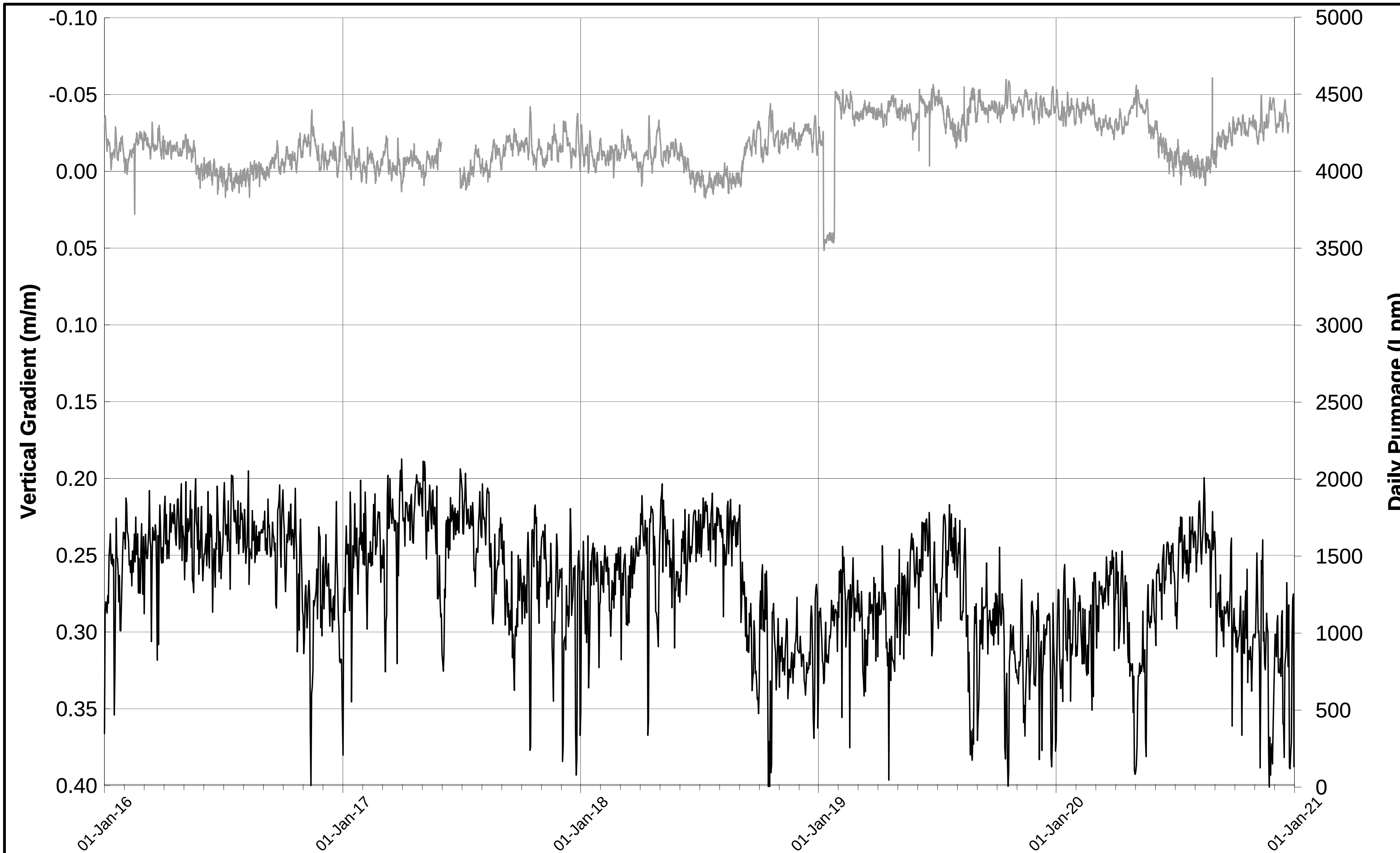
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW7 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D38



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

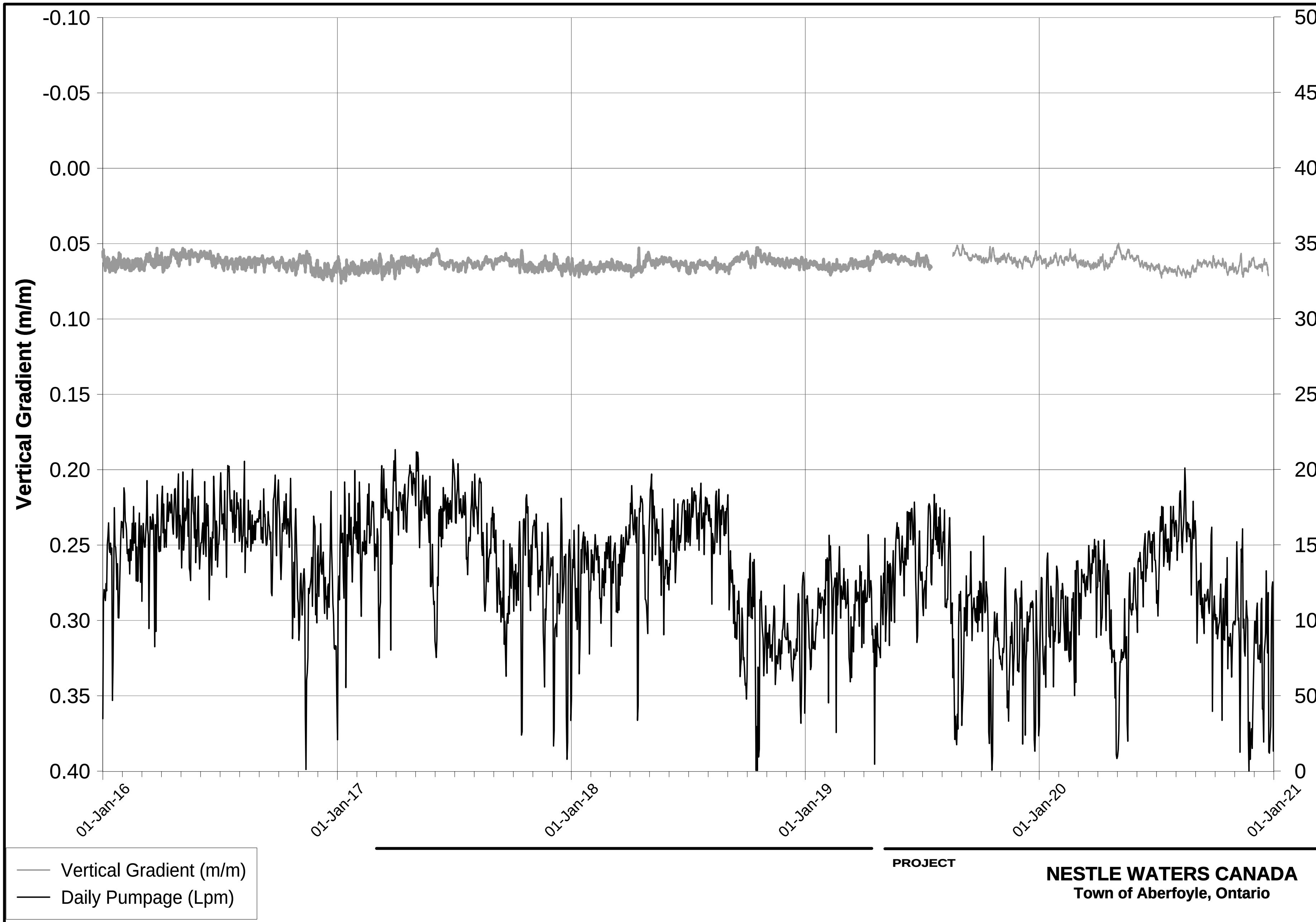
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW8 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D39



Note: Vertical gradient between MW10B-09 and MW10C-09

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

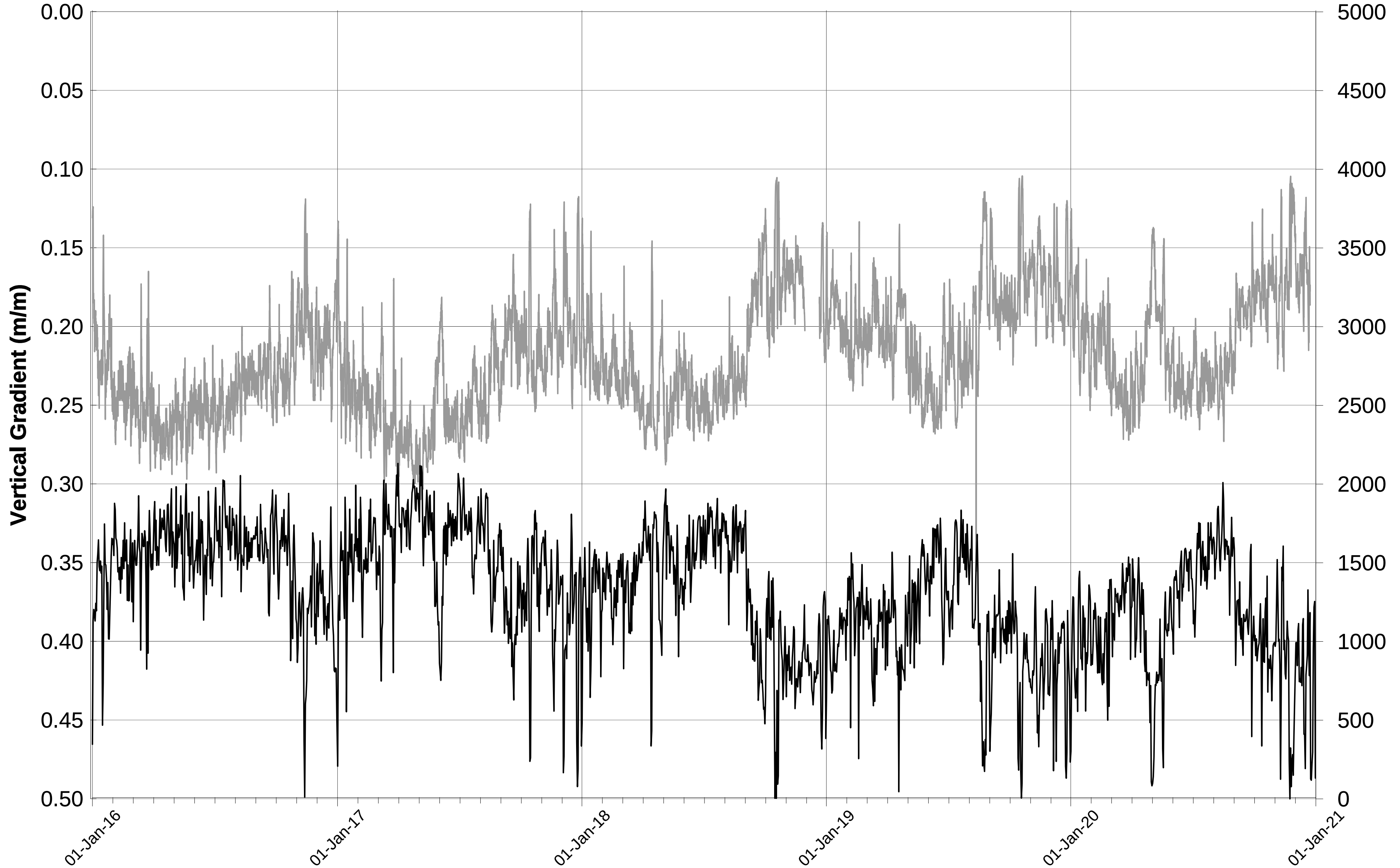
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW10 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D40



Note: Vertical gradient between MW14C-11 and MW14A-11

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

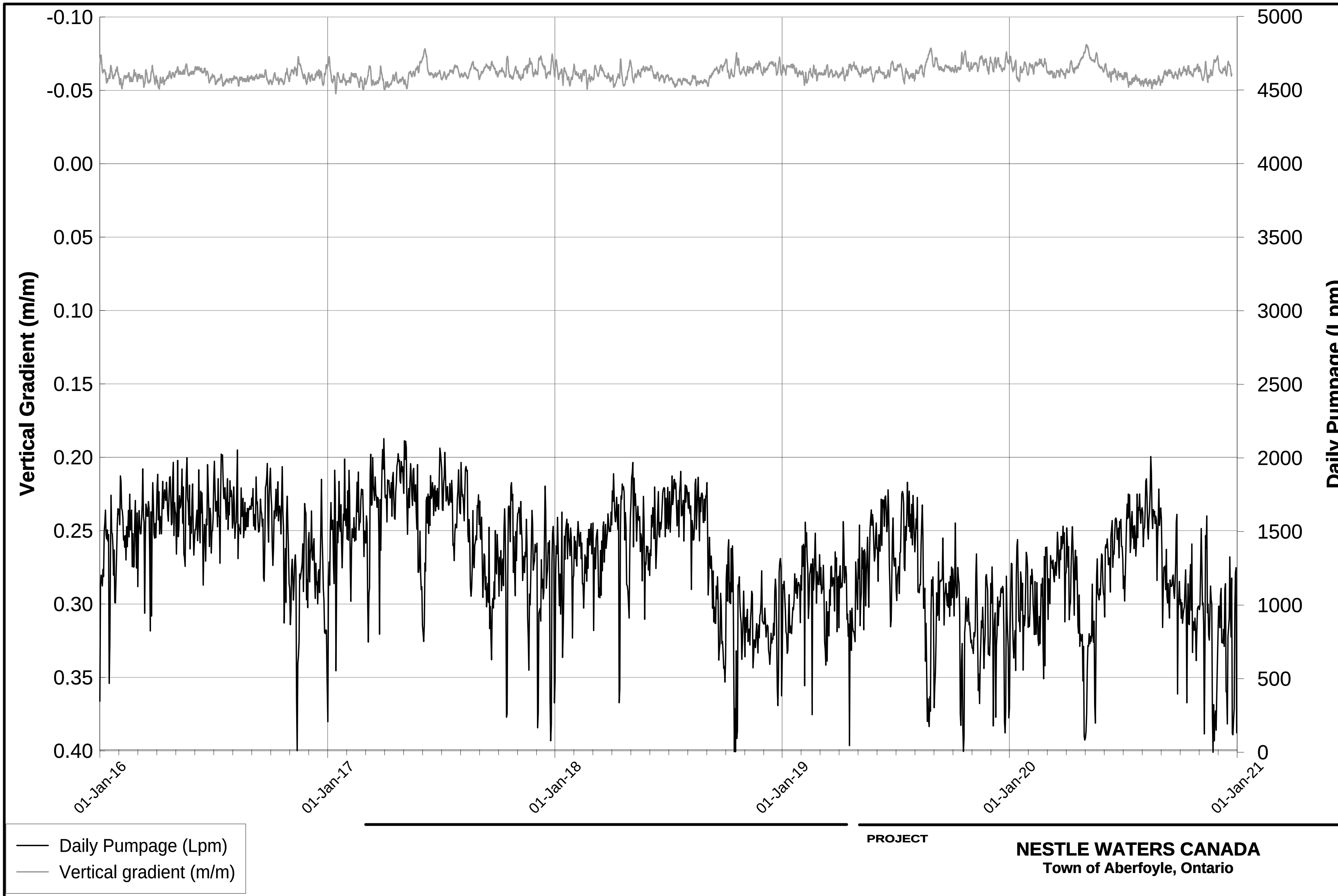
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW14 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D41



GOLDER	DATE	DECEMBER 2020	
	DESIGN	KS	
	REVIEW	GP	
	APPROVED	GP	

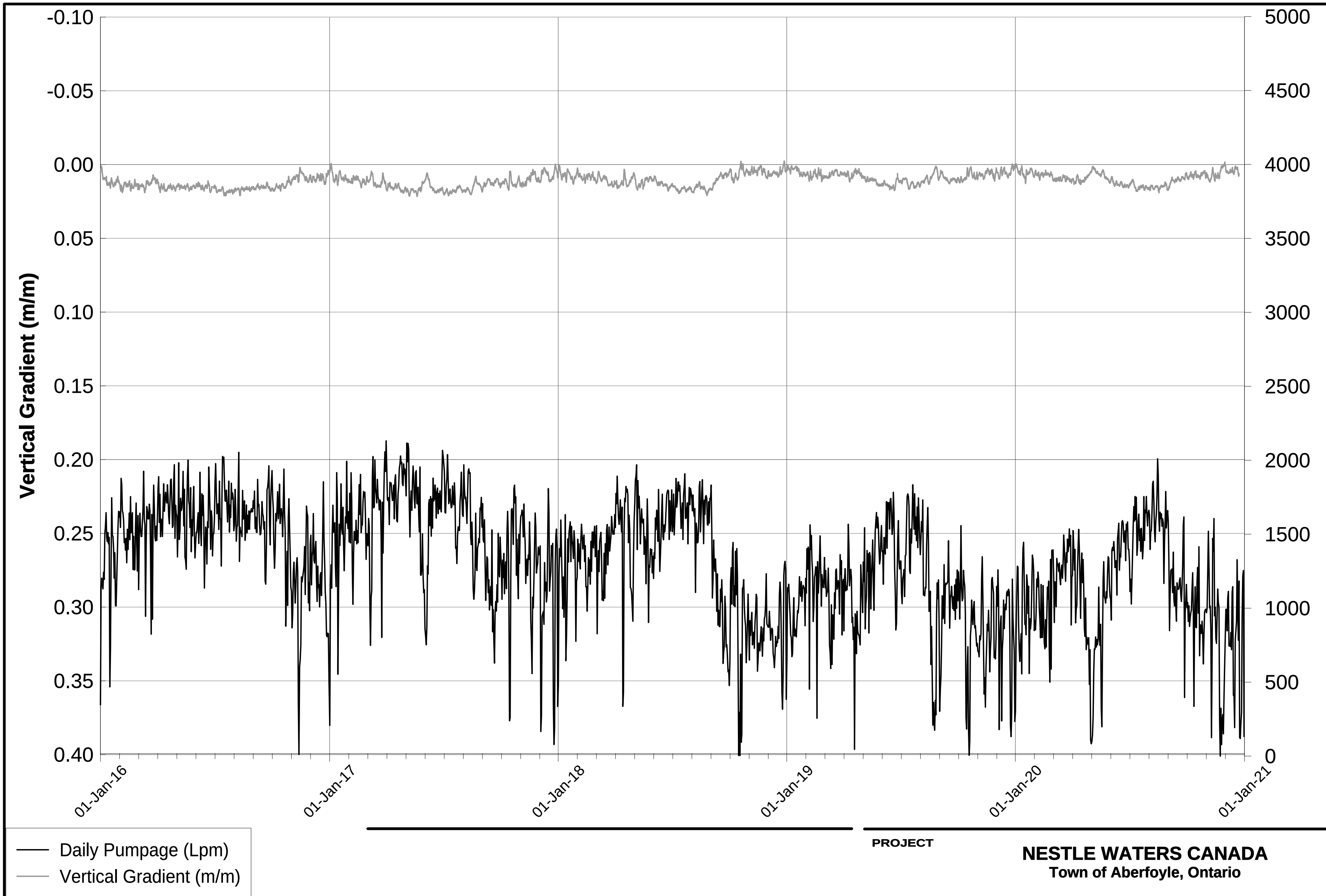
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW15 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D42



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

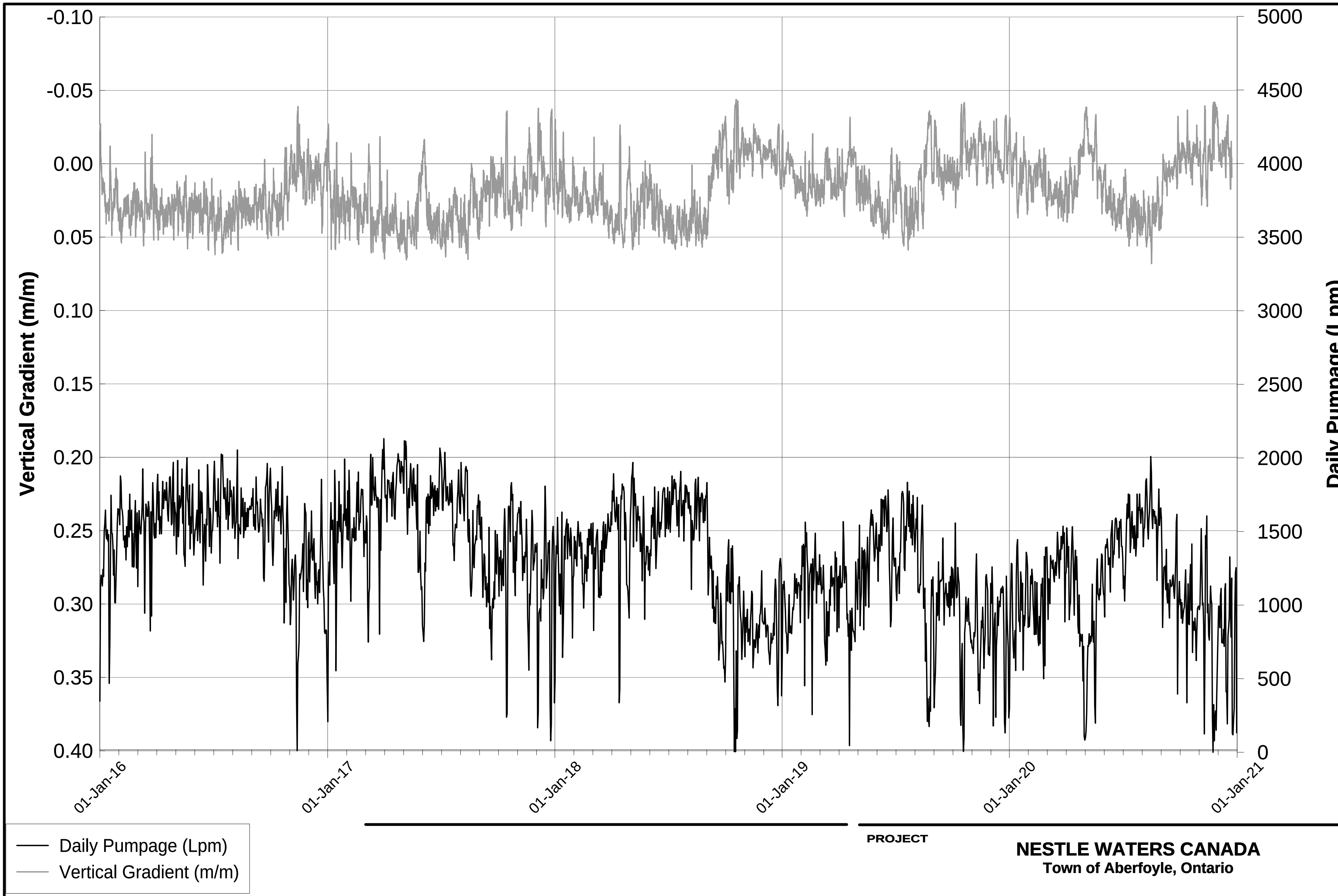
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW16 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D43



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

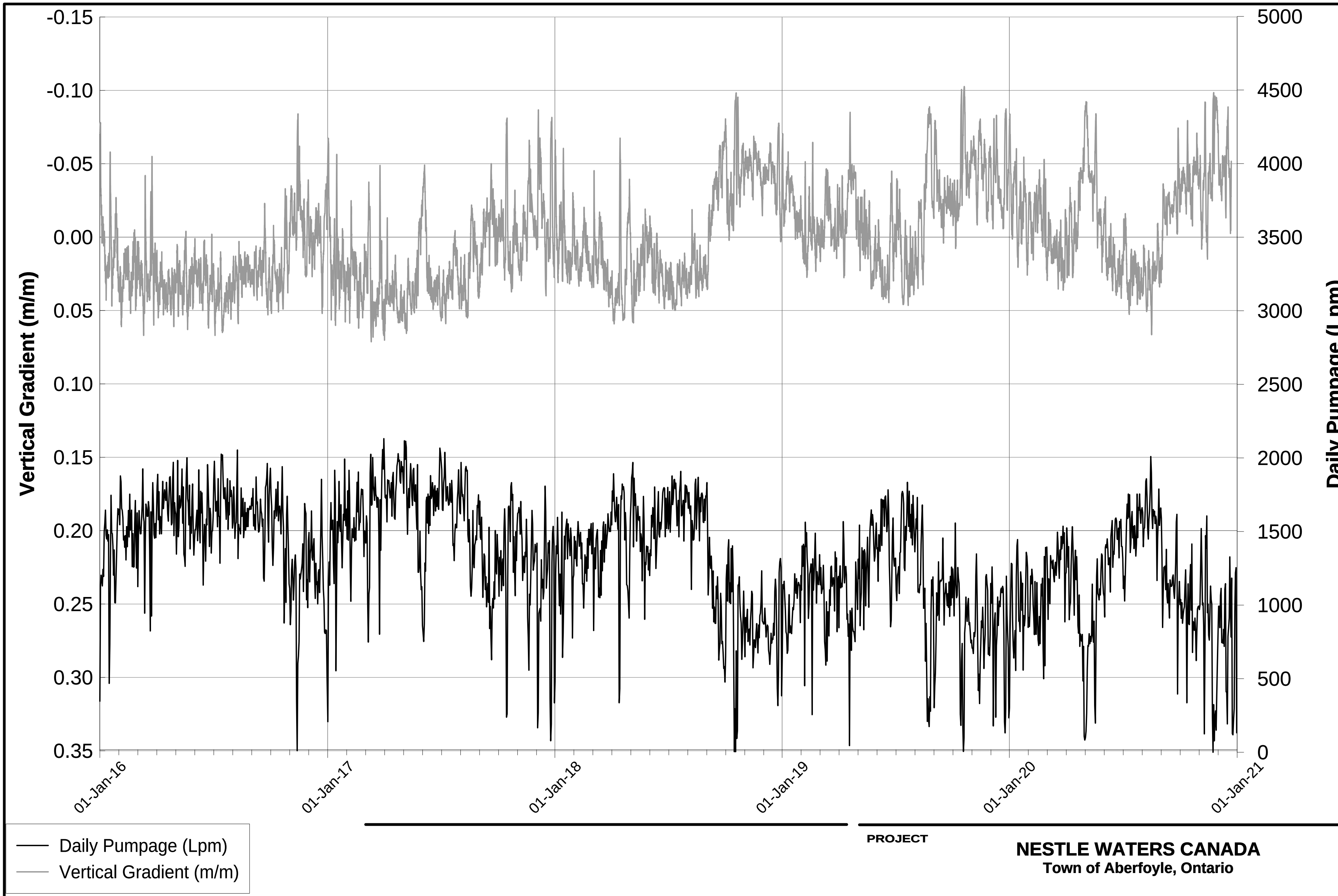
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW17 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D44



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MW18 VERTICAL GRADIENT
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	D45

TABLE D1
Manual Groundwater Elevations
2020 Annual Report

Date	Water Level (masl)							
	TW3-80	MW02A-07	MW02B-07	MW02C-07	MW02D-07	MW02E-07	MW04A-07	MW04B-07
20-Jan-20	305.26	308.70	309.74	311.41	311.90	311.74	309.46	312.37
20/21-Feb-20	306.85	309.36	310.09	311.44	311.85	311.68	309.47	312.32
16/17-Mar-20	305.40	309.21	310.00	311.46	311.92	311.74	309.93	312.43
21/22-Apr-20	307.43	309.42	310.22	311.52	311.89	311.70	310.20	312.40
21/22-May-20	305.23	307.33	308.65	311.12	311.88	311.71	309.32	312.37
18/19-Jun-20	302.98	307.99	309.10	311.04	311.70	311.56	307.76	312.25
22/24-Jul-20	304.28	305.93	307.38	310.50	311.50	311.44	307.74	312.04
19/20-Aug-20	300.85	306.24	307.95	310.51	311.41	311.35	307.48	311.93
21/22-Sep-20	305.99	309.28	309.88	311.04	311.53	311.41	309.66	311.90
21/22-Oct-20	305.14	308.32	309.35	311.08	311.71	311.63	310.12	311.91
19/20-Nov-20	306.51	308.93	309.59	311.05	311.63	311.57	309.33	311.82
22/23-Dec-20	311.26	311.34	311.44	311.66	311.78	311.62	310.47	311.82

TABLE D1
Manual Groundwater Elevations
2020 Annual Report

Date	Water Level (masl)							
	MW04C-07	MW06A-08	MW06B-08	MW07A-08	MW07B-08	MW08A-08	MW08B-08	MW10A-09
20-Jan-20	312.43	315.71	318.69	309.78	311.42	318.17	317.46	319.78
20/21-Feb-20	312.30	315.86	318.51	309.69	311.33	318.02	317.35	319.66
16/17-Mar-20	312.41	315.85	318.61	309.52	311.27	318.02	317.45	319.79
21/22-Apr-20	312.36	316.00	318.57	310.48	311.70	317.96	317.37	319.66
21/22-May-20	312.37	315.77	318.48	309.35	311.02	317.77	317.35	319.67
18/19-Jun-20	312.29	315.36	318.26	308.10	310.23	317.35	317.16	319.59
22/24-Jul-20	312.07	315.17	318.19	308.37	310.24	317.00	317.02	319.47
19/20-Aug-20	312.01	315.05	318.15	307.96	309.93	317.07	317.02	319.39
21/22-Sep-20	311.95	315.21	318.17	309.46	310.80	317.46	317.01	319.39
21/22-Oct-20	311.96	315.08	318.33	310.23	311.30	317.57	317.21	319.56
19/20-Nov-20	311.87	315.41	318.33	309.29	310.76	317.80	317.22	319.48
22/23-Dec-20	311.88	315.40	318.38	308.89	310.70	317.78	317.28	319.59

TABLE D1
Manual Groundwater Elevations
2020 Annual Report

Date	Water Level (masl)							
	MW10B-09	MW10C-09	MW10D-09	MW14A-11	MW14B-11	MW14C-11	MW15A-12	MW15B-12
20-Jan-20	319.85	317.17	316.55	310.51	314.24	314.91	310.82	308.62
20/21-Feb-20	319.75	317.24	316.63	310.52	314.22	314.95	310.84	308.43
16/17-Mar-20	319.85	317.28	316.68	310.40	314.39	315.24	310.80	308.59
21/22-Apr-20	319.76	317.26	316.70	310.79	314.30	315.09	310.78	308.45
21/22-May-20	319.74	317.27	316.64	310.13	314.20	314.90	310.79	308.39
18/19-Jun-20	319.69	316.96	316.30	309.46	313.84	314.55	310.58	308.32
22/24-Jul-20	319.54	316.76	316.10	309.34	313.48	314.13	310.27	308.24
19/20-Aug-20	319.51	316.66	316.00	309.25	313.40	313.99	310.16	308.22
21/22-Sep-20	319.48	316.88	316.19	310.18	313.58	313.92	310.32	308.19
21/22-Oct-20	319.59	316.61	315.93	310.30	313.64	313.95	310.36	308.24
19/20-Nov-20	319.51	316.73	316.06	309.95	313.63	313.93	310.51	308.44
22/23-Dec-20	319.63	316.65	316.45	310.15	313.76	314.07	310.40	308.25

TABLE D1
Manual Groundwater Elevations
2020 Annual Report

Date	Water Level (masl)							
	MW16A-12	MW16B-12	MW17A-12	MW17B-12	MW18A-12	MW18B-12	MW-D	MW-I
20-Jan-20	307.41	307.59	308.80	309.18	308.66	308.46	311.33	311.29
20/21-Feb-20	307.47	307.65	308.99	309.13	309.13	308.42	311.34	311.33
16/17-Mar-20	307.52	307.75	308.80	309.22	308.21	308.48	311.20	311.14
21/22-Apr-20	307.59	307.89	309.41	309.20	309.15	308.31	311.34	311.33
21/22-May-20	307.51	307.77	308.83	309.08	308.39	308.14	311.12	311.09
18/19-Jun-20	307.30	307.68	308.13	309.05	307.66	308.12	310.86	310.81
22/24-Jul-20	307.09	307.51	307.73	308.79	306.93	307.81	310.50	310.44
19/20-Aug-20	306.94	307.38	307.64	308.70	307.40	307.77	310.54	310.49
21/22-Sep-20	306.92	307.21	308.42	308.47	308.06	307.46	310.74	310.73
21/22-Oct-20	306.91	307.13	308.27	308.42	308.25	307.46	310.92	310.90
19/20-Nov-20	306.87	307.04	308.42	308.31	308.01	307.43	310.41	310.83
22/23-Dec-20	306.81	306.98	308.23	308.44	308.76	307.67	311.17	311.18

TABLE D1
Manual Groundwater Elevations
2020 Annual Report

Date	Water Level (masl)							
	MW-S	PCC-D	PCC-I	PCC-S	TW1-93	TW1-99	TW2-11	PW5 Meadows of Aberfoyle
20-Jan-20	311.44	314.75	314.48	314.63	310.24	312.14	310.13	310.76
20/21-Feb-20	311.30	314.66	314.32	314.51	310.20	312.07	310.15	310.42
16/17-Mar-20	311.45	314.78	314.44	314.46	310.21	312.19	310.07	310.44
21/22-Apr-20	311.32	314.62	314.26	314.22	310.15	312.21	310.53	310.74
21/22-May-20	311.33	314.57	314.21	314.15	310.08	312.34	309.92	309.81
18/19-Jun-20	311.17	314.35	314.02	313.93	309.98	312.06	309.20	309.21
22/24-Jul-20	310.88	314.03	313.77	313.72	309.71	311.96	308.65	308.76
19/20-Aug-20	310.88	314.07	313.81	313.77	309.69	311.84	309.00	309.08
21/22-Sep-20	310.74	314.08	313.78	313.70	309.65	311.86	309.96	310.27
21/22-Oct-20	311.07	314.31	314.02	314.15	309.74	311.92	309.90	310.56
19/20-Nov-20	311.04	314.37	314.34	314.11	309.70	311.82	309.75	309.48
22/23-Dec-20	311.20	314.50	314.19	314.22	309.86	311.79	310.36	309.32

TABLE D1
Manual Groundwater Elevations
2020 Annual Report

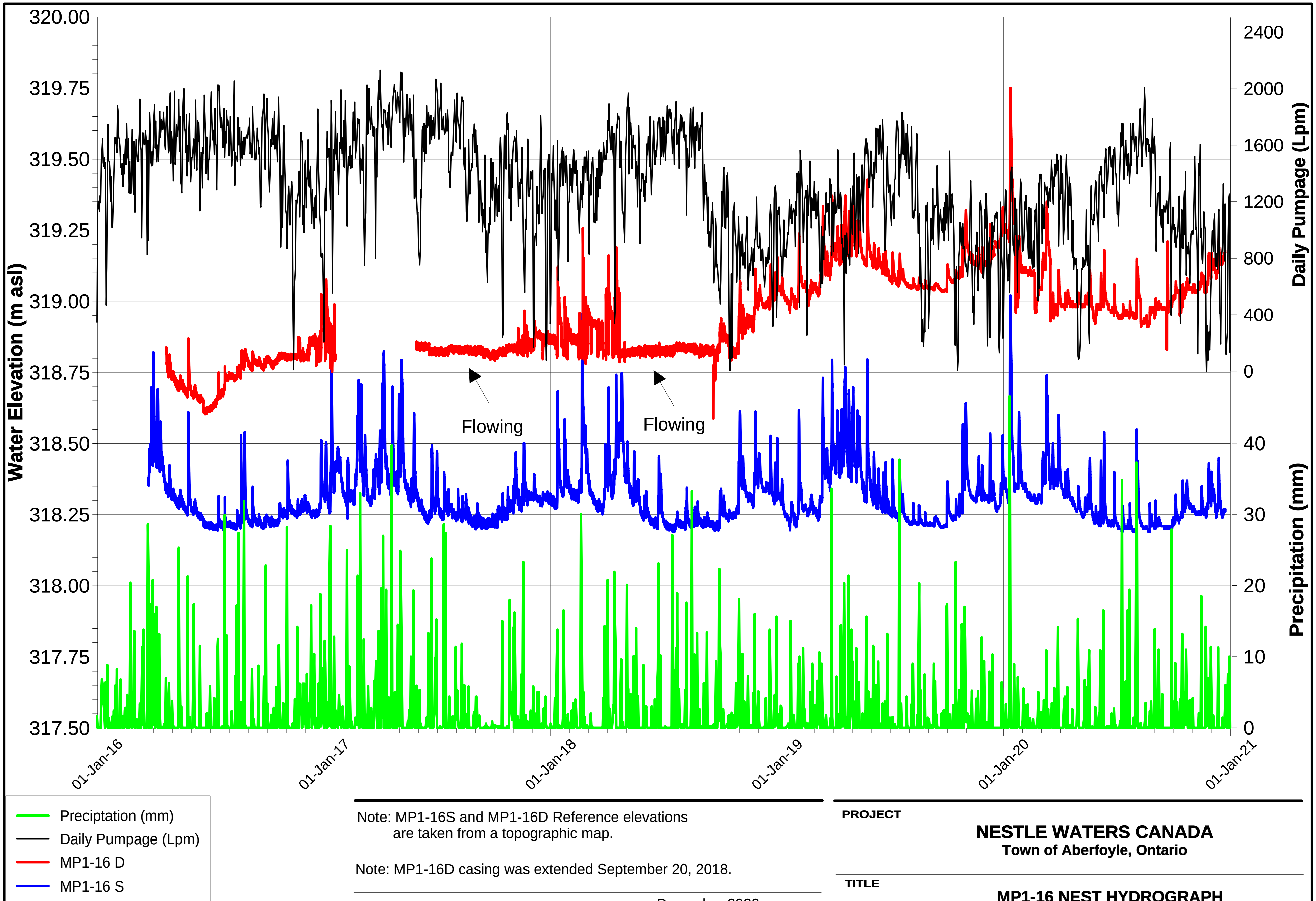
Date	Water Level (masl)							
	#125 Brock S. (Y Well)	#2 Brock N.	#27 Old Brock	#50 Brock S. (I Well)	#58 Brock S.	#7404 Rd. 34	#7425 Rd. 34 (B Well)	#8 Maple Leaf Lane
20-Jan-20	311.97	316.13	309.71	309.66	312.49	316.39	310.74	312.39
20/21-Feb-20	311.93	316.05	309.48	309.49	312.32	316.34	310.78	inaccessible
16/17-Mar-20	312.04	316.14	309.39	inaccessible	312.24	316.51	310.54	312.38
21/22-Apr-20	312.09	316.05	310.10	inaccessible	311.58	316.36	311.07	312.34
21/22-May-20	312.11	316.03	306.60	inaccessible	312.18	316.18	310.38	312.01
18/19-Jun-20	311.98	315.83	308.47	inaccessible	311.38	315.88	309.57	311.72
22/24-Jul-20	311.79	315.65	308.41	inaccessible	311.45	315.55	309.40	311.14
19/20-Aug-20	311.73	315.68	307.76	inaccessible	311.04	315.64	309.35	311.46
21/22-Sep-20	311.69	315.65	inaccessible	inaccessible	311.46	315.69	310.34	311.71
21/22-Oct-20	311.63	316.39	310.25	inaccessible	312.08	316.04	310.36	312.01
19/20-Nov-20	311.55	315.88	307.69	inaccessible	311.28	316.05	310.22	inaccessible
22/23-Dec-20	311.50	315.97	308.78	inaccessible	309.23	316.16	310.41	311.71

TABLE D1
Manual Groundwater Elevations
2020 Annual Report

Date		
	#98 Brock S. (M1 Well)	Fireflow
20-Jan-20	310.40	310.16
20/21-Feb-20	310.19	310.41
16/17-Mar-20	310.11	309.90
21/22-Apr-20	310.26	310.35
21/22-May-20	309.34	309.82
18/19-Jun-20	308.65	309.57
22/24-Jul-20	308.35	309.16
19/20-Aug-20	308.75	309.33
21/22-Sep-20	309.95	309.72
21/22-Oct-20	310.33	309.90
19/20-Nov-20	309.01	309.86
22/23-Dec-20	308.89	310.18

APPENDIX E

Surface Water Level Monitoring



Note: MP1-16S and MP1-16D Reference elevations are taken from a topographic map.

Note: MP1-16D casing was extended September 20, 2018.

GOLDER

DATE	December 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

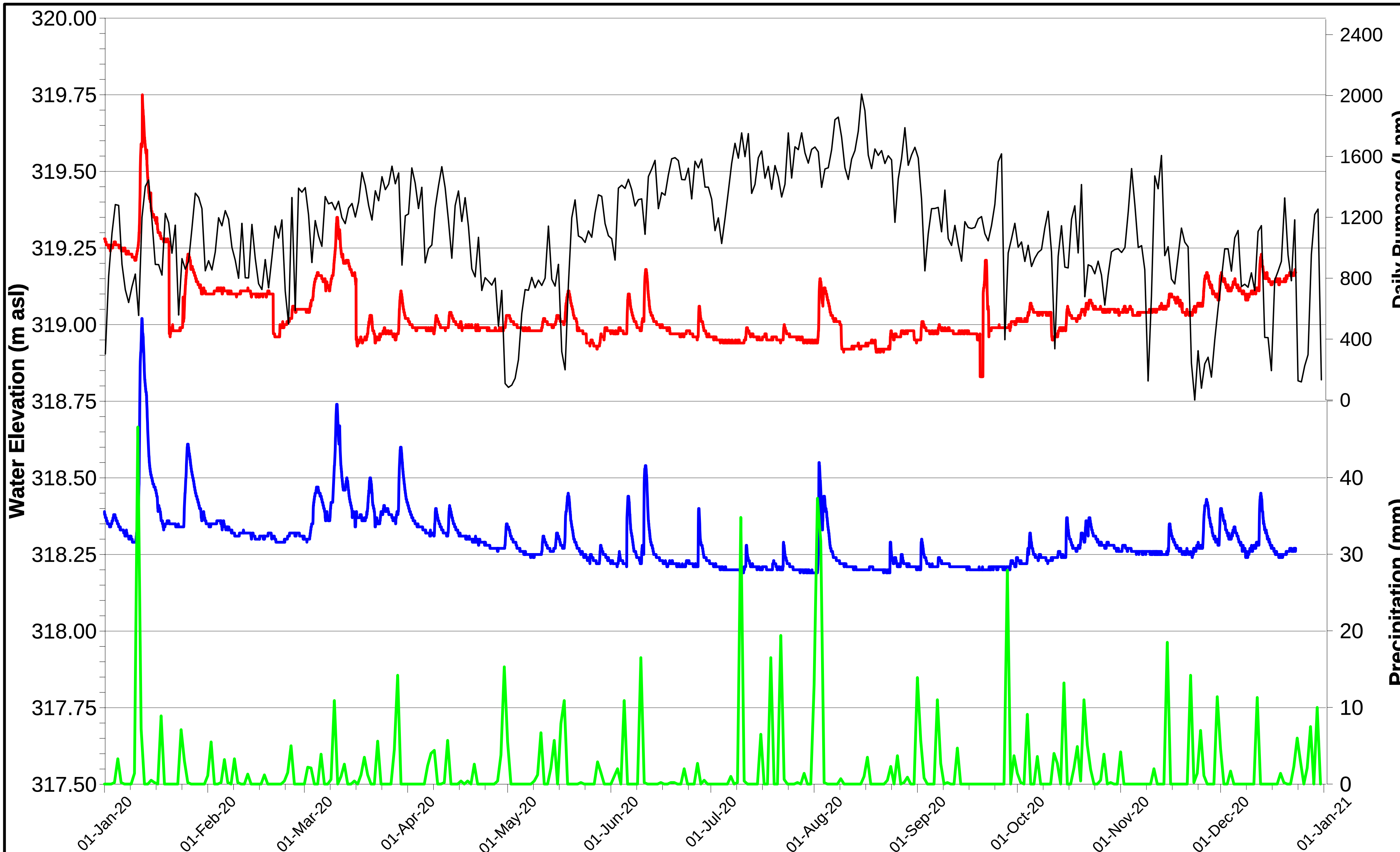
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP1-16 NEST HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E1a



Note: MP1-16S and MP1-16D Reference elevations are taken from a topographic map.

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

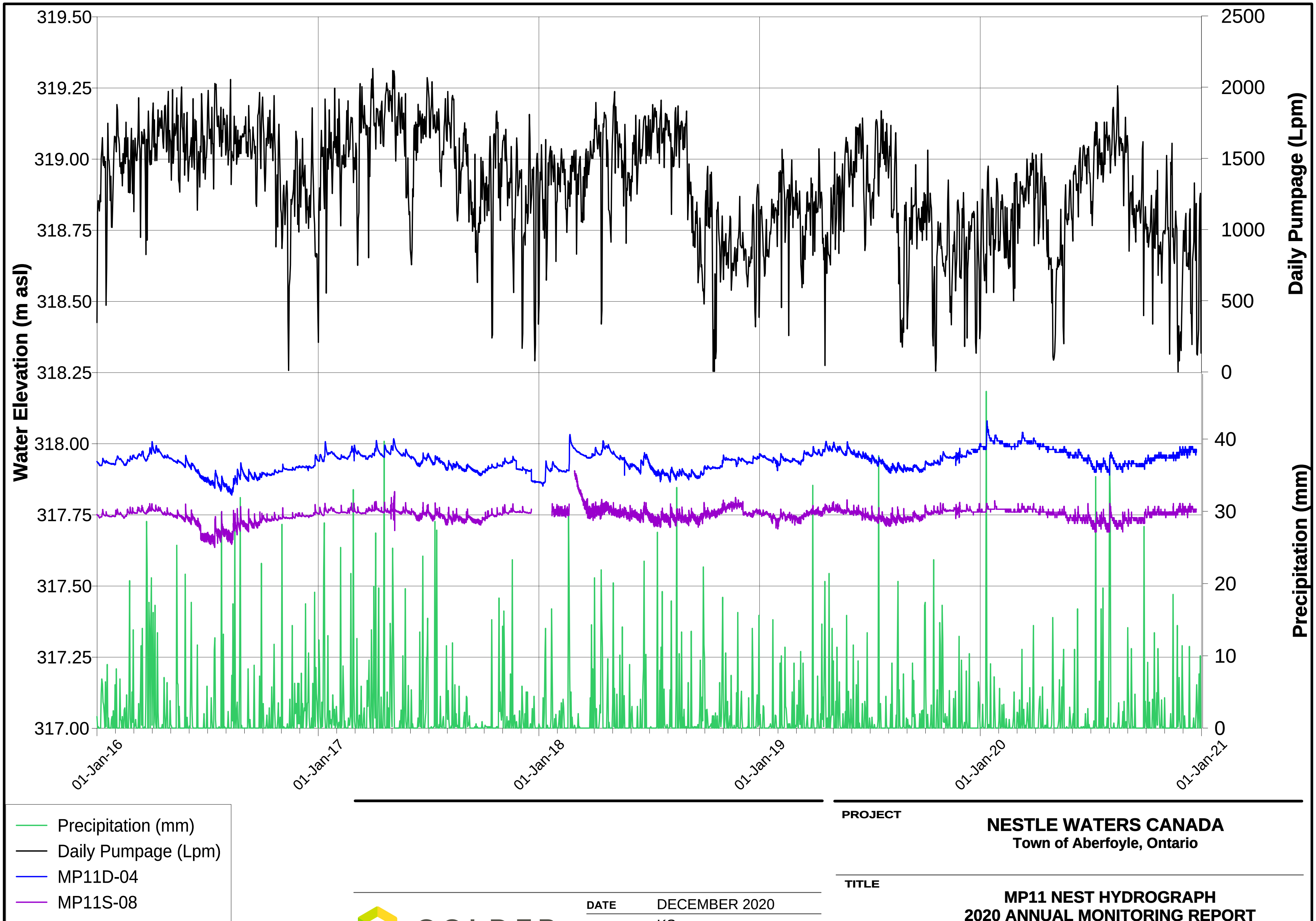
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP1-16 NEST HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E1b



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

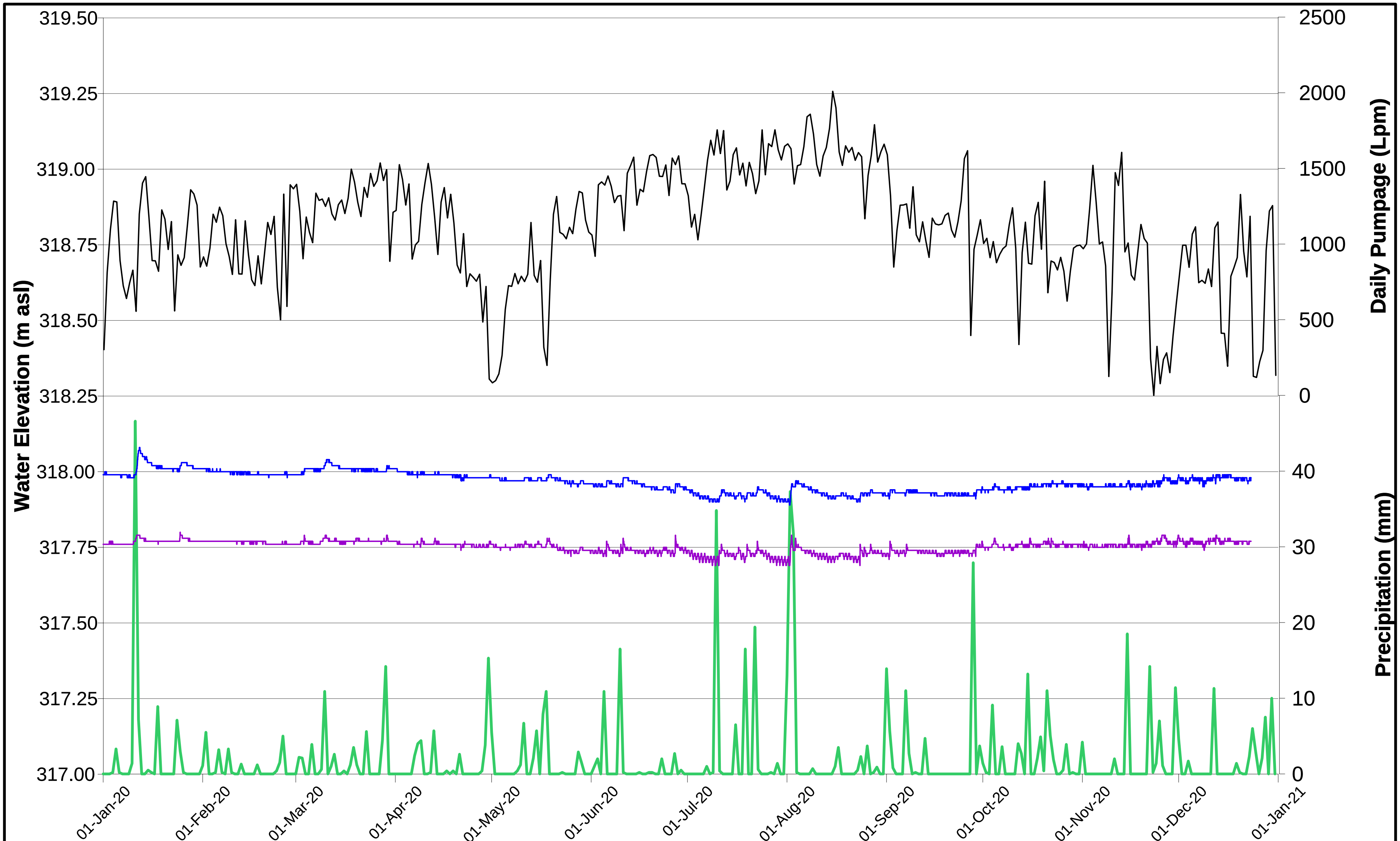
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP11 NEST HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E2a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

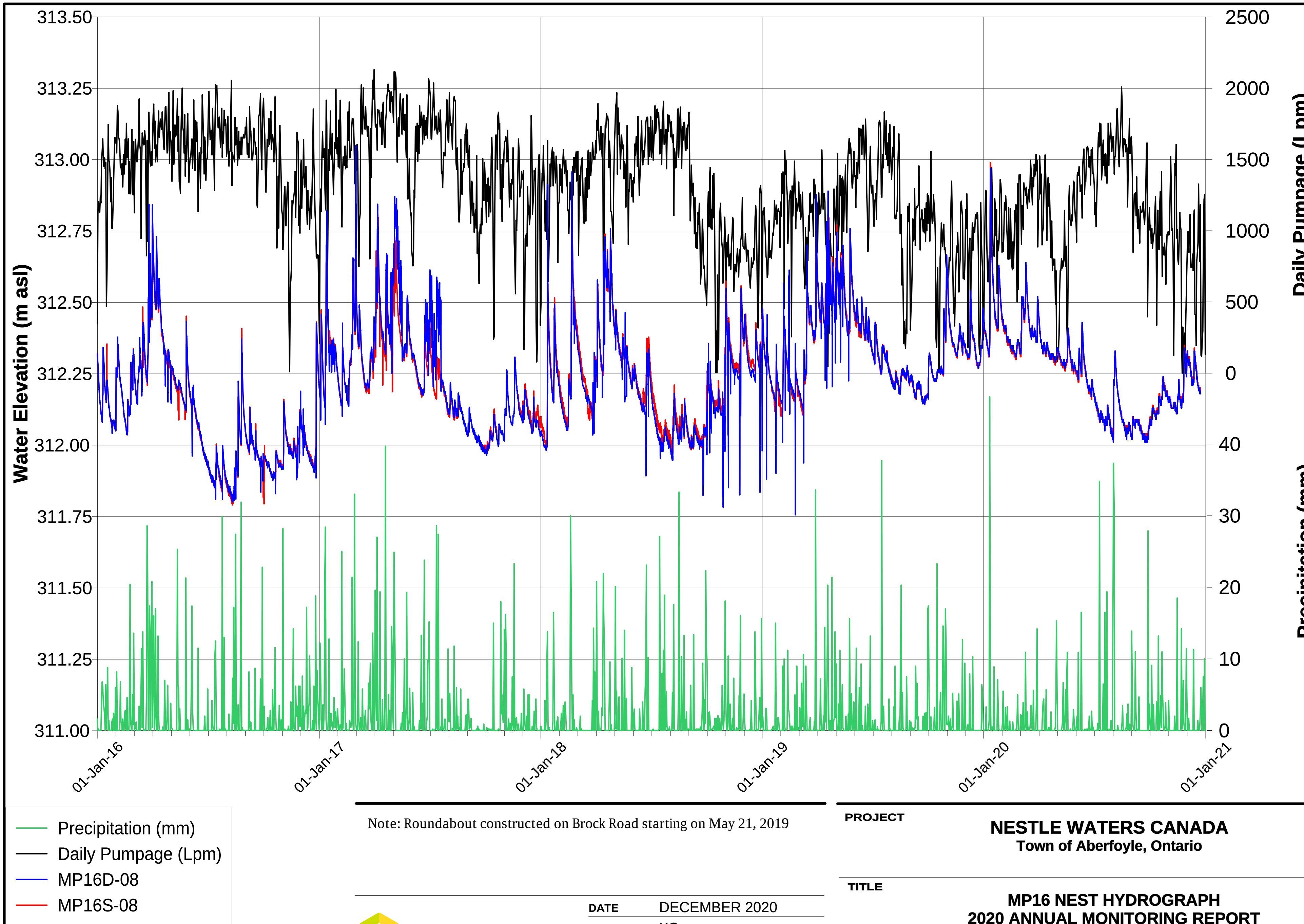
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP11 NEST HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E2b



Note: Roundabout constructed on Brock Road starting on May 21, 2019

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

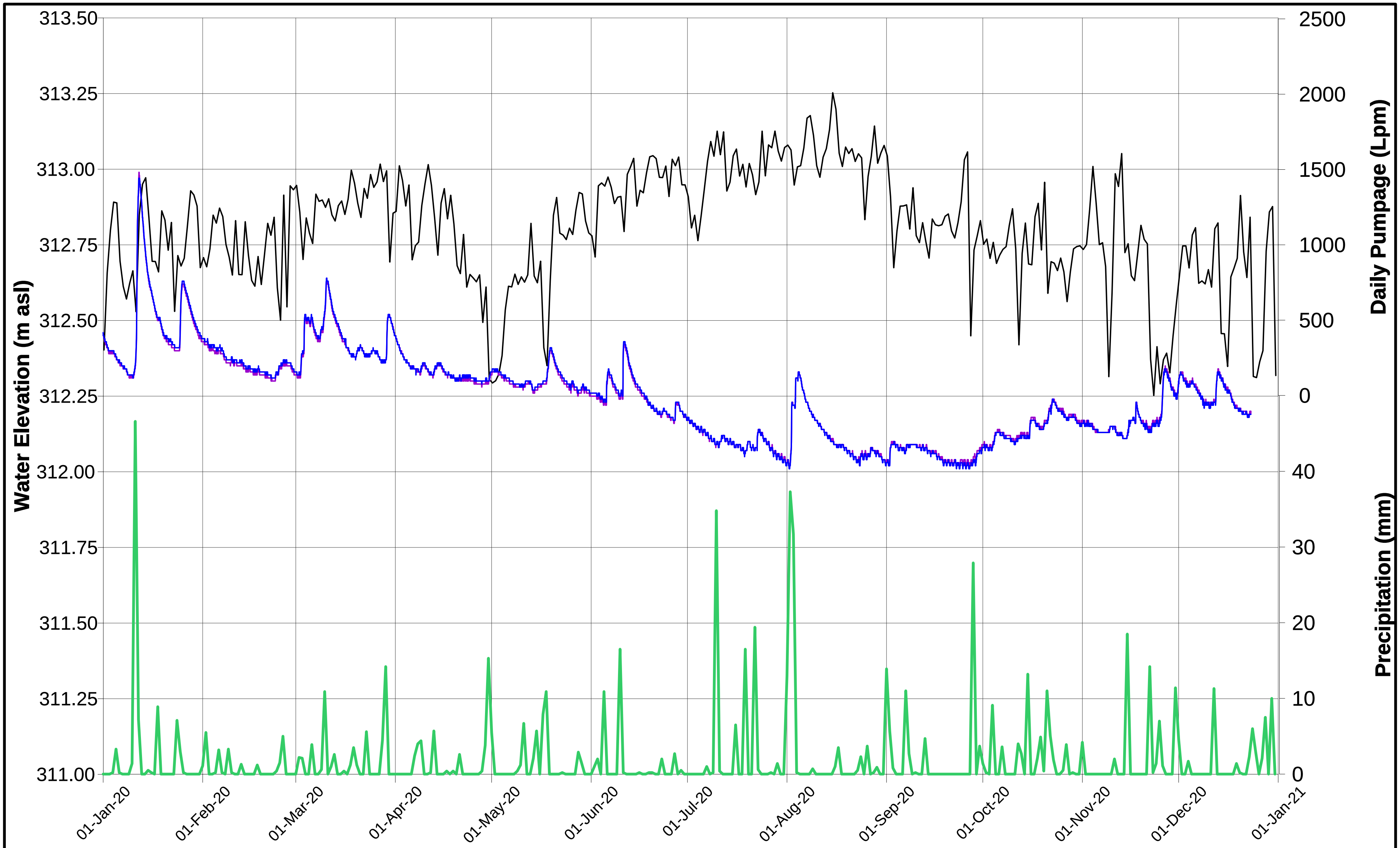
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP16 NEST HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E3a



