

**2025 Biennial Groundwater Monitoring
Report - Linwood Well Field (L1A, L2)**

The Region of Waterloo

2025 Biennial Groundwater Monitoring Report - Linwood Well Field (L1A, L2)

The Region of Waterloo

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1.0 Introduction

The Regional Municipality of Waterloo (the Region) is unique in Ontario in that it is the largest urban municipality to rely almost exclusively on groundwater supplies for its drinking-water (Region of Waterloo, 2015). Figure 1 shows the location of municipal well fields within the Region.

The Permit to Take Water (PTTW 2680-B8HT58) for the Linwood Well Field (L1A, L2), requires submission of a well field specific biennial report to the Ministry of Environment, Conservation and Parks (MECP) which documents production well pumping volumes and water levels in specific monitoring wells during 2024 and 2025. This report has been prepared to meet the reporting conditions of the PTTW for 2024 and 2025. A copy of the PTTW is included in Appendix A.

The location of the Linwood Well Field is shown in Figure 1 and the production wells in Wellesley are shown in Figure 2 with the monitoring network for L1A and L2 shown in Figure 3. Well records for the production and monitoring wells are found in Appendix B.

1.1 Scope of Work

The Region records water levels on a regular basis within a network of monitoring wells to satisfy the requirements of their PTTW and to confirm that water taking is sustainable in the long term. The monitoring wells are concentrated near the production wells. The data from these wells and regular measurements of pumping volume obtained from the production wells are used to evaluate the impact of Region pumping on aquifers and potential impacts to private wells, other water takers and the natural environment.

The Region has developed a monitoring program for Linwood Well Field (L1A, L2) in accordance with PTTW 2680-B8HT58 which consists of the following activities:

- Measuring the daily volume pumped from the L1A and L2 production wells (Condition 4.1 of the PTTW);
- Measuring the water levels in monitoring well WY-LW-OW01-09-A (Condition 4.2 of the PTTW);
- Review of precipitation data from the nearest GRCA / Environment Canada weather station (Condition 4.3 of the PTTW); and
- Completion of a biennial report (every 2 years) that presents data in compliance with condition 4.3 of the PTTW.

The Monitoring data (pumped volumes and hydrographs) are found in Appendix C with precipitation data in Appendix D. The monitoring program procedures and methodology are included in Appendix E.

2.0 Site Setting

2.1 Well Field Description

The Linwood Well Field is located in the northwest portion of the Township of Wellesley. Wells L1A and L2 are located just to the north of the Village of Linwood. Wells L1, L3, L4, L5, and L6 have been decommissioned (Figure 3). The closest municipal well field is St. Clements, located 8.7 km to the southeast. The Wellesley Well Field is located 12.7 km to the southwest on the southern edge of the Township (Figure 2). The closest surface water feature to the L1A and L2 site is a tributary of Boomer Creek, located 185 m to the southeast (Figure 3).

2.1.1 Pumping Wells

The active production wells associated with the Linwood well field are L1A and L2. Production well L1A was drilled in 1986 with an open hole interval from 66.1 mbgs to 79.6 mbgs in the Salina Formation bedrock aquifer (Salina aquifer). Production well L2 was drilled in the 1984 with an open hole interval from 64.3 mbgs to 78.6 mbgs in the Salina aquifer. Five wells that were previously active at Linwood (L1, L3, L4, L5 and L6) have since been abandoned. Well records for the production wells are found in Appendix B.

A summary of the production well construction details is provided in Table 1 below.

Table 1: Production Well Construction Details

Well Name	Year Built	Casing Diameter (mm)	Open Hole Diameter (mm)	Open Hole interval (mbgs)	Aquifer
L1A	1986	203	203	66.1-79.6	Salina Formation
L2	1984	203	203	64.3-78.6	Salina Formation

The water taking volumes for the Linwood L1A and L2 Well Field are regulated by Condition 3.2 of the PTTW and are summarized in Table 2 below.

Table 2: Annual Water Taking 2024 / 2025

	PTTW Details	2024			2025		
Well	Permitted Max. Daily Water Taking (m ³)	Avg. Daily Water Taking (m ³)	Max Taken per Day (m ³)	Total Volume Pumped (m ³)	Avg. Daily Water Taking (m ³)	Max Taken per Day (m ³)	Total Volume Pumped (m ³)
L1A	1,046.88*	103	350	37,571	107	287	38,981
L2	1,046.88*	98	323	35,744	61	336	22,140
Combined	1,046.88*	201	400	73,315	167	337	61,121

Note: * the Max Taken per Day of 1,046.88 m³/day is based on a combined Max taken per minute of 727 (L).

¹ Daily maximum water taking in 2024 of 400 m³ was recorded on October 14th.

² Daily maximum water taking in 2025 of 337 m³ was recorded on October 9th.

The pumping volumes are based on the total daily volumes as recorded by the Region's SCADA system and are presented in Appendix C as total monthly volumes. Production wells L1A and L2 are pumped in alternation. Pumping volumes from the well field ranged from 5,175 m³/month to 8,428 m³/month in 2024, and from 2,903 m³/month to 6,210 m³/month in 2025. In total, 73,315 m³ was produced at this well field in 2024 and 61,121 m³ was produced in 2025. Annual pumped volumes in 2024 and 2025 remained within the typical operating range observed over the previous three years (2021-2023). Volumes in 2024 were higher than any of the prior three years, whereas 2025 totals were similar to the 2021–2023 average. Both years remained well below the permitted annual volume of 382,111 m³ per year (Table C-1).