Note: Roundabout constructed on Brock Road starting on May 21, 2019

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

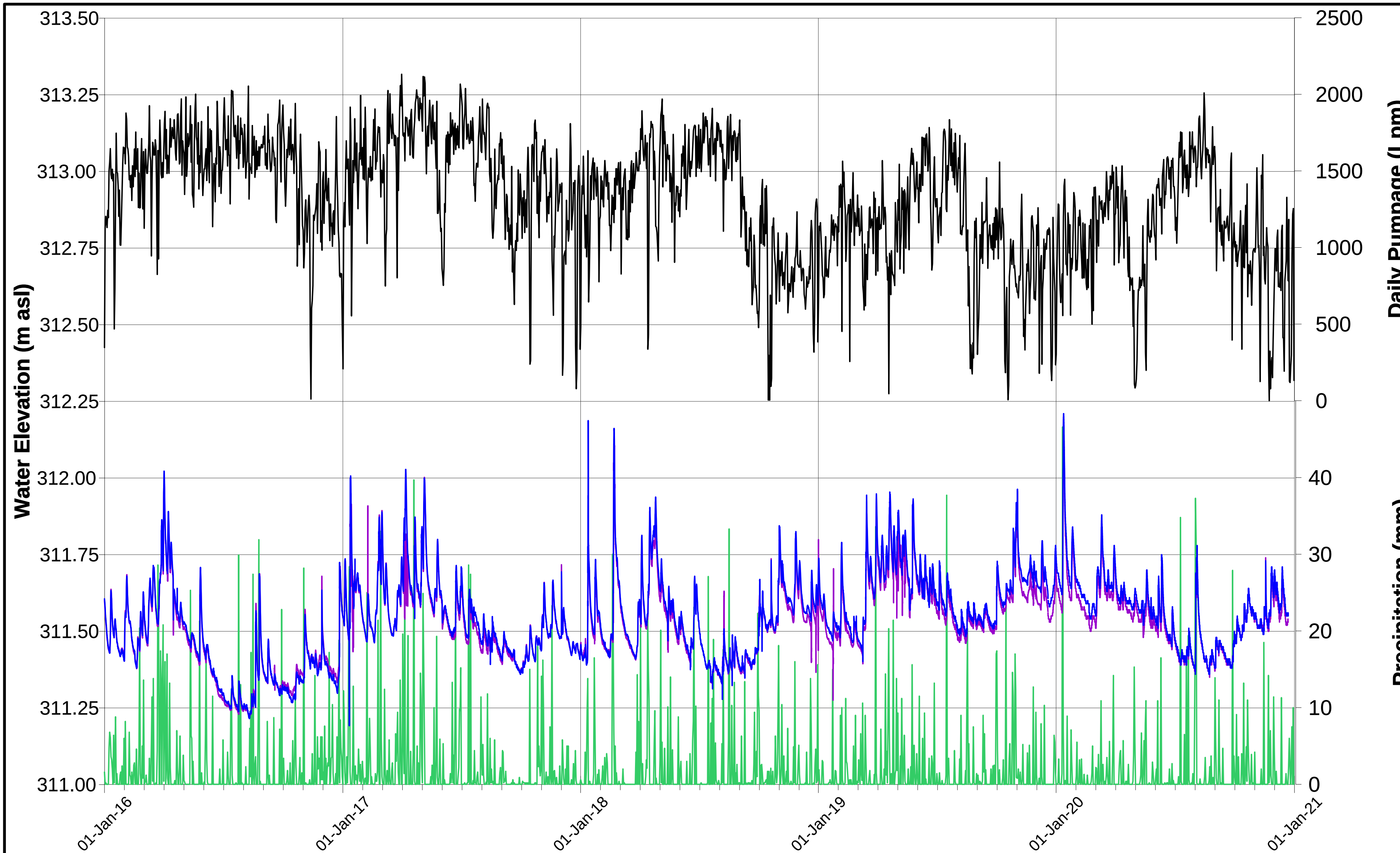
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP16 NEST HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E3b



Note: Roundabout constructed on Brock Road starting on May 21, 2019

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

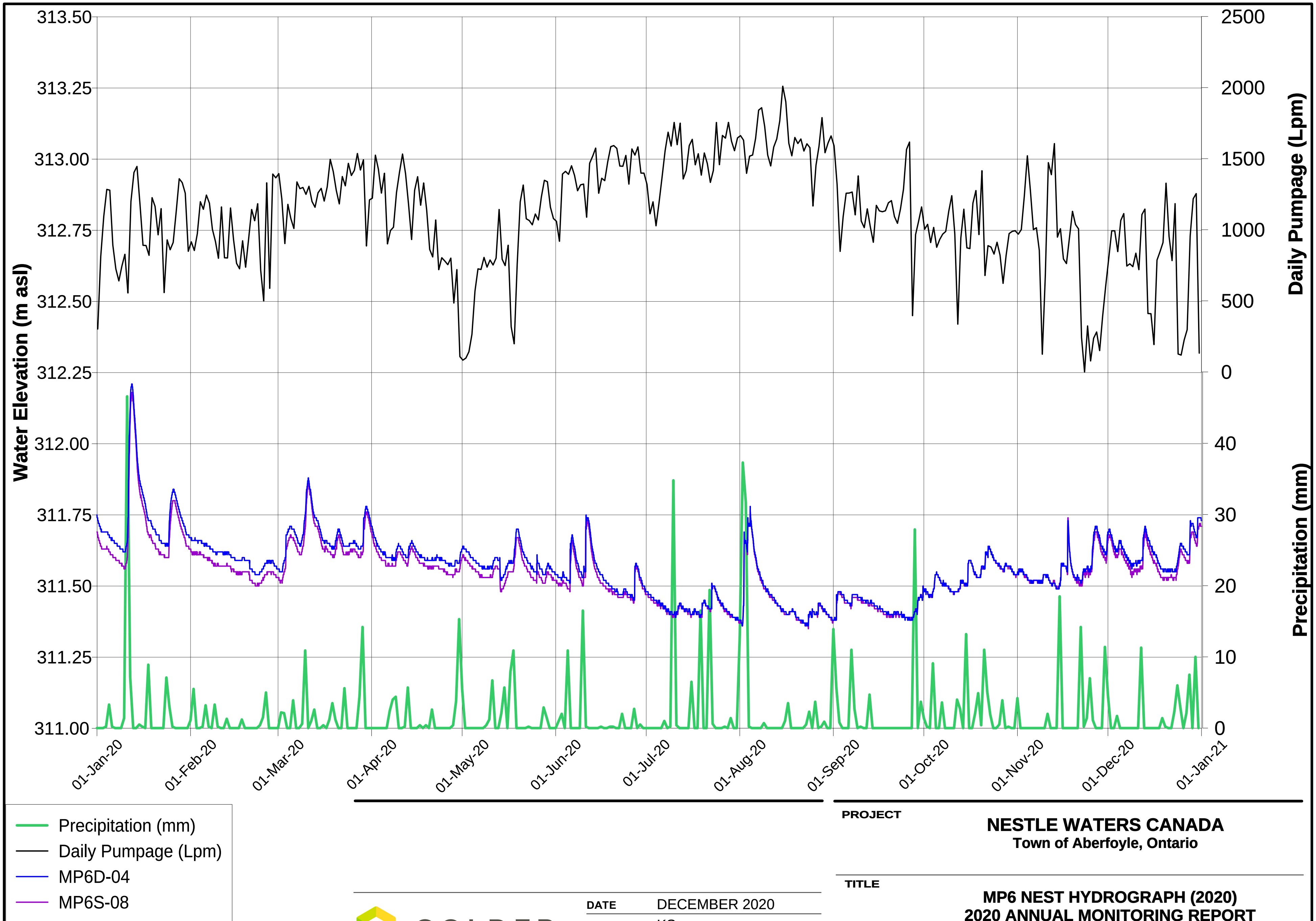
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP6 NEST HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E4a



DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA

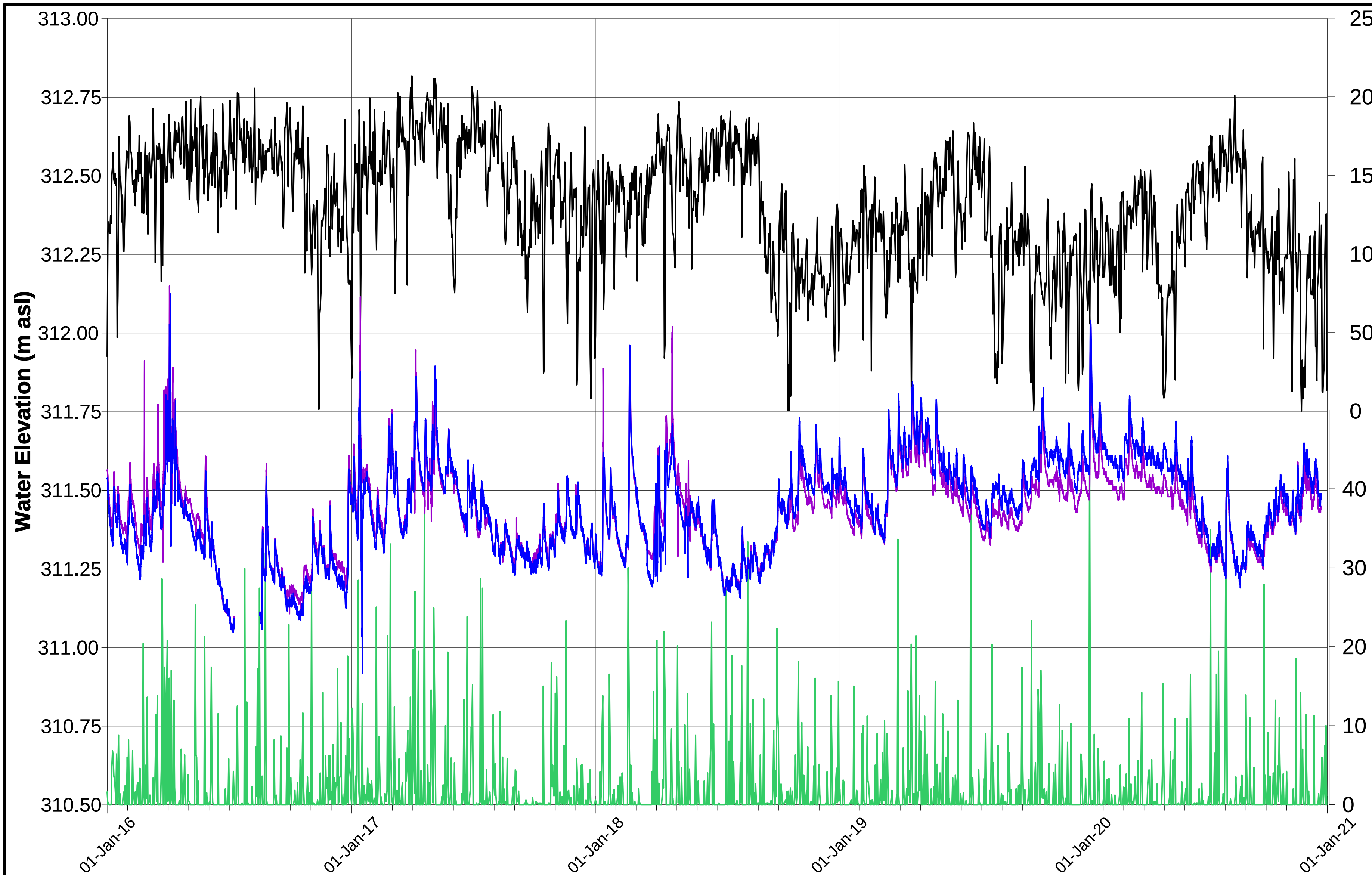
Town of Aberfoyle, Ontario

TITLE

MP6 NEST HYDROGRAPH (2020)

2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E4b



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

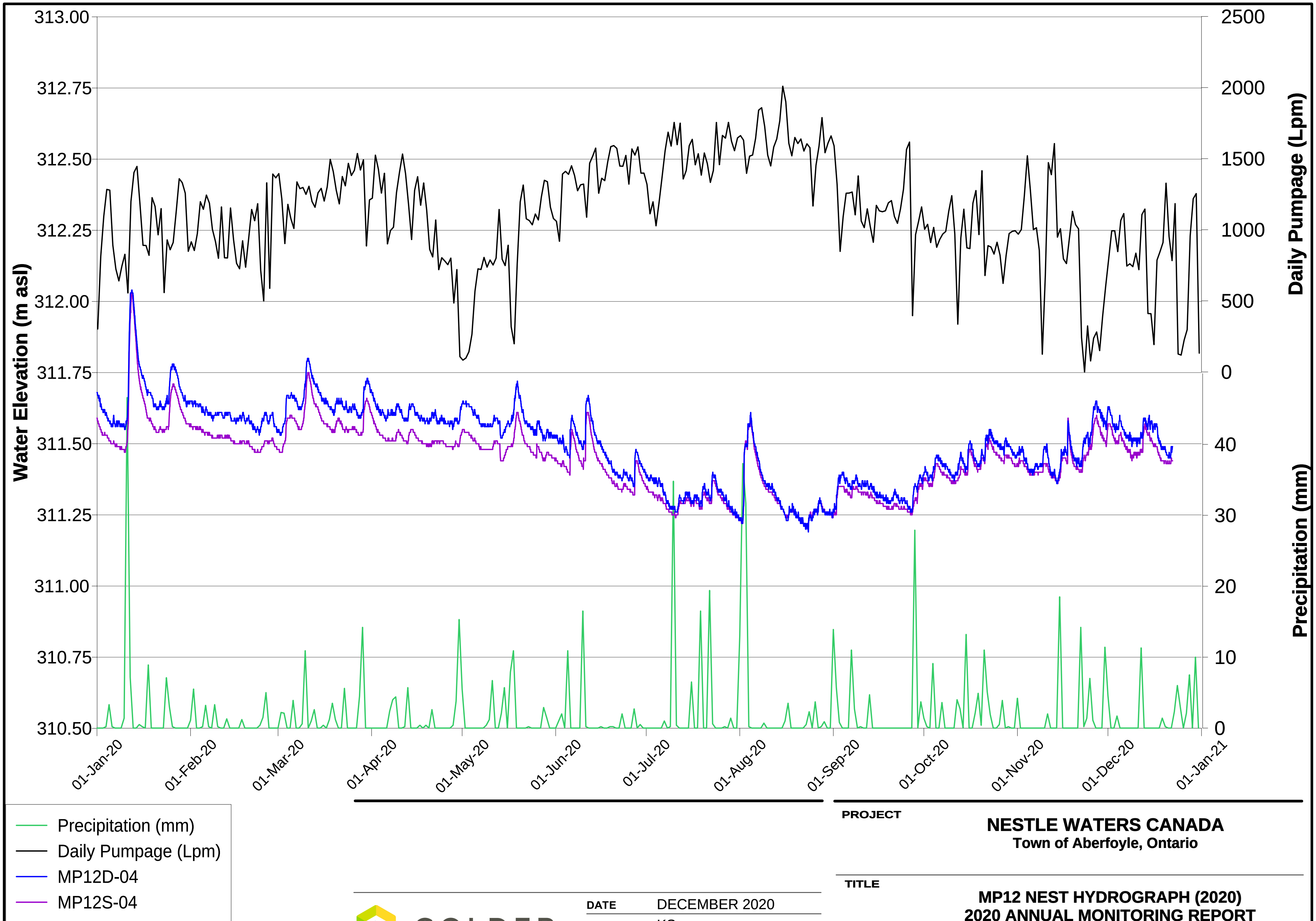
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP12 NEST HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E5a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

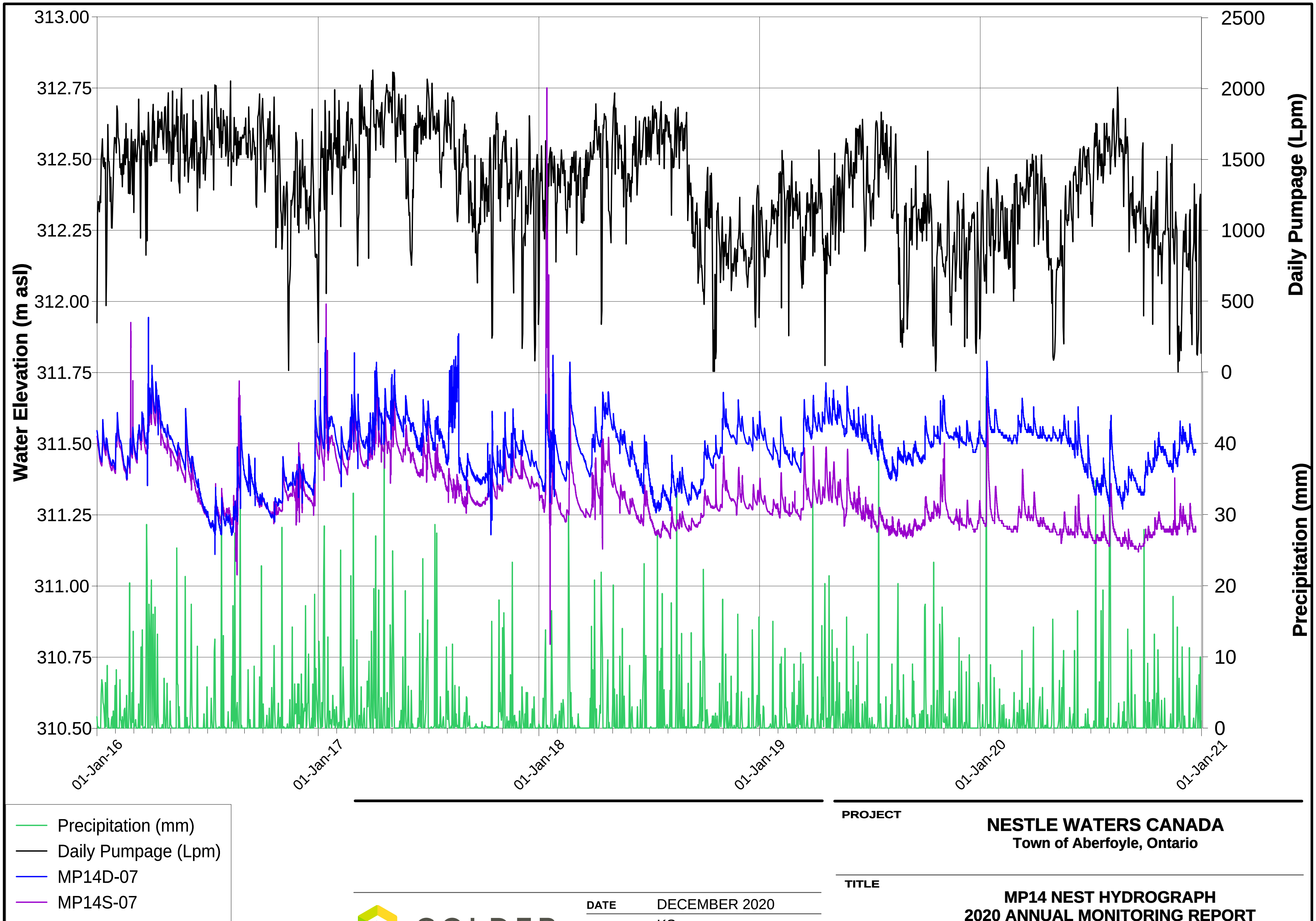
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP12 NEST HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E5b



DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

GOLDER

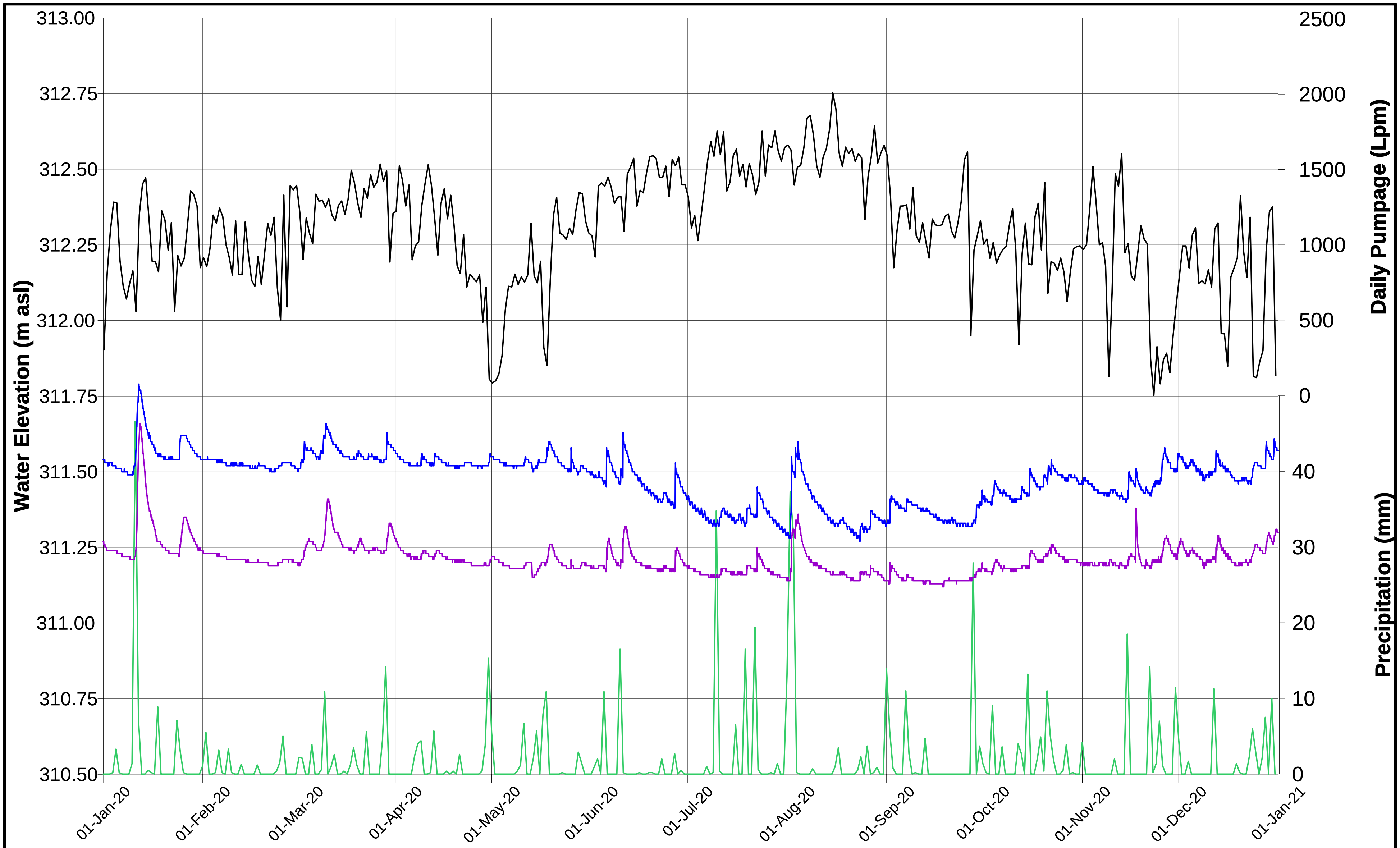
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP14 NEST HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E6a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

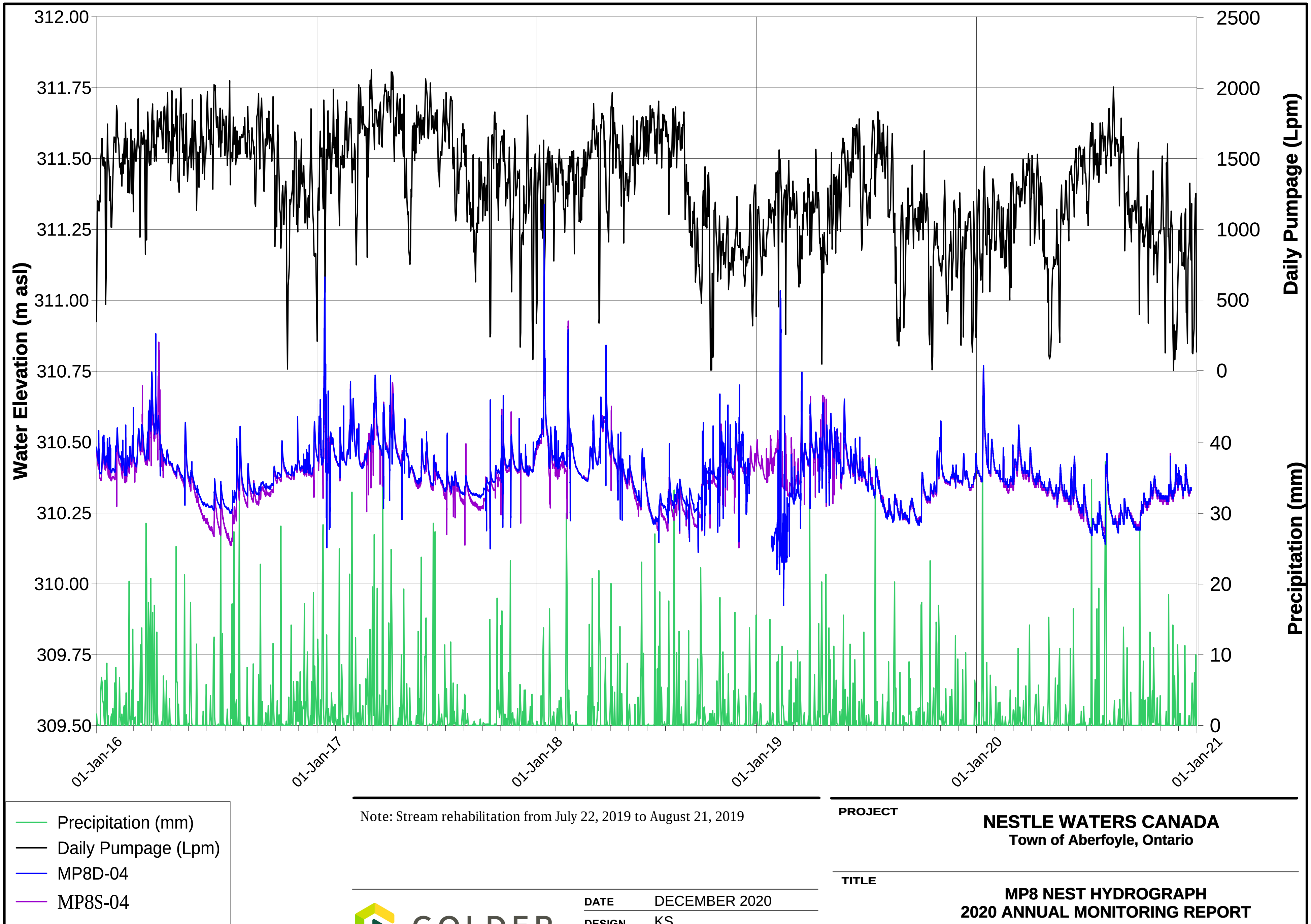
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP14 NEST HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E6b



Note: Stream rehabilitation from July 22, 2019 to August 21, 2019

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA

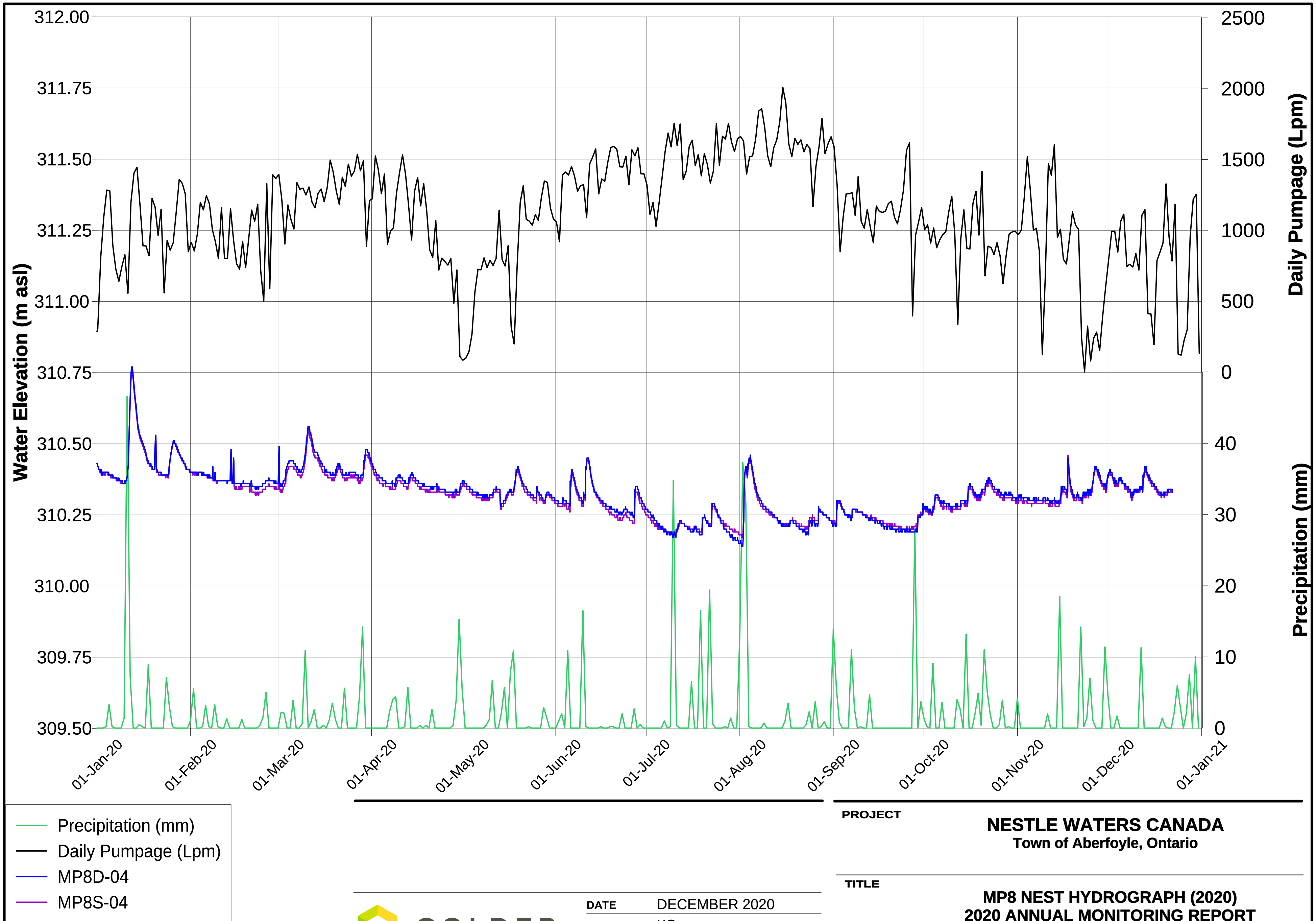
Town of Aberfoyle, Ontario

TITLE

MP8 NEST HYDROGRAPH

2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E7a



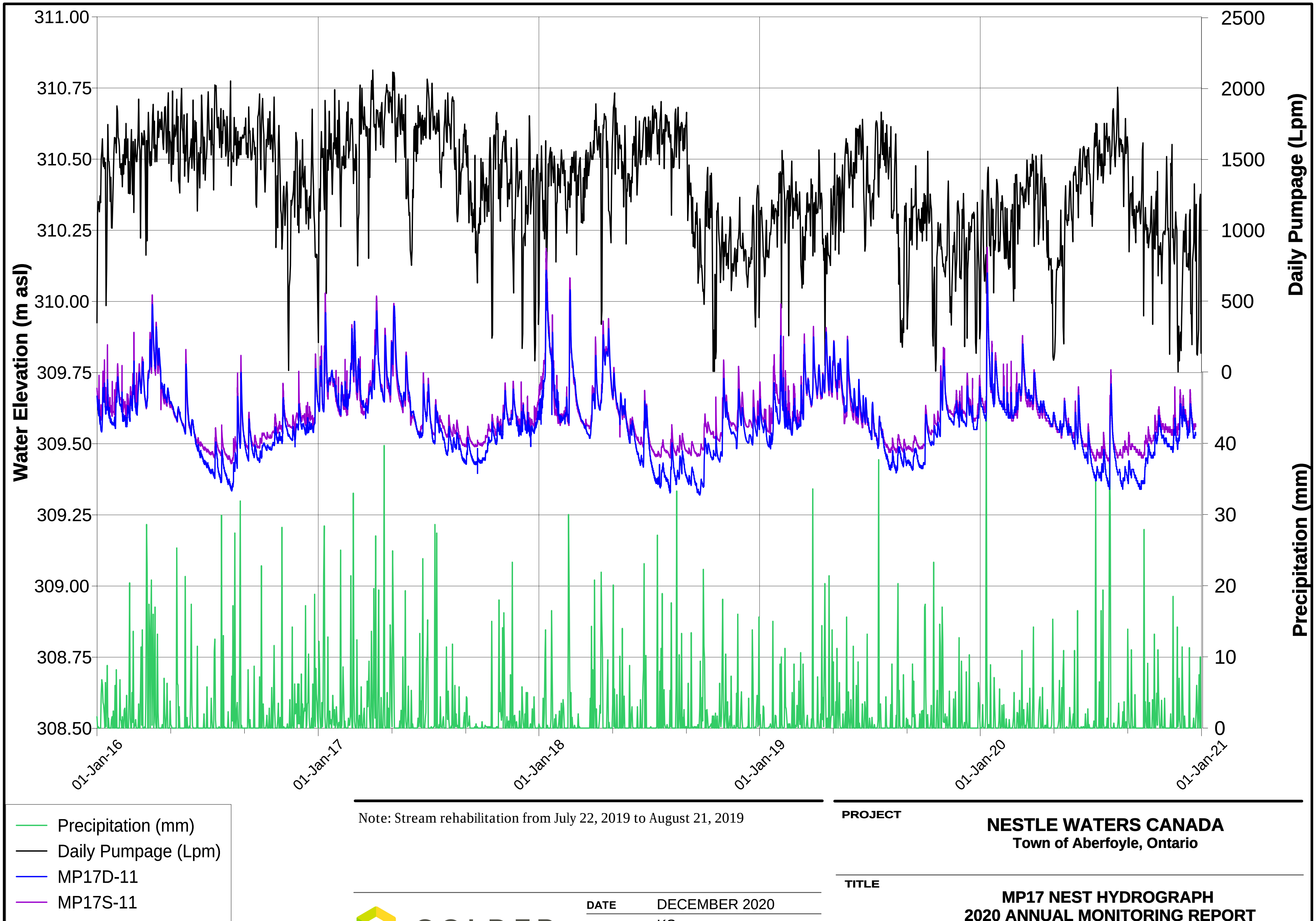
GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
MP8 NEST HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E7b



Note: Stream rehabilitation from July 22, 2019 to August 21, 2019

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

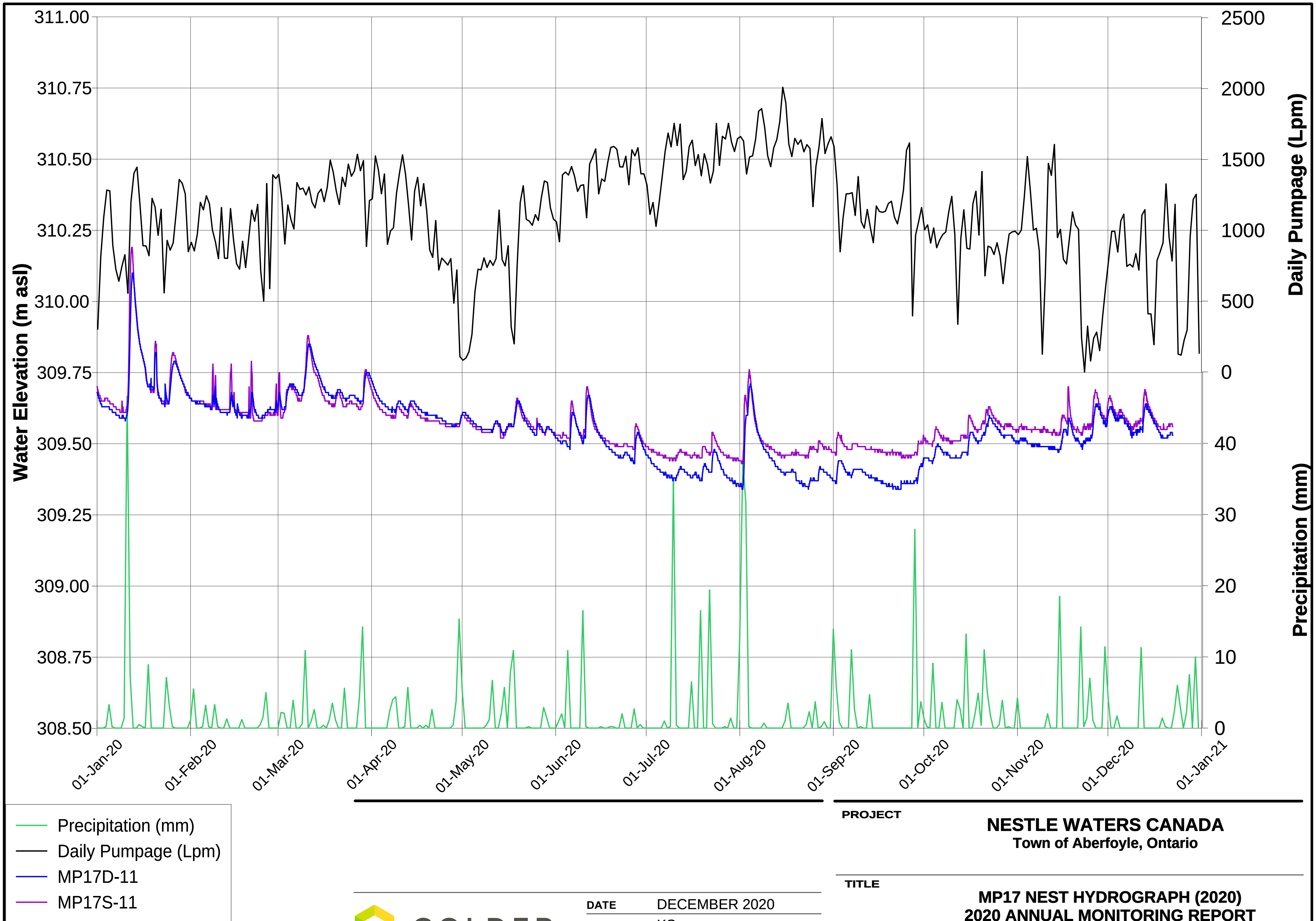
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP17 NEST HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E8a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

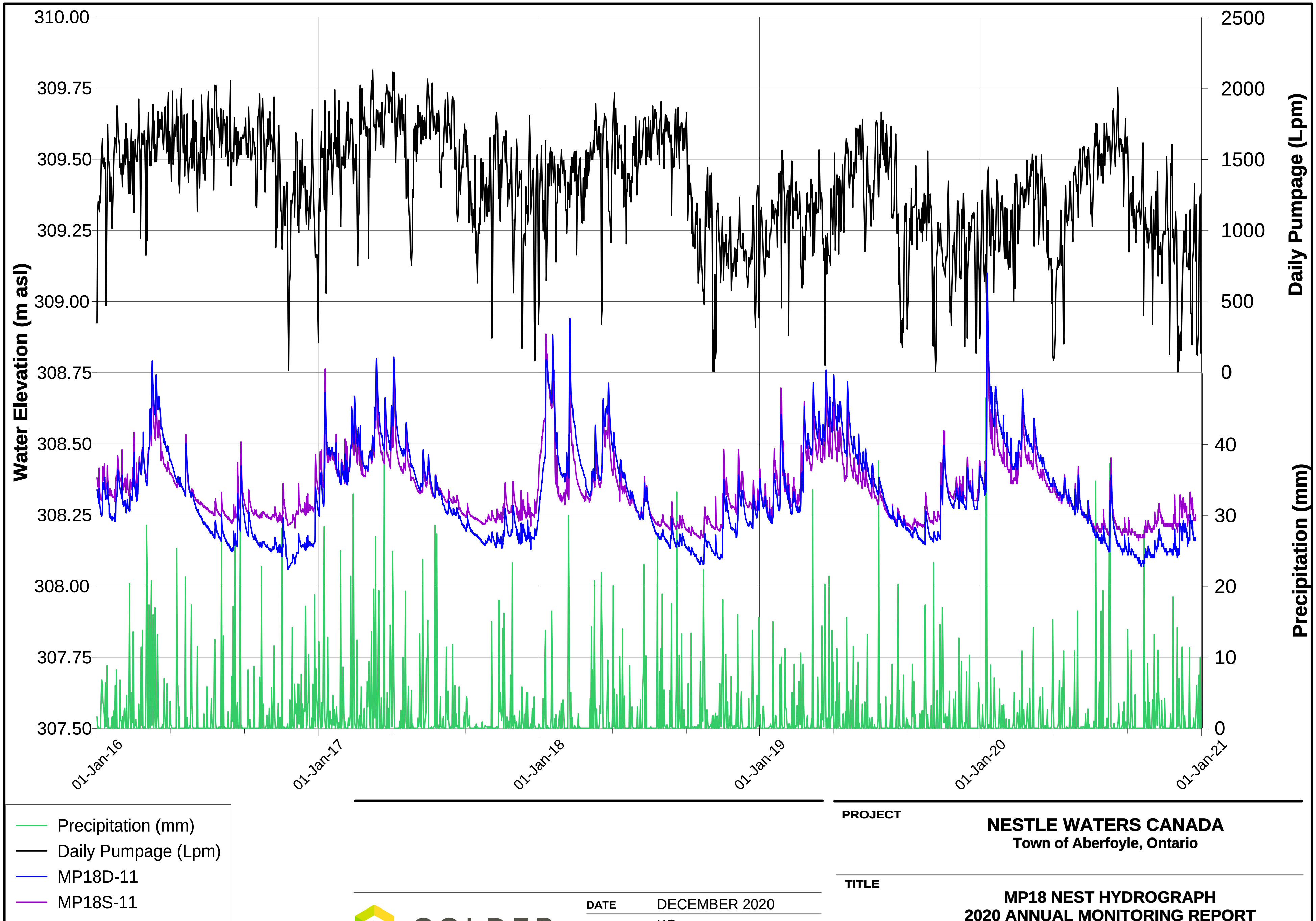
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP17 NEST HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E8b



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

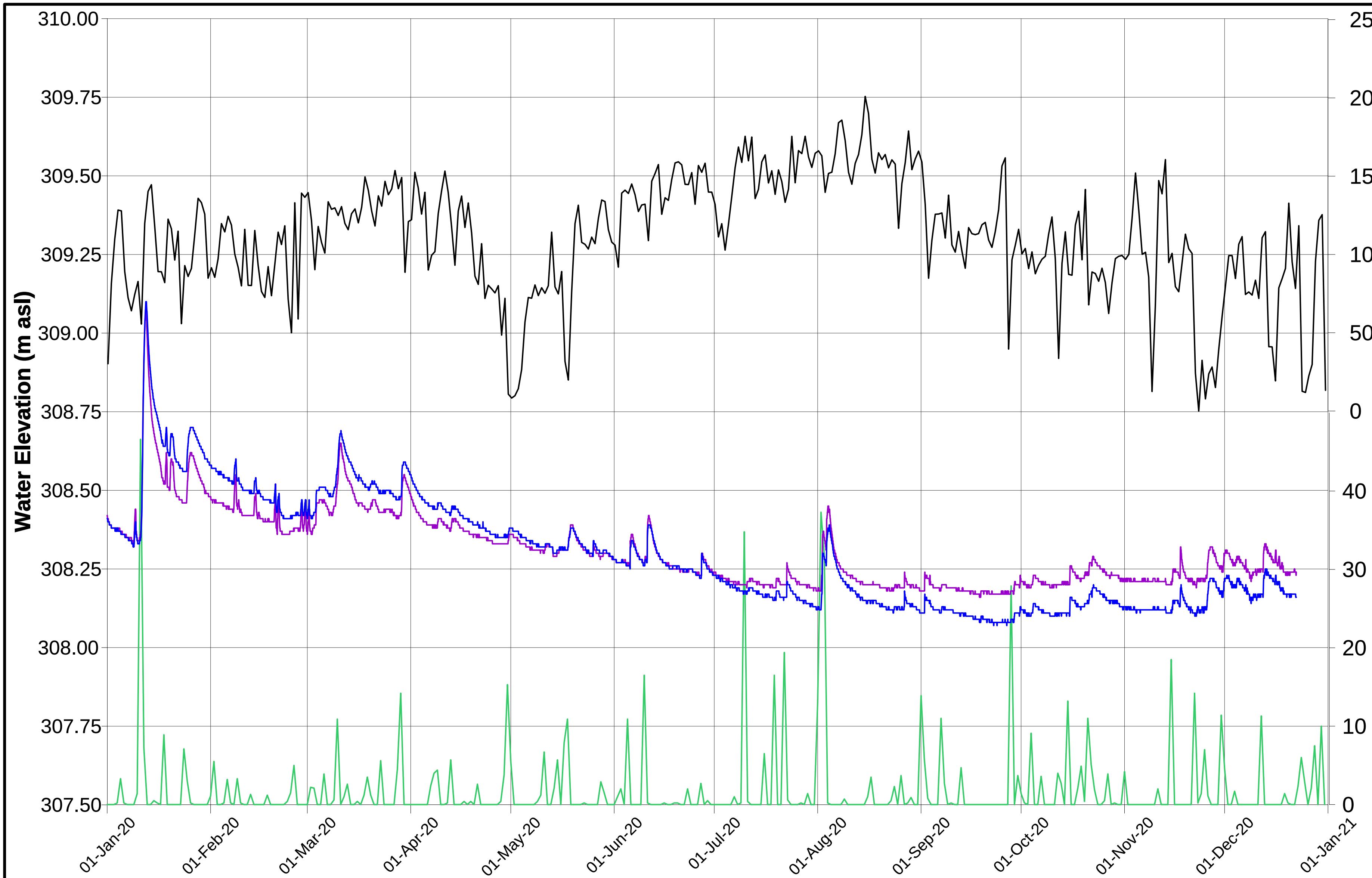
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP18 NEST HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E9a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

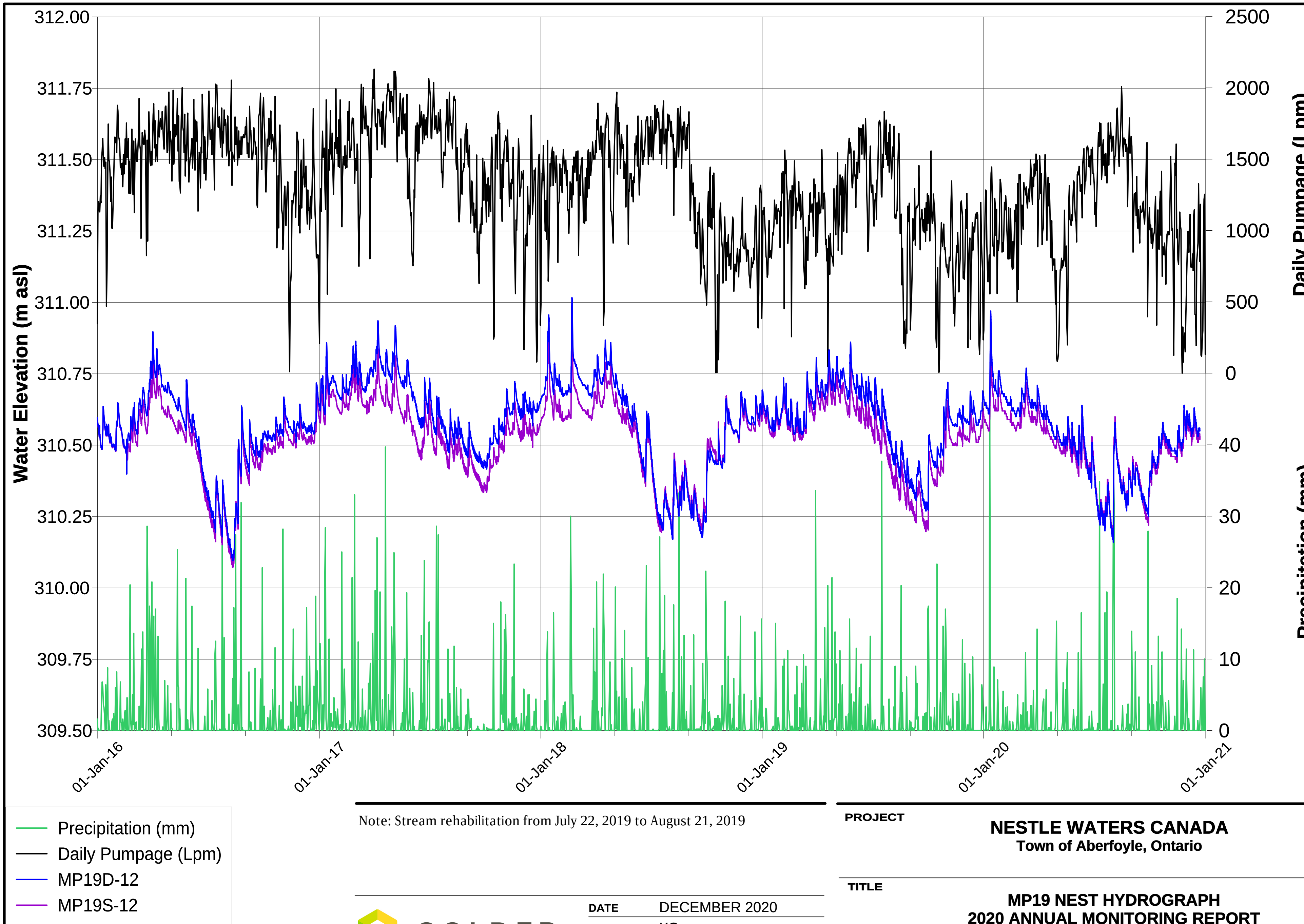
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP18 NEST HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E9b



Note: Stream rehabilitation from July 22, 2019 to August 21, 2019

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

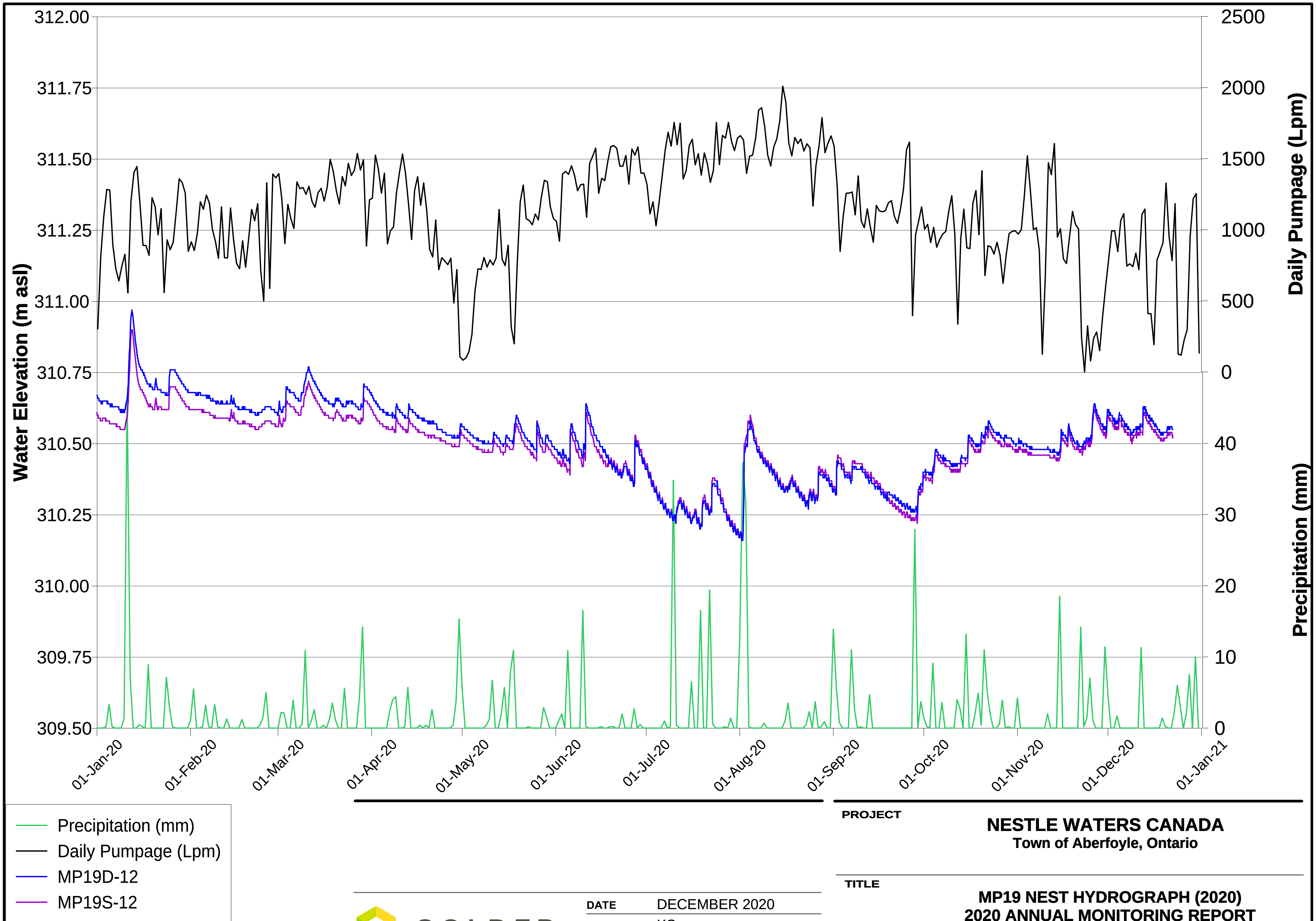
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP19 NEST HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E10a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

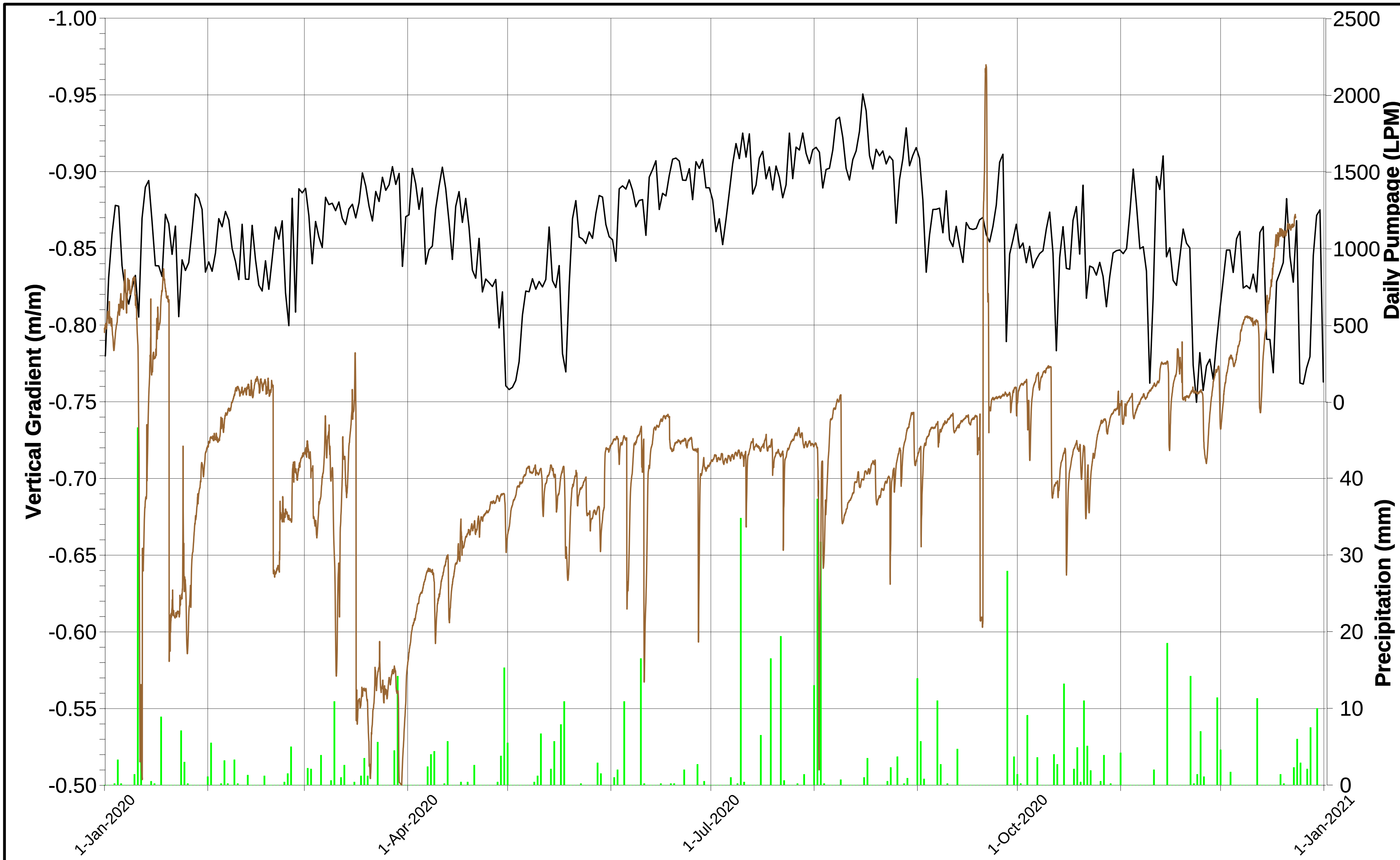
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

MP19 NEST HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E10b



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

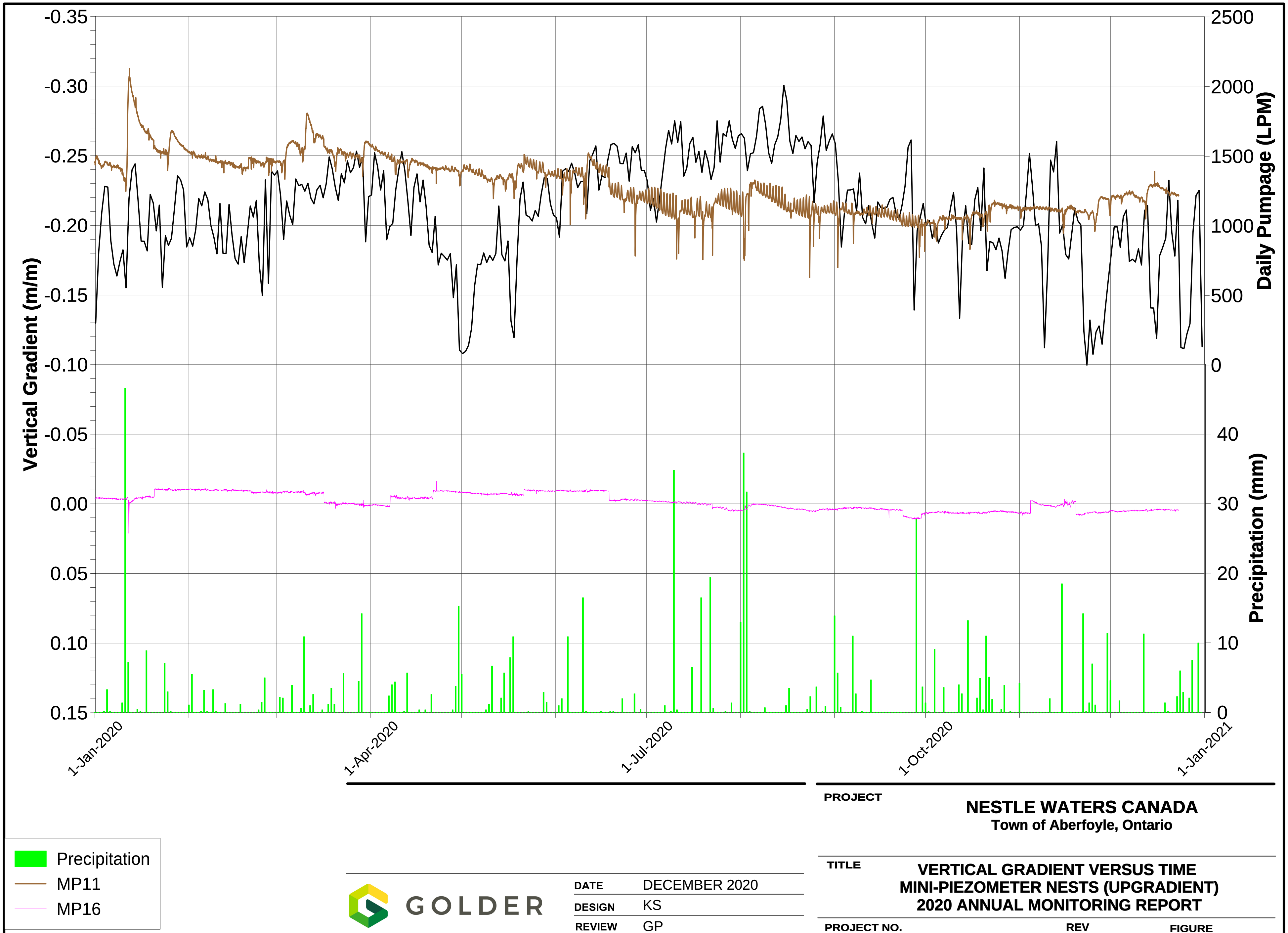
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

VERTICAL GRADIENT VERSUS TIME
MINI-PIEZOMETER NESTS (UPGRADIENT)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E11a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

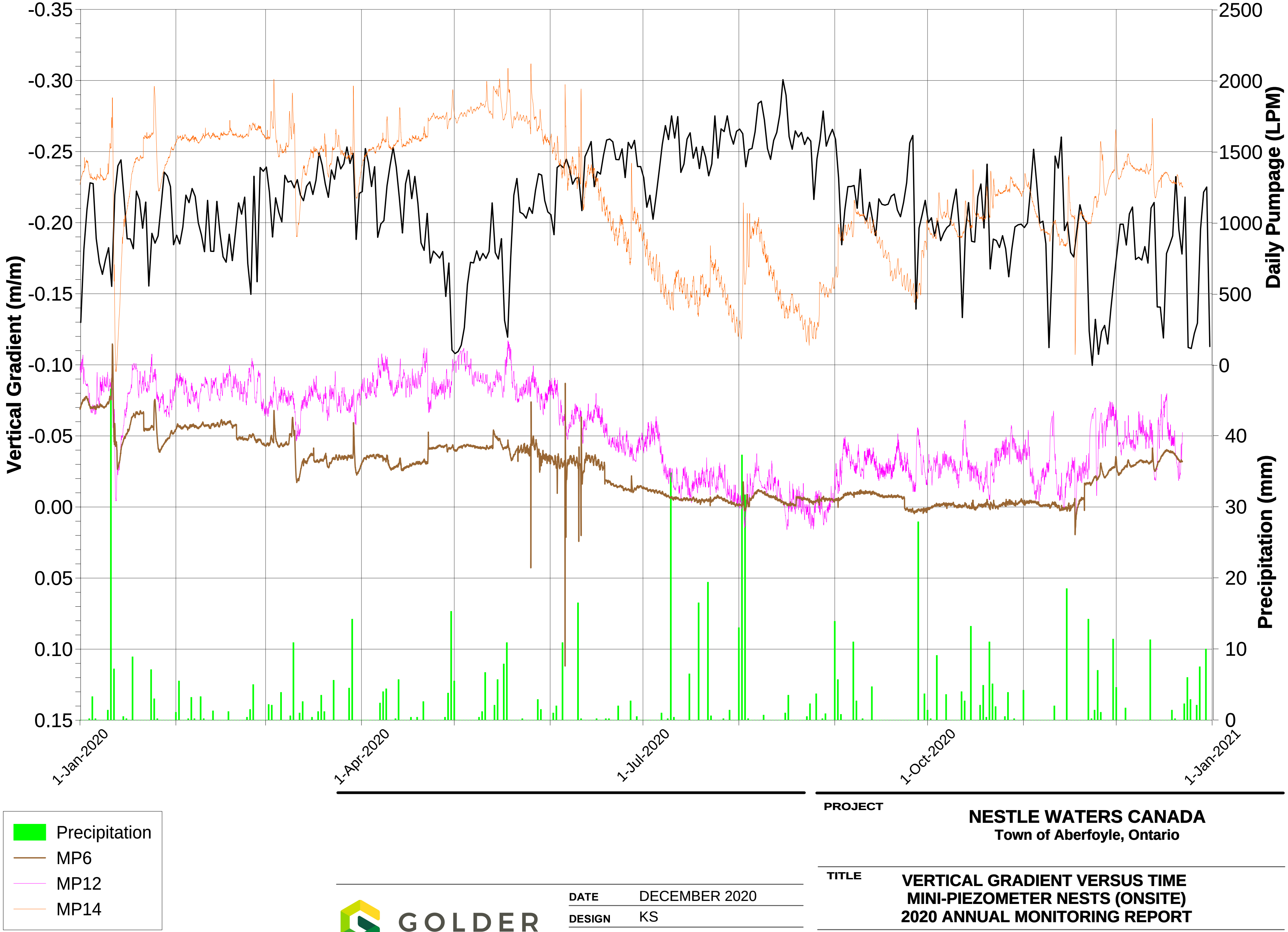
NESTLE WATERS CANADA

Town of Aberfoyle, Ontario

TITLE

VERTICAL GRADIENT VERSUS TIME
MINI-PIEZOMETER NESTS (UPGRADIENT)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E11b



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

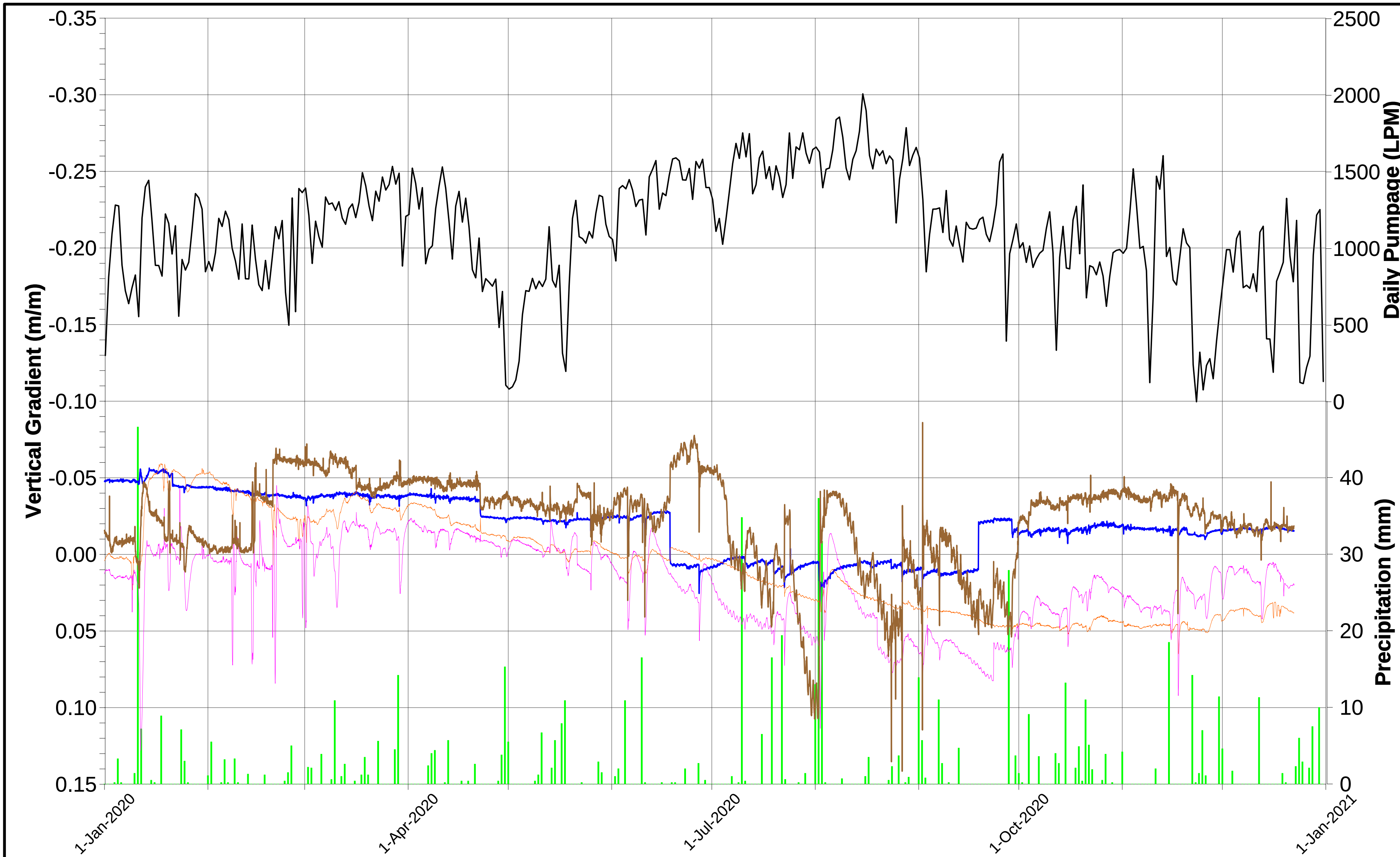
PROJECT

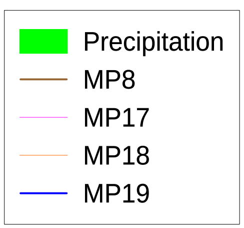
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

VERTICAL GRADIENT VERSUS TIME
MINI-PIEZOMETER NESTS (ONSITE)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E11c





DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

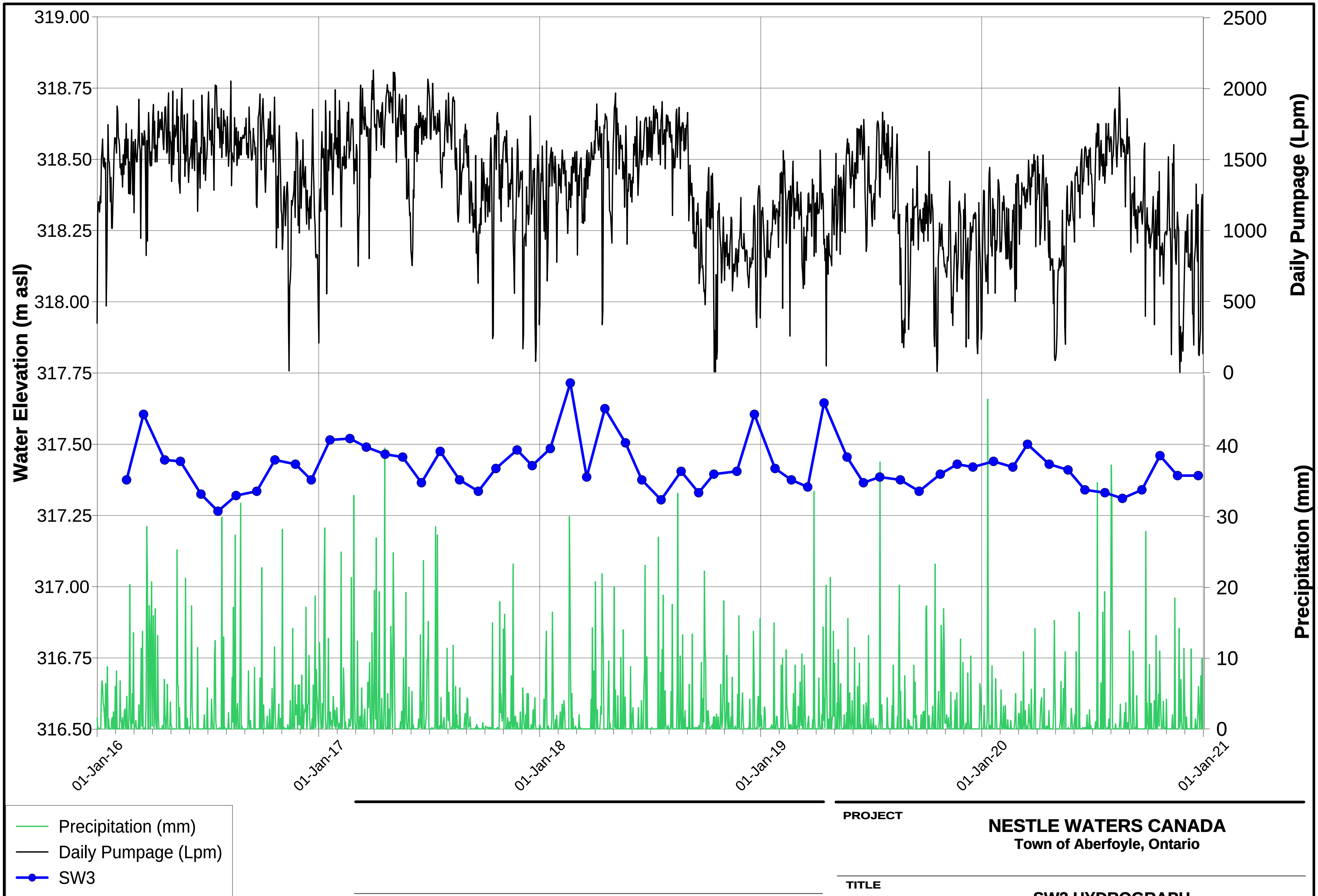
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

VERTICAL GRADIENT VERSUS TIME
MINI-PIEZOMETER NESTS (DOWNGRADIENT)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E11d



DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA

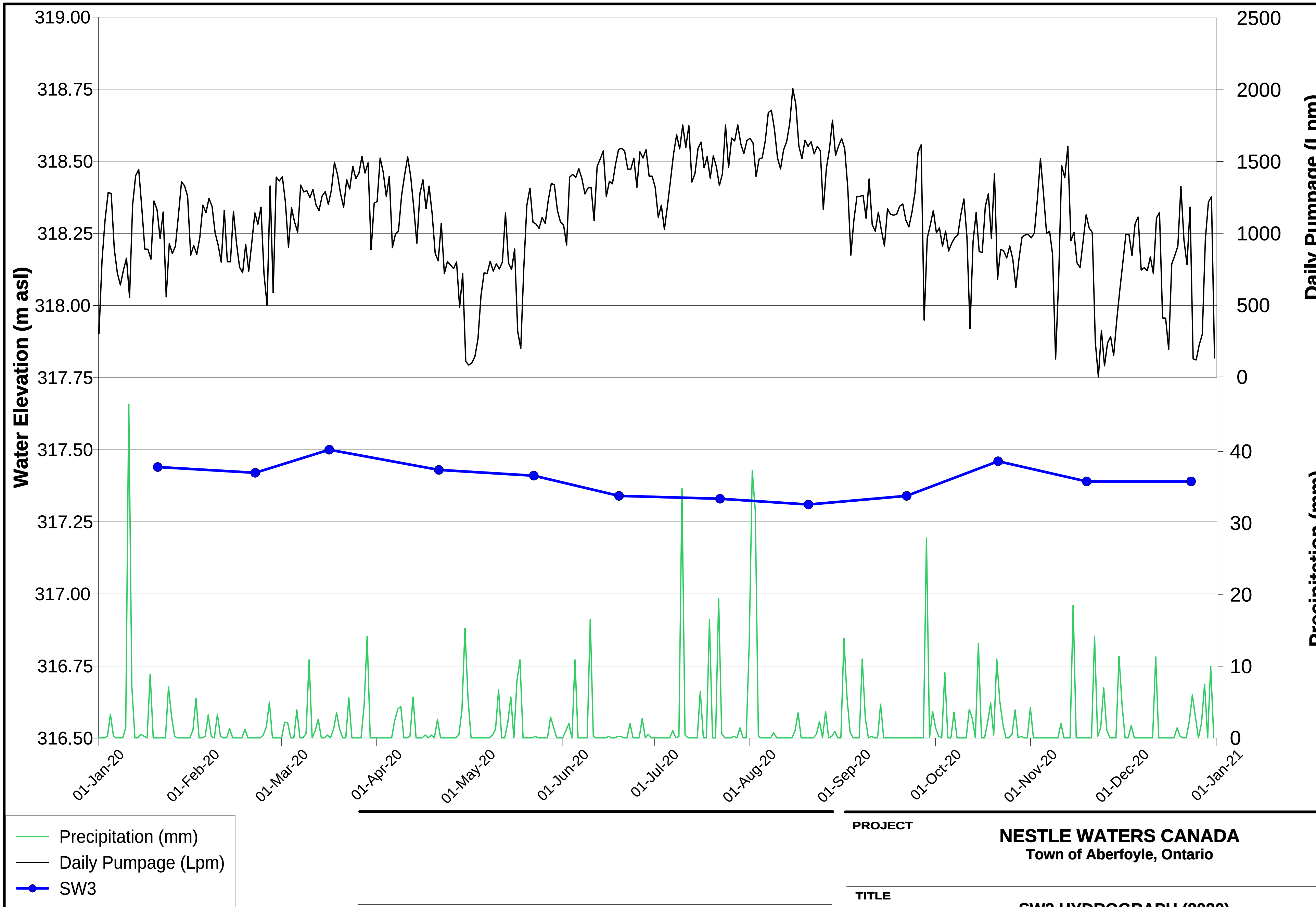
Town of Aberfoyle, Ontario

TITLE

SW3 HYDROGRAPH

2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E12a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

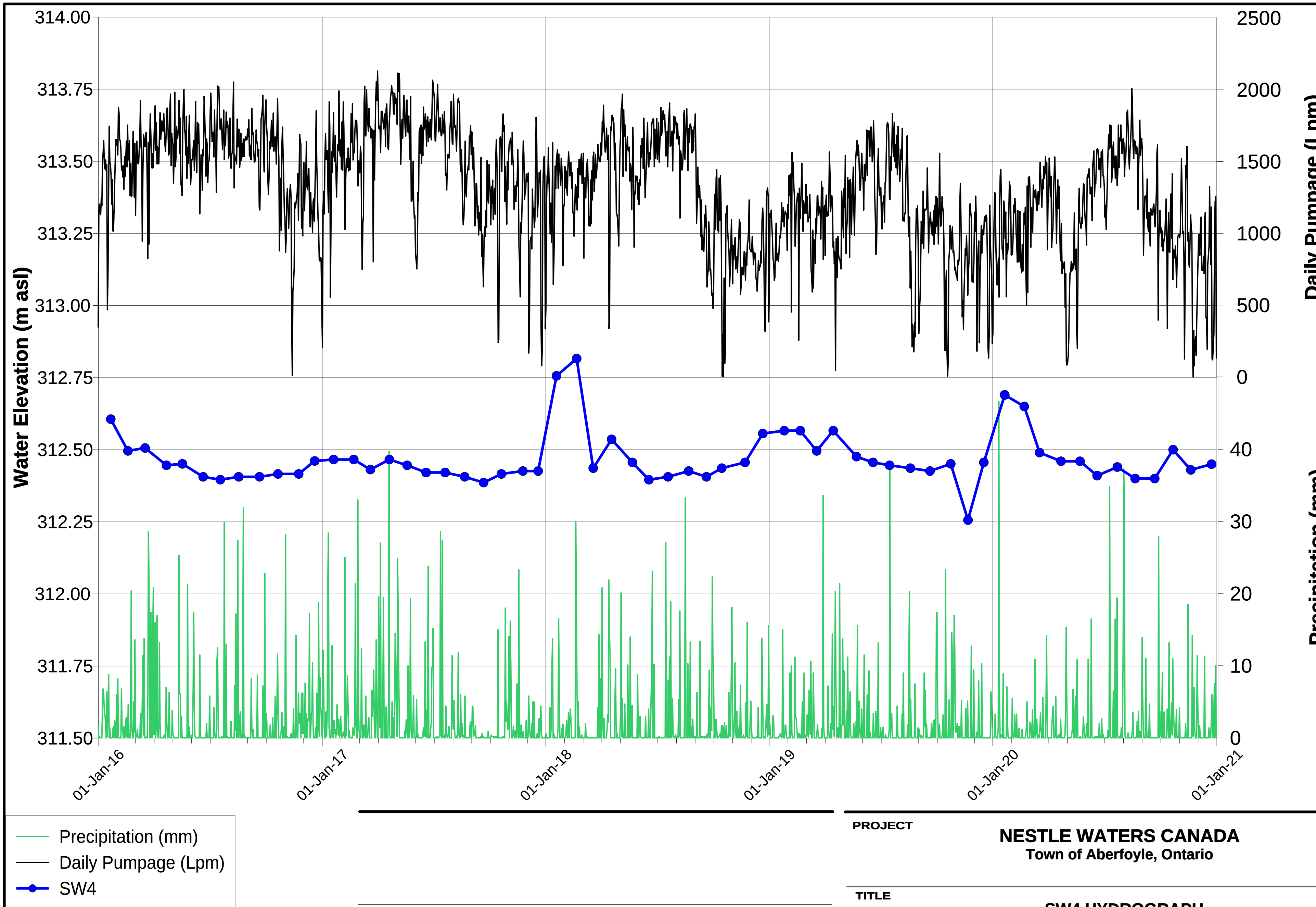
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

SW3 HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E12b



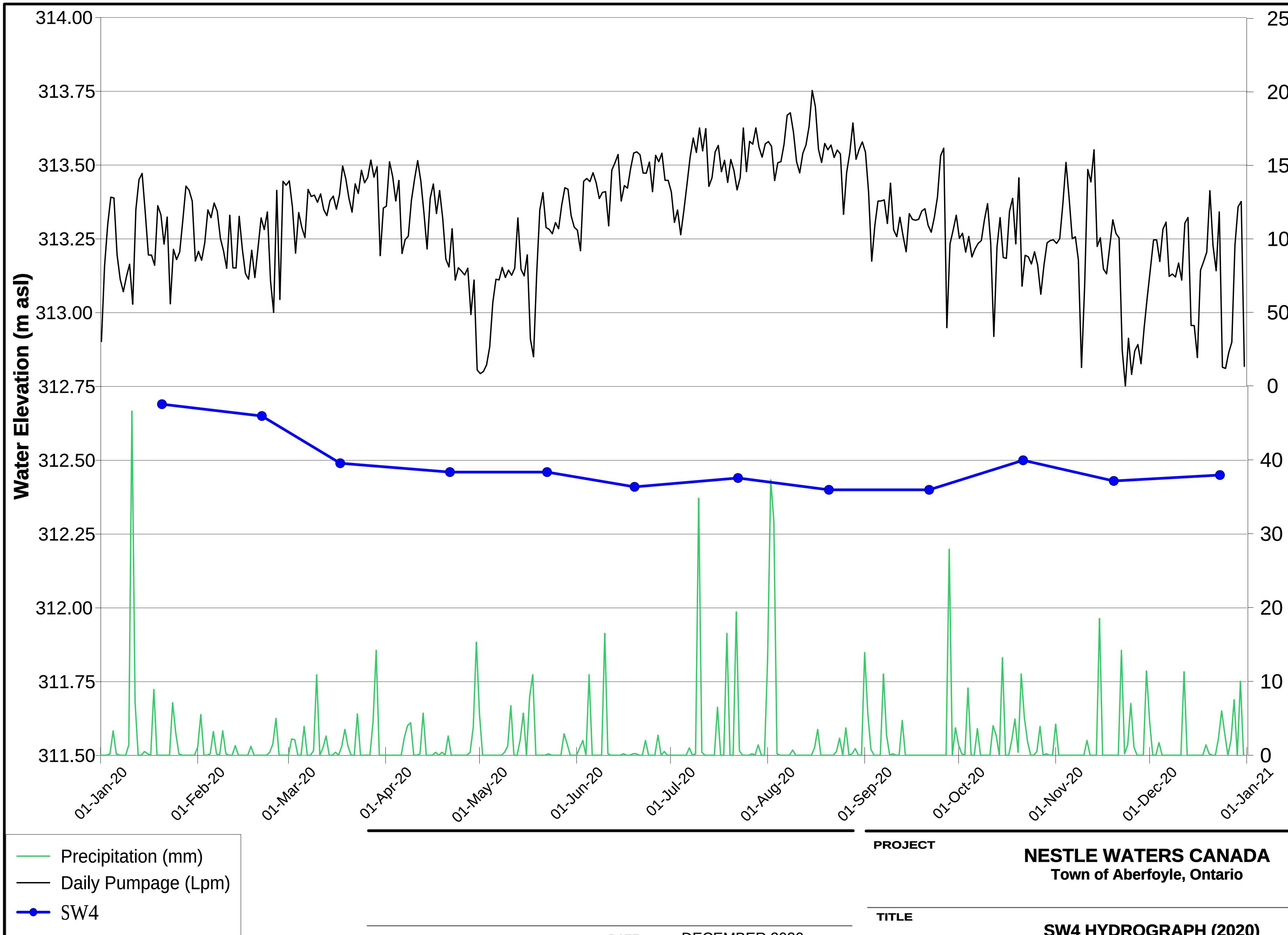
GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
SW4 HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E13a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

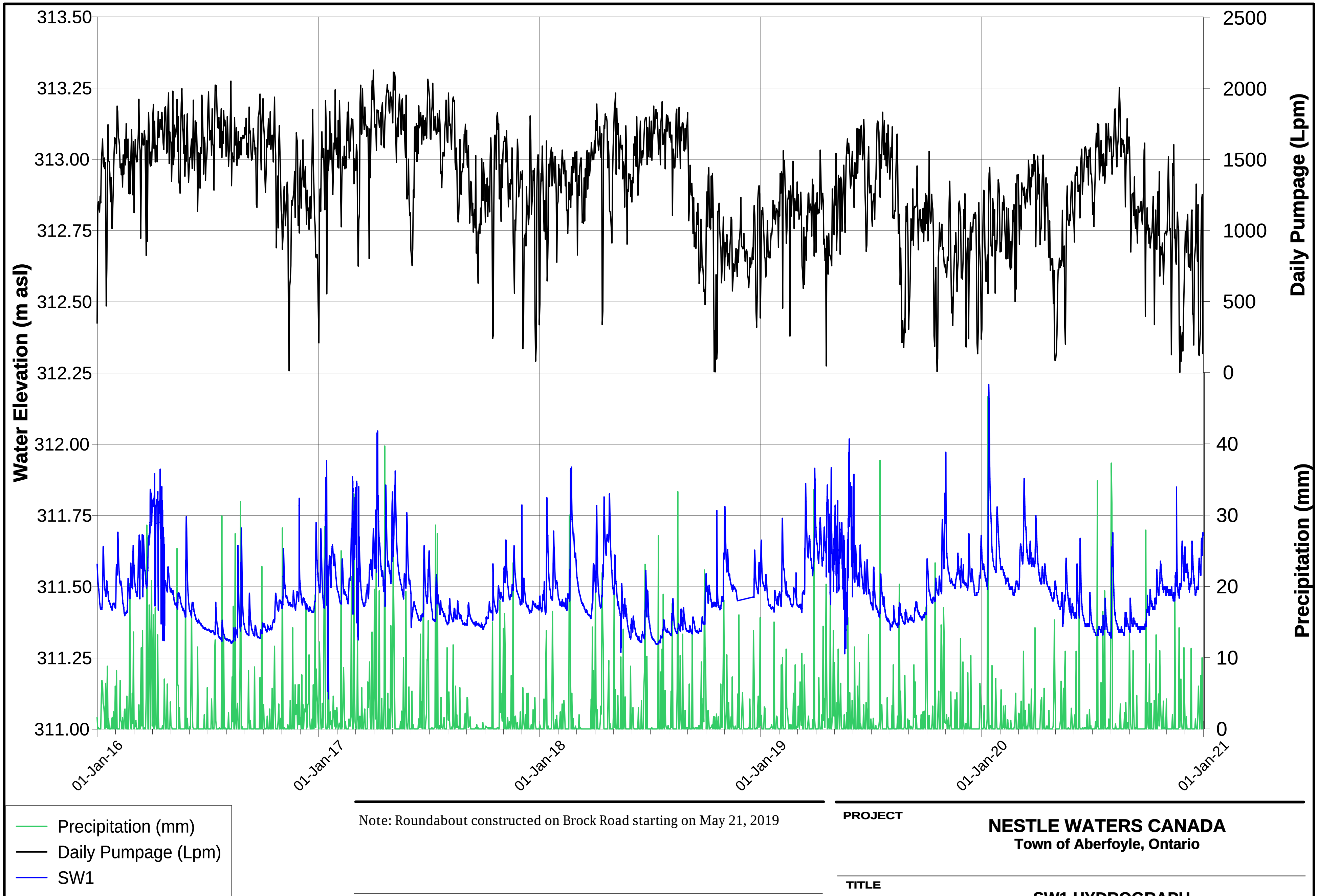
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

SW4 HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E13b



Note: Roundabout constructed on Brock Road starting on May 21, 2019

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

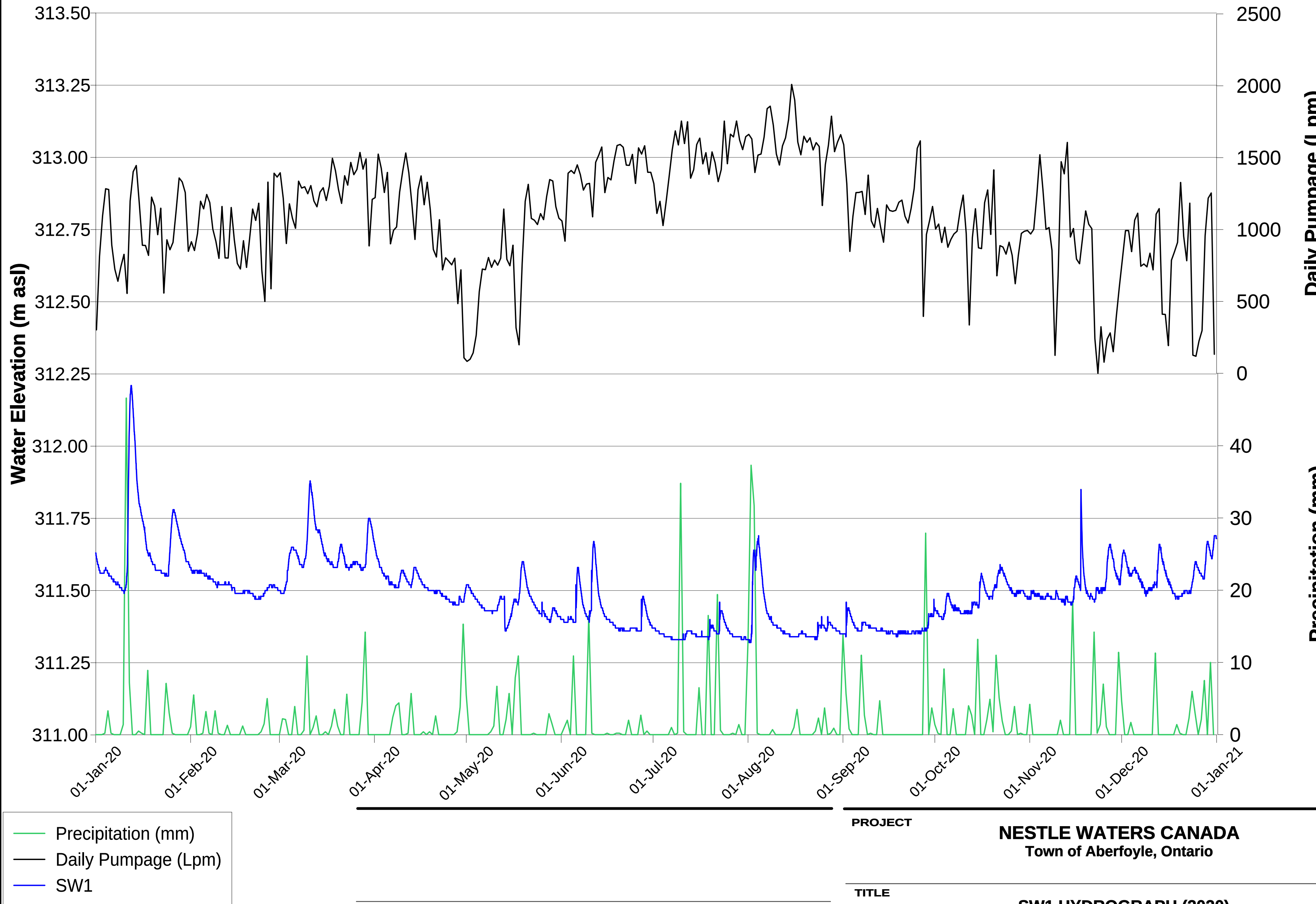
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

SW1 HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E14a



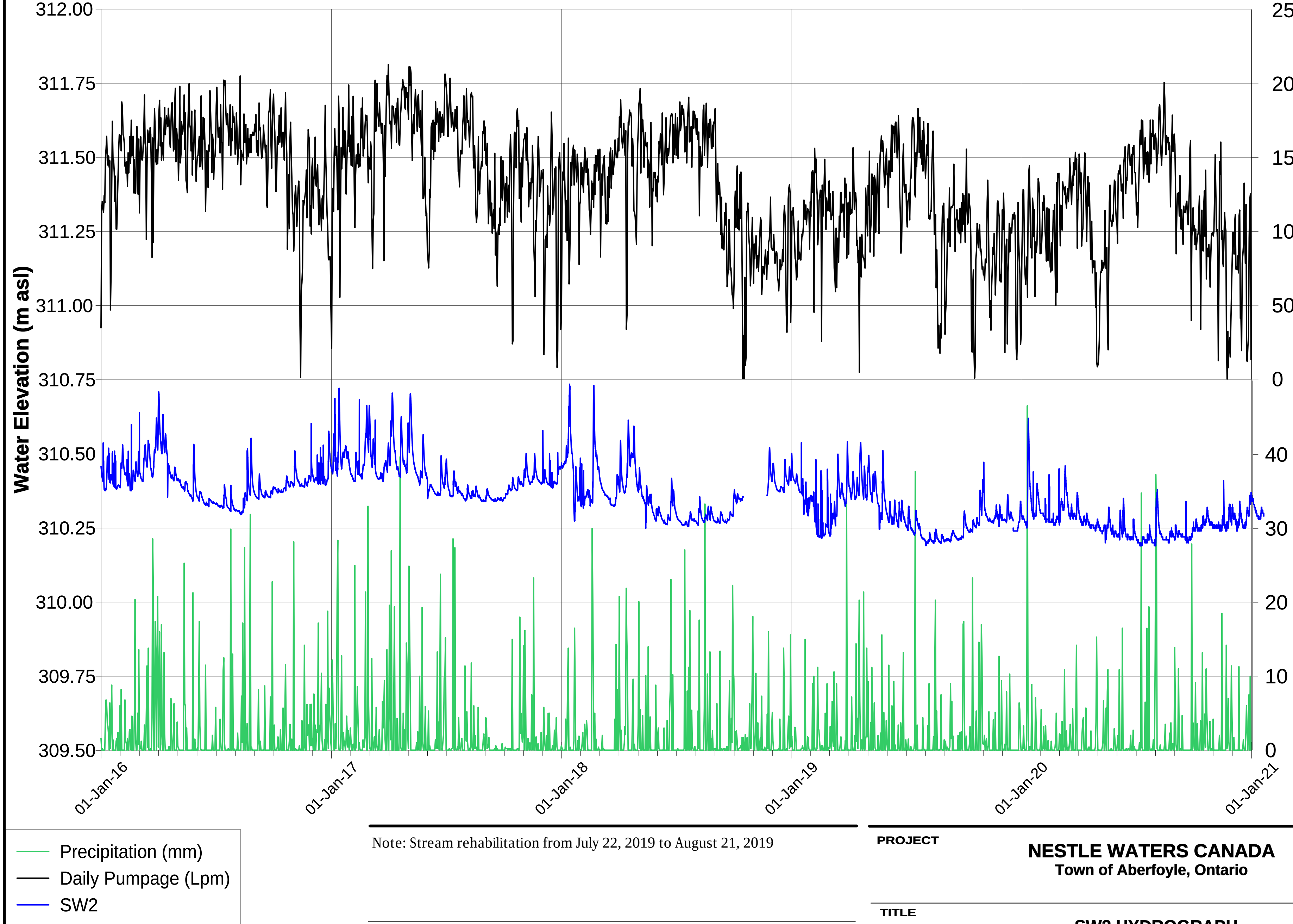
GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
SW1 HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E14b



Note: Stream rehabilitation from July 22, 2019 to August 21, 2019

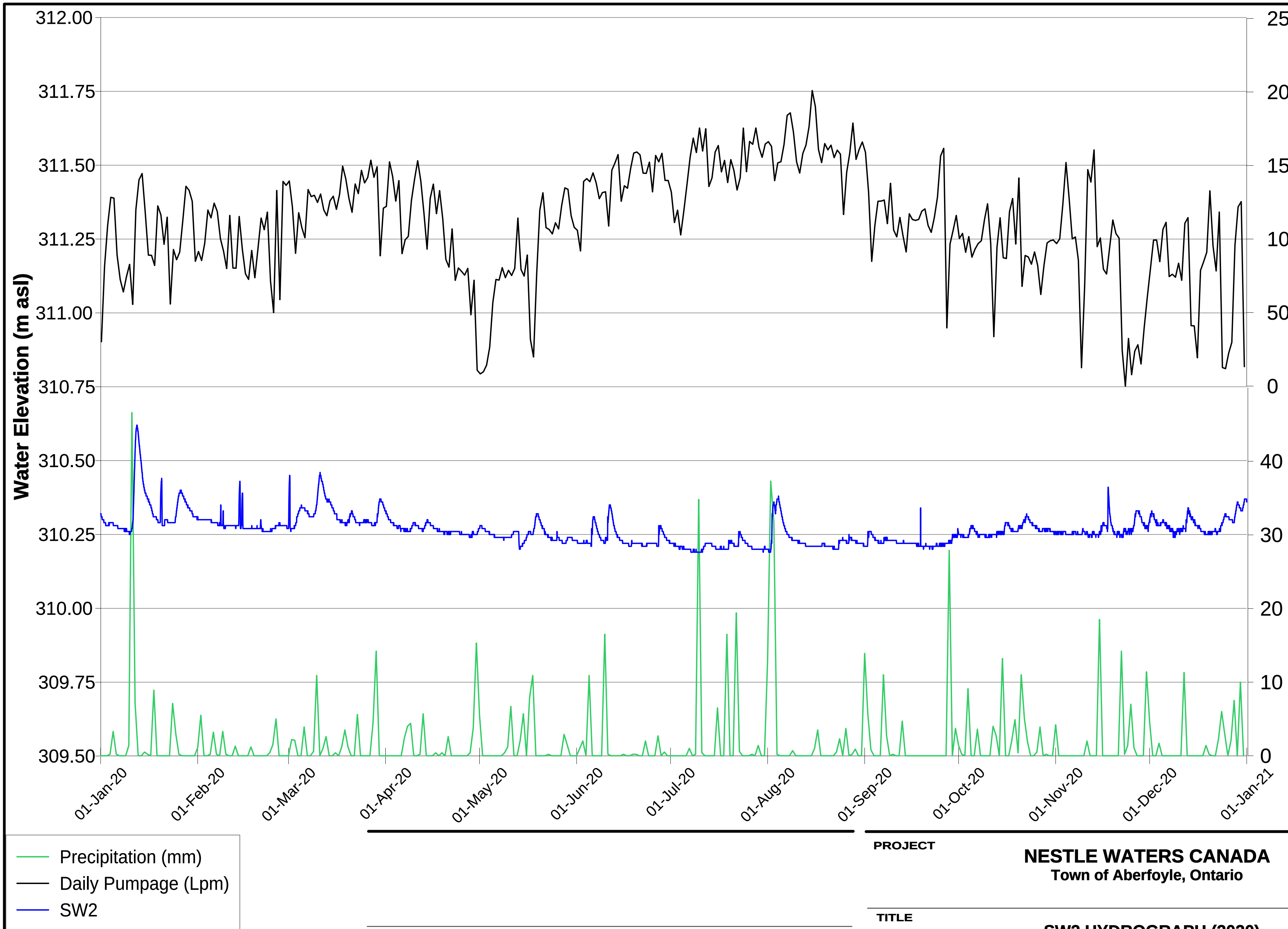
GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
SW2 HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E15a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

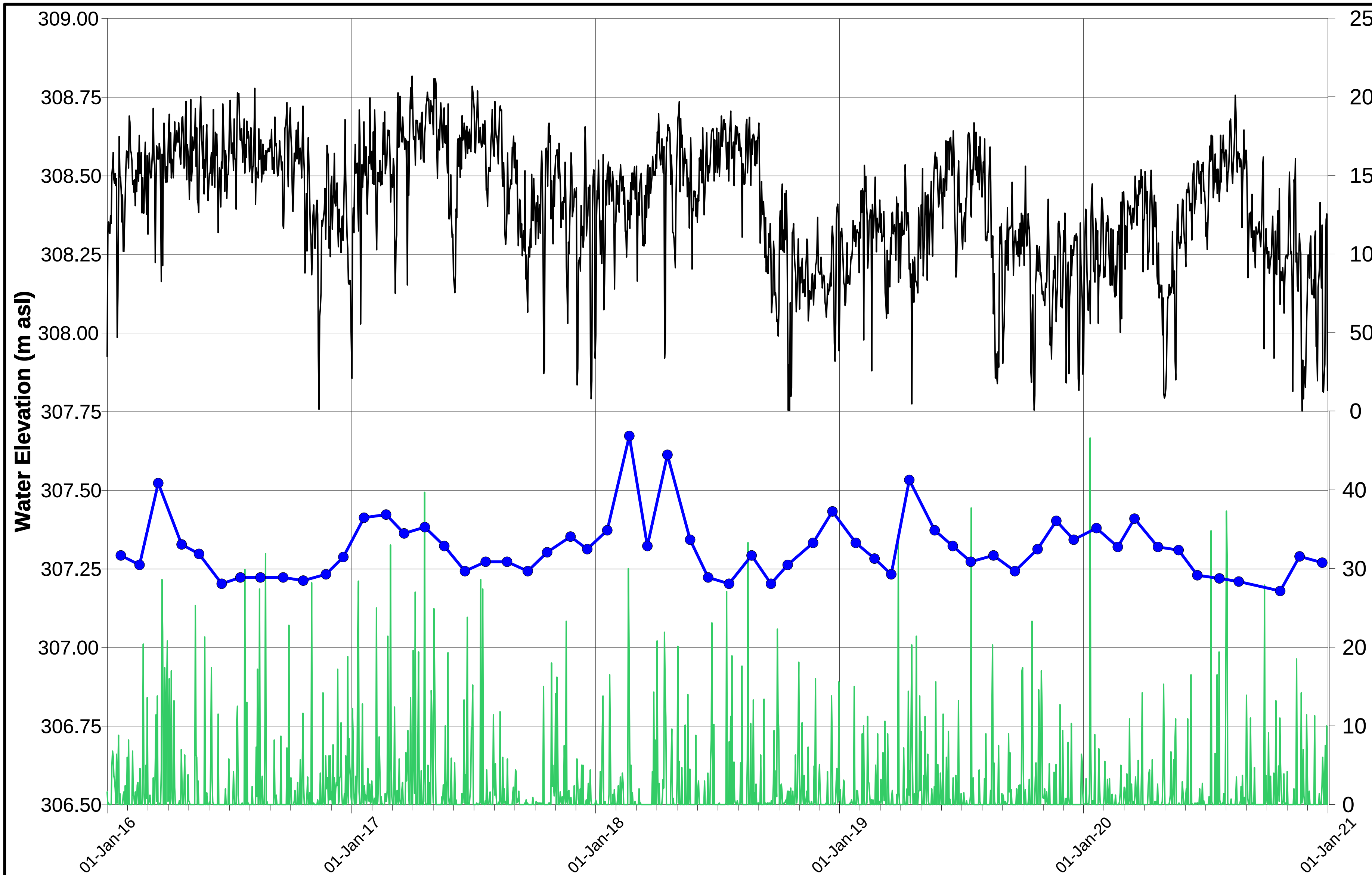
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

SW2 HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E15b



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA

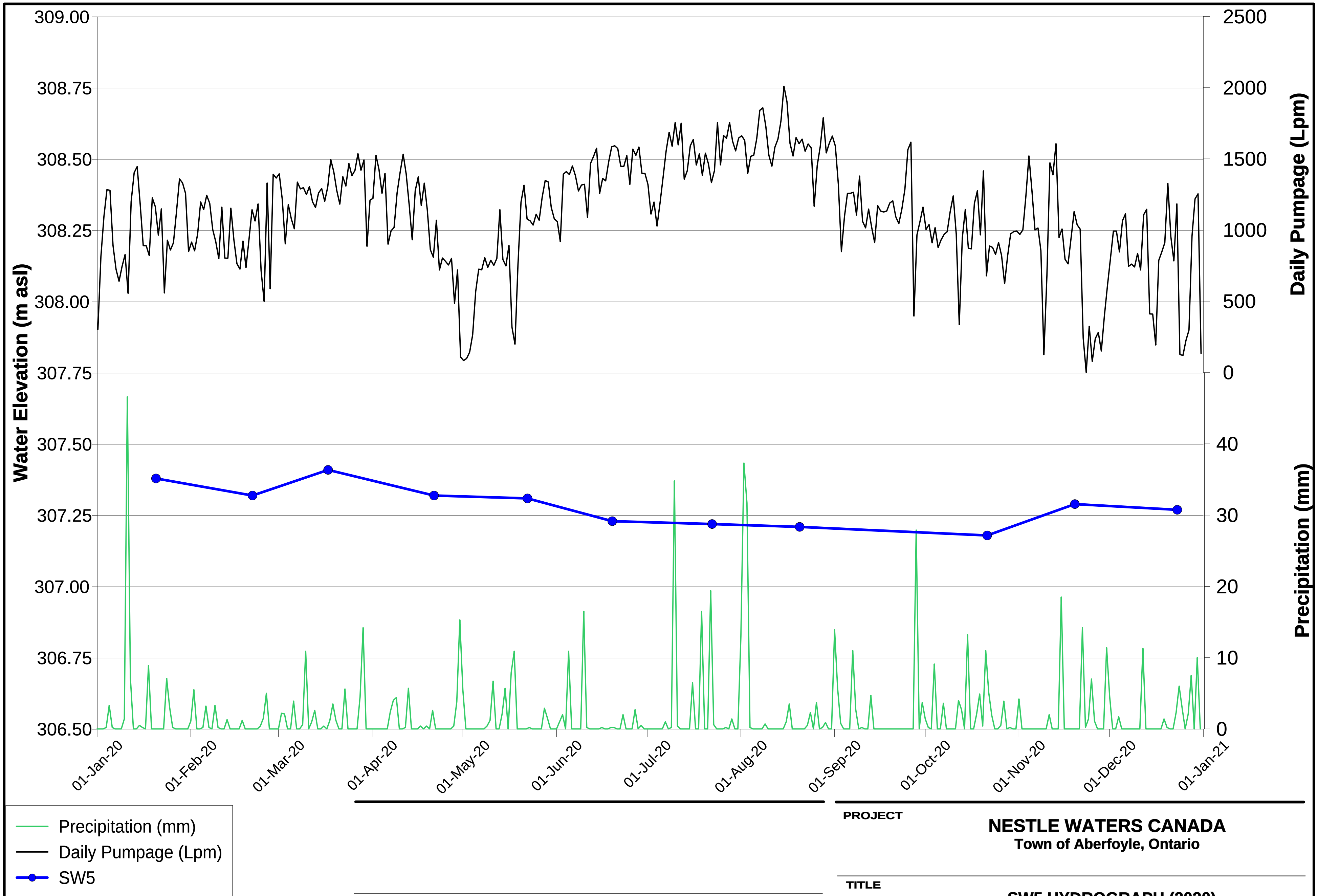
Town of Aberfoyle, Ontario

TITLE

SW5 HYDROGRAPH

2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E16a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

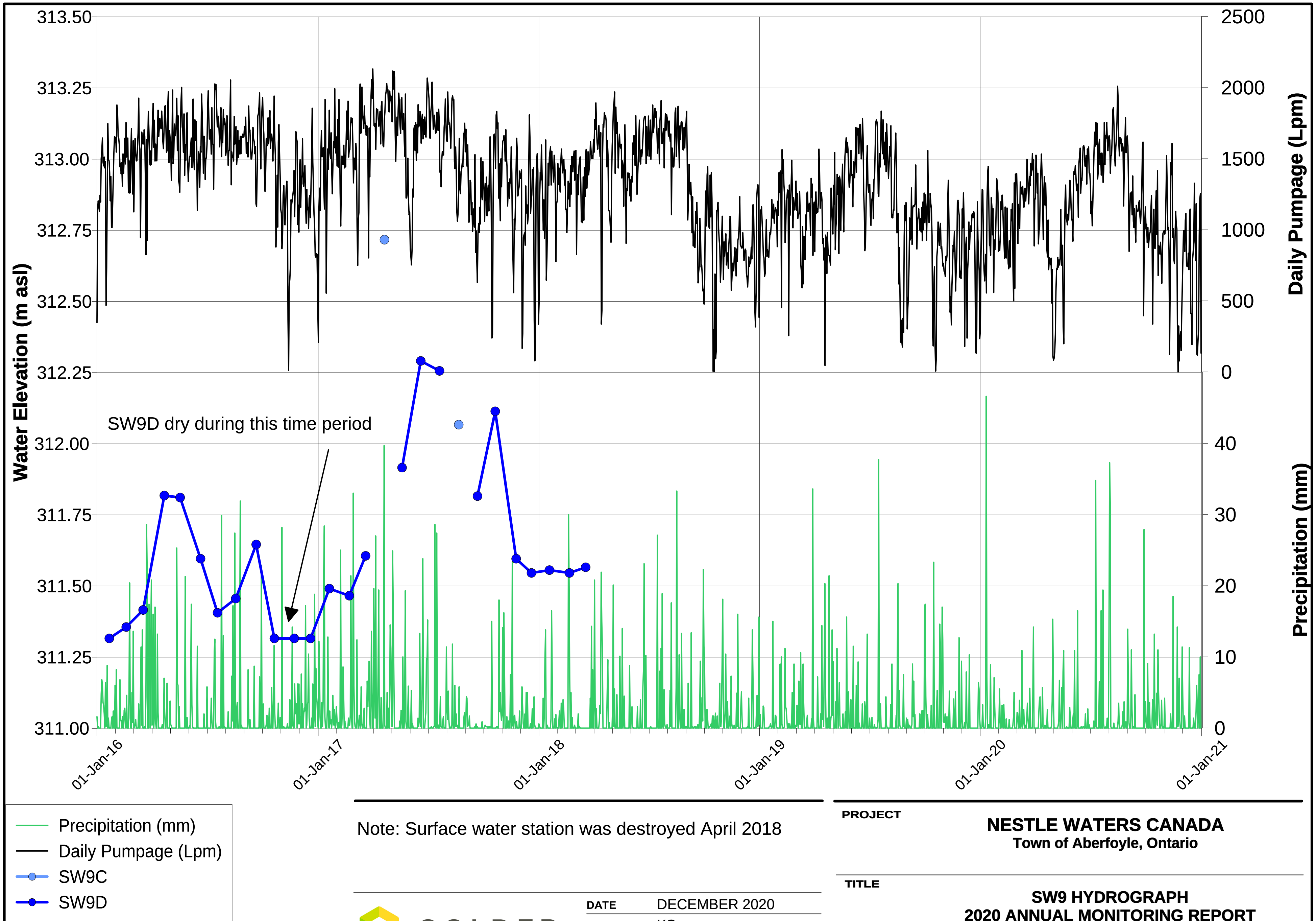
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