2.1.2 Monitoring Wells

The Region recently updated their well naming protocol and as a result, the well names in EQuIS may vary from the names listed on the PTTW. The well name on the PTTW is shown below along with the updated name that is used by the Region. The updated Region name will be used throughout this report.

Table 3: Well Nomenclature

Monitoring well names as they appear on the PTTW	Revised well names consistent with Region nomenclature
WY-LW-OW1-09	WY-WL-OW01-09-A

Water level monitoring is completed at observation well WY-LW-OW01-09-A, which is located 389 m west of L1A and 455 m west of L2 (Figure 3). Construction and

monitoring details of WY-LW-OW01-09-A are described in the table below. Well records for the monitoring wells are provided in Appendix B.

Table 4: Monitoring Well Construction Details

Monitoring Well ID	Year Built	Screened Depth (mbgs)	Screened Formation	Distance to L1A (m)	Distance to L2 (m)
WY-LW-OW01-09-A	2009	73.3-76.4	Salina - Bedrock	389	455

2.2 Regional Geology and Hydrostratigraphy

The surficial geology based on regional OGS mapping is provided in Figure 4. Representative cross-sections showing the stratigraphy in the vicinity of the Linwood Well Field (L1A, L2) are included as Figures 5 and 6. The cross-section locations are provided in Figure 3.

The cross-sections are provided as a visual aid and do not necessarily contain all wells in the monitoring program for the Linwood Well Field (L1A, L2). The layers displayed were generated from results of the Hydrogeological Characterization and Conceptual Model Tier 3 Assessment Update Project (Aqua Insight et al, 2023) and associated hydrogeological modelling work.

2.2.1 Surficial Geology and Conceptual Hydrostratigraphy

The surficial geology has been mapped and described by the Ontario Geological Survey (2003) and updated in Bajc and Shirota (2007). The surficial geology in the Linwood Well Field area consists predominantly of glaciolacustrine-derived silty to clayey till (Figure 4). The till typically forms a gently undulating surface with local sand deposits in depressions and is bisected by deposits of recent alluvium which are associated with the numerous creeks and streams found in the area.

The Macton Moraine forms a belt of low hummocky topography 1.6 to 6.5 km wide that forms an arc which extends from east of Listowel to New Hamburg. The west edge of the moraine is found just east of Linwood with a small lobe extending in a westerly direction south of Linwood.

Borehole logs indicate the overburden in the vicinity of the Linwood Well Field is typically between 63 and 67 m thick.

The hydrostratigraphic units typically present in the vicinity of Linwood are briefly described below, in order from youngest to oldest.

Aquitard ATA1 – Whittlesey Clay

This silt and clay unit is present at surface across the section and corresponds to glaciolacustrine Whittlesey clay (Bajc and Shirota, 2007). This unit forms a laterally extensive, low-permeability aquitard that restricts infiltration and provides partial confinement to the underlying aquifer.

Aquifer AFA1 - Whittlesey Sand

This very fine to coarse sand unit is interpreted as glaciolacustrine Whittlesey sand (Bajc and Shirota, 2007) and is encountered immediately below ATA1 across the section. AFA1 is continuous aquifer that facilitates groundwater flow within the upper overburden sequence.

Aquitard ATB1 – Mornington Till

The Mornington Till consists of low permeability, spatially discontinuous, surficial till units found predominantly along the flanks of the Waterloo Moraine. Along the western flank of the Moraine, ATB1 corresponds to the Mornington, Stratford and Tavistock Tills; whereas along the eastern flank of the Moraine this unit corresponds to the Upper Maryhill and Port Stanley Tills (Bajc and Shirota, 2007). The Mornington Till is mapped as the surficial deposit in the area (Figure 4).

Aquifer AFB1 / AFB2 – Upper Waterloo Moraine Stratified Sediments and Equivalents

Aquifer AFB1 / AFB2 represents the main water supply aquifer in the core areas of the Waterloo Moraine. These units are generally comprised of layered silt and fine sand to coarse sand and gravel. Throughout the core areas of the Moraine (Figure 5), the unit typically exceeds 45 m in thickness. In some areas, the Upper Waterloo Moraine is interpreted to be bisected by the middle Maryhill Till (ATB2), effectively separating the aquifer into two units, AFB1 and AFB2. This aquifer is the most prolific aquifer in the Waterloo Region due to its high hydraulic conductivity and transmissivity, lateral extent, and high recharge rate.

Aquitard ATB3 – Lower Maryhill Till

The Lower Maryhill Till is described as a clayey silt to silty clay till. This unit represents one of the primary regional aquitards due to its strong influence on the groundwater flow system within the Waterloo Moraine. This unit is extensive within the core area of the Waterloo Moraine, and along the eastern flank tends to be thin, discontinuous, or re-worked and re-deposited as glaciofluvial sediments.