SW5 HYDROGRAPH (2020)
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E16b



Note: Surface water station was destroyed April 2018

GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

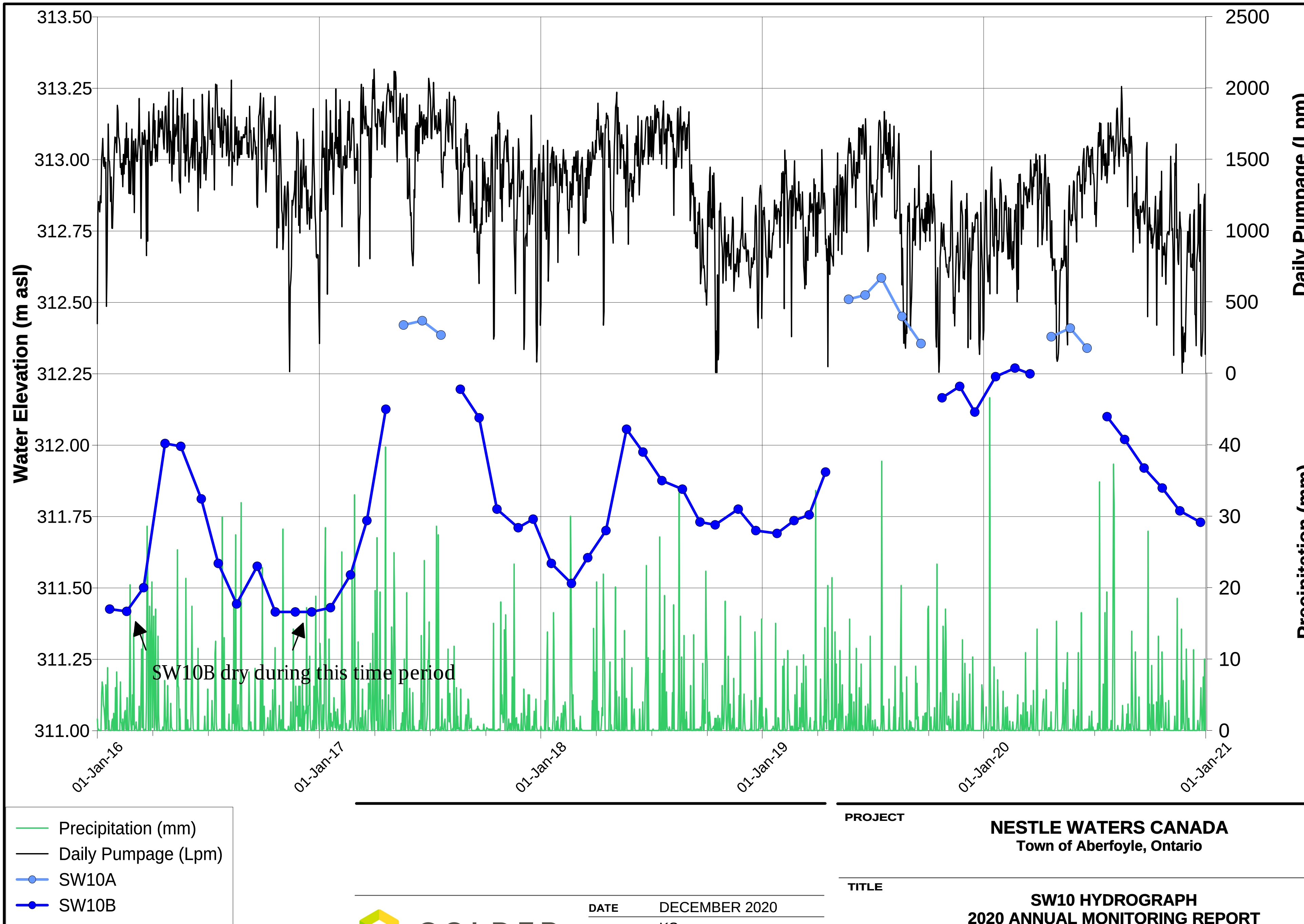
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

SW9 HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E17



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

SW10 HYDROGRAPH
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	E18

TABLE E1
Manual Surface Water Elevations (Mini Piezometers)
2020 Annual Report

Date	Water Level (masl)							
	MP1D-16	MP1S-16	MP11D-04	MP11S-08	MP16D-08	MP16S-08	MP06D-04	MP06S-08
20-Jan-20	FROZEN	318.36	FROZEN	317.78	FROZEN	FROZEN	FROZEN	FROZEN
20/21-Feb-20	FROZEN	318.32	FROZEN	317.77	FROZEN	FROZEN	FROZEN	FROZEN
16-Mar-20	FROZEN	318.39	318.02	317.77	312.42	312.43	311.66	311.63
21/22-Apr-20	319.00	318.31	317.99	317.77	312.31	312.31	311.60	311.58
21-May-20	319.02	318.29	317.98	317.76	312.35	312.34	311.61	311.59
18-Jun-20	318.99	318.22	317.96	317.73	312.24	312.23	311.51	311.49
20/24-Jul-20	318.96	318.21	317.93	317.74	312.09	312.09	311.47	311.47
19-Aug-20	318.93	318.20	317.93	317.74	312.08	312.08	311.41	311.40
21/22-Sep-20	318.98	318.21	317.93	317.74	312.03	312.03	311.41	311.41
21/22-Oct-20	319.05	318.34	317.97	317.78	312.26	312.21	311.65	311.64
19/20-Nov-20	319.08	318.27	317.96	317.76	312.17	312.18	311.54	311.53
22/23-Dec-20	318.91	318.32	317.97	317.77	312.20	312.37	311.56	311.54

TABLE E1
Manual Surface Water Elevations (Mini Piezometers)
2020 Annual Report

Date	Water Level (masl)							
	MP12D-04	MP12S-04	MP14D-07	MP14S-07	MP08D-04	MP08S-04	MP17D-11	MP17S-11
20-Jan-20	FROZEN	FROZEN	FROZEN	FROZEN	FROZEN	FROZEN	FROZEN	FROZEN
20/21-Feb-20	FROZEN	FROZEN	FROZEN	FROZEN	310.36	FROZEN	FROZEN	FROZEN
16-Mar-20	FROZEN	311.57	FROZEN	311.26	310.41	310.40	309.70	309.67
21/22-Apr-20	FROZEN	311.51	311.54	311.21	310.35	310.34	309.60	309.59
21-May-20	311.60	311.53	311.55	311.22	310.36	310.34	309.61	309.59
18-Jun-20	311.45	311.40	311.46	311.20	310.29	310.27	309.49	309.51
20/24-Jul-20	311.36	311.34	311.41	311.21	310.27	310.27	309.47	309.52
19-Aug-20	311.26	311.26	311.33	311.16	310.23	310.23	309.41	309.48
21/22-Sep-20	311.31	311.28	311.34	311.14	310.21	310.21	309.37	309.47
21/22-Oct-20	311.53	311.51	311.53	311.26	310.39	310.38	309.59	309.64
19/20-Nov-20	311.44	311.43	311.32	311.20	310.32	310.30	309.51	309.55
22/23-Dec-20	311.50	311.45	311.47	311.21	310.34	310.33	309.54	309.57

TABLE E1
Manual Surface Water Elevations (Mini Piezometers)
2020 Annual Report

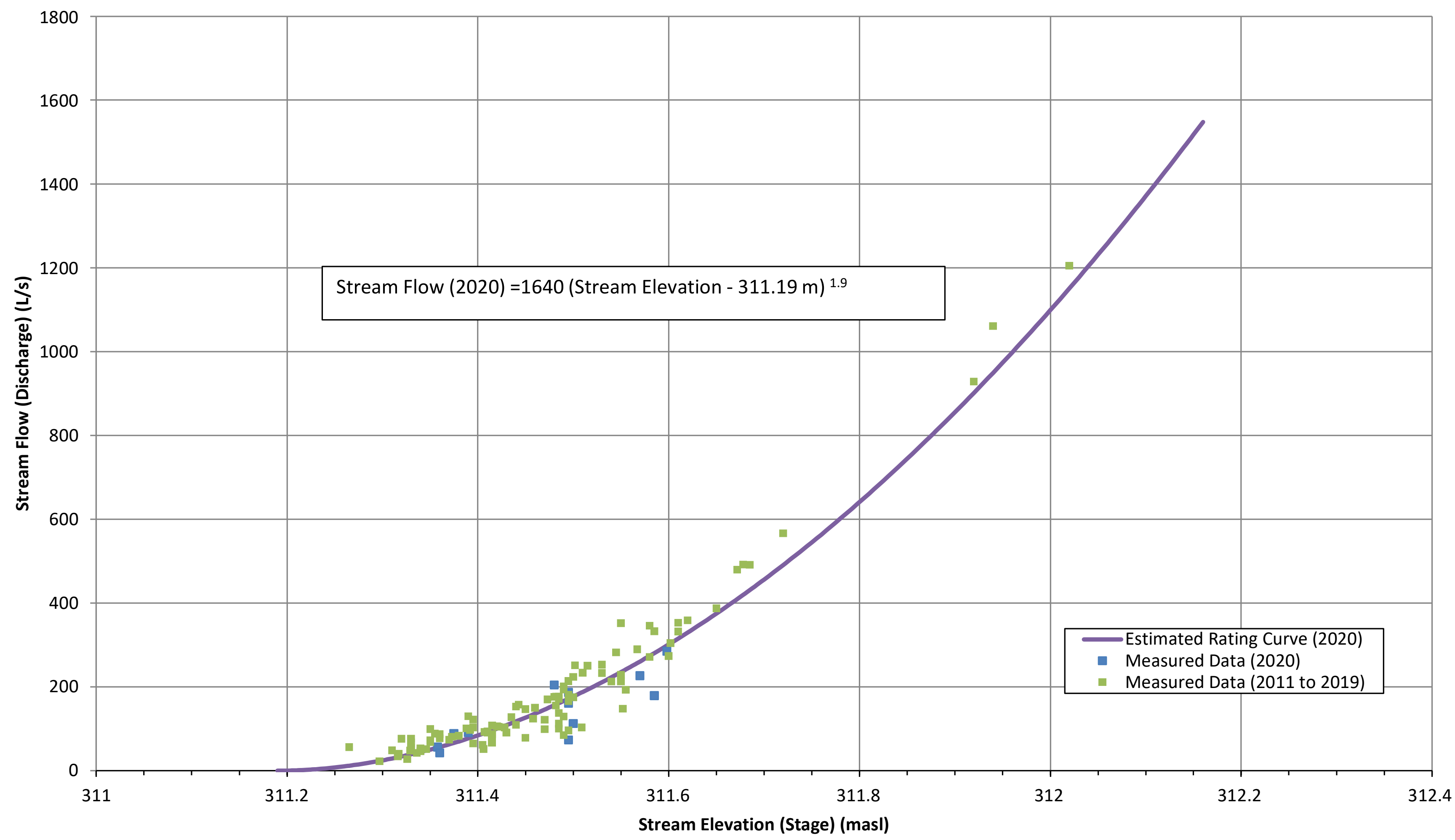
Date	Water Level (masl)			
	MP18D-11	MP18S-11	MP19D-12	MP19S-12
20-Jan-20	FROZEN	FROZEN	FROZEN	FROZEN
20/21-Feb-20	FROZEN	FROZEN	310.62	310.57
16-Mar-20	308.54	308.46	FROZEN	310.60
21/22-Apr-20	308.39	308.36	310.54	310.50
21-May-20	308.35	308.34	310.54	310.51
18-Jun-20	308.27	308.26	310.48	310.44
20/24-Jul-20	308.19	308.24	310.37	310.37
19-Aug-20	308.14	308.20	310.38	310.34
21/22-Sep-20	308.09	308.18	310.30	310.28
21/22-Oct-20	308.19	308.34	310.59	310.57
19/20-Nov-20	308.12	308.22	310.50	310.49
22/23-Dec-20	308.17	308.24	310.55	310.53

TABLE E2
Manual Surface Water Elevations (Surface Water Stations)
2020 Annual Report

Date	Water Level (masl)					
	SW1	SW2	SW3	SW4	SW5	SW10
20-Jan-20	FROZEN	310.29	317.45	312.70	307.38	FROZEN
20/21-Feb-20	311.50	310.28	317.42	312.66	307.32	FROZEN
16-Mar-20	311.60	310.32	317.50	312.50	307.41	312.25
21/22-Apr-20	311.50	310.26	317.44	312.47	307.32	312.38
21-May-20	311.48	310.27	317.42	312.47	307.31	312.41
18-Jun-20	311.38	310.22	317.34	312.42	307.23	312.34
20/24-Jul-20	311.39	310.23	317.34	312.45	307.22	312.10
19-Aug-20	311.36	310.20	317.32	312.41	307.22	312.02
21/22-Sep-20	311.36	310.20	317.35	312.41	INACCESSIBLE	311.92
21/22-Oct-20	311.59	310.31	317.47	312.51	307.18	311.85
19/20-Nov-20	311.50	310.26	317.39	312.44	307.30	311.77
22/23-Dec-20	311.50	310.26	317.40	312.46	307.27	311.73

APPENDIX F

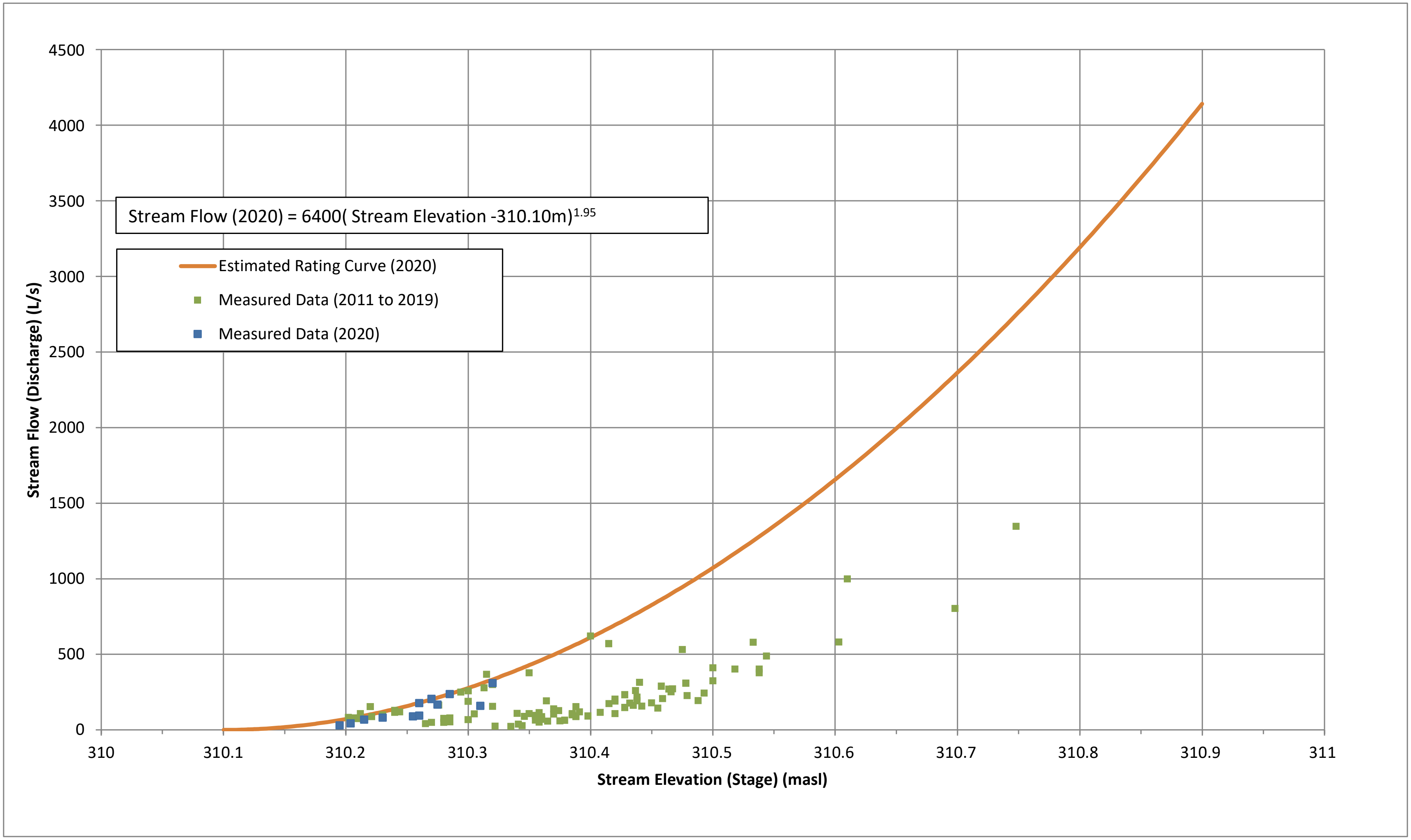
Surface Water Flow Monitoring



2020 Data Notes:
In 2020, the range of water levels recorded during manual flow measurements (and used to determine the stage-discharge relationship) = ~311.36 to 311.60 masl. The full range of water levels recorded in 2020 = ~311.32 to 312.21 masl.

GOLDER

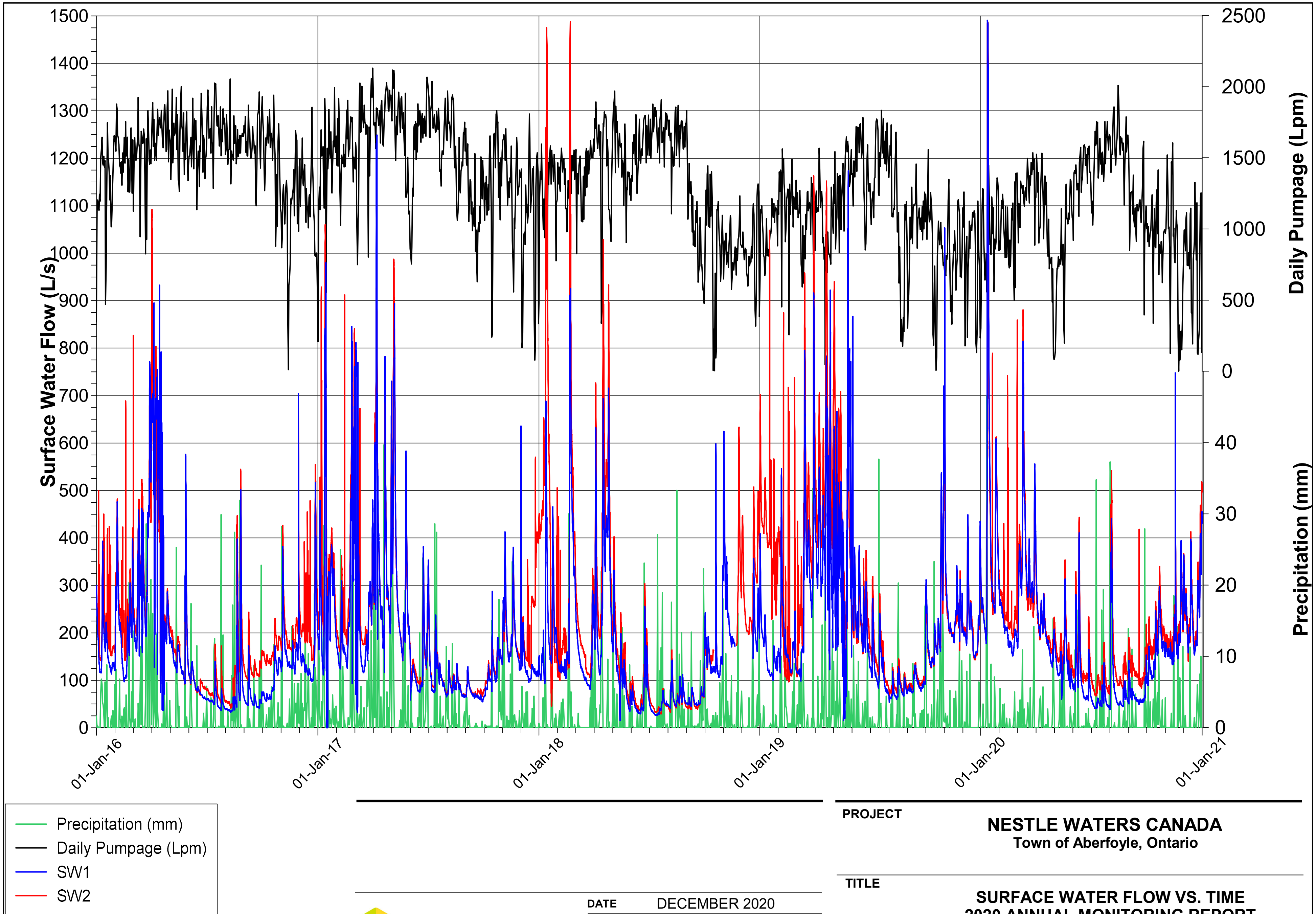
Figure. F1
STAGE-DISCHARGE MEASUREMENTS FOR SW1 (2020)
2020 ANNUAL MONITORING REPORT
NESTLE WATERS CANADA
Aberfoyle, Ontario



2020 Data Notes:
In 2020, the range of water levels recorded during manual flow measurements = 310.19 to 310.32 masl. The full range of water levels recorded in 2020 = ~310.20 to 310.63 masl.

GOLDER

Figure. F2
STAGE-DISCHARGE MEASUREMENTS FOR SW2 (2020)
2020 ANNUAL MONITORING REPORT
NESTLE WATERS CANADA
Aberfoyle, Ontario

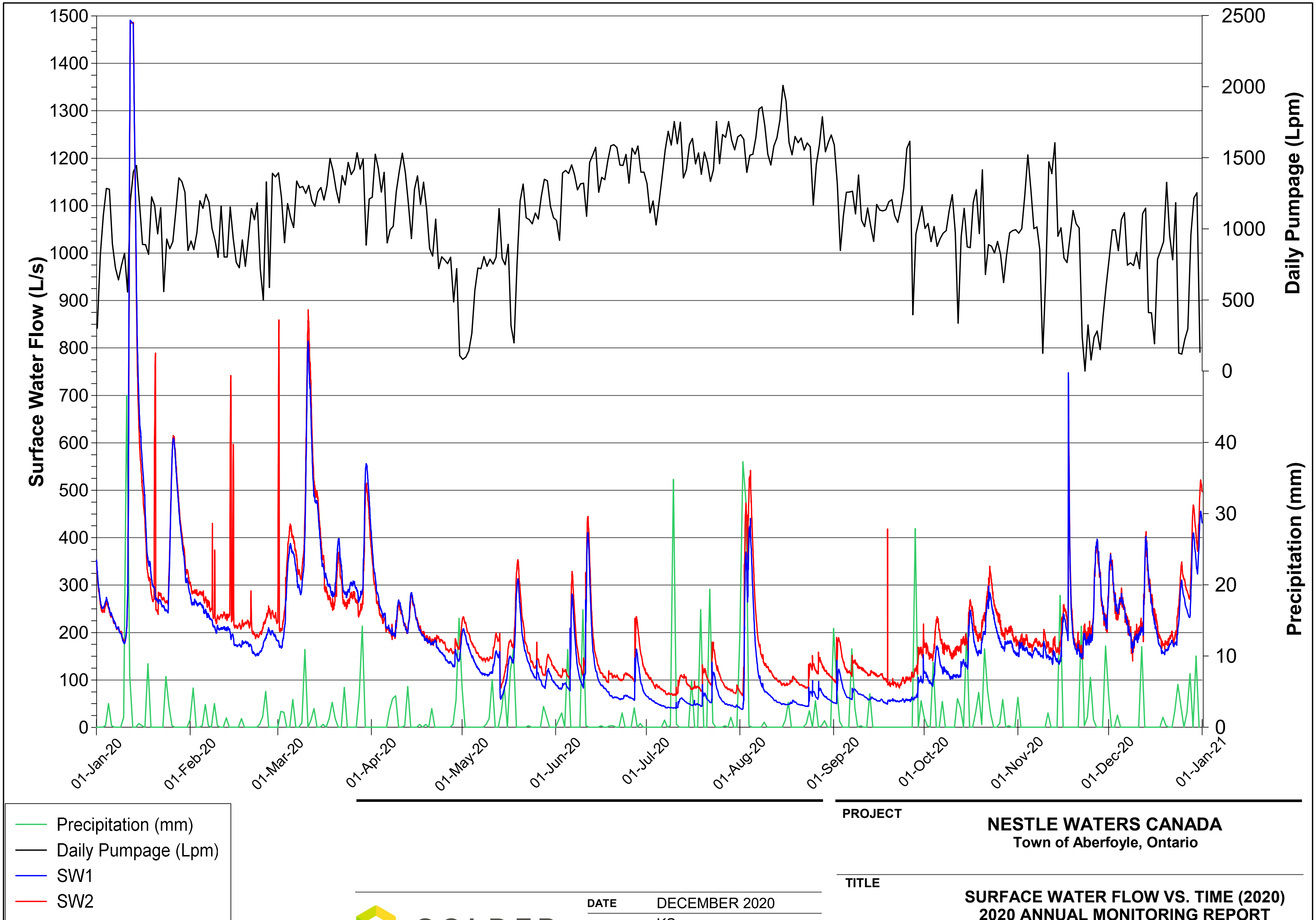


DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT
NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE
SURFACE WATER FLOW VS. TIME
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	F3a



DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

GOLDER

PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

SURFACE WATER FLOW VS. TIME (2020)
2020 ANNUAL MONITORING REPORT

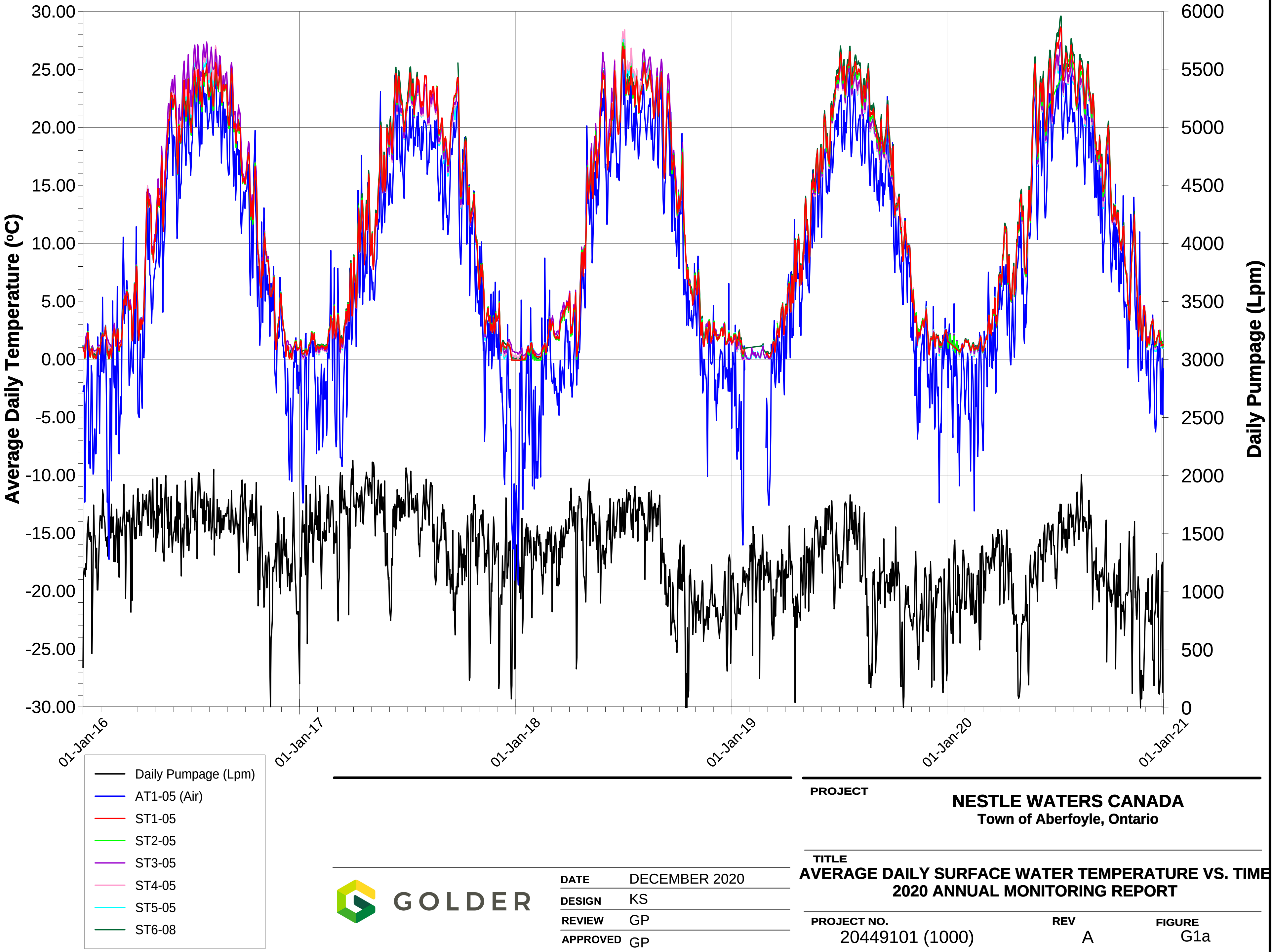
PROJECT NO.	REV	FIGURE
20449101 (1000)	A	F3b

TABLE F1
Surface Water Flow
2020 Annual Report

DATE	SW-1 Flow (L/sec)	SW-2 Flow (L/sec)
20-Jan-20	226.0	237.3
20-Feb-20	160.2	166.4
16-Mar-20	284.9	309.8
22-Apr-20	186.2	177.6
21-May-20	204.1	204.1
18-Jun-20	87.9	67.6
24-Jul-20	90.3	80.5
19-Aug-20	55.6	42.0
23-Sep-20	41.8	29.5
22-Oct-20	178.4	159
20-Nov-20	73	88.9
22-Dec-20	112.4	94.6

APPENDIX G

Stream Temperature Monitoring



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

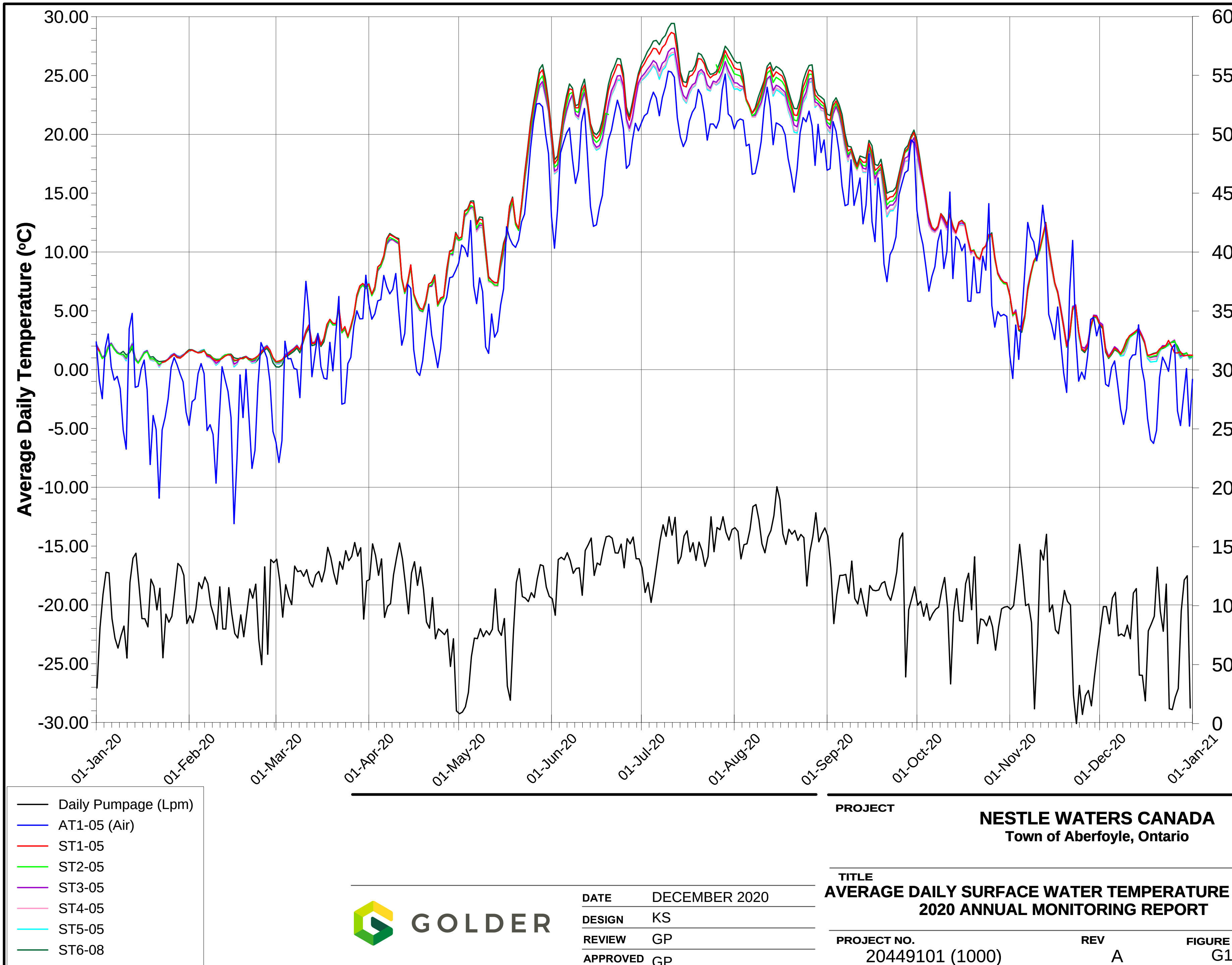
PROJECT

NESTLE WATERS CANADA
Town of Aberfoyle, Ontario

TITLE

AVERAGE DAILY SURFACE WATER TEMPERATURE VS. TIME
2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	G1a



GOLDER

DATE	DECEMBER 2020
DESIGN	KS
REVIEW	GP
APPROVED	GP

PROJECT

NESTLE WATERS CANADA

Town of Aberfoyle, Ontario

TITLE

AVERAGE DAILY SURFACE WATER TEMPERATURE VS. TIME

2020 ANNUAL MONITORING REPORT

PROJECT NO.	REV	FIGURE
20449101 (1000)	A	G1b

Examination of the Temperature Suitability of Aberfoyle Creek for Resident Fishes: 2006-2020

Prepared for Nestlé Waters Canada

Prepared by Cam Portt and Jim Reid

C. Portt and Associates

February 2021

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Introduction

Condition 4.4 of the Permit to Take Water (PTTW Number 1763-8FXR29) issued to Nestlé Waters Canada (Nestlé) by the Ontario Ministry of Environment (MOE, now Ministry of Environment, Conservation and Parks) on April 29, 2011, required that Nestlé review the appropriateness of the methodology of their water temperature monitoring program in Aberfoyle Creek (the Nestlé program). C. Portt and Associates conducted that review for Nestlé and made a number of recommendations (Portt, 2011). The recommendations of the review were accepted by the MOE and were to be incorporated commencing in the 2012 field season (letter from Carl Slater, MOE, to Don DeMarco, Nestlé, October 26, 2011). One of those recommendations was that historical and future temperature data be analyzed using ThermoStat software that has been developed to evaluate the thermal suitability of Ontario streams for thermal guilds for individual species of fishes in order to provide insight into the ecological implications of the current temperature regime. Subsequently, the results of these analyses have been reported annually (Portt and Reid, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020). This report presents the results of the analyses of the 2020 data, together with the data from previous years.

Methods

Water temperature is monitored at the sediment-water interface at six locations in Aberfoyle Creek (Figure 1) using Tidbit© V2 and MX2203 temperature loggers manufactured by Onset Computer Corporation. (http://www.onsetcomp.com/products/data-loggers/utbi-001 or mx2203). The loggers have an accuracy of ±0.2°C between 0°C and 50°C and drift is 0.1°C per year. Monitoring at Stations 1 – 5 began in 2005; monitoring at Station 6, which is the station furthest upstream, began in 2008.

The 2020 data were logged at half-hour intervals. Temperature has typically been logged at 30 minute intervals, but was logged at 60 minute intervals for a period of time at some locations during some years. The ThermoStat software (Version 3.1, Jones and Schmidt, http://people.trentu.ca/nicholasjones/thermostat.htm) requires that the time interval be consistent during the period covered by each analysis. Therefore, in cases where temperature at a location was logged at half-hour intervals during part of the period and at one-hour intervals during another part, every second recorded temperature was deleted from the half-hour interval portion, so that the values were at one-hour intervals through the entire period.

The data were analyzed using ThermoStat Version 3.1 temperature analysis software. ThermoStat calculates the thermal suitability for individual fish species based on laboratory determined optimal and lethal temperatures, compiled by Hasnain et al. (2010), and the water temperature record.

Hasnain *et al*. (2010) provide the following definitions for the temperature criteria:

Optimum growth temperature (OGT)*: The optimum growth temperature is that which supports the highest growth rate in an experiment where separate groups of fish are exposed to one of a set of constant temperatures under ad libitum feeding conditions. The range of these constant temperatures is* *chosen so that reduced growth is observed at both extremes (McCauley and Casselman 1980 cited in Wismer and Christie 1987, Jobling 1981).*

Final temperature preferendum (FTP)*: Final temperature preferendum is that towards which fish gravitate when exposed to an 'infinite' temperature range (Giattina and Garton 1982 cited in Wismer and Christie 1987). Two methods are used to determine FTP: the gravitation method and the acclimation method (Jobling 1981). The gravitation method involves exposing fish to a temperature gradient until they gravitate towards a specific temperature. The acclimation method extends the gravitation method by carrying out repeated 'gravitation trials' with fish acclimated to progressively higher temperatures. The preferred temperature exhibited in each trial is then plotted against the acclimation temperature and the FTP is the temperature at which the best fit line for these data crosses the line of equality (Jobling 1981). An informal survey of a subset of the original sources indicated that most estimates were determined via the gravitation method. FTP estimates obtained using both methods were compiled in the database.*

Upper incipient lethal temperature (UILT)*: The upper incipient lethal temperature is that at which 50% of the fish in an experimental trial survive for an extended period (Spotila et al. 1979, Jobling 1981, Wismer and Christie 1987). Testing for UILT involves placing groups of fish in separate baths, each held at a different constant temperature, using a sufficiently wide range of constant temperatures that rapid mortality is observed in some baths whereas slow incomplete mortality occurs in others (Spotila et al. 1979).*

Critical thermal maximum (CTMax)*: The critical thermal maximum is an indicator of 'thermal resistance' and is defined as the temperature at which a fish loses its ability to maintain a 'normal' upright posture in the water (loss of equilibrium; Jobling 1981). It is determined by exposing fish in a tank to steadily increasing water temperatures (typically at a rate of 1 °C min-1) and noting the temperature at which the fish exhibit spasms and loss of equilibrium (Jobling 1981, Wismer and Christie 1987). Remaining at, or above, CTMax results in mortality (Jobling 1981, Wismer and Christie 1987).*

Thermal indices that reflect suitability are calculated based on the temperature record for a location and the laboratory derived criteria (Table 1). The proportion of the June through August temperature measurements that are within ±2 °C of the optimal or preferred temperature and the proportion of the June through August temperature measurements that equal or exceed the lethal threshold temperatures are expressed as a percentage of the total number of temperature measurements during this period. Because the temperature measurements occurred at fixed intervals, this percentage of measurements is equivalent to the percentage of the time from June 1st through August 31st that the temperature conditions are met.

Table 1. Indices used to evaluate the thermal suitability for individual fish species.

Optimal Range Indices	
%OGT	Percent of temperature measurements within ±2°C of the optimal growth temperature. Higher values indicate better conditions, to a theoretical maximum of 100%.
%FTP	Percent of temperature measurements within ±2°C of the final temperature preferendum. Higher values indicate better conditions, to a theoretical maximum of 100%.
Lethal Threshold Indices	
%>UILT	Percent of temperature measurements that equal or exceed the upper incipient lethal temperature. Lower values indicate better conditions. 0% is optimum.
%>CTmax	Percent of temperature measurements that equal or exceed the critical thermal maximum. Lower values indicate better conditions. 0% is optimum.

Not all of the temperature criteria are available from the scientific literature (Hasnain et al, 2010) and, therefore, some of the thermal suitability indices cannot be calculated for some species. The temperature criteria that were available and used by ThermoStat for the fish species that were captured in Aberfoyle Creek during electrofishing conducted in 2008 are presented in (Table 2), together with the number of individuals of each species that was captured on each of the two sampling dates.

Table 2. Number of individuals of each species that were captured by electrofishing Aberfoyle Creek on January 31 and September 24, 2008 and the temperature criteria that are available from the scientific literature, from Hasnain et al (2010), and are used by ThermoStat to calculate thermal indices.

Common name	Scientific name	Number of individuals captured Sampling date		Temperature criteria available from the scientific literature			
		01/31/2008	**09/24/2008**	**OGT**	**FTP**	**UILT**	**CTmax**
blacknose dace	*Rhinichthys atratulus*	25	29	na[1]	19.6	28.6	30.2
bluntnose minnow	*Pimephales notatus*	3	2	26.2	24.1	31.5	29.9
brook trout	*Salvelinus fontinalis*	1	0	14.2	14.8	24.9	29.3
brown trout	*Salmo trutta*	4	3	12.6	15.7	25.0	28.3
common shiner	*Luxilus cornutus*	96	36	22.0	21.9	30.4	31.2
common white sucker	*Catostomus commersonii*	49	76	25.5	23.4	27.8	31.6
creek chub	*Semotilus atromaculatus*	154	353	na	24.9	29.1	33.0
johnny darter	*Etheostoma nigrum*	59	52	na	na	na	na
largemouth bass	*Micropterus salmoides*	0	3	26.6	28.6	31.9	38.4
pumpkinseed	*Lepomis gibbosus*	2	10	25.0	27.7	31.7	37.6
rainbow darter	*Etheostoma caeruleum*	3	28	na	19.9	na	32.1
rock bass	*Ambloplites rupestris*	9	37	28.4	24.9	33.9	36.0

1. na indicates that the temperature metric was not available.

The water temperature data were analyzed for each year at each monitoring location, excluding cases for which a significant portion of the potential temperature measurements was missing for the June through August period. Temperature logging at Sites 1 through 5 began on July 1, 2005; consequently, 2006 is the first year for which thermal suitability indices were calculated. Temperature logging at Site 6 began on May 15, 2008, so there are no thermal suitability indices for that site prior to 2008. There are significant gaps in the summer temperature data for Site 4 in 2010, so the thermal suitability indices were not calculated. Approximately 3.5 days of data were missing for Sites 2 and 3, at the end of August in 2010, and 9.5 hours of data for June 1 were missing for Site 1 in 2010; it was assumed that these amounts of missing data would not materially alter the calculated thermal suitabilities. There are no gaps in the summer temperature data series after 2010.

The mean air temperature at the Guelph Turfgrass Institute, which is the closest Environment Canada weather station to the site, was calculated for the period June 1 through August 31 for the years 2007-2009 and 2011-2019. The weather station began operating during the summer of 2006, and there are missing data during June of 2010, so the June – August mean could not be calculated for those years. The relationship between mean June – August air temperature and mean June – August water temperature was explored graphically and using regression analyses.

Results

Graphs of the thermal suitability indices are presented in Figure 2 (%>UILT), Figure 3 (%>CTmax), Figure 4 (%FTP) and Figure 5 (%OTG). The indices values are presented in Appendix A. Summer water temperatures are highest at the most upstream location, which is closest to the Aberfoyle Mill pond, and decrease with distance downstream. This is reflected in the thermal indices, which improve from upstream to downstream for species that require cold temperatures and improve from downstream to upstream for species that require warm temperatures. Mean June – August air temperature was 19.75 °C in 2020, which is highest for the period 2007 – 2020 (Figure 6). This is also evident in the thermal suitability indices.

Lethal temperatures are arguably the most critical thermal factor in determining fish distributions. If lethality occurs, other factors such as growth are immaterial. It is clear from Figure 2 that brook trout and brown trout are the species whose upper incipient lethal temperature is equaled or exceeded most frequently from June 1st to August 31st; in the warmest years, at the warmest site (Site 6), the %>UILT exceeds 40% for those species. The upper incipient lethal temperature is also exceeded, but infrequently, for blacknose dace, creek chub and white sucker. In 2020, the upper incipient lethal temperature for brook trout and brown trout was exceeded 51% and 49% of the time, respectively, at the farthest upstream station and 20% of the time for brook trout and 19% of the time for brown trout at the station farthest downstream. In 2020, the *CTMax* was exceeded occasionally for brown trout at all stations, for brook trout and bluntnose minnow at the three most upstream stations, for blacknose dace at the two most upstream stations, and for common shiner at the most upstream station (Figure 3).

The percentage of the time, from June 1st to August 31st, that water temperature is within 2°C of the final temperature preferendum (%FTP) is lowest for brown trout and brook trout, which have the lowest preferred temperatures, at all sites in all years (Figure 4; Table 2). The next lowest %FTP values, in most years, are for pumpkinseed and largemouth bass (Figure 4), which have the highest preferred temperatures (Table 2). In 2020, the %FTP for those two species was the highest it has been since data collection began at all sites, consistent with the high air and water temperatures. As in past years, the %FTP was highest in 2020 for species with intermediate temperature requirements.

The percentage of the time, from June 1st to August 31st, that water temperature was within 2°C of the optimal temperature for growth (%OGT) is presented in Figure 5. The lowest %OGT values are for brown trout and brook trout, which have the lowest optimum temperature for growth among the species that occur in this portion of Aberfoyle Creek (Table 2). The next lowest value is for rock bass, which is the species with the highest optimum temperature for growth (Table 2). As in previous years, the highest mean %OGT in 2020 was for species with intermediate optimum temperatures for growth.

The mean June – August water temperature at each monitoring location is plotted versus mean June – August air temperature at the Guelph Turfgrass Institute in Figure 6. Mean June – August water temperature decreases in a downstream direction through the Nestlé property (Figure 6). This is also evident in the plots of the temperature indices (Figures 2 – 5). For example, the percent of temperature measurements that exceed the ultimate upper incipient lethal temperature (%>UILT) for brook trout decreases with distance downstream (Figure 2). As Figure 6 illustrates, the mean June – August water temperature is highly correlated with the mean June – August air temperature. The best fit regressions are two-stage polynomials. At five of the six sites mean June – August air temperature accounts for more than 90% of the variation in mean June – August water temperature. The rate of increase in water temperature with air temperature tends to decrease in a downstream direction, as does the proportion of the variation accounted for (the r^2). As stated previously, the 2020 mean air temperature was the highest during the period 2008-2020. The relationship between mean air temperature and mean water temperature was consistent with previous years and the r^2 of the relationship increased at all six locations with the addition of the 2020 data.

Discussion

The 2020 results were consistent with those from previous years. In the reach of Aberfoyle Creek that flows through the Nestlé property, some species (i.e. largemouth bass, rock bass) are limited by low temperatures and the individuals that occur there probably originate from the mill pond that is just upstream. Brook trout and brown trout, on the other hand, are limited by high temperatures that exceed their upper incipient lethal temperature frequently during the summer (Figure 2) and often exceed their preferred temperature and their optimum temperature for growth (Figure 5), even in cool summers. The 2020 results continue to support the previously expressed opinion that water temperature is the principal factor limiting trout abundance in the Nestlé reach of Aberfoyle Creek, which was based on an analysis by C. Portt using the thermal suitability model of Wehrly et al. (2007), and presented in the Response to Technical Stakeholders' Comments on the TW3-80 Permit Renewal Application (Distributed: March 4, 2011).

The data continue to demonstrate the strong correlation between mean June – August air temperature and mean water temperature for the same period in Aberfoyle Creek. The correlation coefficient increased slightly at each of the sites with the addition of the 2020 data. It is clear that any study that attempts to link changes in water temperature over time to causative factors must take year-to-year differences in air temperature into account.

Conclusions

In 2020, mean summer (June – August) air temperature and water temperatures were the highest in the period 2007 – 2020. The overall pattern of water temperature suitabilities for the fish species found in the Aberfoyle Branch of Mill Creek from Brock Road downstream through the Nestle property in 2020 are consistent with previous years. Water temperatures during the June 1 – August 31 period are usually too warm for coldwater species such as brook trout and brown trout and too cold for warmwater species such as largemouth bass. The water temperatures during this period are most favourable for species such as common shiner that have intermediate thermal requirements. During the summer, the water in the mill pond upstream from Brock Road becomes warm and, although the creek temperature decreases with distance downstream, it frequently exceeds the ultimate upper incipient lethal temperature for brook trout and brown trout at the furthest downstream temperature monitoring site.

The relationships between air temperature and water temperature were consistent with those observed in previous years.

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Figure 1. Temperature logging locations used in the Nestlé Waters Canada monitoring program in Aberfoyle Creek.

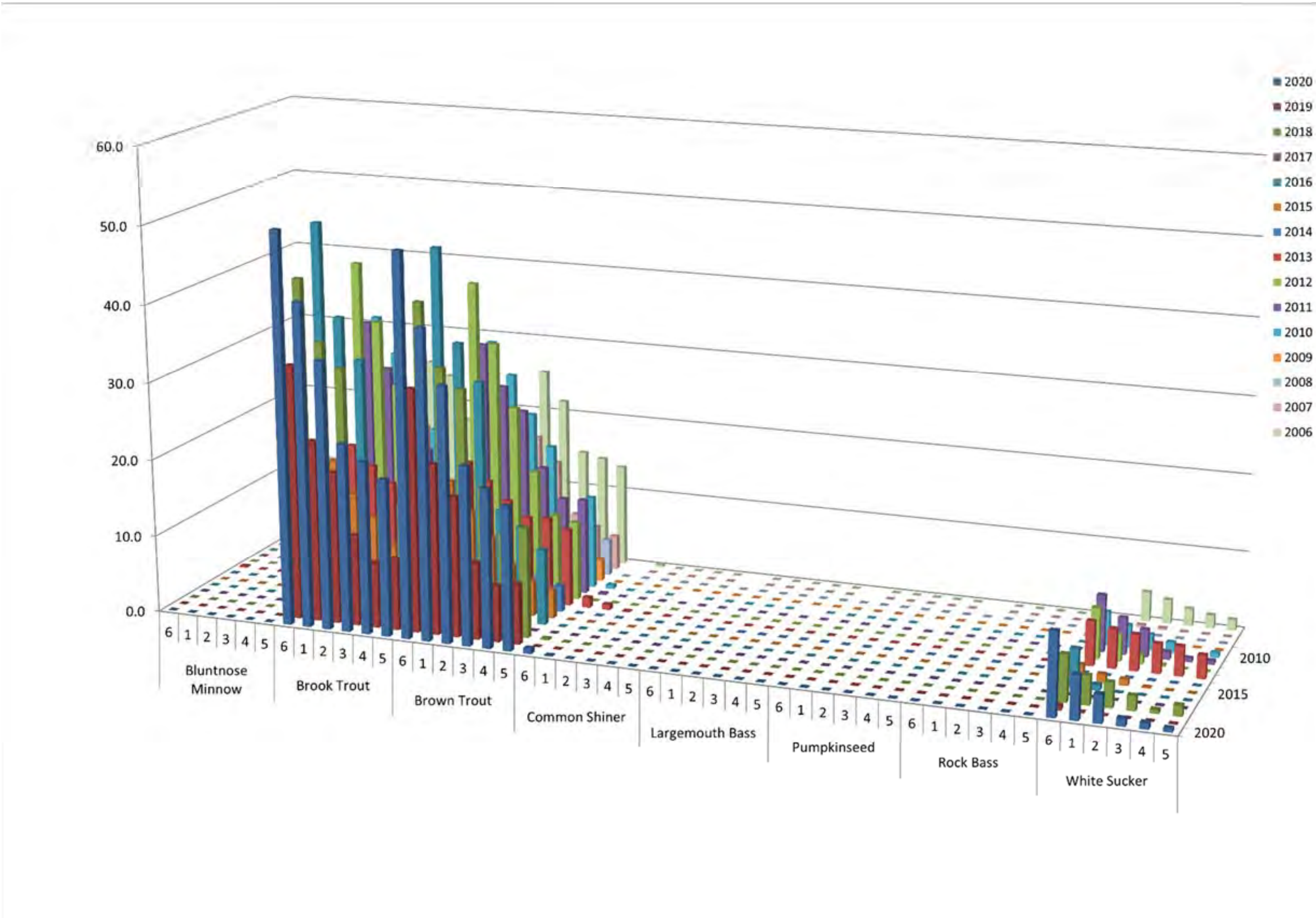

Figure 2. Percent of temperature measurements that exceed the ultimate upper incipient lethal temperature (%>UILT) during the period June 1 to August 31, by species, station and year.

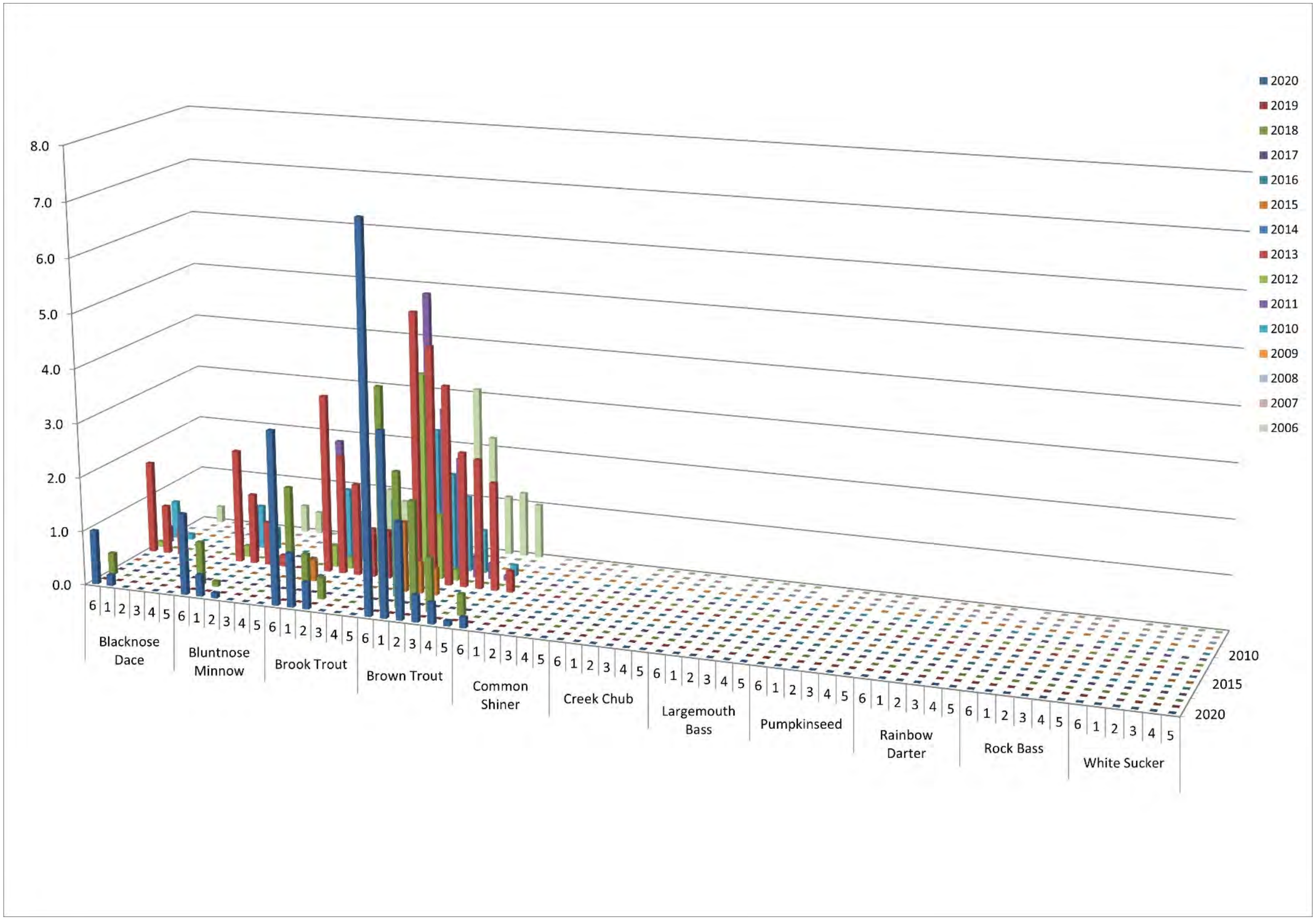

Figure 3. Percent of temperature measurements that exceed the critical thermal maximum temperature (%>CTmax) during the period June 1 to August 31, by species, station and year.

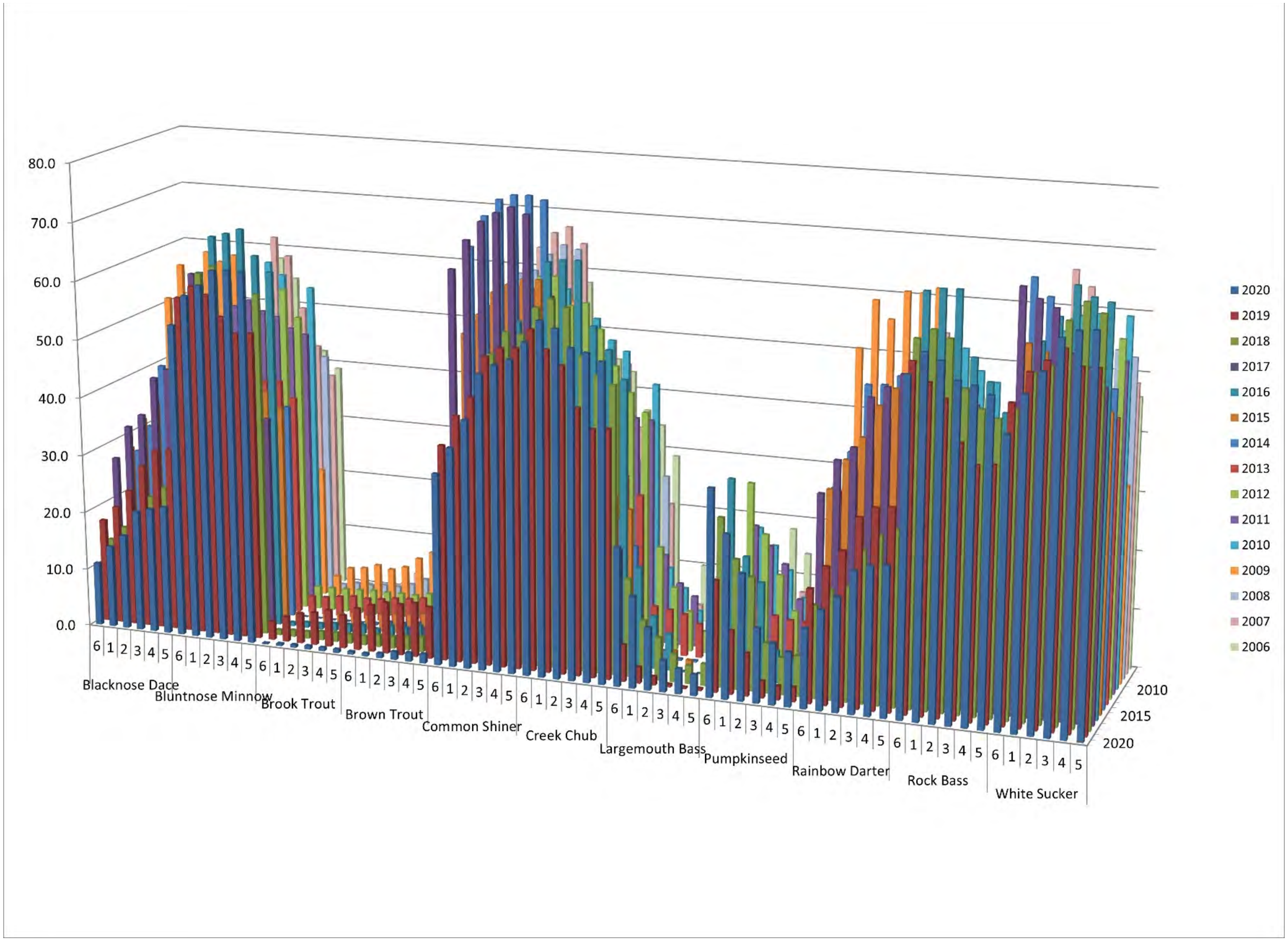

Figure 4. Percent of temperature measurements within ±2°C of the final temperature preferendum (%FTP) during the period June 1 to August 31, by species, station and year.

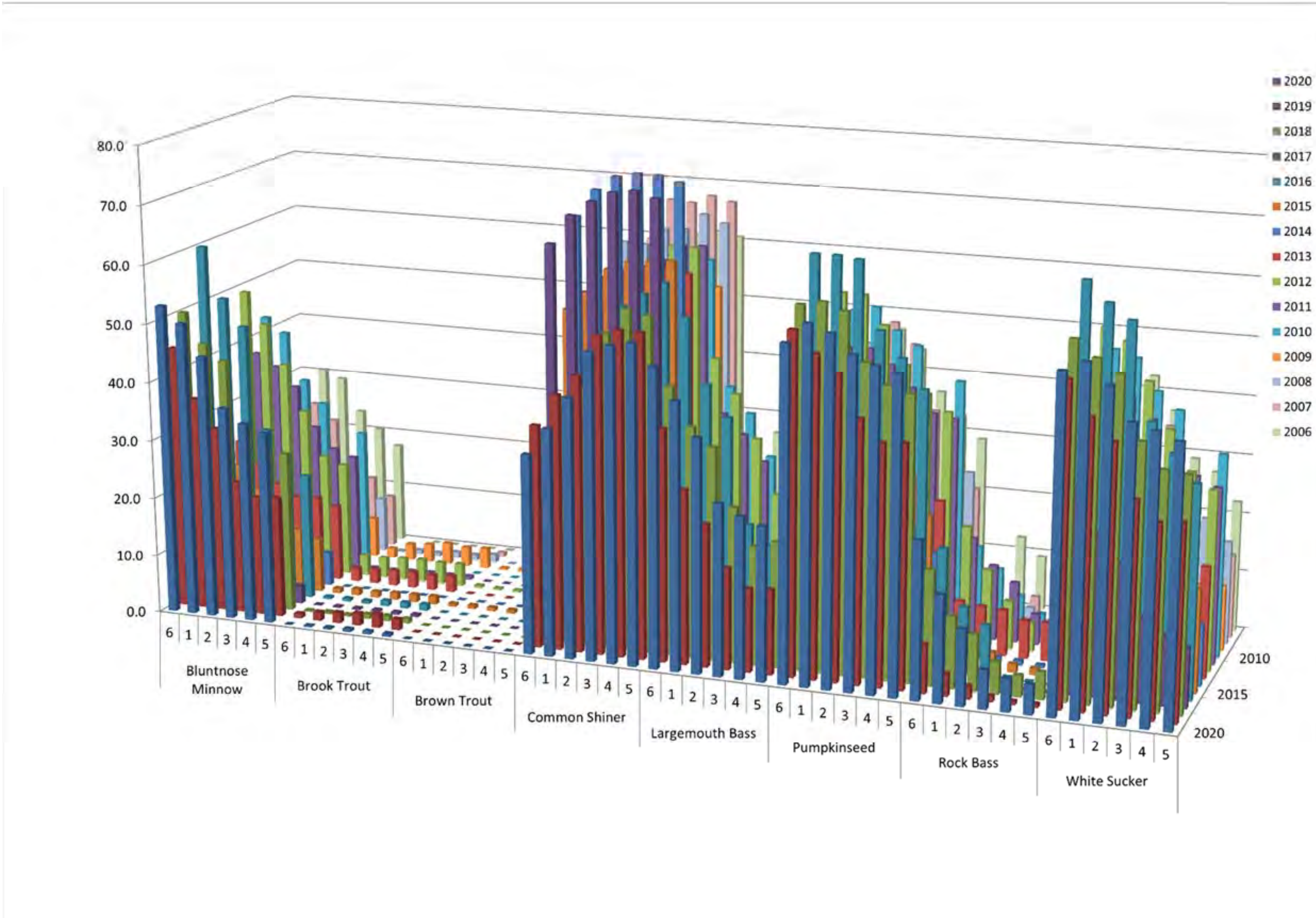

Figure 5. Percent of temperature measurements within ±2°C of the optimal temperature for growth (%OTG) during the period June 1 to August 31, by species, station and year.

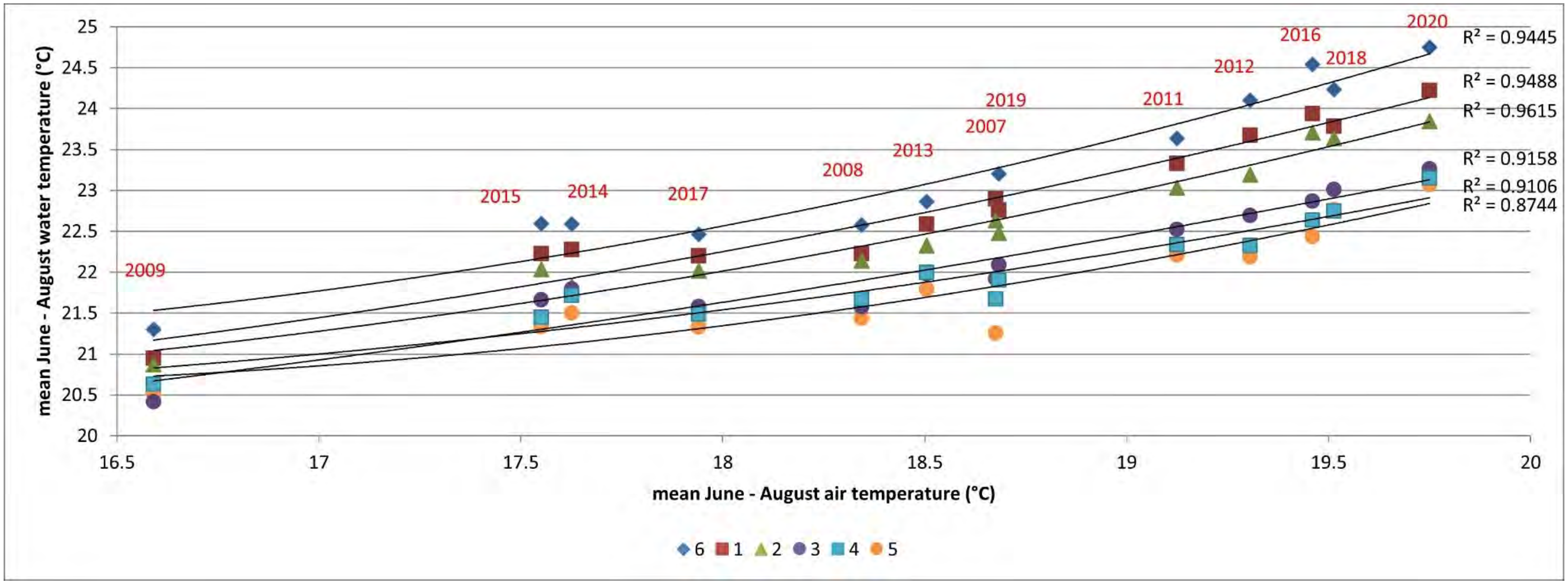

Figure 6. Plot of the mean June 1 - August 31 water temperature at each site versus mean June – August air temperature at the Guelph Turfgrass Institute weather station, by year. The lines and R^2 values are for second order polynomial regressions.

APPENDIX A

Thermal suitability indices

	Percent of temperature measurements within ±2°C of the optimum growth temperature (%OGT)																
		Year															
Species	Station	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	Mean
Blunt-nose Minnow	6	53.0	45.0	50.3	20.9	60.1	27.0	18.2	23.2	49.2	37.4	43.1	12.3	26.2			36.9
	1	50.3	36.5	45.2	14.0	51.4	21.3	13.0	19.3	43.7	35.3	40.6	8.5	19.3	25.0	30.5	31.2
	2	44.9	31.7	42.5	10.6	46.8	17.3	8.5	16.2	36.8	31.9	32.2	7.2	19.3	22.2	29.1	27.5
	3	36.4	22.8	30.9	5.5	29.0	13.2	7.9	14.2	28.7	24.9	28.3	5.9	11.7	15.1	23.3	20.5
	4	34.1	20.5	27.4	4.5	24.9	10.7	7.0	14.3	20.9	21.3		7.0	11.9	12.1	20.3	17.6
	5	32.8	20.7	27.4	3.1	21.6	9.4	5.9	13.2	19.7	20.1	23.5	6.9	9.5	9.0	17.5	16.7
	Mean	41.9	29.5	37.3	9.8	39.0	16.5	10.1	16.7	33.2	28.5	33.5	8.0	16.3	16.7	24.1	24.9
Brook Trout	6	0.0	0.8	0.2	0.1	0.4	0.8	0.0	2.3	3.6	0.2	0.0	1.7	0.2			0.8
	1	0.2	1.5	0.4	0.2	0.5	1.1	0.0	2.4	3.5	0.2	0.0	2.9	0.7	0.0	0.0	0.9
	2	0.3	1.8	0.3	0.3	0.5	1.0	0.0	2.6	3.8	0.4	0.0	3.2	0.6	0.0	0.0	0.9
	3	0.5	2.1	0.8	0.4	0.9	1.2	0.0	2.7	3.9	0.5	0.0	3.8	1.1	0.1	0.0	1.2
	4	0.5	2.4	0.9	0.4	1.0	1.3	0.0	2.6	3.8	0.5		3.4	1.0	0.2	0.0	1.3
	5	0.5	1.9	0.8	0.4	1.1	1.4	0.0	2.8	3.9	0.6	0.0	3.6	1.4	0.7	0.1	1.3
	Mean	0.3	1.8	0.6	0.3	0.7	1.1	0.0	2.6	3.8	0.4	0.0	3.1	0.8	0.2	0.0	1.0
Brown Trout	6	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.4	0.0	0.0	0.3	0.0			0.1
	1	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.3	0.0	0.0	0.5	0.0	0.0	0.0	0.1
	2	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.3	0.0	0.0	0.5	0.0	0.0	0.0	0.1
	3	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.6	0.0	0.0	0.6	0.0	0.0	0.0	0.1
	4	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.3	0.0		0.6	0.0	0.0	0.0	0.1
	5	0.0	0.0	0.0	0.0	0.2	0.6	0.0	0.0	0.5	0.0	0.0	0.6	0.1	0.0	0.0	0.1
	Mean	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.4	0.0	0.0	0.5	0.0	0.0	0.0	0.1
Common Shiner	6	33.7	37.6	35.4	66.0	29.5	53.7	68.5	55.0	36.4	47.3	44.8	63.9	60.0			47.7
	1	38.3	43.0	41.6	70.9	38.8	56.7	73.1	57.7	43.1	51.0	47.0	60.8	59.8	60.1	56.3	52.5
	2	43.7	46.5	43.3	73.4	42.4	60.9	75.6	59.1	51.8	53.4	54.8	62.8	62.7	67.1	61.5	56.4
	3	51.6	53.4	52.9	75.1	55.8	62.4	76.3	60.1	56.8	59.7	56.7	51.4	62.9	66.8	60.5	59.7
	4	52.9	54.6	57.2	75.6	58.1	62.7	76.2	60.1	63.1	62.5		57.9	65.7	68.2	61.4	62.2
	5	53.6	54.5	56.4	74.6	60.2	63.0	75.3	59.4	63.0	62.6	59.6	54.2	64.4	67.4	60.7	61.6

	Mean	45.6	48.3	47.8	72.6	47.5	59.9	74.2	58.6	52.4	56.1	52.6	58.5	62.6	65.9	60.1	56.8
Large-mouth Bass	6	50.1	39.1	45.1	14.8	54.8	20.6	13.4	17.5	44.6	34.2	38.0	9.0	19.6			31.9
	1	44.8	29.4	38.8	8.6	43.9	16.5	9.1	15.1	38.8	31.0	33.7	6.8	15.1	19.9	26.6	26.1
	2	39.2	24.1	35.8	6.1	38.8	13.6	6.2	13.4	31.5	26.6	26.5	4.4	14.8	18.7	25.5	22.6
	3	28.9	17.1	26.2	2.7	21.2	9.5	5.6	11.3	22.3	20.4	22.7	4.3	8.9	12.1	20.2	16.2
	4	27.1	14.1	20.1	1.9	18.1	7.7	5.3	11.3	15.8	16.9		5.2	8.9	9.3	17.6	13.3
	5	25.9	14.3	21.2	1.1	15.7	6.4	4.7	10.2	15.0	16.3	18.0	4.6	7.0	6.4	15.3	12.7
	Mean	36.0	23.0	31.2	5.9	32.1	12.4	7.4	13.1	28.0	24.2	27.8	5.7	12.4	13.3	21.0	20.3
Pumpkin-seed	6	55.7	57.0	60.2	42.9	66.8	42.5	39.8	39.5	57.5	47.5	53.0	23.4	45.8			49.4
	1	59.1	53.5	60.9	36.0	66.8	38.3	33.2	36.5	57.4	47.6	53.8	18.3	38.3	48.8	46.8	47.3
	2	57.8	50.6	59.7	32.6	66.4	35.8	23.5	33.0	52.6	45.1	50.1	15.4	38.2	45.3	43.6	44.3
	3	54.7	43.7	51.8	23.5	55.3	29.3	23.3	28.2	46.3	41.5	47.8	13.7	29.0	34.1	36.5	38.2
	4	53.3	40.2	48.4	21.5	51.1	26.6	21.4	28.6	41.8	37.6		14.4	29.5	27.2	32.6	34.8
	5	52.4	40.5	47.4	18.7	46.3	24.6	17.4	25.1	39.0	37.0	42.4	14.2	25.0	21.2	28.9	33.0
	Mean	55.5	47.6	54.7	29.2	58.8	32.9	26.4	31.8	49.1	42.7	49.4	16.6	34.3	35.3	37.7	41.1
Rock Bass	6	26.3	8.2	19.3	0.2	20.7	5.5	3.1	8.5	20.1	17.1	14.6	1.6	5.4			12.1
	1	17.9	3.8	12.0	0.0	11.3	3.3	1.9	8.0	13.1	12.7	11.1	1.0	2.5	3.8	12.4	7.9
	2	12.7	2.2	9.5	0.0	8.7	3.0	1.0	7.8	8.2	10.2	6.9	0.8	2.5	3.3	9.3	6.0
	3	6.5	1.0	5.4	0.0	0.4	1.4	0.8	6.5	4.9	5.2	4.2	0.2	0.5	1.4	6.5	3.1
	4	5.5	0.6	3.6	0.0	0.1	1.1	0.5	6.5	1.7	4.2		0.3	0.5	0.6	6.0	2.3
	5	5.0	0.6	4.6	0.0	0.1	0.8	0.2	5.7	2.3	3.3	2.5	0.3	0.2	0.1	4.7	2.2
	Mean	12.3	2.7	9.1	0.0	6.9	2.5	1.3	7.2	8.4	8.8	7.9	0.7	1.9	1.8	7.8	5.5
White Sucker	6	55.0	52.9	58.3	34.0	65.9	36.6	30.4	33.6	55.3	44.6	50.0	18.0	37.3			45.0
	1	56.7	47.3	55.6	26.9	62.6	32.0	23.7	30.0	53.3	43.0	48.9	15.0	27.5	37.0	42.4	41.1
	2	53.4	43.8	53.4	22.4	60.1	28.0	15.7	25.8	47.0	39.9	43.6	12.8	28.5	35.1	36.8	37.5
	3	48.0	35.1	43.2	14.1	44.4	22.4	14.9	20.8	39.5	34.6	40.8	9.5	19.4	21.9	29.0	30.1
	4	47.0	31.9	39.1	11.7	39.7	18.9	12.8	21.1	32.9	31.2		10.8	21.1	18.9	27.0	26.9
	5	45.7	32.3	38.7	10.0	35.3	17.2	10.3	18.7	30.3	29.7	34.2	11.1	17.5	14.2	22.3	25.4
	Mean	51.0	40.6	48.1	19.9	51.3	27.6	18.0	25.0	43.1	37.2	43.5	12.9	25.2	25.4	31.5	34.2

Percent of temperature measurements within ±2°C of the final temperature preferendum (%FTP)																	
		Year															
Species	Station	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	Mean
Black-nose Dace	6	10.9	17.8	13.7	27.4	9.2	28.0	26.7	26.9	10.2	21.6	21.1	51.1	30.5			22.1
	1	14.1	20.4	16.1	33.2	12.0	33.3	31.4	30.7	12.9	24.7	22.5	57.2	35.1	24.9	24.8	25.6
	2	16.3	23.5	17.0	35.5	13.6	36.1	42.3	34.0	17.1	28.4	24.8	53.2	34.1	26.7	26.5	27.9
	3	20.8	28.1	22.0	42.2	20.6	41.7	42.0	38.9	22.9	34.1	29.2	59.9	40.2	37.8	37.7	33.8
	4	21.5	31.0	23.9	43.9	24.1	45.0	43.9	38.6	27.4	36.4		58.4	39.6	41.2	42.2	36.1
	5	22.1	31.4	24.7	46.6	26.9	46.9	48.7	42.1	30.9	38.9	34.1	59.7	43.3	49.8	48.4	38.7
	Mean	17.6	25.4	19.6	38.1	17.7	38.5	39.2	35.2	20.2	30.7	26.3	56.6	37.1	36.1	35.9	30.8
Blunt-nose Minnow	6	53.7	57.8	57.3	60.8	60.5	54.3	58.7	51.1	57.0	52.0	57.4	33.9	56.3			54.9
	1	58.9	59.9	61.6	55.3	66.8	50.5	52.9	48.1	60.7	53.2	58.8	28.9	53.8	62.2	58.0	55.7
	2	60.8	58.7	63.0	51.8	67.5	48.0	43.0	44.9	59.9	51.5	59.5	26.6	52.5	59.1	54.6	54.0
	3	63.5	55.2	62.4	41.9	68.4	43.3	42.3	40.5	57.6	50.7	57.5	23.6	47.4	50.0	47.6	50.9
	4	63.7	52.5	60.7	40.5	64.1	40.1	40.9	40.7	56.2	48.9		23.4	46.1	43.4	42.0	48.3
	5	63.7	52.8	58.8	36.9	61.5	37.6	37.1	38.0	51.5	48.0	55.6	22.6	42.3	38.3	39.0	46.4
	Mean	60.7	56.2	60.6	47.9	64.8	45.6	45.8	43.9	57.2	50.7	57.8	26.5	49.7	50.6	48.2	51.7
Brook Trout	6	0.2	3.2	0.9	0.3	0.6	1.5	0.0	2.9	3.9	0.8	0.0	3.5	1.2			1.4
	1	0.4	4.3	1.1	0.4	0.9	1.8	0.0	3.0	3.9	0.8	0.0	5.2	1.7	0.2	0.0	1.6
	2	0.5	5.1	1.2	0.5	1.0	1.8	0.0	3.4	4.0	1.0	0.0	5.5	1.6	0.3	0.0	1.7
	3	0.6	5.6	1.5	0.8	1.3	2.1	0.1	3.7	4.1	1.2	0.0	6.3	1.9	0.5	0.1	2.0
	4	0.6	6.3	1.6	0.8	1.4	2.6	0.1	3.6	4.3	1.2		5.8	1.8	1.7	0.2	2.2
	5	0.6	5.7	1.6	1.4	1.6	2.5	0.3	3.8	4.2	1.2	0.0	6.5	2.6	3.8	0.4	2.4
	Mean	0.5	5.0	1.3	0.7	1.1	2.1	0.1	3.4	4.1	1.0	0.0	5.5	1.8	1.3	0.1	1.9
Brown Trout	6	0.5	7.2	1.6	0.8	1.2	2.9	0.8	4.2	4.3	2.3	0.7	8.3	3.8			2.9
	1	0.5	8.1	2.1	1.1	2.0	3.4	0.9	4.4	4.3	2.3	0.6	9.7	4.5	2.6	0.2	3.1
	2	0.8	8.8	2.1	1.4	2.0	3.5	1.2	4.8	4.8	2.6	1.1	10.1	4.7	2.8	0.4	3.3
	3	1.4	8.8	2.4	3.2	2.7	3.9	1.4	5.4	5.0	3.1	1.4	11.6	5.6	4.0	1.0	4.0
	4	1.5	9.3	2.6	3.4	2.9	4.1	1.4	5.4	5.4	3.1		10.5	5.1	5.0	1.6	4.3
	5	1.6	8.9	2.6	4.1	3.4	4.4	1.8	5.9	5.3	3.3	2.1	11.8	5.9	6.6	2.8	4.6

	Mean	1.1	8.5	2.2	2.3	2.4	3.7	1.3	5.0	4.9	2.8	1.2	10.3	4.9	4.2	1.2	3.7
Common Shiner	6	32.7	36.8	34.3	65.0	28.1	53.2	67.2	54.2	34.8	46.0	43.9	62.5	57.2			46.4
	1	37.3	42.0	40.0	70.0	37.1	56.6	72.5	56.9	41.5	50.3	46.2	60.8	59.8	60.1	56.3	51.7
	2	42.2	45.3	42.1	73.2	40.7	60.5	75.4	59.1	50.7	52.6	53.0	62.8	60.5	63.9	58.9	55.2
	3	50.0	52.3	52.1	74.8	54.0	62.0	76.3	60.4	55.9	59.1	55.7	56.5	63.4	66.6	61.4	59.5
	4	51.7	53.9	56.0	75.9	56.6	63.1	76.4	60.3	61.9	62.0		60.5	65.2	67.8	62.2	62.0
	5	52.8	54.1	55.8	74.9	59.0	63.1	75.8	59.3	62.1	62.1	58.9	56.3	64.6	65.1	57.9	61.1
	Mean	44.5	47.4	46.7	72.3	45.9	59.8	73.9	58.4	51.2	55.4	51.5	59.9	61.8	64.7	59.3	56.1
Creek Chub	6	55.9	57.4	60.4	44.9	66.8	43.9	42.1	40.5	57.4	47.9	53.6	23.3	45.2			50.0
	1	59.6	54.3	62.0	38.1	67.3	39.4	34.8	37.7	58.0	48.4	54.3	18.1	38.3	48.8	45.0	47.9
	2	58.5	51.9	60.8	34.3	67.4	37.1	25.3	33.9	53.8	45.8	50.8	19.2	38.0	44.9	43.0	45.3
	3	55.6	45.2	53.1	25.7	56.8	30.9	24.9	29.4	47.8	42.9	49.1	13.7	29.0	34.1	36.5	39.2
	4	55.0	41.9	50.1	23.1	53.1	27.8	23.3	30.0	43.5	38.6		16.2	32.1	30.1	34.1	36.6
	5	53.8	42.2	48.8	20.5	48.4	25.9	18.9	26.9	40.4	38.4	43.9	14.9	26.7	21.2	28.9	34.3
	Mean	56.4	48.8	55.9	31.1	60.0	34.2	28.2	33.1	50.2	43.7	50.3	17.6	34.9	35.8	37.5	42.1
Largemouth Bass	6	23.5	6.3	16.7	0.1	17.1	4.8	2.4	8.0	17.5	15.4	12.4	1.1	4.4			10.5
	1	15.6	2.8	9.9	0.0	9.0	2.9	1.4	7.7	10.8	10.7	9.1	0.5	2.5	3.8	10.0	6.7
	2	10.6	1.5	7.3	0.0	6.3	2.5	0.3	7.2	6.9	8.7	5.4	0.5	1.8	2.7	8.3	4.8
	3	5.4	0.5	4.8	0.0	0.1	1.2	0.3	5.8	3.7	4.2	3.6	0.2	0.5	1.4	6.5	2.7
	4	4.3	0.3	3.1	0.0	0.0	0.7	0.2	5.7	1.1	3.3		0.2	0.2	0.4	5.4	1.9
	5	3.6	0.4	3.7	0.0	0.0	0.5	0.0	5.1	1.5	2.6	2.1	0.1	0.2	0.1	4.7	1.8
	Mean	10.5	2.0	7.6	0.0	5.4	2.1	0.8	6.6	6.9	7.5	6.5	0.4	1.6	1.7	7.0	4.6
Pumpkin seed	6	34.9	18.9	28.6	3.4	33.6	9.8	5.4	10.0	30.1	22.1	21.0	3.6	9.4			18.5
	1	27.6	10.8	21.9	0.7	20.8	6.3	3.9	9.7	21.6	18.9	18.2	2.7	5.6	8.1	18.1	13.6
	2	21.4	7.3	19.2	0.1	16.7	5.2	2.2	8.7	14.9	16.0	14.2	2.3	5.9	8.0	14.0	11.0
	3	12.6	2.9	8.4	0.0	5.5	2.9	2.1	8.2	9.0	10.2	9.7	0.7	2.2	3.1	9.8	6.0
	4	10.4	2.4	6.3	0.0	4.3	2.1	2.0	8.2	5.3	7.7		0.9	2.5	2.4	9.1	4.7
	5	9.2	2.5	6.9	0.0	2.4	1.6	1.6	7.8	5.7	6.3	5.5	0.6	1.0	0.8	6.8	4.1
	Mean	19.4	7.5	15.2	0.7	13.9	4.7	2.9	8.8	14.4	13.5	13.7	1.8	4.4	4.5	11.6	9.5
Rainbow Darter	6	13.5	19.2	15.7	33.4	10.6	32.7	32.2	31.0	12.9	25.4	23.7	52.3	31.5			25.0
	1	16.8	23.1	18.5	39.1	14.4	37.8	38.4	34.7	15.9	28.1	25.6	60.5	37.5	29.1	29.4	29.2
	2	19.2	26.0	19.4	41.4	16.3	41.7	49.7	38.2	21.0	32.5	28.8	57.5	36.8	31.4	31.9	32.0
	3	23.8	31.7	25.6	49.7	23.9	47.1	49.9	43.6	27.9	38.4	33.7	62.3	45.2	42.5	42.7	38.4
	4	24.8	33.5	28.4	51.6	28.0	50.1	51.5	43.3	31.9	41.1		62.2	43.7	46.5	46.8	40.8
	5	25.2	33.8	29.6	53.9	31.3	52.1	55.6	45.7	35.6	42.9	37.4	63.2	49.0	54.7	52.3	43.2

	Mean	20.6	27.9	22.9	44.9	20.8	43.6	46.2	39.4	24.2	34.7	29.8	59.7	40.6	40.8	40.6	34.9
Rock Bass	6	55.9	57.4	60.4	44.9	66.8	43.9	42.1	40.5	57.4	47.9	53.6	23.3	45.2			50.0
	1	59.6	54.3	62.0	38.1	67.3	39.4	34.8	37.7	58.0	48.4	54.3	18.1	38.3	48.8	45.0	47.9
	2	58.5	51.9	60.8	34.3	67.4	37.1	25.3	33.9	53.8	45.8	50.8	19.2	38.0	44.9	43.0	45.3
	3	55.6	45.2	53.1	25.7	56.8	30.9	24.9	29.4	47.8	42.9	49.1	13.7	29.0	34.1	36.5	39.2
	4	55.0	41.9	50.1	23.1	53.1	27.8	23.3	30.0	43.5	38.6		16.2	32.1	30.1	34.1	36.6
	5	53.8	42.2	48.8	20.5	48.4	25.9	18.9	26.9	40.4	38.4	43.9	14.9	26.7	21.2	28.9	34.3
	Mean	56.4	48.8	55.9	31.1	60.0	34.2	28.2	33.1	50.2	43.7	50.3	17.6	34.9	35.8	37.5	42.1
White Sucker	6	47.9	52.2	50.5	69.2	51.1	59.1	69.0	57.1	52.3	54.7	56.2	43.5	59.9			55.2
	1	54.4	57.2	56.5	67.4	60.2	57.9	66.1	55.5	57.5	56.1	58.4	38.1	58.2	66.7	60.3	57.9
	2	58.1	59.2	57.8	66.2	64.3	56.9	58.3	52.8	61.7	55.4	61.1	35.8	57.6	64.1	59.3	57.9
	3	63.5	61.3	65.0	59.3	69.4	53.9	58.3	49.7	62.7	56.1	61.6	32.2	55.3	58.5	54.7	57.9
	4	64.8	58.7	68.1	57.4	67.7	51.3	57.2	50.0	62.7	57.0		33.6	54.8	54.0	49.7	57.0
	5	65.1	58.7	66.5	54.4	67.1	49.3	52.3	47.1	59.1	55.0	61.6	33.4	53.8	49.0	46.1	55.3
	Mean	59.0	57.9	60.7	62.3	63.3	54.7	60.2	52.0	59.3	55.7	59.8	36.1	56.6	58.5	54.0	56.9

Percent of temperature measurements that exceed the ultimate upper incipient lethal temperature (%>UILT)																	
		Year															
Species	Station	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	Mean
Black-nose Dace	6	5.8	0.0	3.3	0.0	0.6	1.0	0.0	4.7	2.2	4.3	2.0	0.0	0.0			1.9
	1	2.5	0.0	1.9	0.0	0.0	0.4	0.0	3.8	0.3	2.3	1.5	0.0	0.0	0.0	2.0	1.0
	2	1.2	0.0	1.6	0.0	0.0	0.2	0.0	2.8	0.0	1.4	1.0	0.0	0.0	0.0	1.6	0.7
	3	0.3	0.0	0.5	0.0	0.0	0.0	0.0	1.9	0.0	0.3	0.6	0.0	0.0	0.0	1.1	0.3
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0		0.0	0.0	0.0	0.8	0.2
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.1
	Mean	1.6	0.0	1.2	0.0	0.1	0.3	0.0	2.8	0.4	1.4	1.0	0.0	0.0	0.0	1.2	0.7
Blunt-nose Minnow	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brook Trout	6	50.6	33.0	43.4	10.6	49.4	17.8	9.9	18.4	42.0	33.6	33.7	7.9	17.7			29.4
	1	41.8	23.5	35.5	5.9	37.5	13.6	7.1	15.9	34.5	27.7	29.1	4.9	11.6	17.1	25.4	22.9
	2	34.7	19.7	32.4	3.4	32.2	10.8	5.0	13.9	26.3	24.4	23.7	3.5	11.2	15.5	23.7	19.6
	3	24.3	11.8	20.6	1.2	16.1	7.3	4.8	11.5	17.8	17.1	19.3	3.1	7.2	9.8	17.8	13.1
	4	22.3	8.5	14.6	0.4	13.8	5.1	4.5	11.5	12.4	13.1		3.4	7.0	6.8	15.4	10.2
	5	20.3	9.3	15.7	0.1	11.0	4.1	3.9	10.5	11.2	13.3	13.0	2.9	5.3	4.5	13.3	9.6
		32.3	17.6	27.0	3.6	26.7	9.8	5.9	13.6	24.0	21.5	23.8	4.3	10.0	10.7	19.1	17.3
Brown Trout	6	49.2	31.4	41.7	9.2	47.4	16.7	9.1	17.7	40.6	32.0	31.7	7.0	15.6			27.9
	1	39.9	22.1	33.6	5.3	35.5	12.9	6.5	15.4	32.9	26.6	27.5	4.9	11.6	17.1	25.4	21.9
	2	32.9	18.2	31.1	2.8	30.7	9.7	4.6	13.1	24.7	23.6	22.5	3.5	10.0	13.9	21.6	18.4
	3	23.1	10.0	18.8	0.8	14.4	6.4	4.4	11.2	16.5	16.3	18.4	2.2	5.3	7.0	14.8	11.8
	4	20.5	7.3	13.2	0.2	12.5	4.5	4.3	11.3	11.0	12.4		2.9	6.0	5.6	14.2	9.3
	5	18.6	7.8	14.2	0.0	9.8	3.7	3.4	10.1	10.3	12.5	12.1	2.8	4.8	4.5	13.3	8.9

	Mean	30.7	16.1	25.4	3.1	25.1	9.0	5.4	13.1	22.7	20.6	22.4	3.9	8.9	9.6	17.9	16.2
Common Shiner	6	0.7	0.0	0.2	0.0	0.0	0.0	0.0	1.3	0.0	0.2	0.5	0.0	0.0			0.2
	1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Creek Chub	6	3.9	0.0	2.3	0.0	0.0	0.6	0.0	3.6	0.6	2.9	1.5	0.0	0.0			1.3
	1	1.3	0.0	1.2	0.0	0.0	0.0	0.0	2.5	0.2	1.2	0.9	0.0	0.0	0.0	1.0	0.6
	2	0.7	0.0	0.6	0.0	0.0	0.0	0.0	2.0	0.0	0.4	0.4	0.0	0.0	0.0	0.9	0.4
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.1	0.0	0.0	0.0	0.7	0.1
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0		0.0	0.0	0.0	0.4	0.1
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	1.0	0.0	0.7	0.0	0.0	0.1	0.0	1.9	0.1	0.8	0.6	0.0	0.0	0.0	0.6	0.4
Large-mouth Bass	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumpkin-seed	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rock Bass	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White Sucker	6	10.6	0.6	6.0	0.0	4.9	2.0	0.0	5.7	6.5	7.3	4.3	0.0	0.4			3.9
	1	5.6	0.1	3.7	0.0	0.7	1.1	0.0	5.0	3.4	4.7	2.9	0.0	0.0	0.3	3.8	2.2
	2	3.6	0.0	3.2	0.0	0.0	0.8	0.0	4.6	1.2	3.5	2.0	0.0	0.0	0.2	3.1	1.6
	3	1.0	0.0	1.9	0.0	0.0	0.1	0.0	3.8	0.2	1.0	1.3	0.0	0.0	0.0	2.2	0.8
	4	0.8	0.0	0.5	0.0	0.0	0.0	0.0	3.8	0.0	0.5		0.0	0.0	0.0	1.7	0.5
	5	0.5	0.0	1.4	0.0	0.0	0.0	0.0	3.0	0.0	0.5	0.6	0.0	0.0	0.0	1.4	0.6
	Mean	3.7	0.1	2.8	0.0	0.9	0.7	0.0	4.3	1.9	2.9	2.2	0.0	0.1	0.1	2.4	1.6

Percent of temperature measurements that exceed the critical thermal maximum temperature (%>Ctmax)																	
		Year															
Species	Station	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	Mean
Black-nose Dace	6	1.0	0.0	0.4	0.0	0.0	0.0	0.0	1.7	0.1	0.3	0.7	0.0	0.0			0.3
	1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.1	0.0	0.0	0.0	0.3	0.1
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.0	0.1	0.2	0.0	0.0	0.0	0.1	0.1
Blunt-nose Minnow	6	1.5	0.0	0.8	0.0	0.0	0.0	0.0	2.1	0.2	0.9	0.8	0.0	0.0			0.5
	1	0.4	0.0	0.1	0.0	0.0	0.0	0.0	1.3	0.0	0.2	0.4	0.0	0.0	0.0	0.5	0.2
	2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.7	0.0	0.2	0.2	0.0	0.0	0.0	0.2	0.1
Brook Trout	6	3.2	0.0	2.0	0.0	0.0	0.4	0.0	3.3	0.4	2.3	1.3	0.0	0.0			1.1
	1	1.0	0.0	0.8	0.0	0.0	0.0	0.0	2.2	0.2	0.6	0.9	0.0	0.0	0.0	1.0	0.5
	2	0.5	0.0	0.4	0.0	0.0	0.0	0.0	1.7	0.0	0.4	0.4	0.0	0.0	0.0	0.8	0.3
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0		0.0	0.0	0.0	0.1	0.1
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.8	0.0	0.5	0.0	0.0	0.1	0.0	1.6	0.1	0.6	0.5	0.0	0.0	0.0	0.4	0.3
Brown Trout	6	7.1	0.0	4.0	0.0	1.8	1.3	0.0	5.0	3.8	5.2	2.6	0.0	0.0			2.5
	1	3.4	0.0	2.5	0.0	0.0	0.6	0.0	4.4	1.2	3.1	1.8	0.0	0.0	0.0	3.1	1.4
	2	1.8	0.0	2.0	0.0	0.0	0.5	0.0	3.7	0.2	2.2	1.4	0.0	0.0	0.0	2.2	1.0
	3	0.5	0.0	1.0	0.0	0.0	0.0	0.0	2.5	0.0	0.4	0.8	0.0	0.0	0.0	1.1	0.5
	4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.3		0.0	0.0	0.0	1.2	0.3
	5	0.1	0.0	0.4	0.0	0.0	0.0	0.0	2.0	0.0	0.1	0.2	0.0	0.0	0.0	1.0	0.3

	Mean	2.2	0.0	1.7	0.0	0.3	0.4	0.0	3.3	0.9	1.9	1.4	0.0	0.0	0.0	1.7	1.0
Common Shiner	6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Creek Chub	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Large-mouth Bass	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumpkin-seed	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rainbow Darter	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rock Bass	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
White Sucker	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0
	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

APPENDIX H

Biological Monitoring

C. Portt & Associates

BEACON ENVIRONMENTAL

GUIDING SOLUTIONS IN THE NATURAL ENVIRONMENT

2020 Biological Monitoring Program
Nestlé Waters Canada
Aberfoyle Property

Prepared For:

Nestlé Waters Canada

Prepared By:

Beacon Environmental Limited
C. Portt & Associates

Date:	*Project:*
February 2021	**216114**

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1. Introduction

Beacon Environmental Limited (Beacon) and C. Portt and Associates were retained by Nestlé Waters Canada (NWC) to undertake terrestrial and aquatic monitoring at the company's Aberfoyle property located at 101 Brock Road South in the Township of Puslinch (**Figure 1**). A Site Context Map is included as **Figure 2**. The biological monitoring program for the property was initiated in 2007 as a condition of a Ministry of Environment, Conservation and Parks (MECP) Permit to Take Water (PTTW) (#7043-74BL3K) for the onsite wells that service their bottling operations. Biological monitoring remains a condition of the current PTTW (#1381-95ATPY).

Condition 4.4 of the PTTW states:

> *The Permit Holder shall undertake wetland monitoring and redd surveys as recommended in "2010 Biological Monitoring Program Final Report" by C. Portt and Associates* dated January 28, 2011. Results from the wetland and redd surveys shall be submitted to the Director as a part of the annual monitoring report…*
>
> **Note: Authorship of the 2010 report should be attributed to Dougan & Associates and C. Portt and Associates.*

The objectives of the biological monitoring program are to:

1. Characterize existing aquatic, wetland and terrestrial resources; and
2. Document potential long-term changes to the site's biological resources.

Existing or baseline biological conditions on the Aberfoyle property were established through surveys and inventories completed between 2007 and 2009 which fulfilled the first objective. To achieve the second objective, there has been ongoing biological monitoring with annual reports submitted to the MECP as per the PTTW conditions. The type and frequency of biological monitoring is variable and based on the recommendations provided in each year's annual monitoring report.

Between 2007 and 2020, biological monitoring has included the following:

- Electrofishing surveys of Aberfoyle Creek;
- Salmonid spawning (redd) surveys of Aberfoyle Creek;
- Ecological Land Classification (ELC);
- Vascular plant surveys;
- Permanent vegetation monitoring plot surveys;
- Amphibian call surveys;
- Breeding bird surveys;
- Odonate (dragonfly/damselfly) surveys;
- Owl surveys;
- Turtle surveys;
- Marsh surveys (assessment of surface hydrology); and
- Invasive species mapping - Common Reed.

Biological monitoring completed on the property between 2007 and 2020 is summarized in **Table 1**.

Table 1. Summary of Biological Monitoring Program (2007-2020)

Year	Aquatic			Vegetation				Wildlife				
	Electrofishing	Habitat characterization	Spawning (*i.e.* Redd) surveys	Ecological Land Classification (ELC) mapping	Vegetation plot sampling	Marsh surveys	Invasive species mapping	Nocturnal amphibian call monitoring	Breeding bird surveys	Owl surveys	Basking Turtle surveys	Odonate surveys
2007			X	X								
2008	X		X	X	X			X	X			
2009		X	X	X		X	X	X	X			
2010			X		X	X	X	X	X	X	X	X
2011			X			X	X	X	X	X	X	X
2012			X								X	X
2013			X		X	X	X					
2014			X		X							
2015			X					X	X		X	
2016			X		X		X	X	X		X	
2017			X				X	X	X		X	
2018			X					X	X		X	
2019			X	X	X			X	X		X	
2020			X					X	X		X	

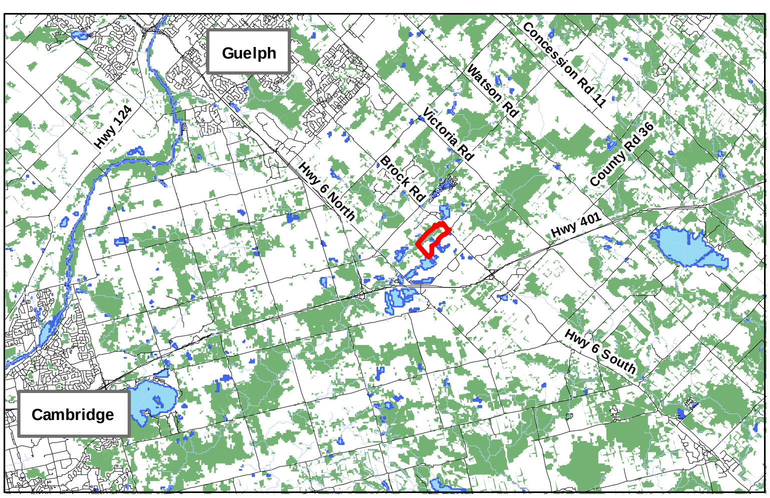
The 2019 Aberfoyle Biological Monitoring Program Report (Beacon 2020) recommended that core wildlife monitoring (amphibian, reptiles and birds) be completed in 2020. Additionally, it recommended Salmonid spawning surveys in Aberfoyle Creek will be conducted as required in 2020 by C. Portt and Associates. The recommended biological monitoring was completed in 2020. C. Portt and Associates completed aquatic monitoring, consisting of salmonid spawning (redd) surveys. Beacon completed terrestrial monitoring which consisted of wildlife monitoring.

This report summarizes the methods and findings of the biological monitoring program that has taken place from 2007 to 2020 and compares the data with that of previous years to identify changes or trends in selected monitoring parameter or indicators over the long term.

2. Methods

2.1 Aquatic Survey

C. Portt and Associates has surveyed Aberfoyle Creek for evidence of Brown Trout (*Salmo trutta*) or Brook Trout (*Salvelinus fontinalis*) spawning, from its confluence with Mill Creek upstream to the limit



Site Location	Figure 1
Aberfoyle 2020 Biological Monitoring Program	
BEACON ENVIRONMENTAL / C. Portt & Associates	Project: 216114 Last Revised: August, 2020
Client: Nestlé Waters Canada	Prepared by: DU Checked by: AC
N — 1:40,000	Inset Map:1:250,000

Contains information licensed under the Open Government License–Ontario Orthoimagery Baselayer: FBS Wellington 2010

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Site Context	Figure 2

Aberfoyle 2020 Biological Monitoring Program

Legend

- Subject Property
- Wetlands
- Watercourse

BEACON ENVIRONMENTAL

C. Portt & Associates

Project: 216114

Last Revised: August, 2020

Client: Nestlé Waters Canada

Prepared by: DU
Checked by: AC

N

1:8,000

0 150 300 m

C:\Dropbox\Dropbox (Beacon)\All GIS Projects\2016\216114\MXD\Aberfoyle\Report Figures\2020 Monitoring Report\2020-08-04_Figure02_SiteContext_NestleAberfoyle_216114.mxd of the Nestlé property (**Figure 2**) annually, beginning in 2007. In 2020, the surveys were conducted on October 22 and November 9. On these dates, this entire reach of the creek was walked and searched for spawning fish or areas of disturbed substrate that could be indicative of salmonid spawning.

2.2 Vegetation Surveys

2.2.1 Ecological Land Classification

Ecological communities associated with the subject property were classified in accordance with the Ecological Land Classification System for Southern Ontario (ELC) (Lee *et al*. 1998). ELC is the provincial standard for classifying ecological communities. Ecological communities are classified based on their biophysical parameters such as vegetation composition and structure as well as physical site conditions such as topography, slope, soil, moisture and drainage. Information on these parameters is collected from each polygon to confirm the appropriate classification using the ELC community catalogue.

Ecological communities were initially described and mapped by Dougan & Associates in the fall 2007. As the mapping was more than ten years old, Beacon reviewed the boundaries of the various ecological communities on July 23, 2019 to confirm their classifications, adjust boundaries and update the mapping where necessary.

ELC classification and mapping is generally conducted only once a decade as the rate of vegetation change is relatively slow and was therefore not repeated in 2020.

2.2.2 Floristic Surveys

A floristic survey of the property was initially completed by Dougan & Associates in the fall of 2007 to establish baseline conditions and develop a checklist of vascular plants for the subject property. The checklist has been variably amended over the years based on data collected from the vegetation plots and incidental observations. To update this checklist, Beacon completed a floristic survey of the subject property on July 23, 2019.

Floristic surveys are generally completed every five to ten years as the rate of vegetation change is relatively slow and was therefore not repeated in 2020.

2.2.3 Vegetation Plot Sampling

To monitor changes to vegetation resources on the property over time, six permanent vegetation sampling plots were established in 2007 in representative wetland communities. The UTM coordinates for each plot in NAD83 are provided in **Table 2** and mapped on **Figure 3**.

Table 2. Locations of Permanent Vegetation Monitoring Plots

Plot No.	UTM Zone	UTM Easting	UTM Northing
1	17T	569227	4812889
2	17T	569075	4812948
3	17T	568804	4812731
4	17T	568500	4812482
5	17T	568500	4812482
6	17T	568892	4812956

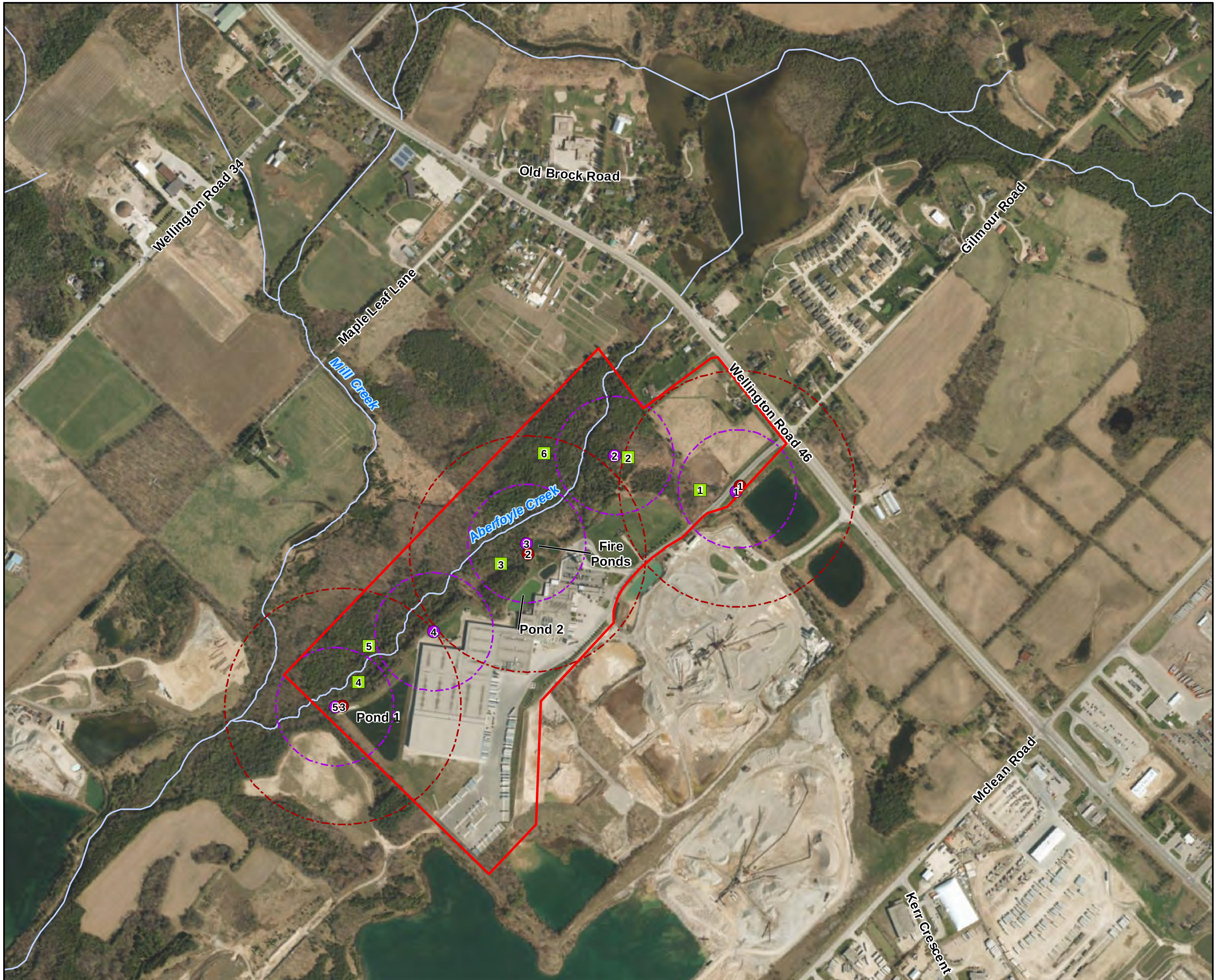
The vegetation plots are circular and 100 m^2 in area. The centre of each plot is marked with a steel T-bar. The plots were sampled in the summers of 2008, 2010, 2013, 2014, 2017 and 2019. No plot sampling occurred in 2020. A handheld GPS is used to locate the plots. The outer boundaries of each sample plot were delineated by attaching a 5.64 m length of rope to the T-bar centre post and temporarily marking the plot perimeter with flagging tape Within each sampling plot, information is collected on the composition and structure of the vegetation, by estimating the cover abundance at various height classes.

Vegetation data collection methods follow the standardized vegetation sampling protocols of the Ecological Land Classification System (ELC) for Southern Ontario (Lee *et al*. 1998). Within each plot, all observed species are documented, and the percent cover estimated by assigning a cover value of 1-4 (1) <10%; 2) 10-25%; 3) 25-60%; and 4) >60%) to each species for each vegetation layer it occurs in. Vegetation layers corresponded with the following height classes 1) <0.5 m; 2) 0.5-2 m; 3) 2-10 m, and 4) >10 m).

As in previous sampling years, vegetation plot data was subjected to a Floristic Quality Assessment (FQA) and provides a metric for monitoring change over time (Oldham *et al*., 1995). The FQA is determined from total number of species (species richness) in a given area (e.g. sampling plot) and summing their conservatism values. Species conservatism is considered a measure of "*the degree of faithfulness a plant displays to a specific habitat or set of environmental conditions*" (Oldham *et al*., 1995). More conservative species display a higher degree of fidelity to particular habitats or ecological conditions and are relatively intolerant of disturbance. Less conservative species tend to be habitat generalists and more tolerant of disturbance. In Ontario, plant species have been assigned a coefficient of conservatism value (CC) value ranging from 0-10. A description of how these values were assigned is provided below:

- 0-3: Species found in a wide variety of habitats including disturbed sites;
- 4-6: Species found in specific habitats, but tolerate moderate disturbance;
- 7-8: Species found in advanced successional communities with minor disturbance; or
- 9-10: Species found in high quality natural areas and/or limited to a narrow range of environmental conditions.

The FQA is used to establish a Floristic Quality Index (FQI) value. Generally speaking, higher FQI values are indicative of higher floristic quality and lower levels of disturbance, whereas lower FQI values indicate poorer quality and higher disturbance. FQI values were determined for each of the six monitoring plots by calculating the mean CC for each plot and multiplying it by the square root of the total number of species. FQI values were calculated using both the total number of species per plot and



Monitoring Stations and Survey Locations

Figure 3

Aberfoyle 2020 Biological Monitoring Program

Legend

- Subject Property
- Watercourse
- Vegetation Monitoring Station
- Amphibian Call Monitoring Station (with 250 m radius)
- Breeding Bird Monitoring Station (with 125 m radius)

Note: Basking Turtle Surveys were conducted at Pond 1, Pond 2 and the Fire Ponds

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for native species only. The FQI values were then used to compare changes over time both within and among vegetation plots.

In addition to the FQI, a Wetness Index was also calculated for each plot and the site as a whole. Each plant species in Ontario has been assigned a Coefficient of Wetness (CW) based on their probability of occurring in wetlands. CW values range from -5 to 5. Species with negative CW values favour wetter conditions and typically occur in wetlands; species with positive CW values prefer drier conditions and tend to occur in uplands. The Wetness Index is calculated by averaging the CW values of each species observed in the plot. A Wetness Index for the site was obtained by averaging the CW of each plot. The wetness index could potentially be used as an indicator of hydrological changes.

Vegetation plot sampling is generally completed every three years as the rate of observed vegetation change is relatively slow and was therefore not repeated in 2020.

2.2.4 Marsh Surveys

Marsh surveys were undertaken by Dougan & Associates in 2009, 2010, 2011 and 2013. The purpose of these surveys was to check moisture levels and to confirm these classifications of ELC communities. This was done by determining the approximate depth of standing water (if present) versus the presence of saturated soil, moist soil or dry soil. This level of detail is sufficient to differentiate a Shallow Marsh and a Meadow Marsh within the ELC system (Lee *et al.* 1998). A key difference between the two communities is the presence of standing water for much or all of the growing season within a Shallow Marsh compared to the seasonally flooded meadow marsh. However, this level of detail is not sufficient for correlating long term trends with any degree of certainty, as moisture levels in wetlands vary seasonally and annually depending on factors such as precipitation, average temperature, etc. For these reasons, the surveys have not been repeated.

2.2.5 Invasive Species Mapping

There are several colonies of Common Reed (*Phragmites australis*) present on the subject property. Common Reed is a highly invasive non-native plant species that is known to displace native wetland vegetation. Since 2007, the colonies on the property have been observed to be expanding. Colonies of Common Reed were originally mapped in several locations on the property in 2009, 2010, 2011, and 2013 by Dougan & Associates to track changes in the size of the colonies. The edges of the colonies were mapped using a high-resolution GPS. The Common Reed colonies were re-surveyed and mapped again by Beacon in 2016 and 2017 using an RTK (Real-Time-Kinematic) GPS to facilitate comparison with prior years. The Common Reed colonies were not surveyed in 2020.

Common Reed is ubiquitous in the adjacent landscape. It is prevalent in roadside ditches next to the property and is also present on neighbouring properties. The species is very difficult to control. The most effective control method is chemical treatment using herbicide. While such treatments are considered safe and pose minimal risk to the environment when appropriately applied, NWC has elected not to implement a treatment program due to the proximity of the colonies to the production well (TW3-80). Common Reed will continue to be monitored and alternative management approaches researched to inform potential future management actions.

2.3 Wildlife Surveys

2.3.1 Amphibian Surveys

Amphibian call surveys were undertaken to document species richness and abundance of frog and toad populations associated with the subject property. Because there is variation in the breeding periods during which different frog and toad species frogs are calling and detectable, surveys were completed at three different periods between April and June to ensure coverage of the full range of early to late breeding species. These surveys were conducted by Dougan and Associates in 2008, 2009, 2010 and 2011, and Beacon conducted these surveys in 2015, 2016, 2017, 2018 and 2019.

In 2020, Beacon conducted surveys on April 25, May 22, and June 9 using the survey protocols developed for the Marsh Monitoring Program (MMP) (Bird Studies Canada, 2009). On each occasion the subject property was visited at least 0.5 hours after sunset during suitable weather conditions to listen for calling frogs and toads using three permanent monitoring stations that were established in 2008. The locations of these amphibian monitoring stations are illustrated in **Figure 3**. Amphibians observed or heard calling in other locations on the property during these and other surveys were also recorded as incidental observations.