Aquifer AFB3 – Lower Waterloo Moraine Stratified Sediments

The Lower Waterloo Moraine Stratified Sediments is present below the Lower Maryhill Till, mainly along the eastern flank of the Moraine. This unit consists of stratified gravels, sands, or silts and is of very limited extent. Absence of AFB3, where it was previously identified in the well field area

Aquitard ATC1 / ATC2 – Catfish Creek Till

Bajc and Shirota (2007) divided the Catfish Creek Till into an upper (ATC1) and lower aquitard (ATC2), with an aquifer (AFC1) found occasionally between the two units. It is a dense, stony, sandy silt to silty sand till with little clay content. The hydrogeologic properties of the Catfish Creek Till are variable, ranging from a good aquitard to a poor aquifer, depending on local lithology, degree of compaction, and the presence of overlying aquitard units. The Catfish Creek Till is typically thickest in the core area of the Waterloo Moraine, and thin or absent along the eastern flank.

Aquifer AFD1 – Pre-Catfish Creek Sand and Gravel

Pre-Catfish Creek Till aquifer corresponds to sands and gravel re-worked from Catfish Creek and Pre-Catfish Creek Tills and represents the main supply aquifer in several production wells in the Cities of Kitchener and Waterloo. This unit is spatially discontinuous throughout much of the core areas of the Waterloo Moraine.

Aquitard ATE1 – Canning Drift

The Canning Drift is comprised of till and associated fine-textured lake deposits. It is typically found at depths of greater than 70 mbgs in the Waterloo Moraine area and is identified to be discontinuous and limited in lateral extent and thickness. Where it is absent, a hydraulic connection is present between the deep overburden aquifers and the underlying bedrock.

Aquifer AFF1 – Pre-Canning Till

The Pre-Canning aquifer is characterized by coarse-grained sand and gravel sediments and is typically found within bedrock depressions. This unit is discontinuous throughout the Region, and where present is hydraulically connected with the upper weathered portion of the bedrock aquifer.

2.2.2 Bedrock Geology and Conceptual Hydrostratigraphy

The underlying bedrock at the Linwood Well Field is characterized as the Salina Formation, and consists of interbedded grey and brown dolostone, green to red shale units, and gypsum. Groundwater extracted from this unit tends to be of poor quality due to the presence of sulphates (Johnston et al., 1992). In the Linwood Well

Field area, bedrock is found at depths of approximately 67 metres below ground surface (mbgs). The Salina Formation is interpreted to represent the main supply aquifer for production wells L1A and L2.

2.3 Local Geology

The following description of local geology is based primarily on the detailed lithological descriptions in the borehole log for WY-LW-OW1-09-A (Appendix B). According to the water well records in the area, the overburden varies from 63 to 68 m in thickness.

Aquitard ATB1 – Mornington Till – This unit was encountered at WY-LW-OW1-09-A from surface to a depth of 15 mbgs. It is described as primarily clay with a trace of silt and / or gravel.

Aquifer AFB1 / AFB2 – Upper Waterloo Moraine Stratified Sediments and Equivalents – This unit is described as brown silty sand. It is present underlying ATB1 and is approximately 7.6 m thick.

Aquitard ATB3 – Lower Maryhill Till – Silty clay sediments of the Lower Maryhill Till are present underlying AFB1/AFB2 at WY-LW-OW1-09-A, and is approximately 5.2 m thick at this location.

Aquifer AFB3 – Lower Waterloo Moraine Stratified Sediments Catfish Creek Till Outwash – Predominant material is sand and some gravel. These deposits do not appear to be continuous and were not described in the borehole log for WY-LW-OW1-09-A.

Aquitard ATC1/AFC1/ATC2 – Catfish Creek Till - Grey to brown sandy silt / silt sediments of the Catfish Creek Till are present underlying the Lower Maryhill Till at WY-LW-OW1-09-A, and is approximately 15 m thick at this location.

ATE1 – Canning Drift (till and fine-textured glaciolacustrine deposit) – Silty to clayey till, silt and clay. It is present underlying ATC1 / AFC1 / ATC2, and was not described in the borehole log for WY-LW-OW1-09-A.

Aquitard ATG1 – Pre-Canning Drift – Silty clay, sand and gravel deposits consistent with the Pre-Canning drift were encountered beneath the Catfish Creek Till at L1A, L2 and WY-LW-OW1-09-A. The thickness of this unit varies from 5.8 m at L1A and L2 to 16.5 m at WY-LW-OW1-09-A.

Aquifer AFF1 – Pre-Canning Till - A thin layer of coarser grained material (likely AFF1), varying in thickness from 1 to 4 m overlies the bedrock at L1A and L2 municipal well locations. These deposits do not appear to be continuous and were not described in the borehole log for WY-LW-OW1-09-A.

Bedrock-Salina Formation - The bedrock is described on the water well records for L1A and L2 as grey or brown limestone with shale interbeds. The borehole record for WY-LW-OW01-09-A describes the bedrock as dolostone with shaley beds.

3.0 2024 / 2025 Results

3.1 Precipitation

Longer term precipitation trends can have an impact on water levels in the supply aquifer. To assess the potential influence, monthly precipitation is plotted for comparison to water levels and pumping and presented in Appendix C.

Since variations in precipitation totals can occur throughout the Region due to localized events, monthly precipitation data from the GRCA and Environment Canada station located closest to the production wells are used. The closest GRCA weather station relative to the Linwood well field is the Conestogo Dam station located 10 km to the north. The closest Environment Canada station is the Waterloo International Airport (WIA) located 31 km to the southeast. The locations of the meteorological stations are shown in Figure 1.

Annual precipitation data from the past 10 years for all stations are compared with long term averages in Table D.1, Appendix D. At Conestogo Dam, the long-term average was calculated from when measurements started until the end of 2025. The WIA have “Climate Normals” calculated by Environment Canada for 1991 to 2020.