Surveys were conducted using the point count method whereby the surveyor stands at a set point or station for a specific period of time and records all species that can be heard calling within the sample area. A minimum of three minutes was spent listening at each station. The approximate locations of calling amphibians were noted on a standard MMP data sheet and chorus activity for each species was assigned a call code as follows:

0 - No calls;
1 - Individuals of one species can be counted, calls not simultaneous;
2 - Calls of one species simultaneous, numbers can be reliably estimated; and
3 - Full chorus, calls continuous and overlapping, individuals indistinguishable.

In addition to recording species and call levels, weather conditions (i.e., air temperature, precipitation, wind speed, and cloud cover) at the time of survey were also recorded. Weather conditions for the 2020 surveys are summarized in **Table 3**.

Table 3. Amphibian Survey Details

	Survey 1	Survey 2	Survey 3
Date:	April 25, 2020	May 22, 2020	June 9, 2020
Start time:	20:47	21:16	21:35
Temperature:	9 °C	19 °C	26 °C
Wind speed:	1-11 km/h	1-5 km/h	0 km/h
Cloud cover:	80%	90%	15%
Precipitation:	None	None	None

2.3.2 Breeding Bird Surveys

Breeding bird surveys were undertaken in 2020 by Beacon to document the diversity and abundance of avian populations associated with the subject property. Previous surveys were completed in 2008, 2009, 2010 and 2011 by Dougan & Associates, and in 2015, 2016, 2017, 2018 and 2019 by Beacon. There are five permanent point count stations that were established in 2008 that provide coverage for the majority of the property. Each point count station is positioned so the observer can detect calling birds up to a distance of 125 m. The locations of the point count stations are illustrated in **Figure 3**. A handheld GPS was used to locate the plots.

A modified point count methodology, based on protocols established for the Ontario Breeding Bird Atlas for point counts (Cadman *et al.* 2007), Forest Bird Monitoring Program (CWS, 2006) and a standard method recommended for monitoring songbird populations in the Great Lakes Region (Howe *et al.* 1997), was utilized to complete breeding bird surveys. The following is a detailed description of the modified approach utilized to complete these surveys:

- Surveys should be conducted a minimum of one week apart (CWS 2006);
- Point count stations will be at least 250 m apart (Howe *et al.* 1997 & CWS 2006);
- Since the Nestlé Waters Canada property in Aberfoyle is relatively small, a randomized site selection approach will not be required. The majority of natural features on the site are covered by the 5- point count station survey areas;
- Survey duration for each point count will be 10 minutes, consistent with the Forest Bird Monitoring Program (CWS 2006) and Howe *et al.* (1997) and will not be restricted to forested habitats;
- The location of each individual adult bird will be recorded on a field sheet as per the layout and symbols used by the Forest Bird Mapping Protocol (CWS 2006) or Howe *et al.* (1997). Bird flying overhead (i.e. not directly associating with the survey area) or otherwise not showing any breeding evidence will be distinguished from the other breeding birds;
- Observations recorded on the field maps will be transferred into a summary table. All birds observed or heard within suitable habitat were assumed to be breeding; and
- Breeding evidence is to be documented according to the Ontario Breeding Bird Atlas protocols (Cadman *et al.* 2007).

Birds that were observed between the point count surveys were noted separately on a field map to help ensure that no bird species present on the property were missed as the point count circles do not cover the entire property.

Weather conditions (i.e., air temperature, precipitation, wind speed, and cloud cover) at the time of survey were recorded (see **Table 4**).

Table 4. Breeding Bird Survey Details

	Survey 1	Survey 2
Date:	June 2, 2020	June 18, 2020
Start time:	6:30	6:00
End Time:	9:00	8:15
Temp:	13-15 °C	14 °C
Wind:	1-5 km/h	0-5 km/h
Cloud cover:	90-100 %	15 %
Precipitation:	Very short period of light rain	None

2.3.3 Owl Surveys

Barred Owl (*Strix varia*) was reported from the north east portion of the subject property in August 2009 by Dougan & Associates. To confirm this record, two surveys were completed in 2010 and an addition survey was completed in 2011. The survey consisted of broadcasting Barred Owl calls using a portable compact disc (CD) player. In 2011, Northern Saw-whet Owl (*Aegolius acadicus*) calls were also broadcast prior to the Barred Owl calls. A period of silence was included following each series of calls to allow the surveyor to listen for a response. The surveys were completed from two stations in forested habitats in the vicinity of the original observation. No additional owl surveys have been undertaken since 2011.

2.3.4 Basking Turtle Survey

The ponds on the subject property are known to support populations of Midland Painted Turtle (*Chrysemys picta marginata*) and Snapping Turtle (*Chelydra serpentina*). Snapping Turtle was assigned "Special Concern" status in Canada in 2008 and Ontario in 2009. Snapping Turtle was originally observed in the large pond near the western property boundary in 2008, which is labelled as Pond 1 on **Figure 3**.

To monitor these populations, basking surveys were completed by Dougan & Associates annually between 2010 and 2012, and by Beacon between 2015 and 2019.

In 2020, basking turtle surveys on the property were focused on Pond 1. The surveys consist of slowly walking along the outer edge of the pond using binoculars to scan its perimeter and other potential basking sites within the pond. Surveys were completed between 8:00 am and 5:00 pm during sunny periods when the air temperature was greater than water temperature and after inclement weather. Brief surveys of the other ponds on the subject property were also completed at the time of this survey. Details of these surveys, including weather conditions, are included in **Table 5.**

Table 5. Basking Turtle Survey Details

	Survey 1	Survey 2	Survey 3
Date:	April 25, 2020	May 21, 2020	September 16, 2020
Start time:	11:20	10:45	11:00
End time:	12:30	11:45	12:00
Temp:	12-13 °C	16-20 °C	20-21 °C
Wind:	0-11 km/h	0 km/h	0-6 km/h
Cloud cover:	<10%	0%	0% but with a haze
Precipitation:	None	None	None

2.3.5 Odonate Surveys

While not included in the original monitoring program, it was felt that baseline surveys for dragonflies and damselfly surveys could be used to supplement the baseline biological data available for the site. In 2010, 2011 and 2012, Dougan & Associates conducted odonate surveys for select habitats on the subject property, while in 2009 they were recorded incidentally. Surveys were informally conducted during ideal weather conditions simultaneously to turtle basking surveys using a net. Any individuals caught were immediately examined with a 10x (power) hands lens and then released following identification. No individuals were collected, and no microscopic analysis was conducted. When needed, identifications were confirmed using Jones (2008) and Lam (2004). The surveys were brief, and the findings were not considered a comprehensive list of species potentially present. No additional odonate surveys have been undertaken since 2012.

2.3.6 Other Wildlife Observations

Other wildlife species observations and habitat encountered over the course of the 2020 field season were recorded as incidental observations. When encountered, the species and locations of the wildlife were noted.

3. Results

3.1 Aquatic Survey

No evidence of salmonid spawning was observed along Aberfoyle Creek on the subject property in 2020. This is consistent with the findings of previous surveys completed annually from 2007 through 2019.

3.2 Vegetation Surveys

No vegetation surveys were conducted in 2020. The discussion presented below provides a summary of previous surveys. It is expected that vegetation surveys will be conducted again in 2022.

3.2.1 Ecological Land Classification Mapping

No significant changes to any of the ecological communities were observed during the 2019 review, however minor adjustments were made to the boundaries of several communities. The changes are as follows:

- ELC unit 22 changed from Cultural Woodland (CUW1) to Fresh-Moist White Cedar Coniferous Forest (FOC 4-1) due to increased size and dominance of Eastern White Cedar; and
- ELC Unit 11 changed from Mineral Meadow Marsh (MAM2) to Cattail Mineral Shallow Marsh/Reed Canary Grass Mineral Meadow Marsh (MAS2-1/MAM2-2) due to a shift in dominance of cattails and reed canary grass.

The revised ELC mapping is presented in **Figure 4** and a table summarizing the various ecological communities in presented in **Appendix A**.

3.2.2 Flora

Floristic surveys completed between 2007 and 2019 have documented a total of 255 vascular plant species. Of these, 242 have been determined to the species level and 13 could only be determined to genus for various reasons. An updated checklist is provided in **Appendix B.** Of the species identified, 56 are considered non-native to Ontario and represents 23% of the total site flora. Native species are ranked S4 or S5 by the NHIC, indicating that they are generally common and secure in Ontario.

Two regionally rare and six regionally uncommon species have been documented on the subject property, which are summarized in **Table 6**.

Table 6. Regionally Rare and Uncommon Plants Species

Scientific Name	Common Name	Region Status[1]
Asplenium platyneuron	Ebony Spleenwort	Rare
Brachyelytrum erectum	Long-awned Wood Grass	Rare
Symphyotrichum urophyllum	Arrow-leaved Aster	Uncommon
Cardamine pensylvanica	Pennsylvania Bitter-cress	Uncommon
Equisetum sylvaticum	Woodland Horsetail	Uncommon
Cinna latifolia	Slender Wood Reedgrass	Uncommon
Ranunculus pensylvanicus	Bristly Crowfoot	Uncommon
Symphyotrichum pilosum	Frost Aster	Uncommon

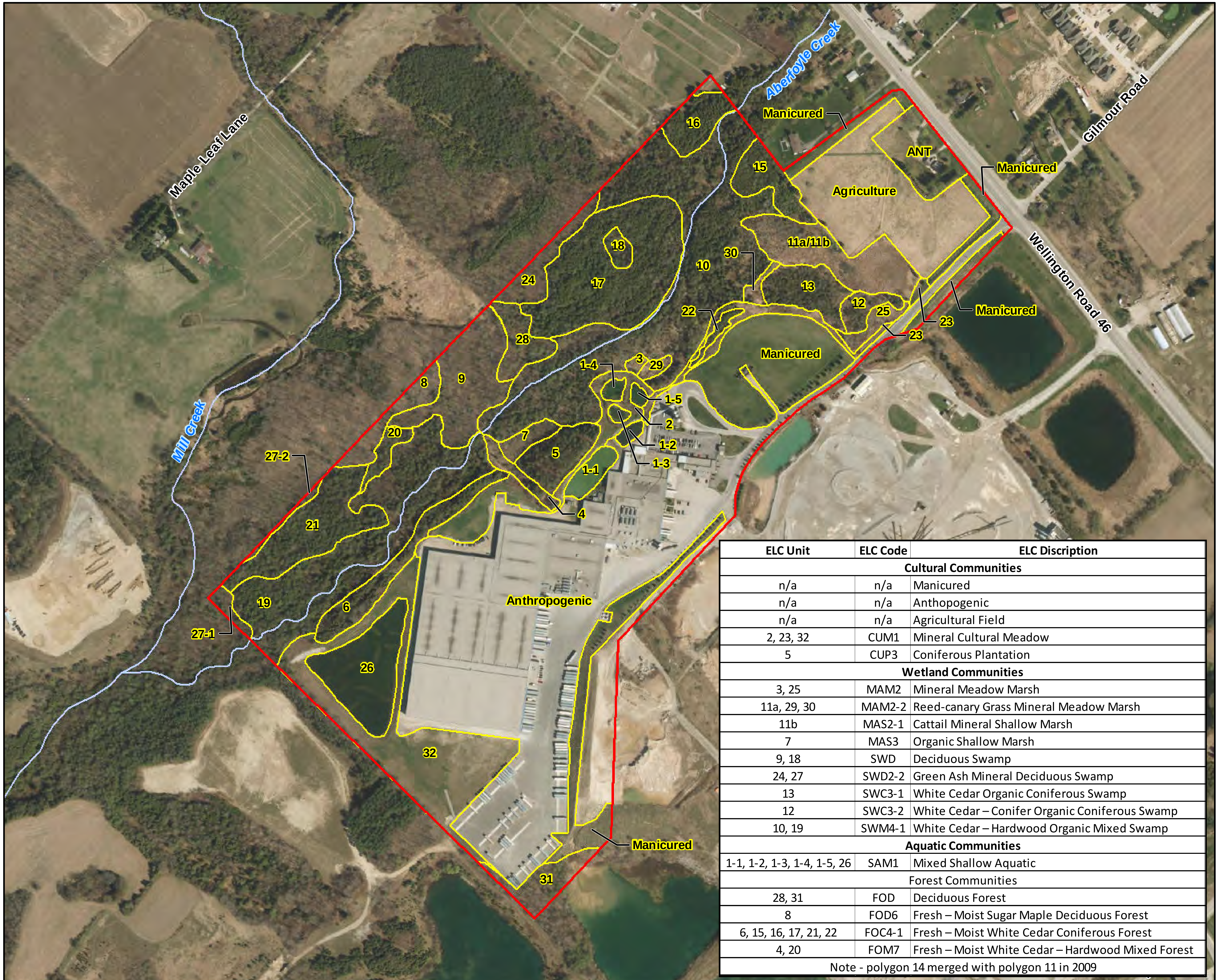
[1]Draft Wellington Country Vascular Plant List (Cecile 2017)

3.2.3 Vegetation Plot Sampling

A total of 115 plants were recorded from the six vegetation plots in 2019, including five that were identified to genus. Of the 110 species identified, 85 (85%) are native, and 16 (15%) are considered non-native in Ontario. The proportion of native/non-native is similar to previous years with 88% native

ELC Vegetation Communities	Figure 4

Aberfoyle 2020 Biological Monitoring Program



ELC Unit	ELC Code	ELC Discription
Cultural Communities		
n/a	n/a	Manicured
n/a	n/a	Anthopogenic
n/a	n/a	Agricultural Field
2, 23, 32	CUM1	Mineral Cultural Meadow
5	CUP3	Coniferous Plantation
Wetland Communities		
3, 25	MAM2	Mineral Meadow Marsh
11a, 29, 30	MAM2-2	Reed-canary Grass Mineral Meadow Marsh
11b	MAS2-1	Cattail Mineral Shallow Marsh
7	MAS3	Organic Shallow Marsh
9, 18	SWD	Deciduous Swamp
24, 27	SWD2-2	Green Ash Mineral Deciduous Swamp
13	SWC3-1	White Cedar Organic Coniferous Swamp
12	SWC3-2	White Cedar – Conifer Organic Coniferous Swamp
10, 19	SWM4-1	White Cedar – Hardwood Organic Mixed Swamp
Aquatic Communities		
1-1, 1-2, 1-3, 1-4, 1-5, 26	SAM1	Mixed Shallow Aquatic
Forest Communities		
28, 31	FOD	Deciduous Forest
8	FOD6	Fresh – Moist Sugar Maple Deciduous Forest
6, 15, 16, 17, 21, 22	FOC4-1	Fresh – Moist White Cedar Coniferous Forest
4, 20	FOM7	Fresh – Moist White Cedar – Hardwood Mixed Forest
Note - polygon 14 merged with polygon 11 in 2009		

Legend

- Subject Property
- ELC Communities
- Watercourse

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C:\Dropbox\Dropbox (Beacon)\All GIS Projects\2016\216114\MXD\Aberfoyle\Report Figures\2020 Monitoring Report\2020-08-04_Figure04_ELC_NestleAberfoyle_216114.mxd in 2008, 87% in 2010, 85% in 2013, 87% in 2014, and 92% in 2016. **Photograph 1** shows a portion of Plot 5 that was surveyed in 2019.

Data for individual vegetation plots has not included in this report but is on file with Beacon.

Photograph 1. Representative Photograph of Plot 5 on August 12, 2019

3.2.3.1 Floristic Quality Assessment

FQA values for each plot between 2008 and 2019 is summarized in **Table 7**. A comparison of FQA values averaged across all plots is provided in **Table 8.** Species richness is noticeably lower in 2008 compared to the following five monitoring years. The data show a spike in species richness and a corresponding increase in FQI between 2008 and 2010. After 2010, the numbers decrease somewhat and generally level off between 2013 and 2019.

Table 7. FQA Summary by Plot for 2008-2019

Plot	Variable/ Parameter	2008	2010	2013	2014	2016	2019
1	Total Species	22	52	41	44	39	35
	Native Species	19	43	31	36	31	30
	Introduced Species	3	9	10	8	8	5
	Wetness Index	-2.18	-2.33	-1.24	-1.93	-1.49	-2.26
	Mean Total CC	3.32	2.98	2.20	2.65	2.59	3.17
	Mean Native CC	3.84	3.60	2.90	3.51	3.26	3.60
	Total FQI	15.56	21.49	13.86	17.55	16.17	18.76
	Native FQI	16.75	23.64	16.16	21.09	18.15	19.72

Plot	Variable/ Parameter	2008	2010	2013	2014	2016	2019
2	Total Species	30	53	40	41	41	41
	Native Species	27	48	34	38	34	35
	Introduced Species	3	5	6	5	7	6
	Wetness Index	-1.93	-2.52	-1.73	-1.93	-1.61	-1.78
	Mean Total CC	3.23	3.88	3.08	3.32	3.1	3.12
	Mean Native CC	3.59	3.51	3.62	3.78	3.74	3.66
	Total FQI	17.71	25.55	18.14	21.24	19.85	19.99
	Native FQI	18.67	26.85	21.09	22.67	21.81	21.64
3	Total Species	23	62	47	50	48	47
	Native Species	20	55	39	45	42	41
	Introduced Species	3	7	8	6	7	6
	Wetness Index	-1.09	-1.86	-1.26	-2.18	-2.10	-1.89
	Mean Total CC	3.26	3.60	3.21	3.62	3.42	3.57
	Mean Native CC	3.75	4.05	3.97	4.11	3.90	4.10
	Total FQI	15.64	28.45	20.36	25.60	23.7	24.5
	Native FQI	16.77	30.33	24.18	27.29	27.27	26.24
4	Total Species	17	30	28	31	37	39
	Native Species	15	27	25	29	32	34
	Introduced Species	2	3	3	3	5	4
	Wetness Index	-0.29	-1.63	-1.61	-1.42	-1.27	-1.33
	Mean Total CC	4.00	4.17	3.82	4.10	3.97	3.92
	Mean Native CC	4.53	4.63	4.28	4.54	4.59	4.50
	Total FQI	16.49	22.82	18.92	22.81	24.13	24.5
	Native FQI	17.56	24.06	21.4	24.00	25.98	26.24
5	Total Species	21	46	37	36	41	47
	Native Species	19	39	33	34	36	42
	Introduced Species	2	7	4	3	5	5
	Wetness Index	-1.19	-0.48	-0.95	-0.75	-1.15	-1.26
	Mean Total CC	4.05	3.85	3.78	3.88	3.71	3.77
	Mean Native CC	4.47	4.54	4.24	4.33	4.27	4.21
	Total FQI	18.55	26.10	21.6	23.27	23.74	25.82
	Native FQI	19.50	28.34	24.37	24.89	25.32	27.31
6	Total Species	16	29	26	28	24	24
	Native Species	14	21	20	22	19	20
	Introduced Species	2	8	6	6	5	4
	Wetness Index	-1.00	0.21	-0.46	-0.32	-0.1	-0.63
	Mean Total CC	3.06	2.45	2.62	2.86	2.92	2.71
	Mean Native CC	3.50	3.38	3.40	3.64	3.68	3.25
	Total FQI	12.25	13.18	12.85	15.12	14.31	13.27
	Native FQI	13.10	15.49	15.21	17.06	16.04	14.53

Table 8. Comparison of Floristic Quality Assessment scores averaged across all plots, 2008-2019

Parameter	2008	2010	2013	2014	2016	2019
Average Total Species Richness	21.50	45.33	36.50	38.33	38.33	38.83
Average Native Species richness	19.00	38.83	30.33	34.00	32.33	33.67
Average Non-native Species Richness	2.50	6.50	6.17	5.17	6	5.16
Average Wetness Index	-1.28	-1.44	-1.21	-1.42	-1.29	-1.52
Average Native CC	3.95	3.95	3.74	3.99	3.90	3.89
Average Total CC	3.49	3.49	3.12	3.41	3.28	3.38
Average Native FQI	17.06	24.79	20.40	22.83	22.1	22.61
Average Total FQI	16.03	23.04	17.62	20.93	20.31	21.14

The fluctuations in the floristic parameters could be attributed to various environmental factors such as precipitation, herbivory, competition from dominant species, and natural dieback, which can vary on a seasonal and annual basis. Based on the monitoring data available, it is not possible to directly attribute the observed changes to specific environmental factors or variables. Some of the variability observed is likely attributable to observer bias, especially in plots where certain species occur in low numbers and can be easily overlooked or are not reliably detected.

Overall, there have been some minor shifts in species composition and abundance from year-to-year, which is to be expected within a dynamic natural environment. The general composition and structure of the vegetation within the plots have not changed substantially and the observed changes are within the expected range of natural variation for the wetland community types present.

3.2.4 Marsh Surveys

As part of the ELC confirmation work completed by Dougan & Associates in 2009, marshes on the subject property were assessed and recorded, and some ELC was updated from 2008 to 2009. These surveys were again conducted by Dougan & Associates in 2010, 2011 and 2013 (not in 2012). The resulting predominant vegetation species and the biophysical characteristics of each marsh surveyed have been included in Dougan and Associates' annual monitoring reports.

In 2010, the overall conditions that had been recorded in 2009 had not changed substantially. However, ELC Unit 7 (**Figure 4**) appeared drier due to lack of deep standing water and a new moisture gradient was observed in ELC Unit 29. No changes or re-classifications to ELC communities were made in 2010.

Again, the hydrologic conditions and vegetation composition observed in 2011 were not significantly different from 2010. Common Reed had spread, but the abundance of hydrophilic species (which would be indicative of changing wetland conditions) did not significantly change. No changes or re-classifications to ELC communities were made in 2010.

The conditions of the marshes observed in 2013 were slightly drier in comparison to what was noted in 2010 and 2011. Dougan & Associates attributed these changes to the much lower than average level of precipitation in 2012 and the slightly lower than average precipitation in 2013. No changes or re-classifications to ELC communities were made in 2013.

Dougan & Associates note that ELC Units 3, 29, 5 and 6 are impacted by discharge of water from the complex of small ponds west of the parking lot. The water level in these ponds are being artificially regulated, which could explain fluctuations. Dougan & Associates also noted that the variation in vegetation in marshes could also be a result of plant responses to variations in weather patterns and environmental conditions rather than permanent trends.

3.2.5 Invasive Species Mapping

Since monitoring was initiated on the property, colonies of Common Reed have been slowly expanding (**Figure 5**). Patch sizes were recorded in 2013, 2016 and 2017 (**Table 9)**.

Table 9. Comparison of Common Reed Patch Size between 2013, 2016 and 2017

Colony	Size (m^2)			Difference (m^2)	Difference (%)
	2013	2016	2017		
A	172.28	254.43	255.04	0.61	0.24%
B	1,698.69	1,813.99	1,964.49	150.50	8.30%
C	1,920.17	1,401.47	2,886.44	266.24	10.16%
D	1,511.74	1,218.73	-	-	-
E	3,095.25	1,913.31	2,439.94	526.63	27.52%
F	1,061.60	202.67	123.36	-79.31	-39.13%
G	101.73	84.08	118.58	34.50	41.03%
H	-	127.31	162.44	35.13	27.59%
I	-	4.92	7.55	2.63	53.46%
J	-	25.05	18.73	-6.32	-25.23%
K	-	1,655.91	1,456.14	199.77	-12.06%
L	-	182.24	210.49	28.25	15.50%
M	-	-	16.77	-	-
N	-	-	70.55	-	-
O	-	-	132.15	-	-
P	-	-	62.52	-	-
Q	-	-	6.23	-	-
Total	**9,561.46**	**8,884.11**	**9,931.42**	**1,047.31**	**11.79%**

Monitoring of the Common Reed colonies in 2016 revealed a decrease in the rate of expansion of these colonies, but an increase in the colony size was observed in 2017. Between these two years, the following changes in Common Reed on the property were documented:

- Notable increases in colonies B, C (which has now joined with colony D), E and K;

Common Reed Colony Locations

Figure 5

Aberfoyle 2020 Biological Monitoring Program

Legend

- Subject Property
- Common Reed Colonies (December 2017)
- Common Reed Colonies (December 2017)
- Common Reed Colonies (2016)
- Common Reed Colonies (December 2017)

BEACON ENVIRONMENTAL

C. Portt & Associates

Project: 216114

Last Revised: August, 2020

Client: Nestlé Waters Canada

Prepared by: DU
Checked by: AC

N

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- Small increases in colonies A, G, H, I and L;
- Small decreases in colonies F and J;
- Five new colonies, M through Q, were identified; and
- 32 additional points that were too small to map as polygons were identified.

The change in cover of Common Reed on the subject property increased by 1,047.31 m^2, or 11.79% between 2016 and 2017. The Common Reed cover in 2017 was similar to that of the patch size recorded in 2013. It is anticipated that Common Reed will continue to spread throughout suitable open habitat on the property. An area being invaded by Common Reed in shown in **Photograph 2**.

Photograph 2. Common Reed within Colony E on December 18, 2017

3.3 Wildlife Surveys

3.3.1 Breeding Amphibians

Four frog species and one toad species were recorded from three stations on the subject property during the 2020 nocturnal amphibian call surveys. Species include American Toad (*Anaxyrus americanus*), Green Frog (*Rana clamitans*), Gray Tree Frog (*Hyla versicolor*), Spring Peeper (*Pseudacris crucifer*) and Wood Frog (*Lithobates sylvaticus*). The findings of these amphibian breeding surveys are summarized in **Table 10**.

The primary amphibian breeding areas on the property are: Pond 1 at west end of the property and the group of three small ponds/shallow aquatic features ("fire ponds") located just west of the parking lot.

Amphibians observed incidentally during other field surveys included: Green Frog, Gray Tree Frog and Bull Frog (*Lithobates catesbeianus*). **Photograph 3** shows a Green Frog that was noted during a basking turtle survey in Pond 1.

Table 10. Breeding Amphibian Survey Results (2020)

Location (Figure 3)	Round 1 (April 25, 2020)	Round 2 (May 22, 2020)	Round 3 (June 9, 2020)
1	0	SPPE - 1(1) *	GRFR - 1(3) GRTR - 1(1) *
2	SPPE - 2(9) WOFR - 1(1)	AMTO - (2(3) GRFR - 1(1) GRTR - 2(4) SPPE - 2(10)	GRFR - 1(2) GRTR - 2(10)
3	0	AMTO - 1(2)	GRFR - 2(8) GRTR *

* = Call recorded from outside of station area
AMTO = American Toad, GRFR = Green Frog, GRTR = Gray Tree Frog, SPPE = Spring Peeper, WOFR = Wood Frog
Code 0 - No calling
Code 1 - Individuals can be counted; calls not simultaneous. Estimated number of individuals indicated in brackets
Code 2 - Calls distinguishable; some simultaneous calling. Estimated number of individuals indicated in brackets
Code 3 - Full chorus; calls continuous and overlapping.

Photograph 3. Green Frog in Pond 1 on May 21, 2020

The 2020 amphibian breeding surveys are generally comparable to those of previous years (2008-2011 and 2015-2019) as shown in **Table 11**. Spring Peeper, Gray Tree Frog, and Green Frog have been observed each year monitoring has been completed. Wood Frog, previously heard only in 2008, was detected again in 2015, 2017, 2019 and 2020, but not in 2018. Northern Leopard Frog was not noted on the subject property in 200, but it was observed incidentally on the property in 2010, 2016, 2018 and 2019, and was documented calling during the nocturnal amphibian surveys at Pond 1 in 2017 and 2019. American Bullfrog called in Pond 1 during the second breeding bird survey in 2020. Previous, it had been heard calling during the third breeding survey in 2017 and 2019 within the pond just east of the property, and incidental observations were recorded in 2015 and 2018.

Table 11. Breeding Amphibian Monitoring Results (2008-2020)

Year	SPPE	GRTR	GRFR	CHFR	WOFR	AMTO	NLFR	BUFR
2008	X	X	X	X	X	-	-	-
2009	X	X	X	-	-	-	-	-
2010	X	X	X	-	-	-	X	-
2011	X	X	X	X	X	X	-	-
2015	X	X	X	-	X	-	X	X
2016	X	X	X	-	X	X	X	-
2017	X	X	X	-	X	X	X	X
2018	X	X	X	-	-	X	-	-
2019	X	X	X	-	X	X	X	X
2020	X	X	X	-	X	X	-	X

SPPE = Spring Peeper, GRTR = Gray Treefrog, GRFR = Green Frog, CHFR = Western Chorus Frog, WOFR = Wood Frog, AMTO = American Toad, NLFR = Northern Leopard Frog, BUFR = American Bullfrog

Overall the results of these surveys have been relatively consistent with minor variations from year to year which are to be expected based on the types of habitat present on the property and daily and annual species variations as some adult amphibian species are very mobile and often travel over upland areas to other suitable habitats.

3.3.2 Breeding Birds

A total of 47 species of birds (**Appendix C**) were documented on and directly adjacent to the subject property in 2020. Of the 47 species documented, 35 exhibited evidence of breeding and are considered to be breeding on the subject property.

During the field surveys in 2020, species that were observed flying or foraging over the property, or observed during migration and not considered to be breeding on the property, included: Double-crested Cormorant (*Phalacrocorax auritus*), Great Blue Heron (*Ardea Herodias*), Mallard (*Anas platyrhynchos*), Ring-necked Duck (*Aythya collaris*), Turkey Vulture (*Cathartes aura*), Red-tailed Hawk (*Buteo jamaicensis*), American Woodcock (*Scolopax minor*) Ring-billed Gull (*Larus delawarensis*), Belted Kingfisher (*Ceryle alcyon*), Pileated Woodpecker (*Dryocopus pileatus*), Northern Rough-winged Swallow (*Stelgidopteryx serripennis*), and Bank Swallow (*Riparia riparia*). These species were either observed flying overhead or were using the property to forage (e.g. swallow species).

Of the 35 species that exhibited breeding evidence, no species are designated as Special Concern, Threatened or Endangered. All have a conservation rank of S5 (Secure) or S4 (Apparently Secure) (NHIC 2020). Typically, Eastern Wood-Pewee (*Contopus virens*), which is designated as Special Concern under the federal *Species at Risk Act* (2002) and provincial *Endangered Species Act* (2007), has been noted on the property. It was not recorded during the 2020 breeding bird surveys.

Five of the 35 bird species that displayed some level of breeding evidence on the property are considered to be “priority landbird species” in Bird Conservation Region (BCR) 13, the Lower Great Lakes – St. Lawrence Plain. Priority species are those that meet Partners in Flight criteria for Species of Continental or Regional Importance, because of high conservation concern / vulnerability and/or high stewardship responsibility scores (OPIF 2008). Species include:

1. Northern Flicker (*Colaptes auratus);*
2. Willow Flycatcher (*Empidonax traillii*);
3. Eastern Kingbird (*Tyrannus tyrannus*);
4. Rose-breasted Grosbeak (*Pheucticus ludovicianus*); and
5. Baltimore Oriole (*Icterus galbula*).

Northern Flicker was heard calling from the wooded feature south west of Pond 1. One Willow Flycatcher was recorded within breeding bird monitoring station 5, and also heard within the vegetation south west of Pond 1. Eastern Kingbird was noted at breeding bird monitoring station 1 and Rose-breasted Grosbeak was noted at stations 3 and 5. Baltimore Oriole was recorded at breeding bird monitoring station 5 and south west at Pond 1.

Seven of the 35 breeding bird species are considered significant in Wellington County (Dougan & Associates 2009). These species included:

1. Northern Flicker;
2. Willow Flycatcher;
3. Eastern Kingbird;
4. Pine Warbler (*Setophaga pinus*);
5. American Redstart (*Setophaga ruticilla*);
6. Rose-breasted Grosbeak; and
7. Baltimore Oriole.

One Pine Warbler was heard at breeding bird monitoring station 5. American Redstarts were documented on the property at breeding bird monitoring stations 1, 3 and 5.

Two of the 35 breeding bird species observed in 2020 are considered area-sensitive. These species included:

1. Pine Warbler (*Setophaga pinus*); and
2. American Redstart (*Setophaga ruticilla*).

Area-sensitive species require larger areas of suitable habitat in order to sustain their populations (OMNR 2000) and are therefore considered more sensitive to habitat loss and fragmentation. All four species are associated with the forested habitats on the site.

These numbers, which are similar those obtained from the 2008 (40 total / 34 breeding), 2010 (48 total / 36 breeding), and 2019 (44 total / 34 breeding) breeding bird surveys, are in the average range of birds that have been recorded / recorded as breeding on the property since the implementation of the wildlife monitoring program in 2008. A detailed comparison of number of birds recorded each year on and directly adjacent to the subject property is shown in **Table 12**.

Table 12. Breeding Bird Monitoring Results (2008-2020)

Monitoring Year	Number of Total Bird Species	Number of Breeding Bird Species
2008	40	34
2009	45	39
2010	48	36
2011	50	38
2015	39	33
2016	48	40
2017	51	37
2018	39	32
2019	44	34
2020	47	35

Breeding bird species that were not recorded this year were primarily woodland species that breed in the forested habitat north of the plant. Birds in this area can be difficult to hear from the point count stations if wind levels are towards the higher end of what is permitted for breeding bird surveys.

However, the overall results of the breeding bird surveys in 2020 are similar to the results of breeding bird surveys that were completed in previous years at the site. Differences in the results of these surveys can be attributed to minor variations in survey techniques, daily and annual species variations.

3.3.3 Owl Surveys

During the two owl surveys conducted in 2010, no Barred Owls were recorded. However, during the second owl survey in 2010 on July 27, a Northern Saw-whet Owl was recorded calling continuously for 5 minutes in the north east corner. The Ontario Breeding Bird Atlas states that this species breeds in a variety of forest types but is most abundant in coniferous forests (Cadman et al. 2007). Therefore, the NWC Aberfoyle property provides suitable habitat for this owl species. Northern Saw-whet Owl is considered locally rare in Wellington County (Dougan and Associates 2009) and ranked as “apparently secure” (S4) by NHIC (2020).

As a result of this record, the 2011 field surveys included broadcasting calls for Northern Saw-whet Owls, as discussed in **Section 2.3.3**. However, in 2011, no owls were heard during the survey, and no formal owl surveys or incidental observations of owls have occurred since.

3.3.4 Basking Turtle Survey

The results of the basking turtle surveys are shown below in **Table 13**. Pond locations are shown on **Figure 3.** Additionally, two Midland Painted Turtles (Chrysemys picta marginata) were noted incidentally in Pond 1 on June 18, 2020 during a breeding bird survey.

Table 13. Basking Turtle Survey Results (2020)

	Survey 1 (Apr. 25, 2020)			Survey 2 (May 21, 2020)			Survey 3 (Sept. 16, 2020		
	Pond 1	***Pond 2***	***Fire Ponds***	***Pond 1***	***Pond 2***	***Fire Ponds***	***Pond 1***	***Pond 2***	***Fire Ponds***
Midland Painted Turtle (*Chrysemys picta marginata*)	7	0	0	17	0	0	10	0	0
Snapping Turtle (*Chelydra serpentina*)	0	0	0	2	0	4	0	0	0

The majority of the turtles that were observed on the subject property were Midland Painted Turtles, all of which were observed in Pond 1 (**Figure 2**). Two Midland Painted Turtles can be seen basking in Pond 1 in **Photograph 4** below. This species is not considered significant at the local (Dougan & Associates 2009), regional (Plourde *et al*. 1989), or provincial (NHIC 2018) level. In April 2018, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) updated this species' status to Special Concern due to loss of wetlands in Ontario; the *Species at Risk Act* (2002) has not created a schedule yet for Midland Painted Turtle.

The number of Midland Painted Turtles seen in 2018-2020 is lower than what has previously been recorded (refer to **Table 14**). This is likely due to the growth of Common Reed and Willow species around the edge of Pond 1, which could inhibit this species' basking habitat. When the water levels were lower on May 21, 2020, more basking habitat was present, and more Midland Painted Turtles were recorded.

Photograph 4. Midland Painted Turtle Basking in Pond 1 on April 25, 2020

Six Snapping Turtles were observed on the subject property during the second turtle basking survey. Four were recorded basking under some foliage or along the edge within the three small ponds/shallow aquatic features ("fire ponds") located just west of the parking lot (as can be seen in **Photograph 5**). Additionally, two Snapping Turtles were observed basking in Pond 1 on rocks in the middle of the feature. These types of basking behaviour are typical for Snapping Turtles, which typically only leave the water to migrate between suitable habitats or to lay their eggs. Additionally, predated Snapping Turtle nests were observed adjacent this Pond 1 and Pond 2. In 2019, NWC staff indicated that Snapping Turtle a frequently observed and that they occasionally install fencing over the nests to mitigate predation.

Photograph 5. Snapping Turtle Basking in Fire Ponds on May 21, 2020

A summary of the basking turtle survey results from the NWC monitoring program on the Aberfoyle property are shown below in **Table 14**.

Table 14. Basing Turtle Monitoring Results (2008-2020)

Year	Snapping Turtle*	Midland Painted Turtle*
2008	1	0
2010	0	8 (5)
2011	1	38 (23)
2015	2 (1)	80 (36)
2016	5 (4)	42 (23)
2017	5	44 (25)
2018	1	30 (13)
2019	4 (2)	34 (22)
2020	6	34 (17)

* Maximum number observed per survey event are noted in parentheses.

3.3.5 Odonate Surveys

Baseline odonate surveys were completed by Dougan & Associates in 2010 and 2011 in the vicinity of Pond 1. The following taxa were observed:

- Common Green Darner - *Anax junius;*
- Northern/Vernal Bluet - *Enallagma annexum/E. vernale;*

- Rainbow Bluet - *Enallagma antennatum;*
- Boreal Bluet - *Enallagma boreale;*
- Marsh Bluet - *Enallagma erbium;*
- Unidentified Bluet species - *Enallagma sp.;*
- Eastern Pondhawk - *Erythemis simplicicollis;*
- Eastern Forktail - *Ischnura verticalis;*
- Dot-tailed Whiteface - *Leucorrhinia intacta;* and
- Unidentified Spreadwing species - *Sympetrum sp.*

Additionally, Canada Darner and Eastern Pondhawk were noted incidentally in 2009.

Dougan & Associates note that this list in likely quite conservative since the survey was focussed in the Pond 1 area, and there are likely many other taxa present on the subject property. Common Green Darner, Boreal Bluet, Marsh Bluet, Eastern Pondhawk, Eastern Forktail and Dot-tailed Whiteface are ranked as “secure” (S5) while Rainbow Bluet, North Bluet and Vernal Bluet are ranked as “apparently secure” (S4) (NHIC 2020). Both Northern and Vernal Bluets are also considered Significant in Wellington County (Dougan & Associates 2009).

No additional odonate surveys are proposed in the near future.

3.3.6 Other Wildlife Species Observations

Other wildlife that were recorded on the subject property, during the 2020 field season included:

- Bat species;
- Coyote (*Canis latrans*);
- Eastern Cottontail (*Sylvilagus floridanus*);
- Garter Snake (*Thamnophis sirtalis*);
- Raccoon (*Procyon lotor*);
- Smallmouth Bass (*Micropterus dolomieu*); and
- Sunfish (*Crapet* sp.).

A bat flew over staff at amphibian station 1 on April 25, 2020; a Coyote was also heard, and a Racoon was seen in this area on that date. The Eastern Cottontail was noted incidentally on the subject property during amphibian and basking turtle surveys on April 25, 2020 in close proximity to Pond 2 and again on June 2, 2020 during breeding bird surveys. The Garter Snake was an incidental observation during basking turtle surveys on April 25, 2020 near Pond 2.

Smallmouth Bass was recorded within the group of fire ponds during the basking turtle survey on May 21, 2020. Additionally, Sunfish were noted within Pond 1 during the basking turtle survey on April 25, 2020.

These incidental wildlife observations are similar to that noted in previous years.

4. Conclusion and Recommendations

This annual monitoring report describes the methods and findings of the 2020 biological monitoring field programs for the NWC Aberfoyle property. Aquatic and terrestrial monitoring completed in 2020 included:

- Salmonid spawning (redd) surveys in Aberfoyle Creek;
- Stream temperature monitoring;
- Amphibian breeding surveys;
- Breeding bird surveys; and
- Turtle basking surveys.

Consistent with the required aquatic monitoring program, salmonid spawning surveys were completed along Aberfoyle Creek in 2020 by C. Portt and Associates. No evidence of spawning was observed. These findings are consistent with those of previous years (2007-2019).

Amphibian breeding surveys completed in 2020 documented five species and an additional species were documented incidentally. These findings are consistent with previous survey years and there are no significant changes to the resident breeding populations.

Breeding bird surveys were completed in 2020. Thirty-five (35) species were noted to be breeding on the property, which is consistent with numbers observed in 2008, 2010 and 2019. These numbers are average in comparison to other years and are consistent with normal year to year variation.

Turtle basking surveys of the pond habitats on site were completed in 2020 and confirmed that Painted Turtle and Snapping Turtle are actively using the site for basking, breeding and over-wintering. While the survey methodologies employed have been standardized, year to year variation in numbers observed remains relatively high.

Floristic surveys of the property were completed in 2019 to update the overall plant species checklist which was last updated in 2011. A total of 255 species were documented. Over 77% of the species present are considered native to Ontario and is reflects the quality of the ecological communities present.

In 2019, ecological communities on the subject property were verified and ELC mapping updated. The last update was in 2009. No significant changes were observed to warrant re-classification; however the boundaries of several communities were adjusted slightly.

Monitoring of vegetation in the six permanent sampling plots located in select wetland communities was completed in 2019. The data indicate that while there have been minor shifts in species composition and abundance from year-to-year, that most of this variation is attributable to sampling biases and does not reflect changes related to altered hydrology or disturbance; although there is some evidence to suggest compositional changes in some plots are related to expansion of Common Reed colonies.

No vegetation surveys were conducted in 2020. It is expected that vegetation surveys will be conducted again in 2022.

In summary, the findings suggest that there have not been any significant changes to the various terrestrial and aquatic parameters being monitored on the Aberfoyle property. Species richness, abundance, and distribution are generally within the range expected and attributable to natural variation and succession. The subject property continues to support high quality terrestrial and wetland habitats that support a diverse range of native wildlife. The aquatic environment is strongly influenced by the thermal loading from the Aberfoyle Mill Pond.

Based on findings of the 2020 biological monitoring program, we recommend that Core wildlife monitoring (amphibian, reptiles and birds) be completed in 2021. Additionally, Salmonid spawning surveys in Aberfoyle Creek will be conducted as required in 2021 by C. Portt and Associates.

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Appendix A

Key Biophysical Attributes of the Vegetation Communities in the Study Area

Appendix A

Key Biophysical Attributes of the Vegetation Communities in the Study Area[1]

Unit.	1	2	3	4	5
ELC Code	**SAM1**	**CUM1**	**MAM2**	**FOM7**	**CUP3**
Vegetation Type	Mixed Shallow Aquatic Ecosite	Mineral Cultural Meadow Ecosite	Mineral Shallow Marsh Ecosite	Fresh-Moist White Cedar - Hardwood Mixed Forest Ecosite	Coniferous Plantation Ecosite
Overstorey Composition	*Salix sp*	*Thuja occidentalis, Populus tremuloides, Populus deltoides ssp. deltoides,*	*Alnus incana spp. rugosa, Thuja occidentalis, Sambucus nigra ssp. Canadensis, Fraxinus pennsylvanica, Fraxinus nigra*	*Acer rubrum, Acer negundo, Fraxinus pennsylvanica, Thuja occidentalis, Populus tremuloides, Salix amygdaloides*	*Pinus strobes, Pinus sylvestris, Thuja occidentalis, Betula papyrifera, Prunus serotina, Acer saccharum var. saccharum, Carya cordiformis, Fraxinus americana, Rhamnus cathartica, Lonicera tatarica*
Understorey Composition	*Polygonum hydropiper, Rumex crispus, Schoenoplectus tabernaemontani, Typha angustifolia, Verbena hastata*	*Salix eriocephala, Rhamnus cathartica, Lonicera tatarica, Salix purpurea, Cornus sericea ssp. sericea, Vitis riparia, Rubus idaeus ssp. Idaeus, Salix exigua*	*Ribes triste Cornus sericea ssp. sericea*	*Cornus sericea ssp. sericea, Salix sp, Rubus idaeus ssp. idaeus*	*Rubus idaeus ssp. idaeus, Prunus virginiana var. virginiana*
Groundcover Composition	*Lemna minor*	*Solidago Canadensis, Daucus carota, Aster sp, Symphyotrichum novae-angliae, Asclepias syriaca, Echium vulgare, Achillea millefolium var. millefolium, Oenothera biennis, Tussilago farfara, Verbascum Thapsus, Fragaria virginiana ssp. Virginiana, Anemone sp, Trifolium sp*	*Typha latifolia,Carex stricta,Solanum dulcamara, Phalaris arundinacea, Thalictrum dioicum, Laportea canadensis, Mentha sp, Solidago rugosa ssp. Rugosa, Onoclea sensibilis, Carex intumescens, Eupatorium maculatum var. maculatum, Eupatorium perfoliatum, Symphyotrichum puniceum var. puniceum, Impatiens capensis, Lysimachia thyrsiflora, Ranunculus hispidus var. hispidus, Glyceria striata, Leersia oryzoides, Carex sp*	*Equisetum arvense, Tussilago farfara, Phalaris arundinacea*	*Asarum canadense Solidago flexicaulis Maianthemum canadense Tussilago farfara Eurybia macrophylla Carex granularis Sanguinaria canadensis*
Diameter Range	N/A	N/A	1	1– 2	2– 3
Structural Diversity	1	1	2	2	2
Canopy Closure	N/A	1	1	2(3)	3
Relative Age	2	1	2	2	2
Soil Texture	L	L	Om 15/ L	L – rip/rap	LfS
Drainage Class	3	1	3	1	1
Slope Class	1	1	1	2	2– 3
Topographic Class	1	1	2	1	1
Botanical Quality	1	1	2	1	1

[1] *Appendix A is based off the 2011 Biological Monitoring Program - Final Report (Dougan & Associates 2012) with minor updates from work done by Beacon in 2019.*

Unit.	6	7	8	9	10
ELC Code	FOC4-1	MAS3	FOD6	SWD	SWM4-1
Vegetation Type	Fresh-Moist White Cedar Coniferous Forest	Organic Shallow Marsh Ecosite	Fresh-Moist Sugar Maple Deciduous Forest Ecosite	Deciduous Swamp	White Cedar - Hardwood Organic Mixed Swamp
Overstorey Composition	*Thuja occidentalis Fraxinus pennsylvanica Acer saccharum var. saccharum*	*Thuja occidentalis, Betula papyrifera, Ulmus americana, Fraxinus nigra, Betula alleghaniensis, Acer saccharum var.saccharum Fraxinus pennsylvanica, Acer rubrum, Prunus serotina, Carpinus caroliniana ssp. virginiana, Tilia americana,*	*Acer saccharum var. saccharum, Ostrya virginiana, Tilia americana, Thuja occidentalis, Betula alleghaniensis, Betula papyrifera, Tsuga canadensis, Fagus grandifolia, Fraxinus pennsylvanica, Fraxinus americana*	*Fraxinus nigra Populus tremuloides Betula alleghaniensis Acer rubrum Tilia americana Thuja occidentalis Fraxinus pennsylvanica Fagus grandifolia*	*Thuja occidentalis, Populus tremuloides, Fraxinus pennsylvanica, Ulmus americana, Fraxinus nigra, Betula papyrifera, Betula alleghaniensis, Acer rubrum,*
Understorey Composition	*Sambucus racemosa var. racemosa Cornus alternifolia Ribes sp*	*Cornus sericea ssp. sericea, Rubus pubescens, Parthenocissus vitacea, Sambucus nigra ssp. canadensis*	-	*Sambucus nigra ssp. canadensis, Cornus sericea ssp. sericea*	*Rhamnus cathartica, Rubus idaeus ssp. idaeus, Salix petiolaris, Amelanchier alnifolia, Hamamelis virginiana, Cornus sericea ssp. sericea, Sambucus nigra ssp. canadensis, Parthenocissus vitacea, Lonicera dioica, Prunus virginiana var. virginiana, Cornus alternifolia, Alnus incana spp. rugosa, Frangula alnus, Cornus racemosa, Rubus pubescens, Prunus serotina,*
Groundcover Composition	*Cystopteris bulbifera Tussilago farfara Carex communis Asarum canadense Onoclea sensibilis*	*Phragmites australis, Thelypteris palustris var. pubescens, Carex hystericina, Solanum dulcamara, Scirpus atrovirens, Epilobium hirsutum, Onoclea sensibilis, Cicuta maculata, Bidens frondosa, Typha latifolia, Sium suave, Rorippa nasturtium-aquaticum, Lycopus americanus, Agrostis stolonifera*	*Carex pensylvanica, Onoclea sensibilis, Solidago flexicaulis, Tussilago farfara, Polystichum acrostichoides, Caulophyllum thalictroides, Asarum canadense, Anemone acutiloba, Carex pedunculata*	*Phalaris arundinacea Carex sp Solidago rugosa ssp. rugosa Onoclea sensibilis, Boehmeria cylindrica Carex lupulina Euonymus obovata*	*Solanum dulcamara,Agrimonia gryposepala, Thalictrum dioicum, Onoclea sensibilis, Oxalis stricta, Carex eburnean, Cystopteris bulbifera, Pilea pumila, Viola sororia, Clematis virginiana, Echinocystis lobata, Lysimachia thyrsiflora, Circaea lutetiana ssp. canadensis,, Phalaris arundinacea, Aster puniceus var. puniceus, Anemone virginiana var. cylindroidea, Dryopteris carthusiana, Echinocystis lobata*
Diameter Range	3	1	2– 3	2– 3	2– 3
Structural Diversity	2	2	2	2	2
Canopy Closure	3	1	3	3	3
Relative Age	2	2	2	2	2
Soil Texture	LfS	Om/SiL	L	L	O/L
Drainage Class	2	3	2	3	3
Slope Class	2(3)	1	1– 2	1	1
Topographic Class	2	2	1	2	2
Botanical Quality	2	2	2	2	3

Unit.	11	12	13	14-merged with Polygon 11 in 2009	15
ELC Code	**MAS2-1/MAM2-2**	**SWC3-2**	**SWC3-1**	**SWT2**	**FOC4-1**
Vegetation Type	Cattail Mineral Shallow Marsh/Reed Canary Grass Mineral Meadow Marsh	White Cedar - Conifer Organic Coniferous Swamp	White Cedar Organic Coniferous Swamp	Mineral Thicket Swamp Ecosite	Fresh-Moist White Cedar Coniferous Forest
Overstorey Composition	*Populus tremuloides, Thuja occidentalis*	*Thuja occidentalis Larix laricina*	*Thuja occidentalis, Populus balsamifera ssp. balsamifera Larix laricina, Betula papyrifera*	*Thuja occidentalis*	*Thuja occidentalis*
Understorey Composition	*Rhamnus cathartica Salix sp Salix petiolaris Ribes sp Cornus sericea ssp. sericea*	*Lonicera tatarica*	*Parthenocissus vitacea Lonicera tatarica*	*Salix sp Parthenocissus vitacea*	-
Groundcover Composition	*Typha latifolia, Phalaris arundinacea, Solidago canadensis var. scabra Tussilago farfara, Lysimachia thyrsiflora, Solanum dulcamara, Equisetum arvense, Carex hystericina, Carex stipata Aster puniceus var. puniceus, Eupatorium maculatum var. maculatum, Caltha palustris, Onoclea sensibilis, Impatiens capensis, Poa sp, Schoenoplectus tabernaemontani, Cicuta maculate, Carex stricta*	*Carex stricta, Carex pellita Dryopteris carthusiana Thelypteris palustris var. pubescens, Osmunda cinnamomea, Galium aparine, Equisetum arvense, Aster sp, Typha latifolia, Tussilago farfara, Fragaria virginiana ssp. virginiana, Caltha palustris, Solidago canadensis var. scabra, Thalictrum pubescens, Cypripedium parviflorum, Phragmites australis, Onoclea sensibilis*	*Equisetum arvense, Tussilago farfara, Onoclea sensibilis Galium aparine, Solanum dulcamara, Carex stipata, Phalaris arundinacea, Aster puniceus var. puniceus Thalictrum pubescens Dryopteris carthusiana, Caltha palustris, Eupatorium perfoliatum, Impatiens capensis, Eupatorium maculatum var. maculatum, Carex rosea, Cypripedium parviflorum, Taraxacum officinale*	*Typha latifolia Aster puniceus var. puniceus Phalaris arundinacea Solanum dulcamara Carex stipata Cicuta maculata Impatiens capensis Lysimachia thyrsiflora Onoclea sensibilis Thalictrum pubescens Asclepias syriaca Typha angustifolia*	-
Diameter Range	N/A	1– 2	2– 3	1	3
Structural Diversity	2	2	2	2	2
Canopy Closure	N/A	2– 3	3	1	3
Relative Age	2	2	2	2	2
Soil Texture	L	Om	Om	L	LfS
Drainage Class	3	3	3	3	2
Slope Class	1	1	1	1	1
Topographic Class	2	2	2	2	2
Botanical Quality	2	2	2	2	2

Unit.	16	17	18	19	20
ELC Code	FOC4-1	FOC4-1	SWD	SWM4-1	FOM7
Vegetation Type	Fresh-Moist White Cedar Coniferous Forest	Fresh-Moist White Cedar Coniferous Forest	Deciduous Swamp	White Cedar - Hardwood Organic Mixed Swamp	Fresh-Moist White Cedar - Hardwood Mixed Forest Ecosite
Overstorey Composition	*Thuja occidentalis*	*Thuja occidentalis, Pinus strobus Populus tremuloides, Betula papyrifera, Prunus serotina Picea abies, Abies balsamea*	*Fraxinus nigra Rubus idaeus ssp. idaeus Rubus pubescens Parthenocissus vitacea Rhamnus cathartica Thuja occidentalis Vitis riparia Frangula alnus Populus tremuloides*	*Species composition similar to unit 10*	*Thuja occidentalis, tilia americana, Acer saccharum ssp saccharum, Ostrya virginiana, Tsuga canadensis*
Understorey Composition	-	*Prunus virginiana var. virginiana Rhamnus cathartica*	-	-	*Acer saccharum ssp saccharum*
Groundcover Composition	-	*Carex flacca, Danthonia spicata, Solidago nemoralis*	*Anemone canadensis Solanum dulcamara Geum sp Thalictrum pubescens Circaea lutetiana ssp. canadensis Arisaema triphyllum ssp. triphyllum Galium sp Solidago rugosa ssp. rugosa*	-	*Carex pensylvanica, Dryopteris carthusiana, Asarum canadense*
Diameter Range	2– 3	2– 3	1– 2	2– 3	2– 3
Structural Diversity	1	1	2	2	2
Canopy Closure	3	3	2	3	3
Relative Age	2	2	1	2	2
Soil Texture	L	L	L	O/L	L
Drainage Class	1	1	3	3	2
Slope Class	1	1	1	1	1– 2
Topographic Class	2	2	2	2	2
Botanical Quality	2	2	2	3	2

Unit.	21	22	23	24	25
ELC Code	**FOC4-1**	**FOC4-1**	**CUM1**	**SWD2-2**	**MAM2**
Vegetation Type	Fresh-Moist White Cedar Coniferous Forest	Fresh-Moist White Cedar Coniferous Forest	Mineral Cultural Meadow Ecosite	Red Ash Mineral Deciduous Swamp	Common Reed Mineral Meadow Marsh
Overstorey Composition	*Populus tremuloides Thuja occidentalis Fraxinus pennsylvanica Fraxinus americana Acer saccharum var. saccharum Betula alleghaniensis*	*Thuja occidentalis, Betula papyrifera Salix fragilis, Populus balsamifera ssp. balsamifera, Populus tremuloides,*	*Acer negundo*	-	*Populus balsamifera ssp. balsamifera Acer negundo*
Understorey Composition	-	*Salix purpurea, Cornus sericea ssp. sericea, Lonicera tatarica*	*Rhamnus cathartica, Rubus idaeus ssp. idaeus, Vitis riparia*	-	*Vitis riparia, Parthenocissus vitacea*
Groundcover Composition	*Solidago canadensis*	*Equisetum arvense, Solidago canadensis, Tussilago farfara, Taraxacum officinale*	*Solidago canadensis var. scabra, Echium vulgare, Linaria vulgaris, Thlaspi arvense, Equisetum arvense, Symphyotrichum novae-angliae, Bromus inermis ssp. pumpellianus, Leucanthemum vulgare, Solidago canadensis, Arctium minus, Lotus corniculatus, Daucus carota, Cirsium arvense, Rumex crispus, Tussilago farfara, Anemone canadensis, Asclepias syriaca, Trifolium repens*	-	*Phalaris arundinacea Rumex crispus Anemone canadensis, Ranunculus acris, Phragmites australis*
Diameter Range	2– 3	2– 3	N/A	2– 3	N/A
Structural Diversity	1	2	1	2	1
Canopy Closure	3	3	N/A	3	N/A
Relative Age	2	2	1	2	1
Soil Texture	L	L	L	L	L
Drainage Class	1	1	1	3	2
Slope Class	1	2	1– 2	1	1
Topographic Class	2	2	1	2	1
Botanical Quality	2	2	1	2	1