Annual 2024 / 2025 precipitation data for all the meteorological stations closest to the Linwood well field are presented in Table 5 below. WIA was missing 6 days of data in 2024 and 6 days in 2025. As a result, the precipitation totals at this station may be under reported.

Table 5: Summary of Precipitation Data

Station	2024 Precipitation (mm)	2024 Deviation (mm)	Long- Term Average (mm)	2025 Precipitation (mm)	2025 Deviation (mm)
Region of Waterloo International Airport ⁽¹⁾	874	+23	851 ^A	723	-128
Conestoga Dam ⁽²⁾	972	-18	990 ^B	1025	+35
Sources: Environment Canada (1), GRCA (2) ^A 1991 to 2020 Normal ^B Average annual precipitation since monitoring began to the end of 2025					

Water levels typically follow a seasonal trend with highest levels occurring in the spring with the depth and water content of the snowpack having a significant influence on water levels. Lowest levels occurring in July / August. Widespread synoptic rainfall events can also result in Region-wide water level responses. Summer thunderstorms tend to be short lived and occur over a smaller area resulting in short term, localized water level rises not typically seen in the monitoring wells.

The 2024 total precipitation at Conestoga Dam station was 972 mm, which is 18 mm below the long-term average. While an above long-term average trend is noted at the WIA station. The March 1 GRCA snow survey indicated a snowpack across the Region that was low compared to normal. In 2025, the total precipitation at the Conestoga Dam was 1025 mm, which is 35 mm above the long-term average. The 2025 total precipitation at the WIA station was 128 mm below the long-term average. However, WIA was missing 12 days of data in 2024 / 2025 and as a result, precipitation totals may be under reported. The snow survey conducted by the GRCA on March 15, 2025, showed that the stations in the Region had a high to very high measured snow water equivalent.

3.2 Monitoring Results

Hydrographs showing the results of water level monitoring over the past 10 years are provided in Appendix C. The method used to collect water levels (manual or electronic) is indicated on the graph in Appendix C.

WY-LW-OW01-09-A

Water levels at WY-LW-OW01-09-A (Salina Formation) were collected using an electronic logger. Results suggest minor seasonal fluctuations and a minor response to pumping (typically about 0.1 m daily). Water levels declined about 0.5 m in January 2022, 1.3 m from May 2022 to August 2022 and 1.1 m from May 2023 to August 2023 and 1.3 m in March 2024 / April 2024 in response to increased pumping of L1A and L2.

During 2025, water levels showed a seasonal pattern with water levels rising in the spring, declined steadily through the summer and early fall. The overall pattern indicates a continued gradual decline with water levels gradually decreasing approximately 2 m from June 2019 to December 2025.

4.0 Impact Assessment

4.1 Well Interference

PTTW Condition 5.1 states, "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."

The well field is just north of a municipally serviced area and there may be residences within 500 m of L1A and L2 using private wells. Since pumping impacts to the bedrock aquifer are minimal, no impacts to local domestic wells are anticipated. There have been no well interference complaints related to pumping at the Linwood Well Field since the last Biennial Report was issued in 2023.

In the event that a well interference complaint is received, the Region has a Well Interference Policy in place. A copy of the policy is presented in Appendix F of the 2019 Biennial Groundwater Monitoring Report – Multiple Well Fields (Burnside, 2020). This policy is also available to the public on the Region of Waterloo website

Other groundwater takings registered in the MECP PTTW database within 2 km of the wellfield are mapped in Figure 3 and summarized below in Table 6.

Table 6: PTTWs (Groundwater) in Vicinity of Linwood Well Field (L1A, L2)

Permit Number	Permit Holder	Purpose	Max Liters per Day	Distance (km) from L1A and L2 Supply Wells	Expiry Date
0050-BAEP4D	Jones Feed Mills Limited	Commercial	288,000	0.8	2029-03-31

PTTW Number 0050-BAEP4D is issued to Jones Feed Mills Limited, and allows maximum takings of 200 L/min (288,000 L/day) from a bedrock well located about 800 m from L1A and L2 (Figure 3) and about 760 m from WY-LW-OW01-09-A. Drawdown in WY-LW-OW01-09-A was less than 0.4 m during testing of the Feed Mills well (Burnside, 2018).

4.2 Aquifer Response to Pumping and Precipitation

PTTW Condition 4.3 states: " The Permit Holder shall prepare and submit an electronic copy of a report every two years by June 30th, that presents the results of the well field water level monitoring for the two preceding calendar years, assesses changes in water levels in the supply aquifer(s) in relation to precipitation and water taking from the aquifer(s)".

Water levels in the Salina Formation Aquifer show daily fluctuations by approximately 0.8 m in response to the on and off cycling of well L1A and L2. Data collected from WY-L-OW01-09-A shows a seasonal trend of highest water levels in the spring and low

levels in the summer. The 2024 / 2025 precipitation data from the nearest weather station did not correlate with any specific water-level response.

5.0 Conclusions

Impacts from pumping the municipal wells at the Linwood Well Field (L1A, L2) were evaluated through implementation of the Groundwater Monitoring Program. Based on the information contained in the report, Burnside offers the following conclusions:

- The information presented in this report satisfies condition 4.3 of PTTW 2680-B8HT58;
- There were no reported well interference complaints arising from water taking at the Linwood L1A and L2 well field.
- 2024 and 2025 pumping volumes were within the permitted range;
- Water levels in the Salina Formation (WY-LW-OW01-09-A) follow seasonal trends;
- Water levels in the Salina Formation (WY-LW-OW01-09-A) respond to pumping at the Linwood Well Field; and
- There has been an overall decline of water levels in WY-LW-OW01-09-A from June 2019 to December 2025.

6.0 References

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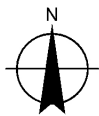
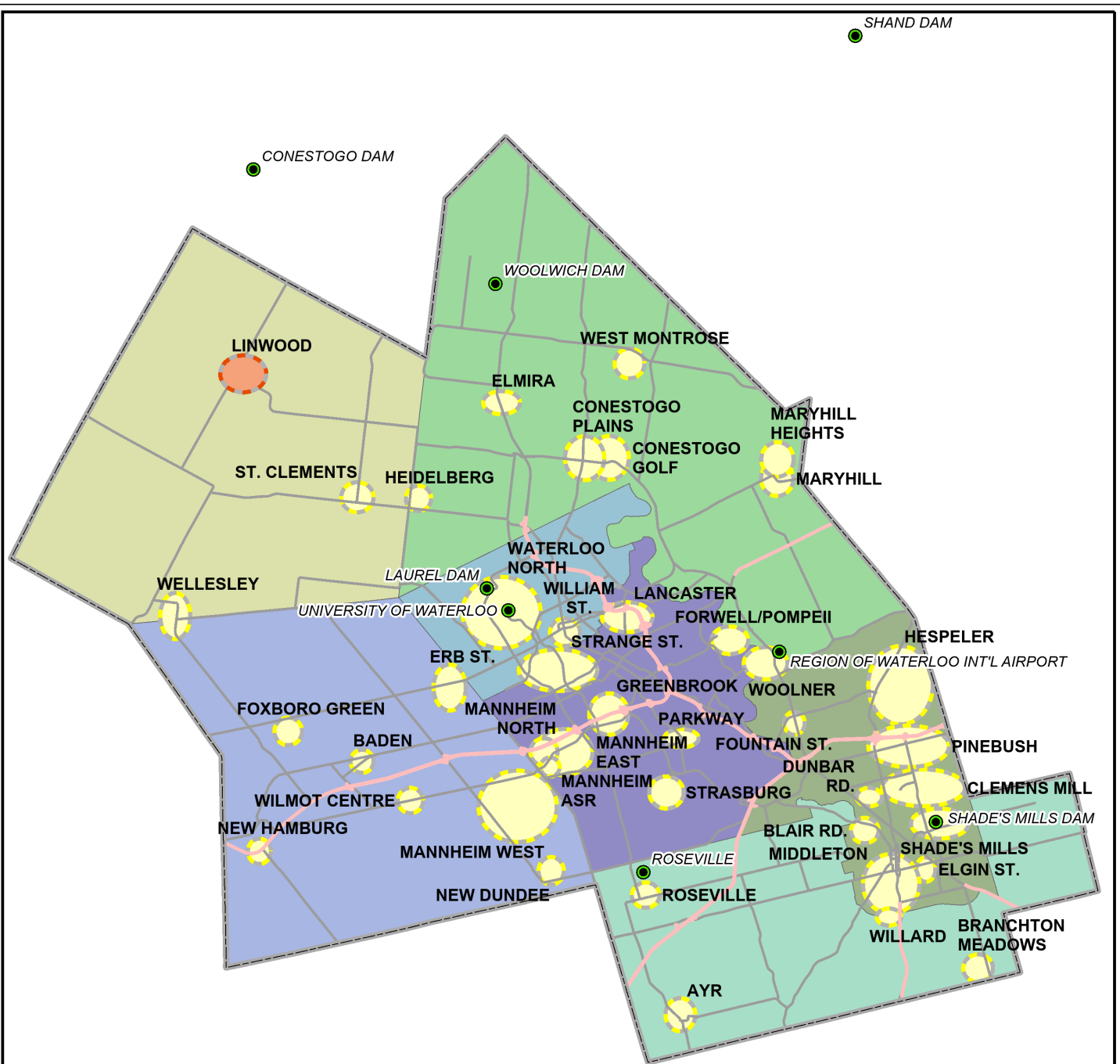


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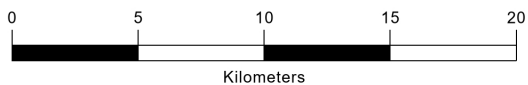
[THE DIFFERENCE IS OUR PEOPLE]



Figures



Data Source:
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|-------------------------------|-------------------------------------|
| Well Field Location | Township of North Dumfries |
| Well Fields | Township of Wellesley |
| Regional Municipal Boundaries | Township of Wilmot |
| City of Cambridge | Township of Woolwich |
| City of Kitchener | Meteorological Monitoring Locations |
| City of Waterloo | |