Unit.	26	27	28	29	30
ELC Code	**SAM1**	**SWD2-2**	**FOD**	**MAM2-2**	**MAM2-2**
Vegetation Type	Mixed Shallow Aquatic Ecosite	Green Ash Mineral Deciduous Swamp	Deciduous Forest	Reed Canary-grass Mineral Meadow Marsh	Reed Canary-grass Mineral Meadow Marsh
Overstorey Composition	*Salix exigua*	*Fraxinus pensylvanica, Fraxinus nigra, Ulmus americana, Betula allegheniensis, Tilia Americana, Populus tremuloides*	*Fraxinus pensylvanica, Populus tremuloides, Thuja occidentalis, Pinus strobus*	*Thuja occidentalis, Fraxinus nigra*	-
Understorey Composition	-	*Rubus idaeus ssp melanolasius, Rhamnus cathyartica, Sambucus canadensis, Thuja occidentalis, Viburnum trilobum (R)*	*Thuja occidentalis, Cornus sericea ssp sericea, Rhamnus frangula, abies balsamea*	*Cornus sericea ssp sericea, Rubus idaeus ssp strigosus, Thuja occidentalis*	-
Groundcover Composition	*Coronilla varia, Poa sp Achillea millefolium var. millefolium, Typha latifolia, Juncus effusus ssp. solutes, Silene vulgaris, Melilotus officinalis Rumex crispus, Schoenoplectus tabernaemontani, Ranunculus sceleratus var. sceleratus*	*Onoclea sensibilis, Solidago rugosa, Clematis virginiana, Cystopteris bulbifera*	*Carex pensylvanica, Solidago canadensis var. scabra, Pteridium aquilinum, solidago rugosa, Solanum dulcamara, Solidago rugosa*	*Phalaris arundinacea -D, Symphyotrichum lateriflorum var. angustifolium, Eupatorium maculatum, Aster puniceus, Carex sp.,*	*Phalaris arundinacea -D, Aster puniceus-A, Typha angustifolia,Typha latifolia, Symphyotrichum lanceolatum var. lanceolatum, Cyperipedium parviflorum var. makasin*
Diameter Range	N/A	2	1,2 (3)	1	1
Structural Diversity	1	2	2	1	1
Canopy Closure	N/A	3	3	1	1
Relative Age	1	2	1– 2	1	1
Soil Texture	L	L	L	L	L
Drainage Class	3	2– 3	1	2– 3	2– 3
Slope Class	1	1	1	1	1
Topographic Class	1	1	1	1	1
Botanical Quality	2	2	2	2	2

Unit.	31	32
ELC Code	**FOD**	**CUM1**
Vegetation Type	Deciduous Forest Remnant	Cultural Meadow
Overstorey Composition	*Acer saccharum ssp saccharum, Tilia americana*	-
Understorey Composition	-	-
Groundcover Composition	-	Some areas manicured turf, some areas seeded; *Medicago sativa, Melilotus sp, Daucus carota*
Diameter Range	2	1
Structural Diversity	1	1
Canopy Closure	3	1
Relative Age	2	1
Soil Texture	L	L
Drainage Class	1	1
Slope Class	1	1
Topographic Class	1	1
Botanical Quality	2	1

LEGEND
Diameter Range (1 = <15 cm dbh.; 2 = 15 – 30 cm dbh.; 3 = >30 cm dbh.)
Structural Diversity (1 = strata 1 & 2; 2 = >2 strata; 3 = > 3 strata, old growth)
Canopy Closure (1 = <25%; 2 = 25– 50%; 3 = >50%)
Relative Age (1 = immature; 2 = mature; 3 = old growth)
Soil Texture (sand/silt/clay/org)
Drainage Class (1 = well-drained; 2 = imperfectly drained (1 – 3 mottles); 3 = poorly drained (>3 mottles)
Slope Class (1 = <10%; 2 = 10– 25%; 3 = >25%)
Topographic Class (1 = uniform; 2 = uneven; 3 = high variability (hummocky)
Botanical Quality (1 = disturbed, exotics; 2 = low diversity; 3 = high diversity (sig spp. present)
Edge Abbreviations: ( ) represent localized condition; D = Dominant (51– 100%); A = Abundant (21– 50%); F = Frequent (11– 20%); O = Occasional (5– 10%); S = Scarce (<5%)

Appendix B

Flora Checklist

Appendix B

Flora Checklist

Family Name	Scientific Name	Common Name (FOIBIS)	Coefficient of Conservatism	Wetness Index	S-Rank	Wellington
Alismataceae	*Alisma triviale*	Northern Water-plantain	1	-5	S5	-
Alismataceae	*Sagittaria latifolia*	Broadleaf Arrowhead	4	-5	S5	-
Anacardiaceae	*Toxicodendron rydbergii*	Western Poison Ivy	0	0	S5	-
Apiaceae	*Cicuta bulbifera*	Bulb-bearing Water-hemlock	5	-5	S5	-
Apiaceae	*Cicuta maculata*	Spotted Water-hemlock	6	-5	S5	-
Apiaceae	*Daucus carota*	Queen Anne's Lace	0	5	SNA	-
Apiaceae	*Hydrocotyle americana*	American Water-pennywort	7	-5	S5	-
Apiaceae	*Sium suave*	Hemlock Water-parsnip	4	-5	S5	-
Apocynaceae	*Apocynum androsaemifolium* ssp. *androsaemifolium*	Spreading Dogbane	3	5	S5	-
Araceae	*Arisaema triphyllum* ssp. *triphyllum*	Jack-in-the-pulpit	5	-2	S5	-
Araliaceae	*Aralia nudicaulis*	Wild Sarsaparilla	4	3	S5	-
Aristolochiaceae	*Asarum canadense*	Wild Ginger	6	5	S5	-
Asclepiadaceae	*Asclepias incarnata* ssp. *incarnata*	Swamp Milkweed	6	-5	S5	-
Asclepiadaceae	*Asclepias syriaca*	Common Milkweed	0	5	S5	-
Aspleniaceae	*Asplenium platyneuron*	Ebony Spleenwort	6	3	S4	R
Asteraceae	*Achillea millefolium* var. *occidentalis*	Wooly Yarrow	0	3	S5	-
Asteraceae	*Ambrosia trifida*	Great Ragweed	0	-1	S5	-
Asteraceae	*Bidens frondosa*	Devil's Beggar's Ticks	3	-3	S5	-
Asteraceae	*Cichorium intybus*	Chicory	0	5	SNA	-
Asteraceae	*Cirsium vulgare*	Bull Thistle	0	4	SNA	-
Asteraceae	*Erigeron philadelphicus* var. *philadelphicus*	Philadelphia Fleabane	1	-3	S5	-
Asteraceae	*Eupatorium perfoliatum*	Common Boneset	2	-4	S5	-
Asteraceae	*Euthamia graminifolia*	Grass-leaved Goldenrod	2	-2	S5	-
Asteraceae	*Eutrochium maculatum* var. *maculatum*	Spotted Joe-pye Weed	3	-5	S5	-
Asteraceae	*Hieracium* sp.	Hawkweed Species	0	0	-	-
Asteraceae	*Lactuca biennis*	Tall Blue Lettuce	6	0	S5	-
Asteraceae	*Lactuca* sp.	Lettuce Species	0	0	-	-
Asteraceae	*Leucanthemum vulgare*	Oxeye Daisy	0	5	SNA	-
Asteraceae	*Solidago altissima var. altissima*	Tall Goldenrod	1	3	S5	-
Asteraceae	*Solidago canadensis*	Canada Goldenrod	1	3	S5	-
Asteraceae	*Solidago flexicaulis*	Broad-leaved Goldenrod	6	3	S5	-
Asteraceae	*Solidago gigantea*	Smooth Goldenrod	4	-3	S5	-
Asteraceae	*Solidago nemoralis* var. *nemoralis*	Field Goldenrod	2	5	S5	-
Asteraceae	*Solidago rugosa* ssp. *rugosa*	Rough Goldenrod	4	-1	S5	-
Asteraceae	*Sonchus arvensis* ssp. *arvensis*	Field Sowthistle	0	1	SNA	-

Family Name	Scientific Name	Common Name (FOIBIS)	Coefficient of Conservatism	Wetness Index	S-Rank	Wellington
Asteraceae	*Sonchus asper* ssp. *asper*	Spiny-leaf Sowthistle	0	0	SNA	-
Asteraceae	*Symphyotrichum lanceolatum* ssp. *lanceolatum*	Panicled Aster	3	-3	S5	-
Asteraceae	*Symphyotrichum lateriflorum* var. *lateriflorum*	Calico Aster	3	-2	S5	-
Asteraceae	*Symphyotrichum novae-angliae*	New England Aster	2	-3	S5	-
Asteraceae	*Symphyotrichum pilosum* var. *pilosum*	Hairy Aster	4	2	S5	U
Asteraceae	*Symphyotrichum puniceum* var. *puniceum*	Purple-stemmed Aster	6	-5	S5	-
Asteraceae	*Symphyotrichum urophyllum*	Arrow-leaved Aster	6	5	S4	U
Asteraceae	*Taraxacum officinale*	Common Dandelion	0	3	SNA	-
Asteraceae	*Tussilago farfara*	Colt's Foot	0	3	SNA	-
Balsaminaceae	*Impatiens capensis*	Spotted Jewel-weed	4	-3	S5	-
Berberidaceae	*Caulophyllum giganteum*	Blue Cohosh	-	-	S5	-
Berberidaceae	*Caulophyllum thalictroides*	Blue Cohosh	6	5	S5	-
Betulaceae	*Alnus incana* ssp. *rugosa*	Speckled Alder	6	-5	S5	-
Betulaceae	*Betula alleghaniensis*	Yellow Birch	6	0	S5	-
Betulaceae	*Betula papyrifera*	Paper Birch	2	2	S5	-
Betulaceae	*Carpinus caroliniana* ssp. *virginiana*	American Hornbeam	6	0	S5	-
Boraginaceae	*Echium vulgare*	Common Viper's-bugloss	0	5	SNA	-
Boraginaceae	*Hackelia virginiana*	Virginia Stickseed	5	1	S5	-
Boraginaceae	*Myosotis laxa*	Small Forget-me-not	6	-5	S5	-
Boraginaceae	*Myosotis scorpioides*	True Forget-me-not	0	-5	SNA	-
Boraginaceae	*Symphytum officinale* ssp. *officinale*	Common Comfrey	0	5	SNA	-
Brassicaceae	*Cardamine diphylla*	Broad-leaved Toothwort	7	5	S5	-
Brassicaceae	*Cardamine pensylvanica*	Pennsylvania Bitter-cress	6	-4	S5	U
Brassicaceae	*Rorippa nasturtium-aquaticum*	True Watercress	0	-5	SNA	-
Brassicaceae	*Thlaspi arvense*	Field Penny-cress	0	5	SNA	-
Campanulaceae	*Lobelia siphilitica*	Great Blue Lobelia	6	-4	S5	-
Caprifoliaceae	*Lonicera tatarica*	Tartarian Honeysuckle	0	3	SNA	-
Caprifoliaceae	*Sambucus canadensis*	Common Elderberry	5	-2	S5	-
Caprifoliaceae	*Sambucus nigra*	Eupopean Elderberry	-	-	SNA	-
Caprifoliaceae	*Viburnum opulus*	Guelder-rose Viburnum	0	0	SNA	-
Caryophyllaceae	*Silene vulgaris*	Maiden's Tears	0	5	SNA	-
Celastraceae	*Euonymus obovatus*	Running Strawberry-bush	6	5	S5	-
Clusiaceae	*Hypericum perforatum*	St. John's-wort	0	5	SNA	-
Convolvulaceae	*Convolvulus arvensis*	Field Bindweed	0	5	SNA	-
Cornaceae	*Cornus alternifolia*	Alternate-leaf Dogwood	6	5	S5	-
Cornaceae	*Cornus racemosa*	Gray Dogwood	2	-2	S5	-
Cornaceae	*Cornus sericea* ssp. *sericea*	Red-osier Dogwood	2	-3	S5	-
Cucurbitaceae	*Echinocystis lobata*	Wild Mock-cucumber	3	-2	S5	-
Cupressaceae	*Thuja occidentalis*	Northern White Cedar	4	-3	S5	-
Cyperaceae	*Carex bebbii*	Bebb's Sedge	3	-5	S5	-

Family Name	Scientific Name	Common Name (FOIBIS)	Coefficient of Conservatism	Wetness Index	S-Rank	Wellington
Cyperaceae	*Carex bromoides*	Brome-like Sedge	7	-4	S5	-
Cyperaceae	*Carex communis*	Fibrous-root Sedge	6	5	S5	-
Cyperaceae	*Carex flacca*	Heath Sedge	0	0	SNA	-
Cyperaceae	*Carex flava*	Yellow Sedge	5	-5	S5	-
Cyperaceae	*Carex gracillima*	Graceful Sedge	4	3	S5	-
Cyperaceae	*Carex granularis*	Meadow Sedge	3	-4	S5	-
Cyperaceae	*Carex hystericina*	Porcupine Sedge	5	-5	S5	-
Cyperaceae	*Carex intumescens*	Bladder Sedge	6	-4	S5	-
Cyperaceae	*Carex lupulina*	Hop Sedge	6	-5	S5	-
Cyperaceae	*Carex pedunculata*	Longstalk Sedge	5	5	S5	-
Cyperaceae	*Carex pellita*	Woolly Sedge	4	-5	S5	-
Cyperaceae	*Carex pensylvanica*	Pennsylvania Sedge	5	5	S5	-
Cyperaceae	*Carex radiata*	Stellate Sedge	4	5	S5	-
Cyperaceae	*Carex* sp.	Sedge Species	0	0	-	-
Cyperaceae	*Carex stipata*	Stalk-grain Sedge	3	-5	S5	-
Cyperaceae	*Carex stricta*	Tussock Sedge	4	-5	S5	-
Cyperaceae	*Carex vulpinoidea*	Fox Sedge	3	-5	S5	-
Cyperaceae	*Schoenoplectus tabernaemontani*	Soft-stemmed Bulrush	5	-5	S5	-
Cyperaceae	*Scirpus atrovirens*	Woolgrass Bulrush	3	-5	S5	-
Dennstaedtiaceae	*Pteridium aquilinum* var. *latiusculum*	Bracken Fern	2	3	S5	-
Dryopteridaceae	*Athyrium filix-femina* var. *angustum*	Lady-fern	4	0	S5	-
Dryopteridaceae	*Cystopteris bulbifera*	Bulblet Fern	5	-2	S5	-
Dryopteridaceae	*Dryopteris carthusiana*	Spinulose Wood Fern	5	-2	S5	-
Dryopteridaceae	*Dryopteris cristata*	Crested Wood Fern	7	-5	S5	-
Dryopteridaceae	*Dryopteris intermedia*	Evergreen Wood Fern	5	0	S5	-
Dryopteridaceae	*Dryopteris marginalis*	Marginal Wood Fern	5	3	S5	-
Dryopteridaceae	*Matteuccia struthiopteris* var. *pensylvanica*	Ostrich Fern	5	-3	S5	-
Dryopteridaceae	*Onoclea sensibilis*	Sensitive Fern	4	-3	S5	-
Dryopteridaceae	*Polystichum acrostichoides*	Christmas Fern	5	5	S5	-
Equisetaceae	*Equisetum arvense*	Field Horsetail	0	0	S5	-
Equisetaceae	*Equisetum sylvaticum*	Woodland Horsetail	7	-3	S5	U
Fabaceae	*Coronilla varia*	Crown-vetch	0	5	SNA	-
Fabaceae	*Lotus corniculatus*	Bird's-foot Trefoil	0	1	SNA	-
Fabaceae	*Medicago lupulina*	Black Medic	0	1	SNA	-
Fabaceae	*Trifolium repens*	White Clover	0	2	SNA	-
Fabaceae	*Trifolium* sp.	Clover Species	0	0	-	-
Fagaceae	*Fagus grandifolia*	American Beech	6	3	S5	-
Geraniaceae	*Geranium maculatum*	Wild Geranium	6	3	S5	-
Geraniaceae	*Geranium robertianum*	Herb-robert	0	5	S5	-
Grossulariaceae	*Ribes cynosbati*	Prickly Gooseberry	4	5	S5	-

Family Name	Scientific Name	Common Name (FOIBIS)	Coefficient of Conservatism	Wetness Index	S-Rank	Wellington
Grossulariaceae	*Ribes triste*	Swamp Red Currant	6	-5	S5	-
Iridaceae	*Iris versicolor*	Blueflag	5	-5	S5	-
Juglandaceae	*Carya cordiformis*	Bitternut Hickory	6	0	S5	-
Juglandaceae	*Juglans nigra*	Black Walnut	5	3	S4?	-
Juncaceae	*Juncus effusus* ssp. *solutus*	Soft Rush	4	-5	S5	-
Lamiaceae	*Galeopsis tetrahit*	Brittle-stem Hempnettle	0	5	SNA	-
Lamiaceae	*Lycopus americanus*	American Bugleweed	4	-5	S5	-
Lamiaceae	*Lycopus uniflorus*	Northern Bugleweed	5	-5	S5	-
Lamiaceae	*Mentha arvensis*	Corn Mint	3	-3	S5	-
Lamiaceae	*Nepeta cataria*	Catnip	0	1	SNA	-
Lamiaceae	*Prunella vulgaris* ssp. *lanceolata*	Self-heal	5	5	S5	-
Lamiaceae	*Prunella vulgaris* ssp. *vulgaris*	Common Heal-all	0	0	SNA	-
Lamiaceae	*Scutellaria galericulata*	Hooded Skullcap	6	-5	S5	-
Lamiaceae	*Scutellaria lateriflora*	Mad Dog Skullcap	5	-5	S5	-
Lamiaceae	*Scutellaria* sp.	Skullcap Species	0	0	-	-
Lemnaceae	*Lemna minor*	Lesser Duckweed	2	-5	S5	-
Liliaceae	*Allium tricoccum*	Wild Leek	7	2	S5	-
Liliaceae	*Maianthemum canadense*	Wild-lily-of-the-valley	5	0	S5	-
Liliaceae	*Maianthemum stellatum*	Starflower False Solomon's Seal	6	1	S5	-
Liliaceae	*Polygonatum pubescens*	Downy Solomon's Seal	5	5	S5	-
Liliaceae	*Trillium grandiflorum*	White Trillium	5	5	S5	-
Liliaceae	*Trillium* sp.	Trillium Species	0	0	-	-
Lythraceae	*Lythrum salicaria*	Slender-spike Loosestrife	0	-5	SNA	-
Oleaceae	*Fraxinus nigra*	Black Ash	7	-4	S5	-
Oleaceae	*Fraxinus pennsylvanica*	Green Ash	3	-3	S5	-
Onagraceae	*Circaea lutetiana* ssp. *canadensis*	Enchanter's Nightshade	3	3	S5	-
Onagraceae	*Epilobium hirsutum*	Great-hairy Willow-herb	0	-4	SNA	-
Onagraceae	*Epilobium parviflorum*	Small-flower Willow-herb	0	3	SNA	-
Onagraceae	*Epilobium* sp.	Willow-herb Species	0	0	-	-
Orchidaceae	*Cypripedium parviflorum*	Small Yellow Lady's-slipper	7	-1	S5	-
Orchidaceae	*Epipactis helleborine*	Eastern Helleborine	0	5	SNA	-
Osmundaceae	*Osmunda cinnamomea*	Cinnamon Fern	7	-3	S5	-
Oxalidaceae	*Oxalis stricta*	Upright Yellow Wood Sorrel	0	3	S5	-
Papaveraceae	*Sanguinaria canadensis*	Bloodroot	5	4	S5	-
Pinaceae	*Abies balsamea*	Balsam Fir	5	-3	S5	-
Pinaceae	*Larix laricina*	American Larch	7	-3	S5	-
Pinaceae	*Pinus nigra*	Black Pine	0	-5	SNA	-
Pinaceae	*Pinus strobus*	Eastern White Pine	4	3	S5	-
Pinaceae	*Tsuga canadensis*	Eastern Hemlock	7	3	S5	-
Plantaginaceae	*Plantago lanceolata*	English Plantain	0	0	SNA	-

Family Name	Scientific Name	Common Name (FOIBIS)	Coefficient of Conservatism	Wetness Index	S-Rank	Wellington
Plantaginaceae	*Plantago major*	Nipple-seed Plantain	0	-1	SNA	-
Poaceae	*Agrostis gigantea*	Redtop	0	0	SNA	-
Poaceae	*Brachyelytrum erectum*	Long-awned Wood Grass	7	5	S4S5	R
Poaceae	*Bromus ciliatus*	Fringed Brome	6	-3	S5	-
Poaceae	*Bromus inermis* ssp. *inermis*	Smooth Brome	0	5	SNA	-
Poaceae	*Cinna latifolia*	Slender Wood Reedgrass	7	-4	S5	U
Poaceae	*Danthonia spicata*	Poverty Oat-grass	5	5	S5	-
Poaceae	*Echinochloa crusgalli*	Barnyard Grass	0	-3	SNA	-
Poaceae	*Elymus hystrix*	Bottle-brush Grass	5	5	S5	-
Poaceae	*Elymus repens*	Quack Grass	0	3	SNA	-
Poaceae	*Elymus virginicus* var. *virginicus*	Virginia Wild-rye	5	-2	S5	-
Poaceae	*Glyceria grandis*	American Manna Grass	5	-5	S4S5	-
Poaceae	*Glyceria striata*	Fowl Manna Grass	3	-5	S5	-
Poaceae	*Leersia oryzoides*	Rice Cutgrass	3	-5	S5	-
Poaceae	*Phalaris arundinacea*	Reed Canary Grass	0	-4	S5	-
Poaceae	*Phleum pratense*	Timothy	0	3	SNA	-
Poaceae	*Phragmites australis ssp. australis*	European Common Reed	0	-4	SNA	-
Poaceae	*Poa palustris*	Fowl Bluegrass	5	-4	S5	-
Poaceae	*Poa pratensis* ssp. *pratensis*	Kentucky Bluegrass	0	1	SNA	-
Poaceae	*Schizachne purpurascens* ssp. *purpurascens*	Purple Oat	6	2	S5	-
Polygonaceae	*Polygonum hydropiper*	Water-pepper	4	-5	SNA	-
Polygonaceae	*Rumex crispus*	Curly Dock	0	-1	SNA	-
Polygonaceae	*Rumex orbiculatus*	Water Dock	6	-5	S4S5	-
Primulaceae	*Lysimachia ciliata*	Fringed Loosestrife	4	-3	S5	-
Primulaceae	*Lysimachia thyrsiflora*	Water Loosestrife	7	-5	S5	-
Primulaceae	*Trientalis borealis* ssp. *borealis*	Northern Starflower	6	-1	S5	-
Pteridaceae	*Adiantum pedatum*	Northern Maidenhair-fern	7	1	S5	-
Ranunculaceae	*Actaea pachypoda*	White Baneberry	6	5	S5	-
Ranunculaceae	*Anemone acutiloba*	Sharp-lobed Hepatica	6	5	S5	-
Ranunculaceae	*Anemone canadensis*	Canada Anemone	3	-3	S5	-
Ranunculaceae	*Anemone virginiana* var. *virginiana*	Virginia Anemone	4	5	S5	-
Ranunculaceae	*Aquilegia canadensis*	Wild Columbine	5	1	S5	-
Ranunculaceae	*Caltha palustris*	Marsh Marigold	5	-5	S5	-
Ranunculaceae	*Clematis virginiana*	Virginia Virgin-bower	3	0	S5	-
Ranunculaceae	*Ranunculus abortivus*	Kidney-leaved Buttercup	2	-2	S5	-
Ranunculaceae	*Ranunculus acris*	Tall Buttercup	0	-2	SNA	-
Ranunculaceae	*Ranunculus hispidus* var. *caricetorum*	Swamp Buttercup	5	-5	S5	-
Ranunculaceae	*Ranunculus pensylvanicus*	Bristly Crowfoot	3	-5	S5	U
Ranunculaceae	*Ranunculus recurvatus* var. *recurvatus*	Hooked Crowfoot	4	-3	S5	-
Ranunculaceae	*Ranunculus* sp.	Buttercup Species	0	0	-	-

Family Name	Scientific Name	Common Name (FOIBIS)	Coefficient of Conservatism	Wetness Index	S-Rank	Wellington
Ranunculaceae	*Thalictrum dioicum*	Early Meadowrue	5	2	S5	-
Ranunculaceae	*Thalictrum pubescens*	Tall Meadowrue	5	-2	S5	-
Rhamnaceae	*Frangula alnus*	Glossy Buckthorn	0	-1	SNA	-
Rhamnaceae	*Rhamnus cathartica*	Buckthorn	0	0	SNA	-
Rosaceae	*Agrimonia gryposepala*	Tall Hairy Agrimony	2	2	S5	-
Rosaceae	*Fragaria virginiana*	Wild Stawberry	2	1	S5	-
Rosaceae	*Geum canadense*	White Avens	3	0	S5	-
Rosaceae	*Geum laciniatum*	Rough Avens	4	-3	S4	-
Rosaceae	*Geum* sp.	Avens Species	0	0	-	-
Rosaceae	*Geum urbanum*	Clover-root	0	5	SNA	-
Rosaceae	*Malus* sp.	Apple Species	0	0	-	-
Rosaceae	*Prunus serotina*	Wild Black Cherry	3	3	S5	-
Rosaceae	*Rubus idaeus* ssp. *strigosus*	Wild Red Raspberry	0	-2	S5	-
Rosaceae	*Rubus pubescens*	Dwarf Raspberry	4	-4	S5	-
Rosaceae	*Spiraea alba*	Narrow-leaved Meadow-sweet	3	-4	S5	-
Rubiaceae	*Galium aparine*	Cleavers	4	3	S5	-
Rubiaceae	*Galium asprellum*	Rough Bedstraw	6	-5	S5	-
Rubiaceae	*Galium palustre*	Marsh Bedstraw	5	-5	S5	-
Rubiaceae	*Galium* sp.	Bedstraw Species	0	0	-	-
Salicaceae	*Populus balsamifera* ssp. *balsamifera*	Balsam Poplar	4	-3	S5	-
Salicaceae	*Populus deltoides* ssp. *deltoides*	Eastern Cottonwood	-	-	S5	-
Salicaceae	*Populus tremuloides*	Quaking Aspen	2	0	S5	-
Salicaceae	*Salix alba*	White Willow	0	-3	SNA	-
Salicaceae	*Salix bebbiana*	Bebb's Willow	4	-4	S5	-
Salicaceae	*Salix discolor*	Pussy Willow	3	-3	S5	-
Salicaceae	*Salix eriocephala*	Heart-leaved Willow	4	-3	S5	-
Salicaceae	*Salix exigua*	Sandbar Willow	3	-5	S5	-
Salicaceae	*Salix fragilis*	Crack Willow	0	-1	SNA	-
Salicaceae	*Salix petiolaris*	Meadow Willow	3	-4	S5	-
Salicaceae	*Salix purpurea*	Basket Willow	0	-3	SNA	-
Salicaceae	*Salix* sp.	Willow Species	0	0	-	-
Sapindaceae	*Acer negundo*	Manitoba Maple	0	-2	S5	-
Sapindaceae	*Acer platanoides*	Norway Maple	0	5	SNA	-
Sapindaceae	*Acer rubrum*	Red Maple	4	0	S5	-
Sapindaceae	*Acer saccharinum*	Silver Maple	5	-3	S5	-
Sapindaceae	*Acer saccharum* var. *saccharum*	Sugar Maple	4	3	S5	-
Sapindaceae	*Acer* x *freemanii*	Freeman's Maple	-	0	S5	-
Saxifragaceae	*Mitella nuda*	Naked Bishop's-cap	6	-3	S5	-
Saxifragaceae	*Tiarella cordifolia*	Heart-leaved Foam-flower	6	1	S5	-
Scrophulariaceae	*Chelone glabra*	Turtlehead	7	-5	S5	-

Family Name	Scientific Name	Common Name (FOIBIS)	Coefficient of Conservatism	Wetness Index	S-Rank	Wellington
Scrophulariaceae	*Verbascum thapsus*	Common Mullein	0	5	SNA	-
Scrophulariaceae	*Veronica anagallis-aquatica*	Brook-pimpernell	0	-5	SNA	-
Scrophulariaceae	*Veronica officinalis*	Common Speedwell	0	5	SNA	-
Smilacaceae	*Smilax herbacea*	Smooth Herbaceous Greenbrier	5	0	S4	-
Solanaceae	*Solanum dulcamara*	Climbing Nightshade	0	0	SNA	-
Thelypteridaceae	*Thelypteris palustris* var. *pubescens*	Marsh Fern	5	-4	S5	-
Tiliaceae	*Tilia americana*	American Basswood	4	3	S5	-
Typhaceae	*Typha angustifolia*	Narrow-leaved Cattail	3	-5	S5	-
Typhaceae	*Typha latifolia*	Broad-leaf Cattail	3	-5	S5	-
Ulmaceae	*Ulmus americana*	American Elm	3	-2	S5	-
Ulmaceae	*Ulmus pumila*	Siberian Elm	0	5	SNA	-
Urticaceae	*Boehmeria cylindrica*	False Nettle	4	-5	S5	-
Urticaceae	*Laportea canadensis*	Wood Nettle	6	-3	S5	-
Urticaceae	*Pilea pumila*	Canada Clearweed	5	-3	S5	-
Urticaceae	*Urtica dioica* ssp. *gracilis*	Slender Stinging Nettle	2	-1	S5	-
Verbenaceae	*Verbena hastata*	Blue Vervain	4	-4	S5	-
Violaceae	*Viola sororia*	Woolly Blue Violet	4	1	S5	-
Violaceae	*Viola* sp.	Violet Species	0	0	-	-
Vitaceae	*Parthenocissus vitacea*	Thicket Creeper	3	3	S5	-
Vitaceae	*Vitis riparia*	Riverbank Grape	0	-2	S5	-

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c - SRANK (from Natural Heritage Information Centre) for breeding status if: S1 (Critically Imperiled), S2 (Imperiled),S3 (Vulnerable), S4 (Apparently Secure), S5 (Secure) SNA (Not applicable…'because the species is not a suitable target for conservation activities'; includes non-native species)
d - Draft Wellington County Vascular Plant List (Cecile 2017). Status only shown if: R = Rare, U = Uncommon

Appendix C

Breeding Bird Checklist (2020)

Appendix C

Breeding Bird Checklist (2020)

Common Name	Scientific Name	Status					April 25, 2020 Incidentals	May 21, 2020 Incidentals	September 16, 2020 Incidentals	June 2, 2020						June 18, 2020					
		National Species at Risk COSEWIC[a]	Species at Risk in Ontario Listing [b]	Provincial breeding season SRANK[c]	Wellington Regional Status[d]	Area-sensitive (OMNR)[e]				PCS #1	PCS #2	PCS #3	PCS #4	PCS #5	Incidentals	PCS #1	PCS #2	PCS #3	PCS #4	PCS #5	Incidentals
Double-crested Cormorant	*Phalacrocorax auritus*	-	-	S5	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-
Great Blue Heron	*Ardea herodias*	-	-	S4	S,R	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-
Green Heron	*Butorides virescens*	-	-	S4	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Canada Goose	*Branta canadensis*	-	-	S5	-	-	X	X	-	1	-	-	-	F	15	-	-	-	-	-	1
Mallard	*Anas platyrhynchos*	-	-	S5	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-
Ring-necked Duck	*Aythya collaris*	-	-	S5	S,R	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Turkey Vulture	*Cathartes aura*	-	-	S5	S,R	-	F	-	F	-	-	-	-	-	-	-	-	-	-	-	-
Red-tailed Hawk	*Buteo jamaicensis*	-	-	S5	-	-	F	-	-	-	-	-	-	-	-	-	-	-	F	-	-
Killdeer	*Charadrius vociferus*	-	-	S5	-	-	-	-	16F	-	-	-	-	-	1	-	-	-	1	-	1
American Woodcock	*Scolopax minor*	-	-	S4	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring-billed Gull	*Larus delawarensis*	-	-	S5	S,R	-	-	F	-	-	-	-	-	-	-	F	-	-	-	F	-
Mourning Dove	*Zenaida macroura*	-	-	S5	-	-	-	-	-	F	-	-	-	-	3	-	-	-	-	-	-
Ruby-throated Hummingbird	*Archilochus colubris*	-	-	S5	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Belted Kingfisher	*Ceryle alcyon*	-	-	S4	S	x	-	X	-	-	F	-	-	-	-	-	-	-	-	-	-
Northern Flicker	*Colaptes auratus*	-	-	S4	S	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Pileated Woodpecker	*Dryocopus pileatus*	-	-	S5	S	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Willow Flycatcher	*Empidonax traillii*	-	-	S5	S	x	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Great Crested Flycatcher	*Myiarchus crinitus*	-	-	S4	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Eastern Kingbird	*Tyrannus tyrannus*	-	-	S4	S	x	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
N. Rough-winged Swallow	*Stelgidopteryx serripennis*	-	-	S4	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	F
Bank Swallow	*Riparia riparia*	THR	THR	S4	S	x	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-
Blue Jay	*Cyanocitta cristata*	-	-	S5	-	-	-	-	X	-	-	-	1	-	-	-	1	1	-	-	-
American Crow	*Corvus brachyrhynchos*	-	-	S5	-	-	-	X	X	1	F	-	-	-	1	-	1	1	-	-	-
Black-capped Chickadee	*Poecile atricapillus*	-	-	S5	-	-	-	-	-	1	2	-	-	1	-	-	3	-	-	1	1
House Wren	*Troglodytes aedon*	-	-	S5	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	-
American Robin	*Turdus migratorius*	-	-	S5	-	-	X	X	-	1	-	-	1	-	-	3	1	1	1	1	-
Gray Catbird	*Dumetella carolinensis*	-	-	S4	-	-	X	-	-	-	1	-	-	-	-	-	-	1	-	1	-
Cedar Waxwing	*Bombycilla cedrorum*	-	-	S5	-	-	-	-	-	4	F	3	-	-	-	-	-	-	-	-	2
European Starling	*Sturnus vulgaris*	-	-	SE	-	-	-	-	-	-	-	-	-	-	1	F	-	-	1	-	1
Warbling Vireo	*Vireo gilvus*	-	-	S5	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-
Red-eyed Vireo	*Vireo olivaceus*	-	-	S5	-	-	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
Yellow Warbler	*Setophaga petechia*	-	-	S5	-	-	-	X	-	1	-	1	-	1	-	1	-	-	-	2	-
Pine Warbler	*Setophaga pinus*	-	-	S5	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
American Redstart	*Setophaga ruticilla*	-	-	S5	S	-	-	-	-	1	-	1	-	-	-	1	-	-	-	1	-
Northern Waterthrush	*Parkesia noveboracensis*	-	-	S5	-	-	-	-	-	-	1	-	1	1	-	-	1	-	1	1	-
Common Yellowthroat	*Geothlypis trichas*	-	-	S5	-	-	-	-	-	1	2	-	1	1	-	2	1	-	-	-	-

Common Name	Scientific Name	Status					April 25, 2020 Incidentals	May 21, 2020 Incidentals	September 16, 2020 Incidentals	June 2, 2020						June 18, 2020					
		National Species at Risk COSEWIC[a]	Species at Risk in Ontario Listing [b]	Provincial breeding season SRANK[c]	Wellington Regional Status[d]	Area-sensitive (OMNR)[e]				PCS #1	PCS #2	PCS #3	PCS #4	PCS #5	Incidentals	PCS #1	PCS #2	PCS #3	PCS #4	PCS #5	Incidentals
Northern Cardinal	*Cardinalis cardinalis*	-	-	S5	-	-	-	-	-	-	1	-	-	-	1	-	1	1	-	-	-
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	-	-	S4	S	x	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
Indigo Bunting	*Passerina cyanea*	-	-	S4	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Chipping Sparrow	*Spizella passerina*	-	-	S5	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Song Sparrow	*Melospiza melodia*	-	-	S5	-	-	X	X	X	2	1	3	1	-	-	3	1	2	-	1	-
Swamp Sparrow	*Melospiza georgiana*	-	-	S5	-	-	X	-	-	-	2	-	-	-	-	1	1	1	-	-	-
Red-winged Blackbird	*Agelaius phoeniceus*	-	-	S4	-	-	X	X	-	6	1	1	1	3	3	4	1	1	2	5	-
Brown-headed Cowbird	*Molothrus ater*	-	-	S4	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
Baltimore Oriole	*Icterus galbula*	-	-	S4	S	x	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
House Finch	*Haemorhous mexicanus*	-	-	SNA	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
American Goldfinch	*Spinus tristis*	-	-	S5	-	-	X	X	X	1	-	F	2	1	-	1	1	1	1	1	-

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c - SRANK (from Natural Heritage Information Centre) for breeding status if: S1 (Critically Imperiled), S2 (Imperiled),S3 (Vulnerable), S4 (Apparently Secure), S5 (Secure) SNA (Not applicable…'because the species is not a suitable target for conservation activities'; includes non-native species)
e - Significant Wildlife List for Wellington County from the City of Guelph Natural Heritage Strategy, Volume 2 (Dougan & Associates with Snell and Cecile 2009), last updated by the City of Guelph 2012. Status only shown if: S = Significant, R = Rare
Note that the following designations were excluded from this list:
** = Only habitats that support or have recently supported active nests should be considered significant;
† = Bank Swallow: Significant only when found nesting in colonies equal to or greater than 100. However, recent OBBA data for Wellington County should be reviewed to see if this is appropriate.
† = Cliff Swallow: Significant only when found nesting in colonies equal to or greater than 8. However, recent OBBA data for Wellington County should be reviewed to see if this is appropriate.
‡ = Being small and secretive, these species are often overlooked. When more information is collected, it is possible that they may not merit significant species status in the future.
o= Habitat protection should be considered only when larval habitat is present at or in close proximity to where adults were documented.
Δ = Considered significant at present, but may prove to be too common to be so regarded in the future.
d - Ontario Ministry of Natural Resources (OMNR). 2000. Significant Wildlife Habitat Technical Guide (Appendix G). 151 p plus appendices.

Beacon Breeding Status classifications:
- breeding pair
F- foraging/flyover
x- Species observed not breeding

APPENDIX I

Technical Memoranda: Estimation of Infiltration and TW3-80 Drawdown Analysis

Memorandum

Date:	January 28, 2021
From:	Christopher Neville and Xiaomin Wang
To:	File
Project:	SSP-994-33: Nestle Ontario - Aberfoyle
Subject:	**Analysis of infiltration at Aberfoyle with the SWB model: 2020 update**

Overview

S.S. Papadopulos & Associates, Inc. (SSP&A) has updated the application of the SWB model of the United States Geological Survey to estimate infiltration in the Aberfoyle area. The analysis has been conducted to support the assessment of the likely variability in annual infiltration and the distribution of infiltration across the area around the NWC production well TW3-80 at the Aberfoyle facility.

The results of the SWB analysis for 2018 and 2019 were reported in the 2018 and 2019 Aberfoyle Annual Monitoring Reports (Golder Associates, March 2019; March 2020). This memorandum documents the updating of the analysis with 2020 climate data from the Kitchener-Waterloo climate station. In 2020 the total annual precipitation was 692.0 mm and the annual infiltration estimated with the SWB model is 87.7 mm. The ratio of the estimated infiltration to the total annual precipitation is lower that estimates for previous years; however, the results of the updated analysis are consistent with the general trends inferred from the analyses for 2008-2019, and consistent with the observation that the annual precipitation in 2020 was the lowest observed between 2008 and 2020.

1. Introduction

In March 2019, S.S. Papadopulos & Associates, Inc. (SSP&A) applied the SWB model of the United States Geological Survey to estimate infiltration in the area that surrounds the Nestlé Waters Canada (NWC) Aberfoyle facility. The SWB model was applied to assess the likely variability in annual infiltration and how the infiltration is distributed across the area around the NWC production well TW3-80.

The SWB model refers consistently to "recharge". In fact, the quantity that is reported as "recharge" should be interpreted as "infiltration". The interval between the bottom of the root zone and the top of the water table is not considered in the SWB analysis. For cases in which the water table is close to the bottom of the root zone, the SWB model should perform well and the estimated annual recharge is expected to be close to the estimated infiltration. For cases in which there is a significant travel time between the bottom of the root zone to the top of water table, the SWB result may not match actual groundwater recharge in time or in space.

To support the NWC Aberfoyle 2020 Annual Monitoring Report, the SWB analysis has been extended with 2020 climate data. This memorandum documents the updating of the SWB analyses that SSP&A conducted in 2020, using the 2020 daily precipitation and temperature data from the Kitchener-Water climate station. These data are used consistently in the preparation of the NWC Aberfoyle Annual Monitoring Reports. The memorandum consists of seven main sections:

1. Introduction [this section];
2. SWB conceptual model;
3. SWB model input;
4. Sources of input data for the Aberfoyle area;
5. Calculated distributions of annual infiltration for the Aberfoyle area, 2008-2019;
6. Updated results for the Aberfoyle area for 2020; and
7. References.

2. SWB conceptual model

The SWB model implements a modified Thornthwaite-Mather soil-water balance analysis (Westenbroek et al., 2010). The SWB model estimates each component of the soil-water balance for daily timesteps. Model outputs may be daily, monthly, or annual values of infiltration, along with estimates of interception, snow cover, runoff, potential and actual evapotranspiration. The spatial distributions of these quantities are calculated over time using a gridded data structure.

The SWB model calculates infiltration with a modified Thornthwaite-Mather soil-water accounting method (Thornthwaite and Mather, 1957). Infiltration is calculated as the difference between the change in soil moisture and sources and sinks:

$$infiltration = (precip + snowmelt + inflow) - (interception + outflow + ET) - \Delta\, soil\ moisture$$

The descriptions of the terms in the water balance are presented below, following the terminology of the documentation of the SWB model:

Precip – daily values of precipitation using ASCII or Surfer grid formats;

Snowmelt – daily values of snowmelt calculated based on air temperature of daily mean, maximum and minimum;

Inflow – daily values of water inflow into a cell calculated over a flow-direction grid derived from a digital elevation model;

Interception – daily values of rainfall trapped and used by vegetation, calculated by use of a “bucket” approach assuming a user-specified amount which varies from different land-use types and seasons;

Outflow – daily values of water outflow from a cell calculated based on curve number rainfall-runoff relation (Cronshey and others, 1986), soil type and runoff conditions;

ET – daily values of evapotranspiration. There are five methods included in the SWB code. The simplest method is Thornthwaite-Mather (1957) requiring only daily maximum and minimum air temperature. The Thornthwaite-Mather method contains functions considering daylight length, radiation, sunset angle for the estimation of potential evapotranspiration; and

Δ soil moisture – daily values of the amount of water held in soil storage for a given cell calculated based on the Thornthwaite-Mather (1957) procedure.

3. SWB model input

The datasets required for the application of the SWB model are listed below.

Gridded (ESRI ASCII or Surfer)
Land-use classification
Hydrologic soil group
Flow direction
Available soil-water capacity
Tabular
Climate data (e.g. precipitation and temperature)
Soil and land use property lookup table
Soil-water retention table (Thornthwaite-Mather, 1957)

A text model control file must be prepared for running the SWB code and the following additional information is required:

- Model domain, grid size;
- Growing season start and end;
- Initial soil moisture;
- Initial snow cover;
- Runoff calculation and routing method;
- Evapotranspiration method; and
- Output options.

Optional inputs for *ET* methods other than Thornthwaite-Mather (1957) and Hargreaves and Samani (1985) include daily average wind speed in m/s, average relative humidity in percent, maximum relative humidity in percent and percentage of possible sunshine.

4. Sources of input data for the Aberfoyle area

The limits of the area considered in the analysis are shown in Figure 1. The area has been selected to extend northeast beyond the expected limits of the capture zone of the NWC TW3-80 production well, and southwest to the Sideroad 10 stream gauge on Mill Creek.

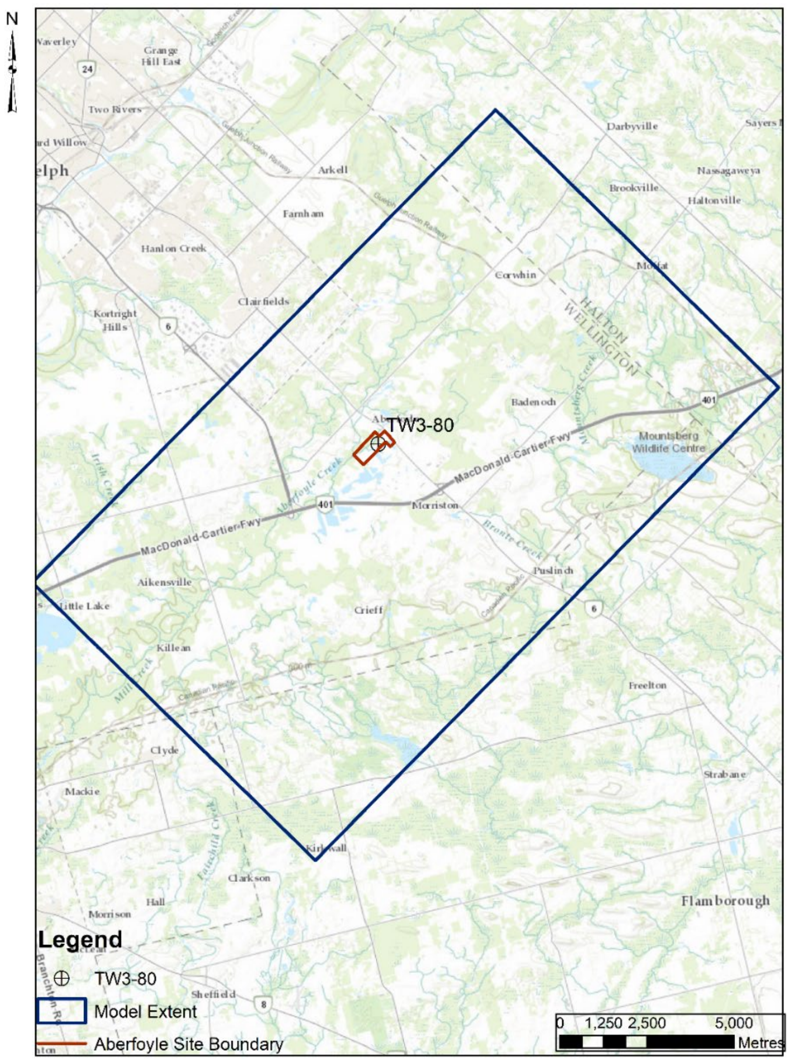

Figure 1. Model limits

Climate data

Two types of climate data are required: daily precipitation and temperature (minimum, maximum and average). Both sets of data are obtained from Environment Canada. For this analysis, 13 years of climate data between 2008 and 2020 are considered.

Where available, the daily precipitation data from the Kitchener/Waterloo (KW) Station are specified as input. When data are missing from the station during 2010 and 2018, the gap is filled in using data from Roseville or Elora RCS meteorological stations. Prior to 2010, the precipitation data are primarily obtained from the Waterloo Wellington 2 Station.

Daily minimum and maximum temperature data are obtained from the from Guelph Turfgrass (GT) Station. When data are missing from the record for the GT station, gaps are filled using data from Waterloo Airport, Elora RCS, Roseville and KW meteorological stations.

Land cover data

Land cover data are obtained from the Southern Ontario Land Resource Information System (SOLRIS v2) mapping compiled by OMNRF (2015).
https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home

Flow direction data

Flow direction data are obtained from the Ontario Integrated Hydrology Data (OMNRF, 2012).
https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home

Hydrologic soil type data

Hydrologic soil groups are used to estimate runoff from precipitation. The classification of soils within the study area has been obtained using the Ontario Data - Soil Survey Complex created by Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA, 2012).
https://www.javacoeapp.lrc.gov.on.ca/geonetwork/srv/en/main.home

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Soil-water capacity data

The soil-water capacity data are specified based on the textures of the surficial soils. The description of the soil textures, 'A' horizon, are provided in the field named "ATEXTURE1" of the Soil Survey Complex Data obtained from the OMAFRA website. A lookup table relating soil-water capacity and soil texture is reproduced below (Earthfx, 2016; Table 8.11).

Table 8.11: Soils mapping based parameters lookup table.

"A" Horizon Texture	Description	Proportion	PRMS Soil Type	Wilting Point (wp)	Field Capacity (Fc)	Porosity (n)	Plant Available Water (PAW)	Sat Hydraulic Conductivity (mm/hr)
SIL	Silt Loam	27%	Loam	0.14	0.32	0.48	0.18	12.2
L	Loam	22%	Loam	0.13	0.27	0.46	0.14	18.6
SL	Sandy Loam	15%	Sand	0.08	0.18	0.45	0.10	50.3
CL	Clay Loam	11%	Clay	0.21	0.35	0.47	0.14	16.7
Unclassified	Unclassified	8.7%	Loam	0.13	0.26	0.40	0.13	9.3
LS	Loamy Sand	5.9%	Loam	0.06	0.12	0.46	0.06	91.3
FSL	Fine Sandy Loam	3.5%	Loam	0.09	0.21	0.45	0.12	42.0
ORG	Organic	3.3%	Clay	0.16	0.34	0.65	0.18	2.1
GL	Gravelly Loam	1.9%	Sand	0.05	0.11	0.42	0.05	12.4
SICL	Silty Clay Loam	0.51%	Loam	0.21	0.38	0.51	0.17	5.9
FS	Fine Sand	0.14%	Sand	0.03	0.08	0.46	0.05	110.0
LFS	Loamy Fine Sand	0.12%	Loam	0.07	0.14	0.45	0.07	72.5
GS	Gravelly Sand	0.11%	Sand	0.02	0.05	0.41	0.03	76.0
VFSL	Very Fine Sandy Loam	0.08%	Loam	0.13	0.25	0.45	0.12	19.5
GSL	Gravelly Sandy Loam	0.01%	Sand	0.00	0.00	0.43	0.00	33.5

Soil and land use property lookup table

The soil and land use property lookup table is developed with the following procedure:

- Obtain the land use description provided by SOLRIS v2, e.g., Forest – tree cover > 60%;
- Download the Land Use Code (LU) "LU_lookup_WISCLAND_w_forested_hillslope.txt" from the USGS website;
- Based on the land description, obtain the SCS number, maximum infiltration rates, interception storage values and depth of root zone from the USGS table; and
- Integrate all the information into a new lookup table for the Aberfoyle analysis.

5. Calculated distributions of annual infiltration for the Aberfoyle area for years prior to the updated analysis, 2008-2019

The calculated distributions of annual infiltration from 2008 to 2019 are shown in Figures 2 to 13. To simplify comparison of the distributions of estimated infiltration, the map of the results for each year are plotted at the same scale and with the same ranges of infiltration.