Map Title

2025 GROUNDWATER MONITORING REPORT - LINWOOD WELL FIELD

WELL FIELD LOCATION MAP

Client

REGION OF WATERLOO

Drawn

HN

Scale

1:300,000

Checked

SQ

Date

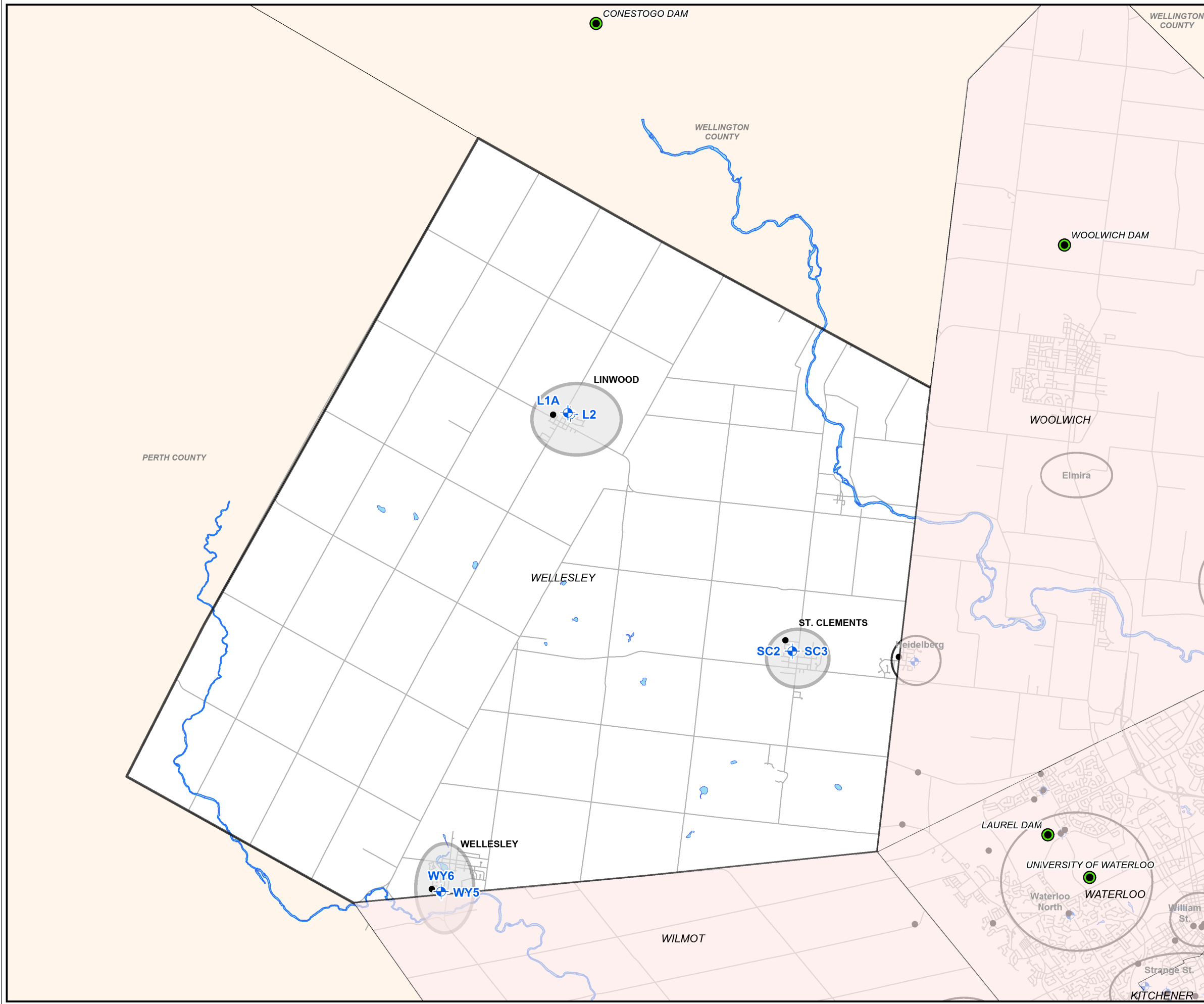
February 2026

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Figure No.

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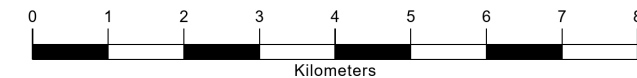
LEGEND

-  Production Well Location
-  Monitoring Well Location
-  Meteorological Monitoring Locations
-  Wellesley Municipal Boundary
-  Well Fields

Sources:

1. Ministry of Natural Resources, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

Datum: North American 1983 CSRS
Coord. System: NAD 1983 CSRS UTM Zone 17N



Client

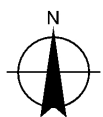
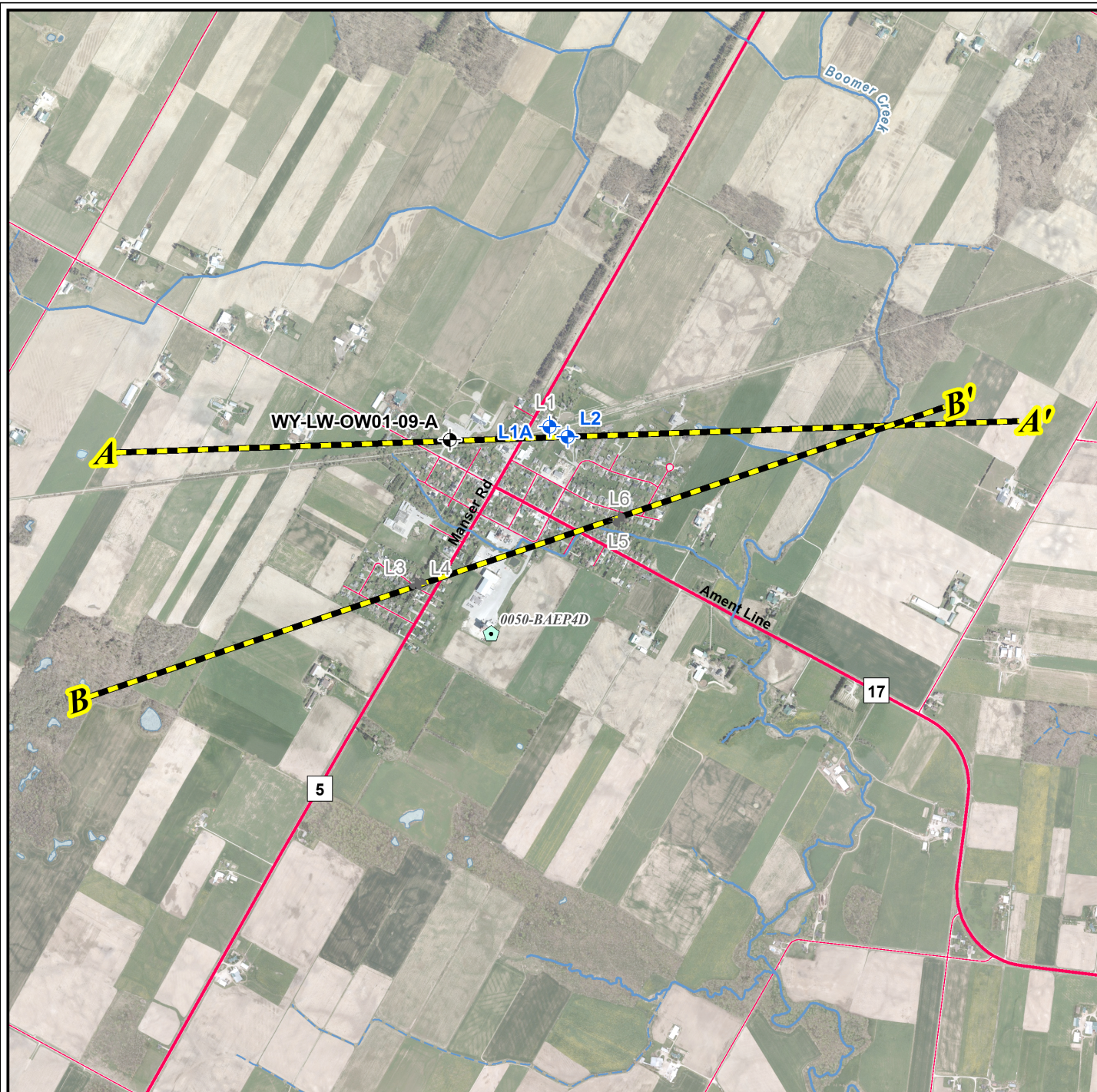
REGION OF WATERLOO

Figure Title

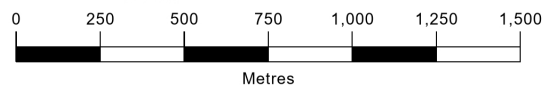
**2025 GROUNDWATER MONITORING
REPORT - LINWOOD WELL FIELD**
**WELLESLEY WELL FIELDS AND
MONITORING NETWORK**

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Data Source:
Region of Waterloo GIS Data; Background 2020 Air Photo;
ArcGIS Image Service Region of Waterloo; Ministry of
Natural Resources, © Queen's Printer for Ontario; Natural
Resources Canada © Her Majesty the Queen in Right of
Canada.



Production Well Location



Decommissioned Production
Well Location

Additional MECP PTTW Locations



Groundwater

--- Cross Section Orientation

- - - Intermittent Creek

— Creek

— Regional Road

— Local Road



Map Title

2025 GROUNDWATER MONITORING REPORT - LINWOOD WELL FIELD

WELL LOCATION MAP

Client

REGION OF WATERLOO

Drawn

HN

Scale

1:22,500

Checked

SQ

Date

March 2026

Project No.

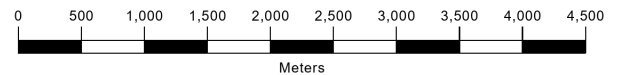
HA0464020

Figure No.

3



Data Source:
 1. Ontario Geological Survey 2003. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.
 2. Region of Waterloo GIS



- RMOW Supply Well
- Decommissioned Supply Well
- Watercourse
- Waterbody

Surficial Geology

- 5b: Stone-poor, carbonate-derived silty to sandy till (ATA2/ATB1 - Aquitard)
- 5d: Glaciolacustrine-derived silty to clayey till (ATB1 - Aquitard)

- 6: Ice-contact stratified deposits (AFB1 - Aquifer)
- 7a: Glaciofluvial deposits: Sandy deposits (AFA2 - Aquifer)
- 7b: Glaciofluvial deposits: Gravelly deposits (AFA2 - Aquifer)

- 8a: Fine-textured glaciolacustrine deposits: Massive-well laminated (ATA1)
- 19: Modern alluvial deposits
- 20: Organic deposits
- Mornington Till

- Hummocky Topography - Macton Moraine
- Sand and Gravel Pit
- Terrace
- Sample Location
- Unit Contact Boundary



Map Title

2025 GROUNDWATER MONITORING REPORT - LINWOOD WELL FIELD

SURFICIAL GEOLOGY

Client

REGION OF WATERLOO

Drawn

HN

Scale

1:60,000

Checked

SQ

Date

March 2026

Project No.