- Figure 2: 2008
- Figure 3: 2009
- Figure 4: 2010
- Figure 5: 2011
- Figure 6: 2012
- Figure 7: 2013
- Figure 8: 2014
- Figure 9: 2015
- Figure 10: 2016
- Figure 11: 2017
- Figure 12: 2018
- Figure 13: 2019

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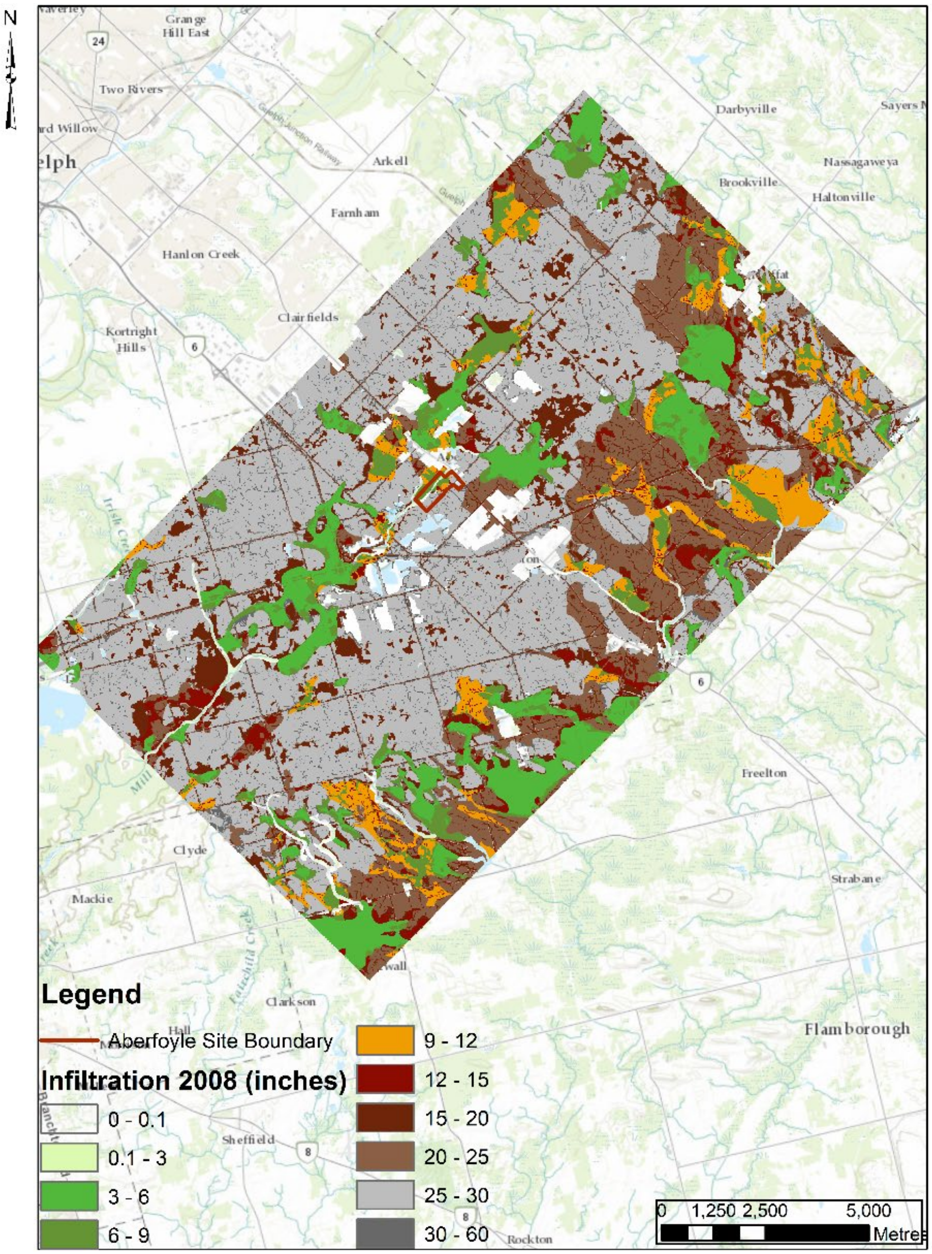

Figure 2. Calculated distribution of annual infiltration for 2008

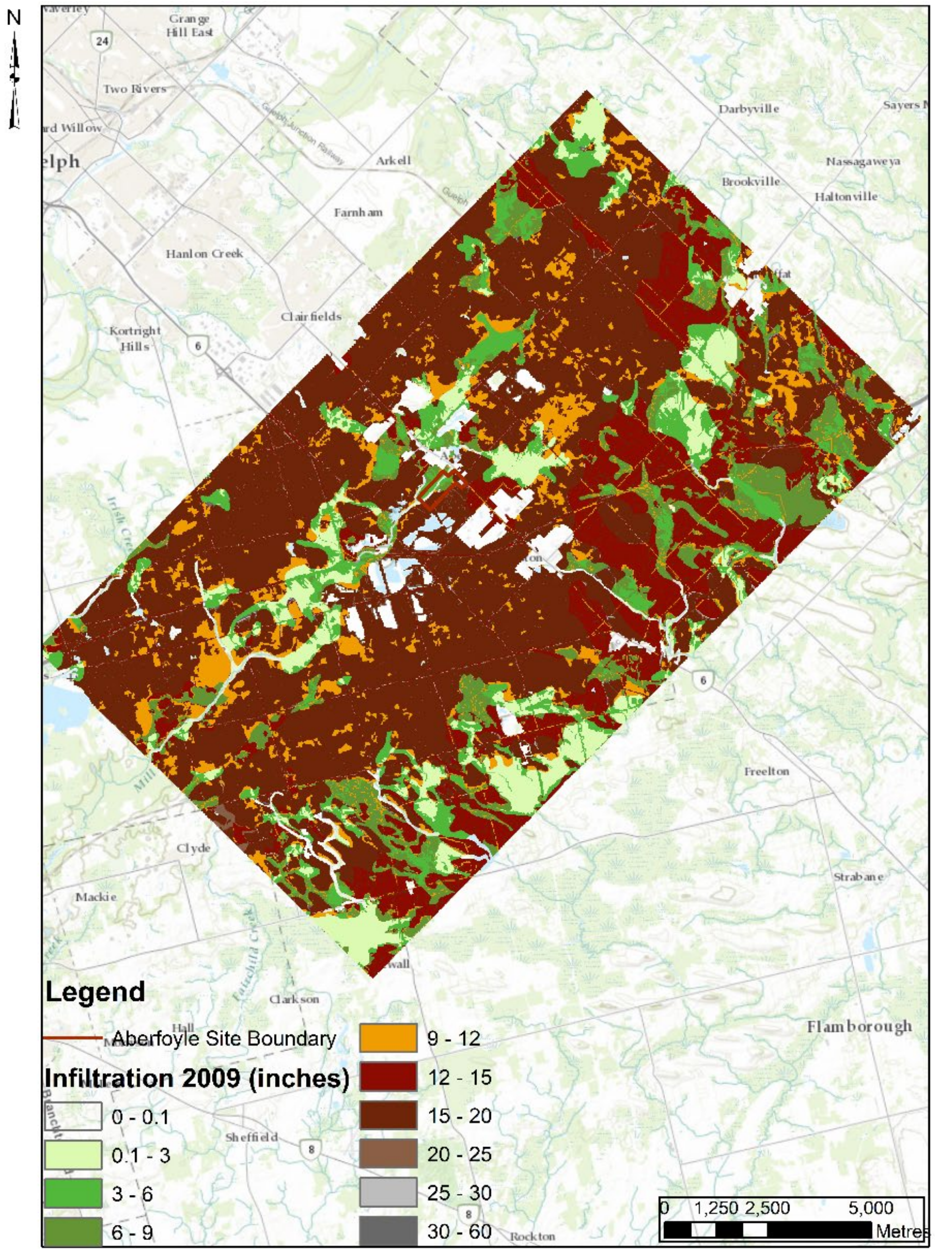

Figure 3. Calculated distribution of annual infiltration for 2009

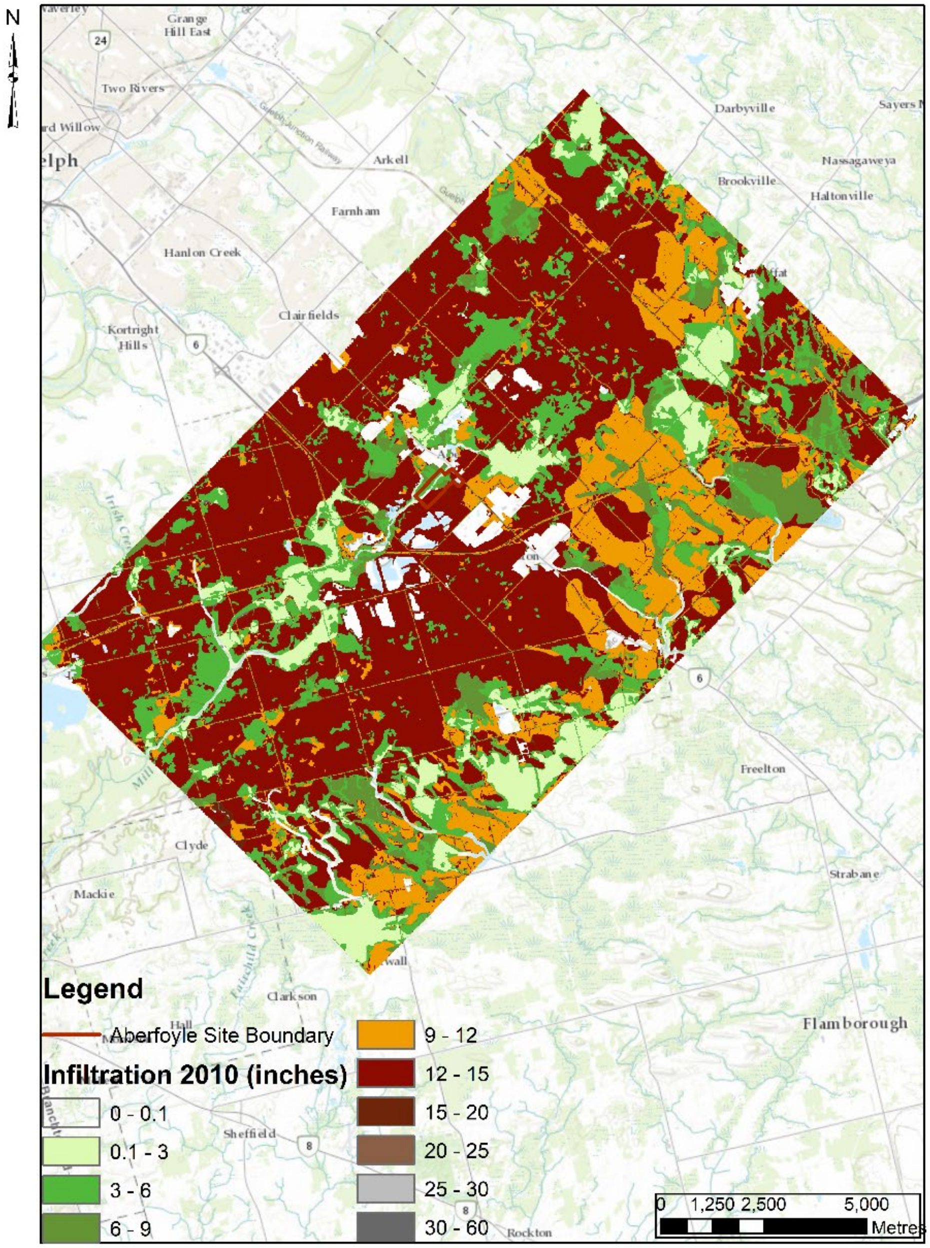

Figure 4. Calculated distribution of annual infiltration for 2010

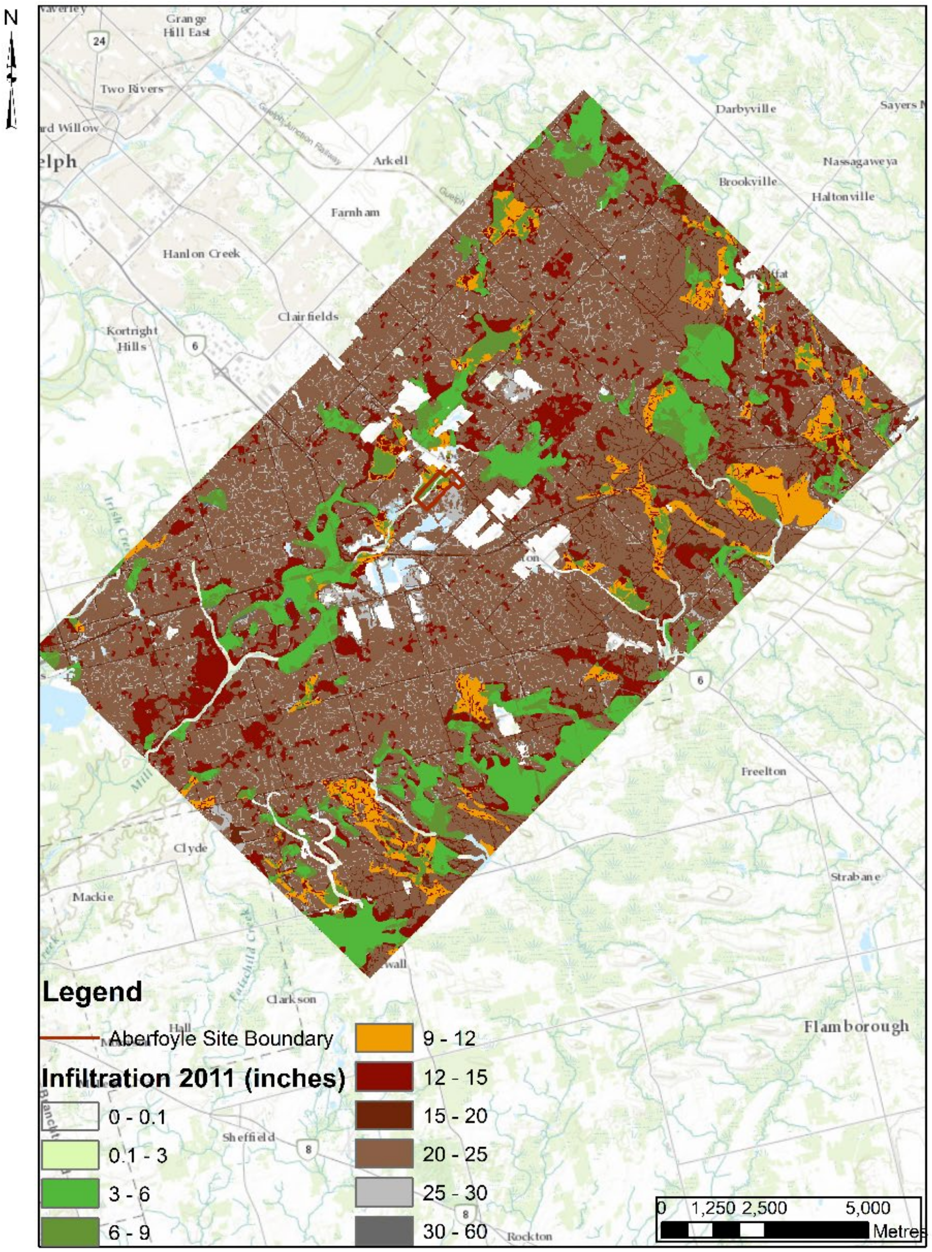

Figure 5. Calculated distribution of annual infiltration for 2011

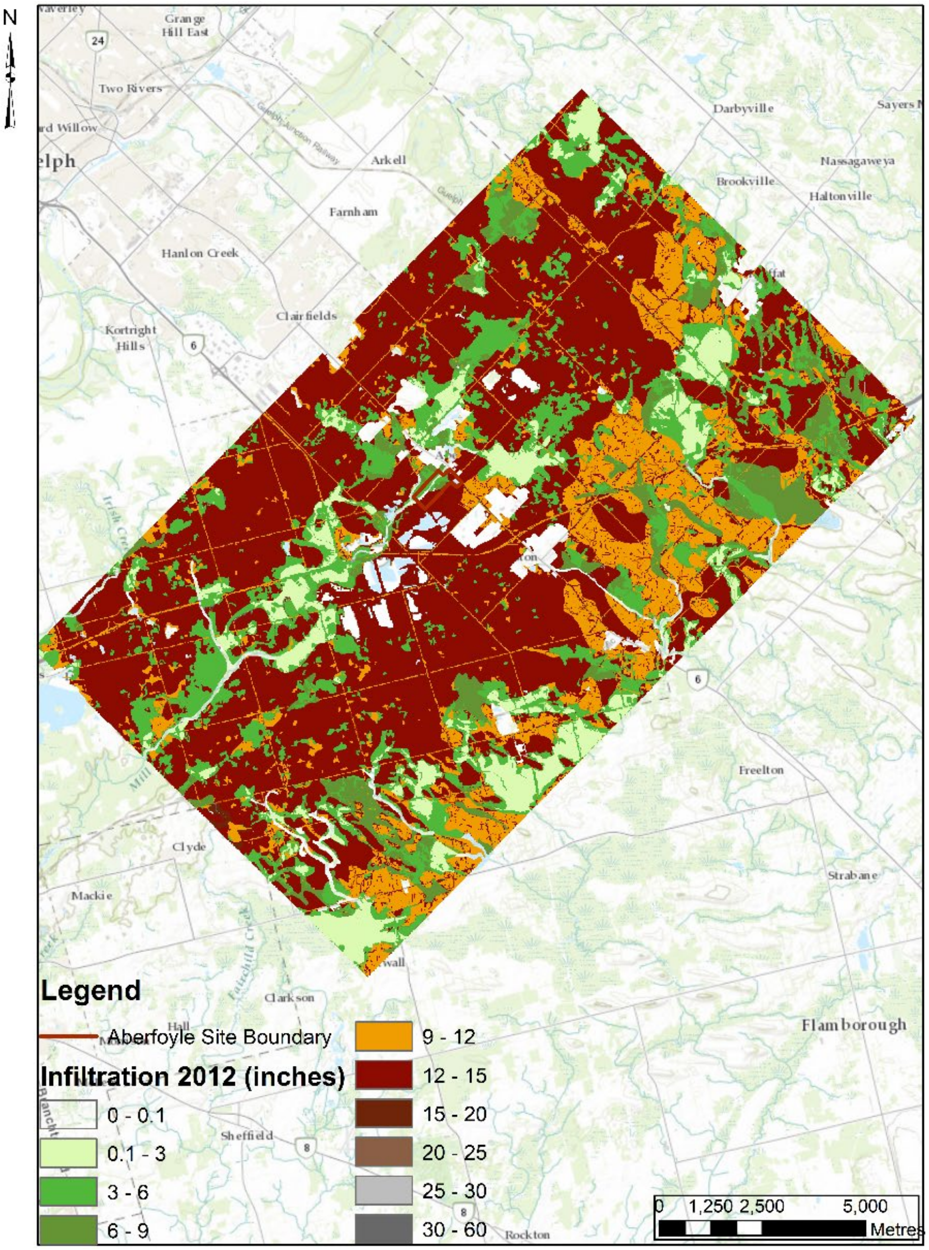

Figure 6. Calculated distribution of annual infiltration for 2012

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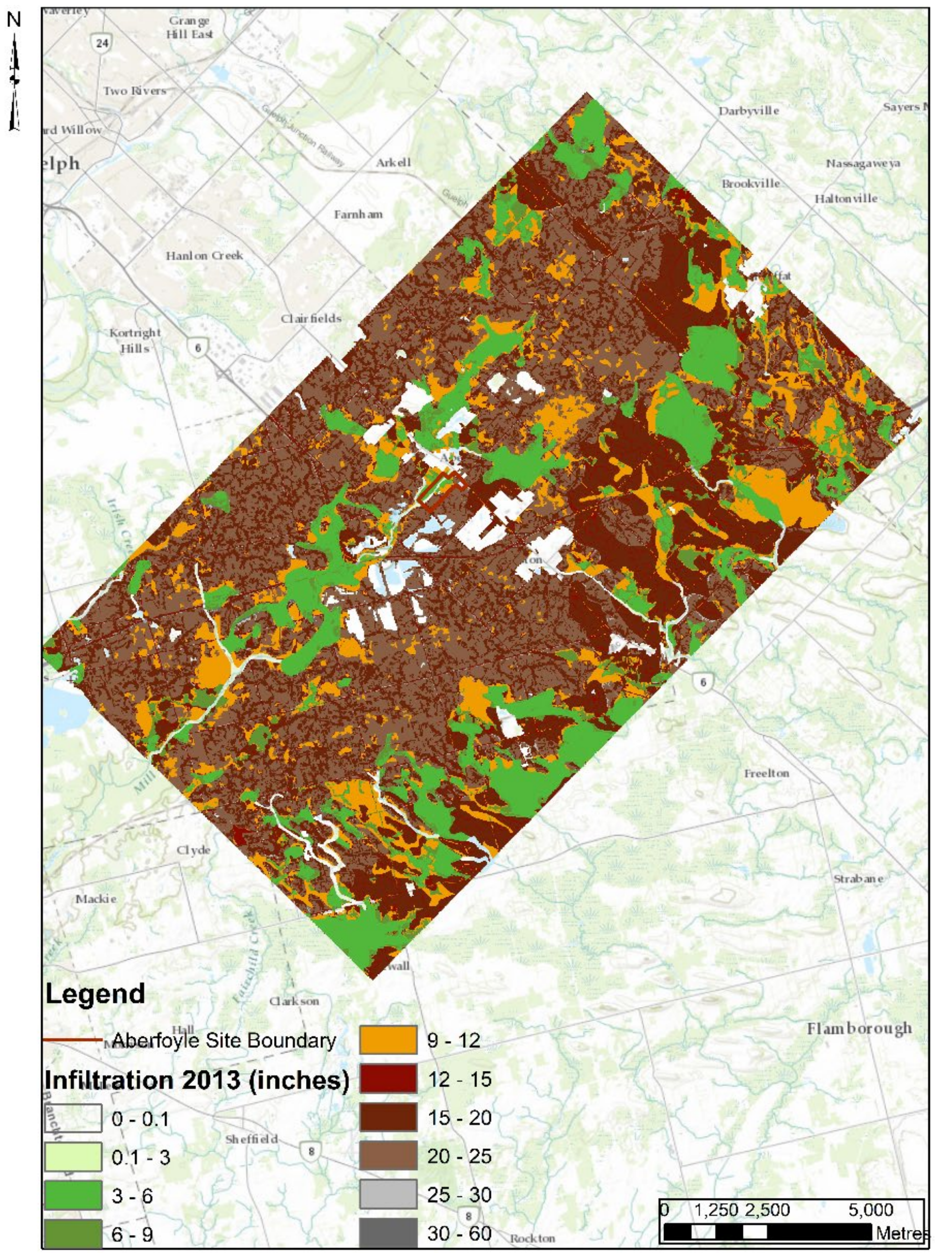

Figure 7. Calculated distribution of annual infiltration for 2013

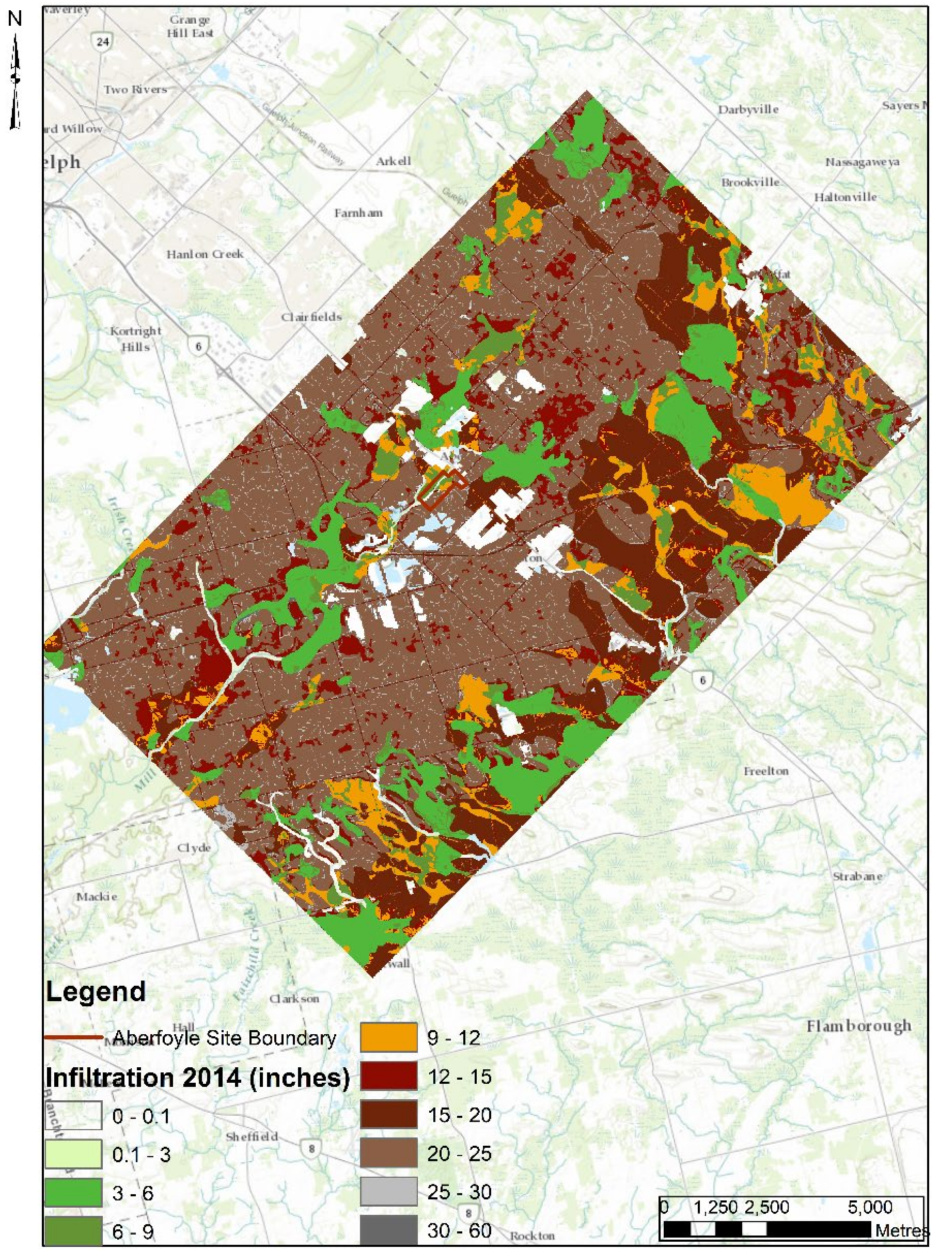

Figure 8. Calculated distribution of annual infiltration for 2014

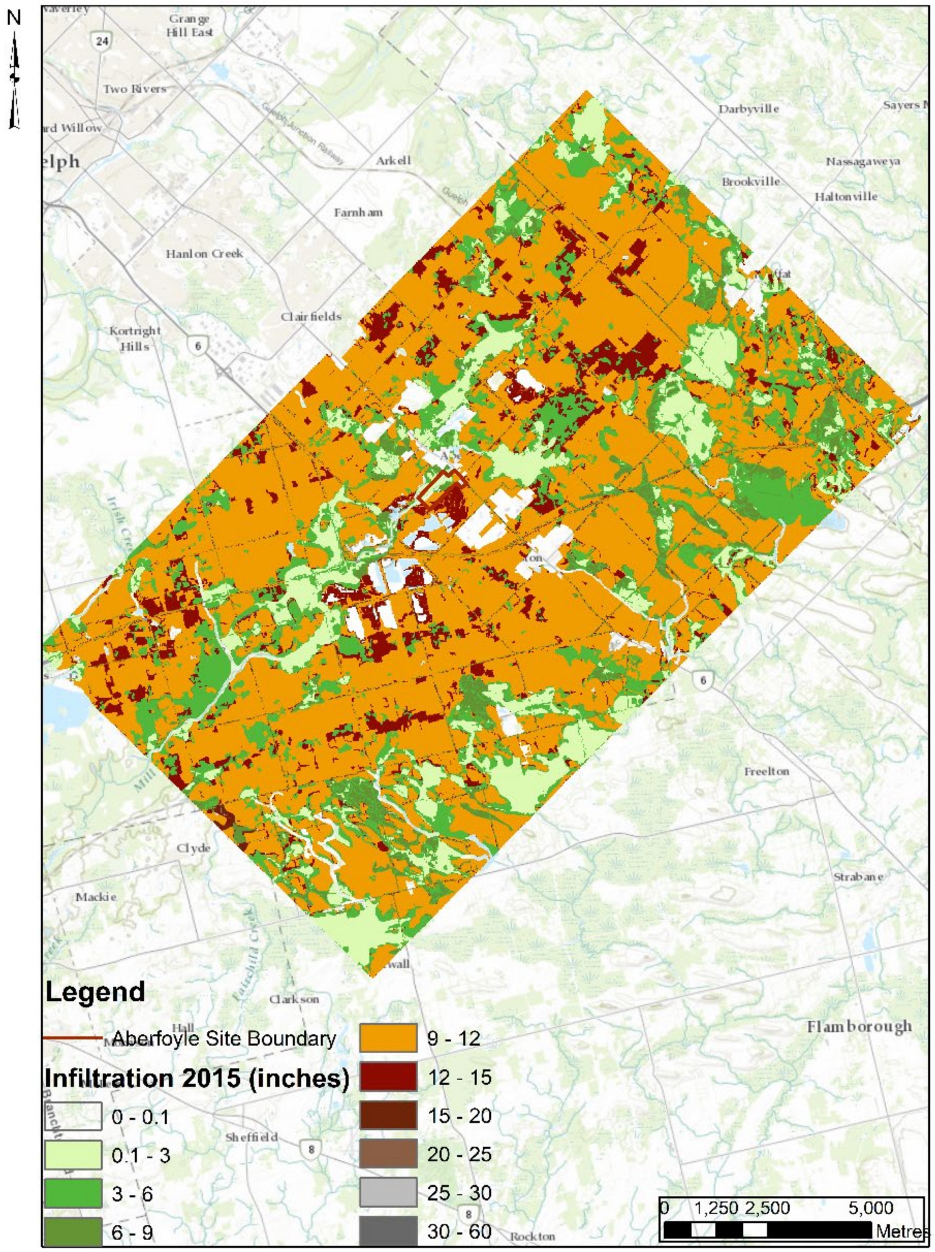

Figure 9. Calculated distribution of annual infiltration for 2015

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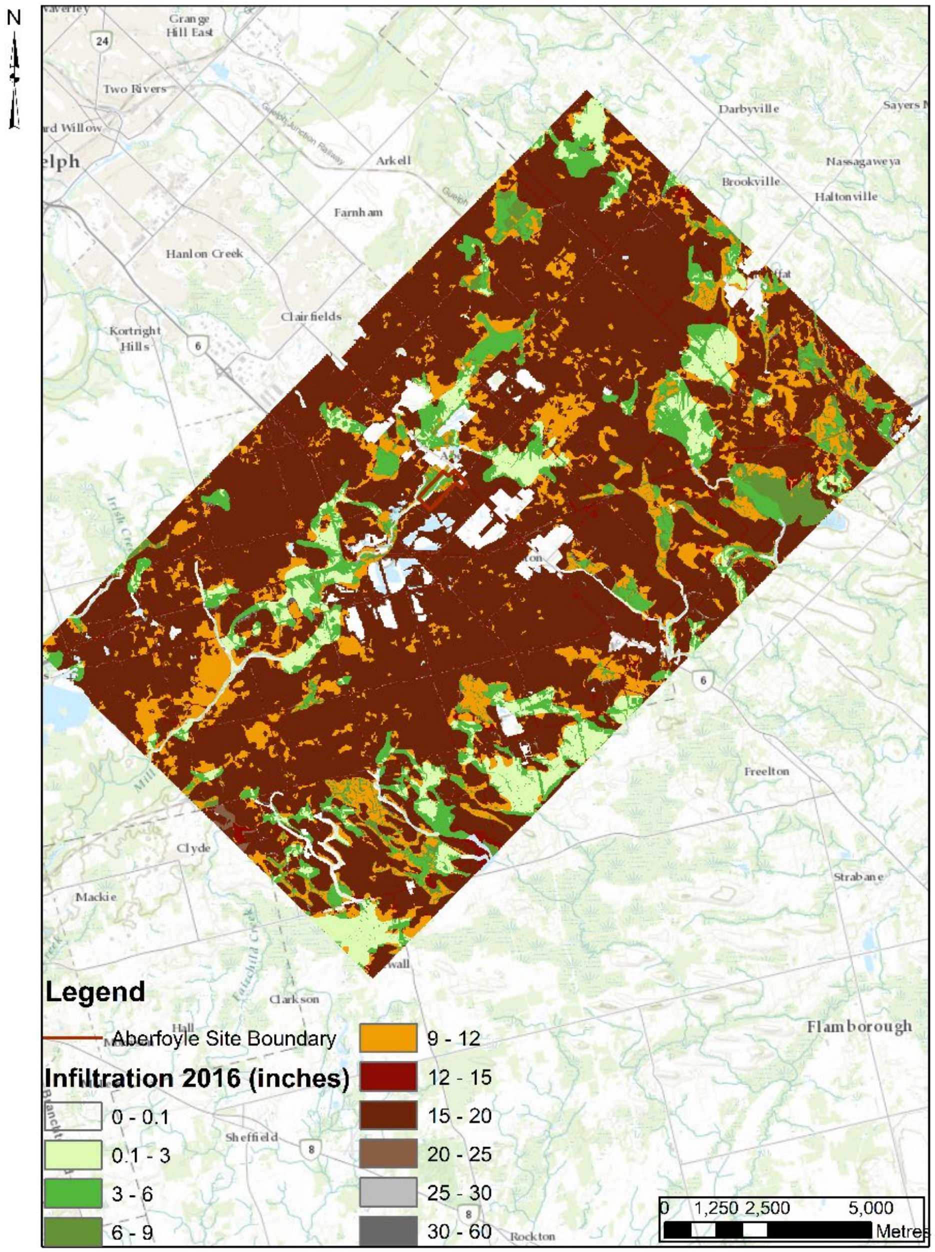

Figure 10. Calculated distribution of annual infiltration for 2016

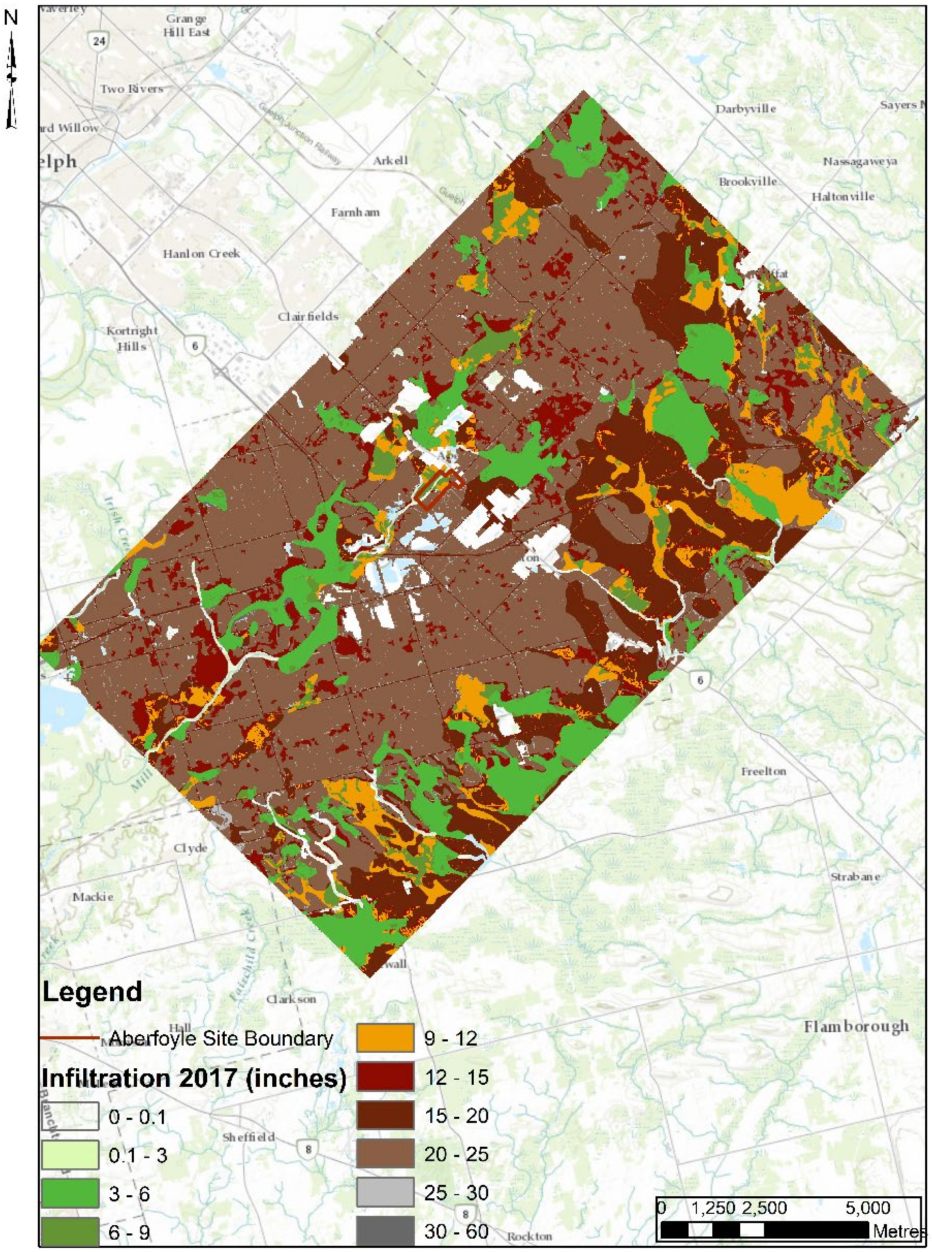

Figure 11. Calculated distribution of annual infiltration for 2017

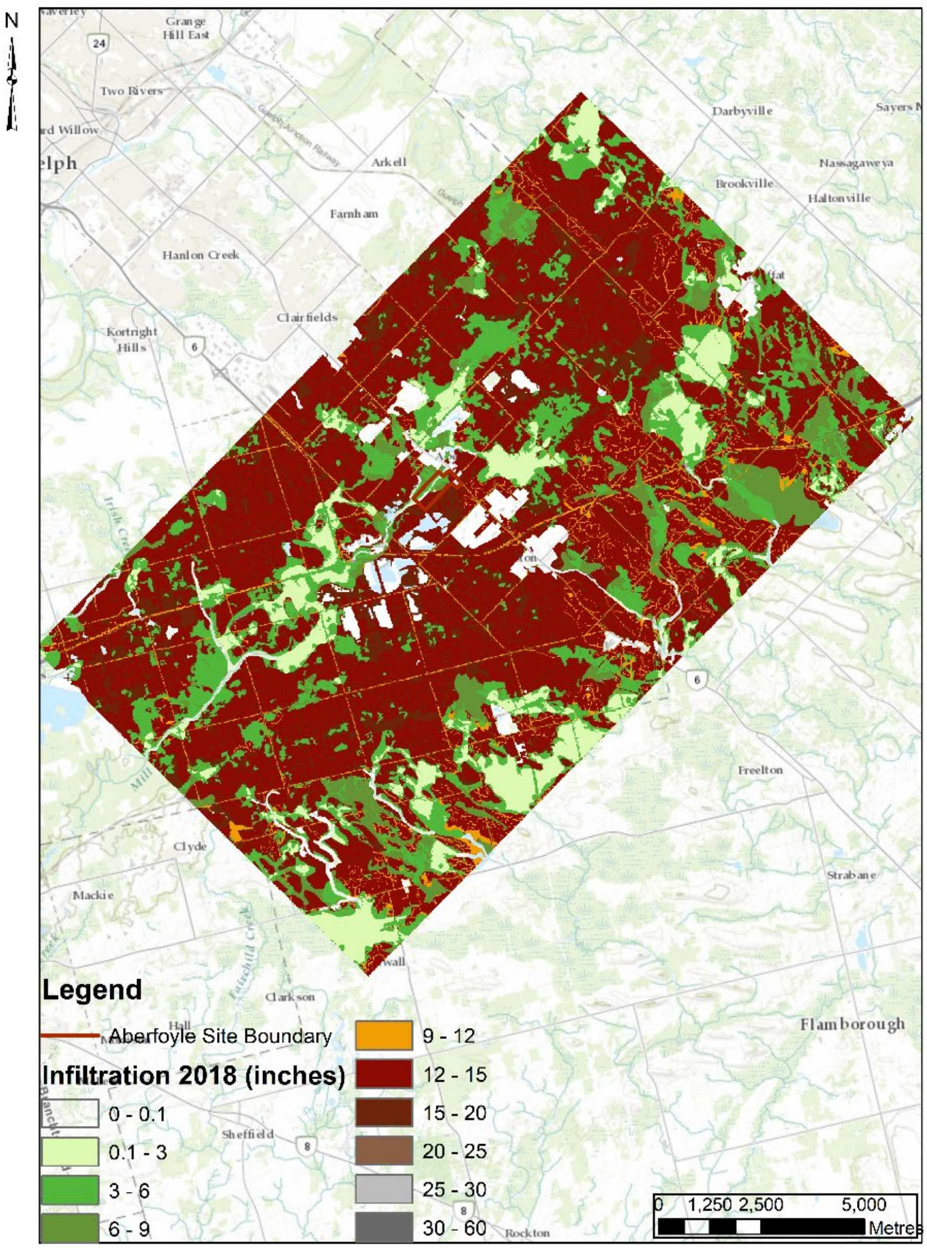

Figure 12. Calculated distribution of annual infiltration for 2018

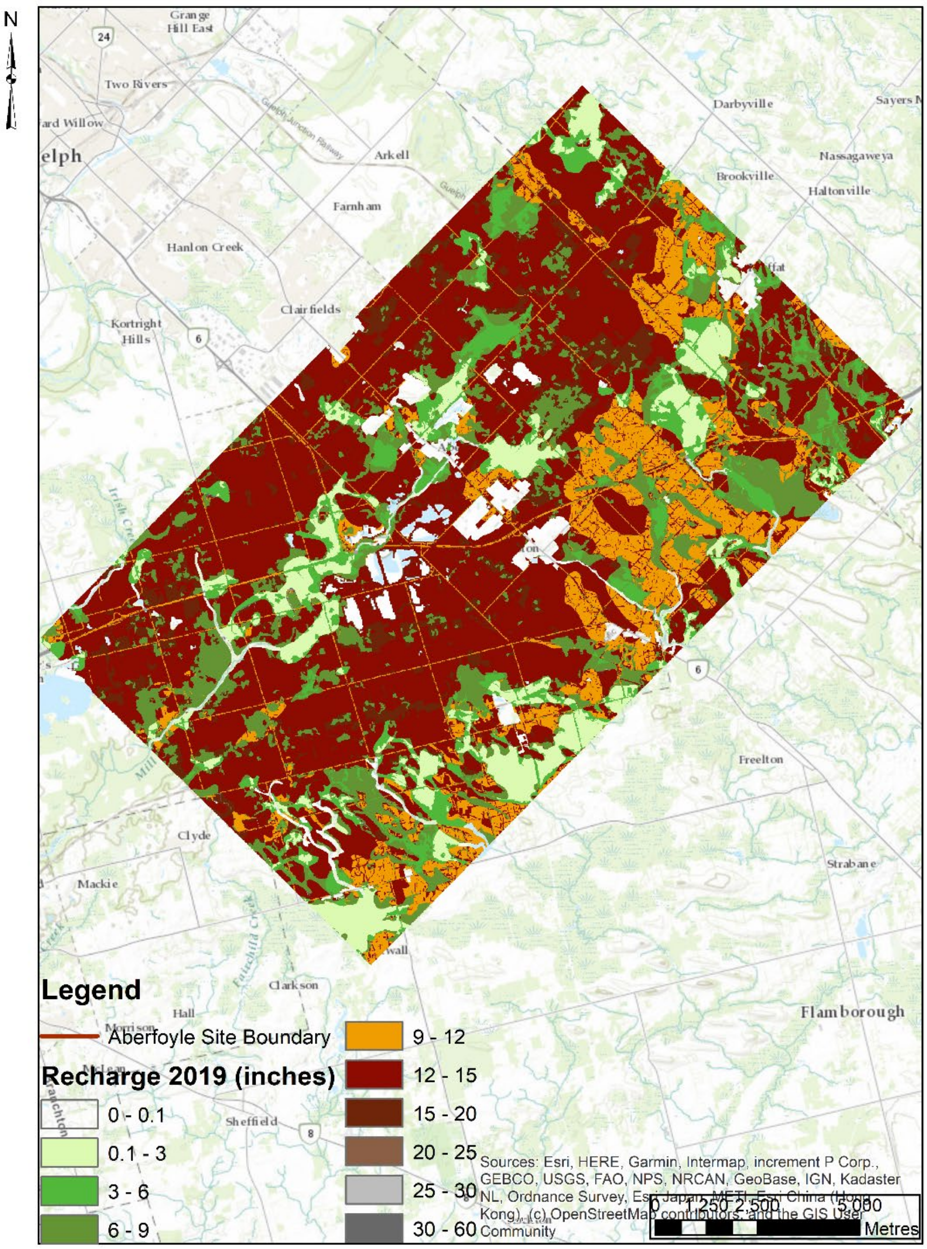

Figure 13. Calculated distribution of annual infiltration for 2019

6. Updated results for the Aberfoyle area for 2020

The calculated distribution of annual infiltration for 2020 is shown in Figure 14.

The annual total precipitation and the annual total infiltration values estimated with the SWB model are tabulated below. Over the 13-year period of the analysis, the estimated annual infiltration has varied over a relatively wide range, from about 90 mm to about 240 mm.

Year	Annual total precipitation (mm)	Annual total infiltration (mm)
2008	1304.7	242.6
2009	964.9	160
2010	833.1	113.7
2011	1081	217.9
2012	770.6	113.7
2013	1088.6	175.5
2014	973.8	201.1
2015	795.8	97.2
2016	931.9	161.9
2017	949.4	195.6
2018	807.1	126.9
2019	740.0	122.6
2020	692.0	87.7
Mean	917.9	155.1
Median	931.9	160.0

Values of estimated annual infiltration are plotted against the total annual precipitation in Figure 15. As shown in the figure, the estimated annual infiltration for 2020 follows the general trend for previous years. The estimated annual infiltration for 2020 is lower than has been estimated for any of the previous years, which reflects the fact that the annual precipitation for 2020 was the lowest between 2008 and 2020.

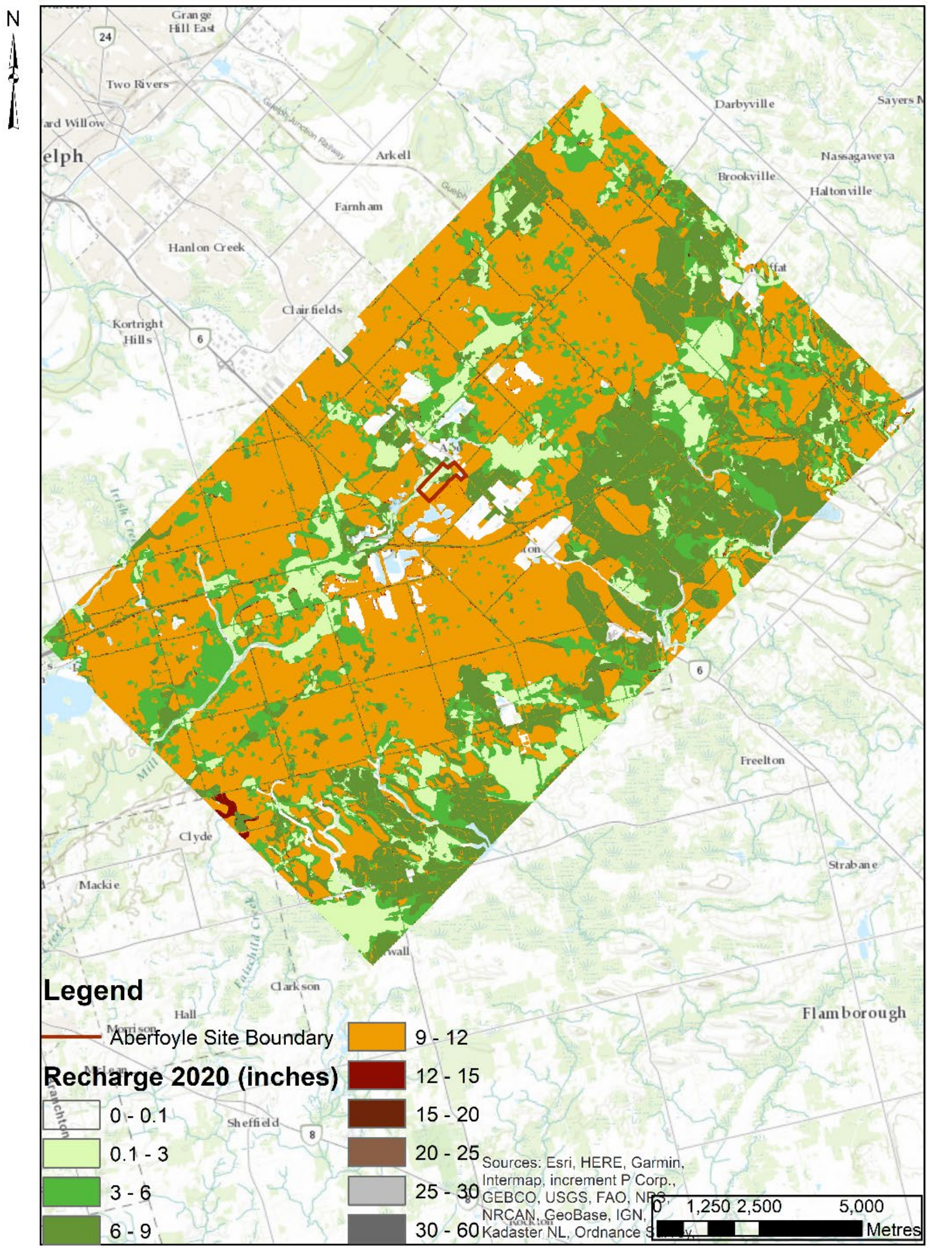

Figure 14. Calculated distribution of annual infiltration for 2020

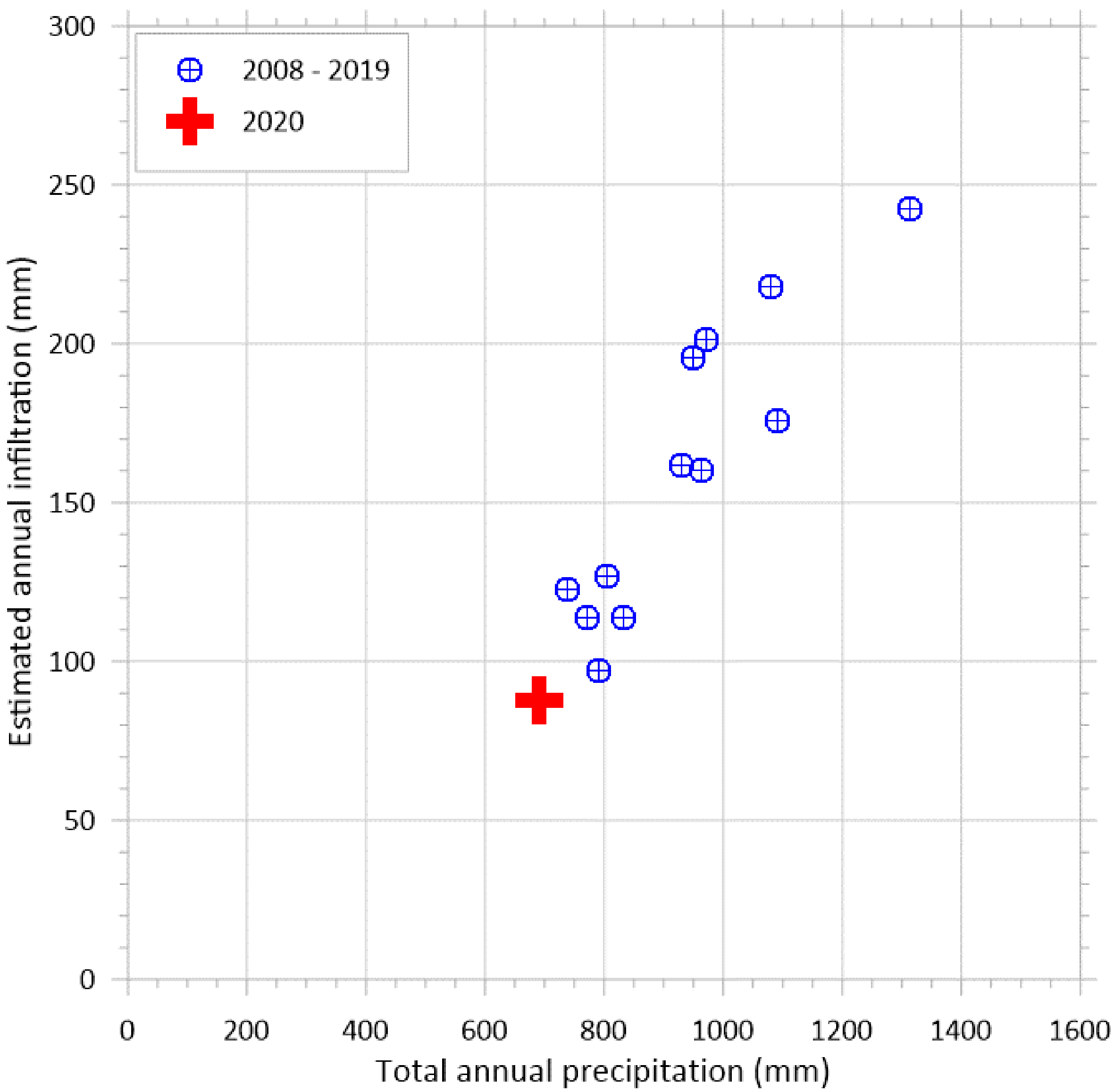

Figure 15. Relationship between infiltration and precipitation

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TECHNICAL MEMORANDUM

DATE February 11, 2021 **Project No.** 20449101 (1000)

TO Andreanne Simard, Ph.D., Natural Resource Manager
Nestle Waters North America

CC John Piersol, GAL Chris Neville, SSP&A

FROM Joel Henry, Greg Padusenko **EMAIL Gregory_Padusenko@golder.com**

TW3-80 DRAWDOWN ANALYSIS

Withdrawals from well TW3-80 by Nestlé Waters Canada (NWC) are authorized by Permit to Take Water (PTTW) number 1381-95ATPY. Water levels have consistently been presented as hydrographs that simultaneously present up to five years of daily pumping data from TW3-80, daily precipitation, and daily water level data (Figure D1a in Annual Report). Because water levels at TW3-80 can vary up to 15 m each day, the TW3-80 hydrograph illustrates both the daily maximum and daily minimum levels rather than each hourly measurement. The hydrographs are effective for enabling a rapid, qualitative assessment of multiple years of data, graphically illustrating the degrees of daily, seasonal, and annual variability. Furthermore, long-term trends in aquifer capacity can be noted in the multi-year hydrographs, and the absence of clear declining trends in water levels is a significant line of evidence that the aquifer is being sustainably managed.

However, a qualitative review of the hydrographs is limited in its ability to support the interpretation of long-term trends, and to distinguish between potential causes of water level changes. The pumping rate of TW3-80 is the primary influence on the water level in TW3-80. Other factors such as aquifer recharge and nearby competing withdrawals also influence water levels, but the degrees to which they contribute to water level changes cannot be distinguished by visual inspection. The following analysis has been completed to quantitatively determine the degree to which TW3-80 pumping rates affect water levels at TW3-80.

TW3-80 Annual Withdrawal Volumes

Annual water withdrawals from well TW3-80 increased each year from 2011 through 2016, before decreasing in 2017 through 2019. The water taking in 2020 was similar but increased compared to 2019. The water takings in 2019 and 2020 were similar to those between 2011 and 2013. The volumes of groundwater withdrawn from TW3-80 in each of the last ten years are listed in Table 1.

Table 1: Annual TW3-80 Withdrawal Volumes

Year	Annual Volume (litres)
2011	568,025,081
2012	583,823,567
2013	600,537,587
2014	678,452,126
2015	762,363,664
2016	783,540,441
2017	767,883,336
2018	676,946,402
2019	565,941,910
2020	582,221,219

To quantitatively demonstrate the degree to which the water levels are directly related to pumping rates, the following analysis evaluates the relationship between monthly pumping rates with monthly average water levels in TW3-80.

Analysis

The TW3-80 transducer dataset extends from September 2005 through December 2020. Hourly water level measurements for the entire dataset were averaged each day and then assembled in monthly averages. Months in which fewer than 20 days of water levels were recorded, due to periodic data gaps related to transducer failure, are excluded from the analysis. Daily groundwater withdrawal data from TW3-80 are aggregated as monthly totals. The monthly-averaged water levels are plotted against cumulative monthly pumping on Figure 1.

Figure 1 illustrates the inverse linear relationship between the monthly TW3-80 pumping rate, and the average monthly water levels in TW3-80. Based on a regression of 177 months of data, every 100 L/min increase in pumping results in a 0.63 m decline in water level. Most individual data points do not fall directly on the regressed line, meaning that variables other than the pumping rate influence the TW3-80 water level; however, 166 of the 177 data points (94%) are within 1 m of the expected water level, defined by the regression.

The goodness-of-fit of the regression (R^2 statistic) may be used to assess the ability of the regression relation to explain the relationship between the pumping level and the pumping rate. The R^2 value of 0.90 means that the monthly average pumping rate accounts for 90% of the variation in the monthly average TW3-80 water level. The 10% balance is understood to be caused by the other external variables, such as variations in vertical flow into the deep bedrock and other nearby groundwater withdrawals.

Effect of Precipitation

It is very challenging to quantitatively describe the relationship between precipitation and aquifer water levels, as precipitation is not the same as recharge which in turn is not the same as flow into the Lower Bedrock Aquifer. The relationship between precipitation and aquifer recharge is seasonally variable, with most recharge occurring in late winter and early spring, after the ground surface thaws and before plant transpiration becomes significant. The relationship between precipitation and aquifer recharge is not linear either, as unusually intense precipitation is likely to increase runoff, and not enhance recharge. Additionally, aquifer recharge (or the lack thereof during a drought) to the deep aquifer is not instantaneous, such that relating precipitation in a discrete month is unlikely to have a good correlation to the average water level in that same month.

However, the data illustrated on Figure 1 suggest that variations in aquifer recharge (and by extension, precipitation) have no greater than about +/-1 m effect on aquifer water levels. As stated, 166 of 177 data points in this regression are within +/-1 m of the regressed line. This means that even under drought conditions and significant precipitation deficits, the deep aquifer is affected by no greater than 1 m beyond what is predicted based only on the monthly pumping.

Conclusions

Changes in groundwater withdrawals from TW3-80 account for 90% of the influence on changes in water levels measured at TW3-80. For each 100 L/min change in the monthly-average pumping rate, water levels are predicted to change by 0.63 m. The effects of precipitation deficits that have been observed, affecting recharge volumes to the Lower Bedrock Aquifer, have been inferred to have no greater impact than about 1 m of additional decline on TW3-80 water levels.

JH/GP/JP/ll

https://golderassociates.sharepoint.com/sites/139500/project files/6 deliverables/aberfoyle/2020 annual report/draft/app i technical memo/memo/20449101 (1000) tm tw3-80 analysis 11feb2021.docx

ATTACHMENT

Figure 1

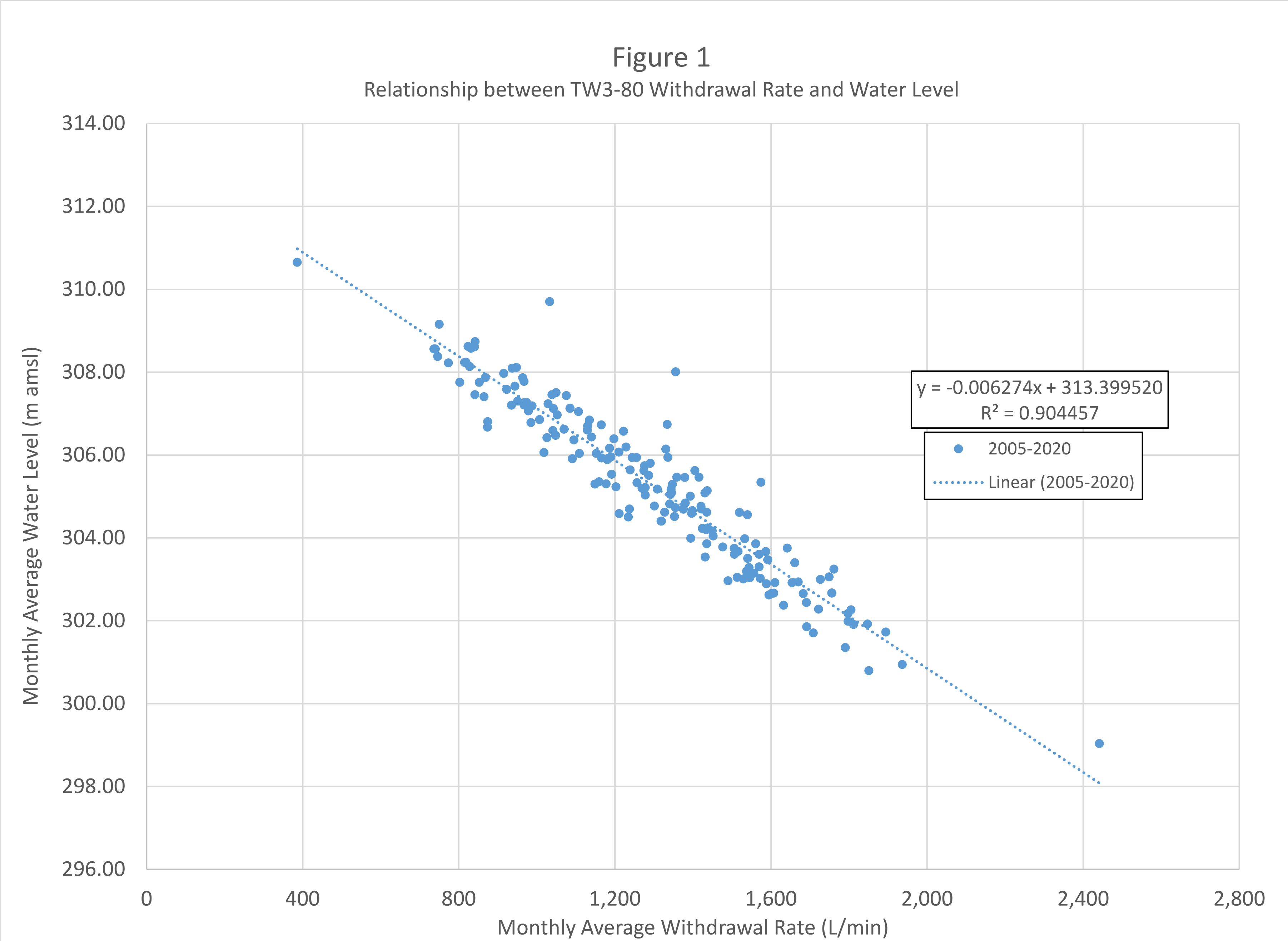
Figure 1
Relationship between TW3-80 Withdrawal Rate and Water Level
Monthly Average Water Level (m amsl)
314.00
312.00
310.00
308.00
306.00
304.00
302.00
300.00
298.00
296.00
0
400
800
1,200
1,600
2,000
2,400
2,800
Monthly Average Withdrawal Rate (L/min)
y = -0.006274x + 313.399520
R² = 0.904457
2005-2020
Linear (2005-2020)

GOLDER

golder.com