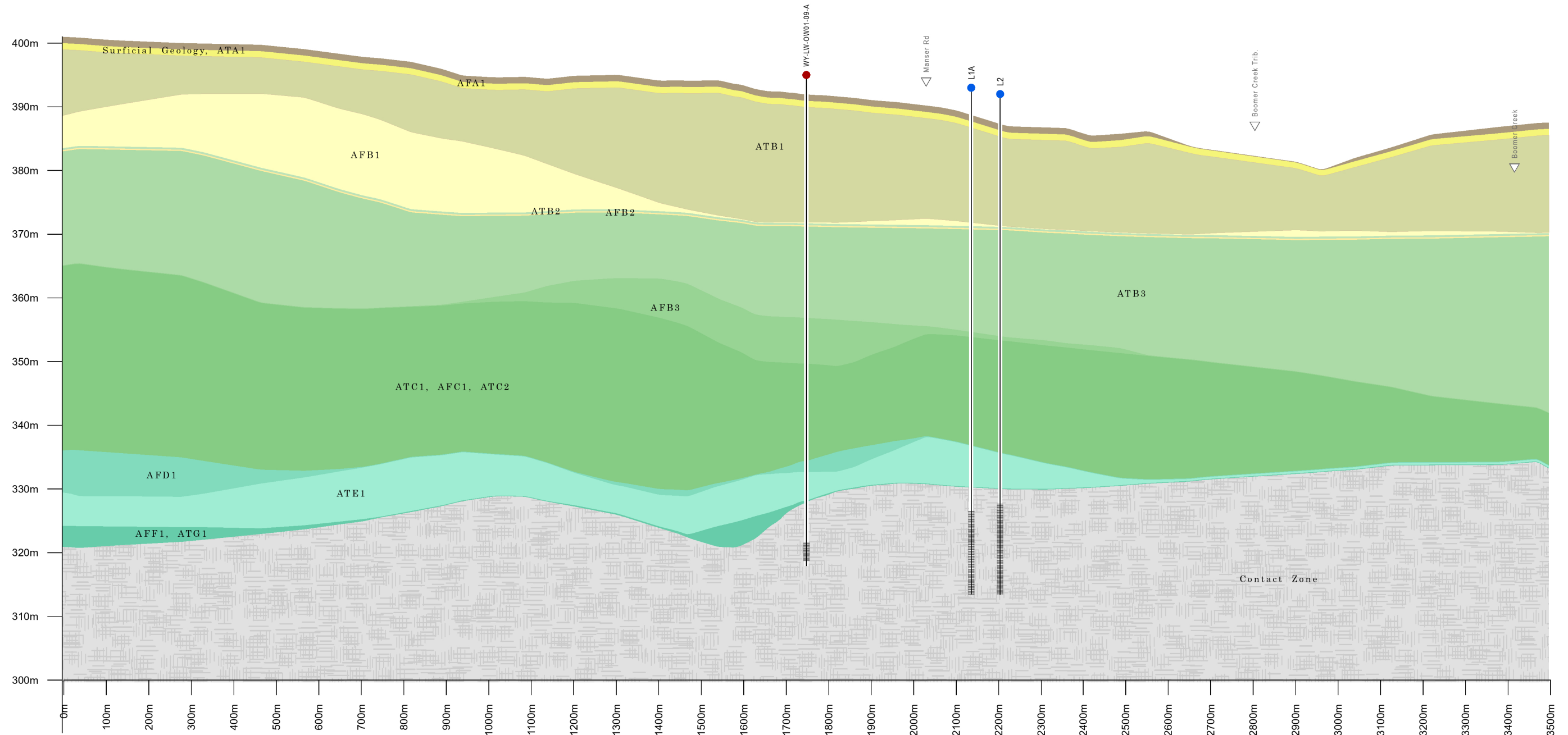
HA0464020

Figure No.

4

A

A'

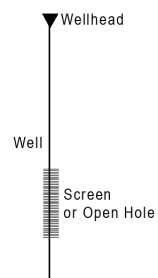


Wells

- Production Well (Active)
- Monitoring Well

Moraine Model Full 2026

 Surficial Geology, Whittlesey Clay (ATA1)	 Upper Waterloo Moraine Stratified Sediments & Equivalents (AFB1)	 Lower Maryhill Till & Stratified Equivalents (ATB3)	 Pre-Catfish Creek Coarse-Grained Glaciofluvial/Lacustrine Deposits (AFD1)	 Weathered Bedrock
 Whittlesey Sand (AFA1)	 Middle Maryhill Till & Equivalents (ATB2)	 Lower Waterloo Moraine Stratified Sediments or Catfish Creek Till Outwash (AFB3)	 Canning Drift, Till & Fine Textured Glaciolacustrine Deposits (ATE1)	
 Upper Maryhill, Port Stanley, Tavistock, Mornington, & Stratford Tills (ATB1)	 Middle Waterloo Moraine Stratified Sediments & Equivalents (AFB2)	 Upper/Main Catfish Creek Till (ATC1), Middle Catfish Creek Stratified Deposits (AFC1), Lower Catfish Creek Till (ATC2)	 Pre-Canning Coarse Textured Glaciofluvial / Glaciolacustrine Deposits (AFF1), Pre-Canning Coarse Textured Till (ATG1)	



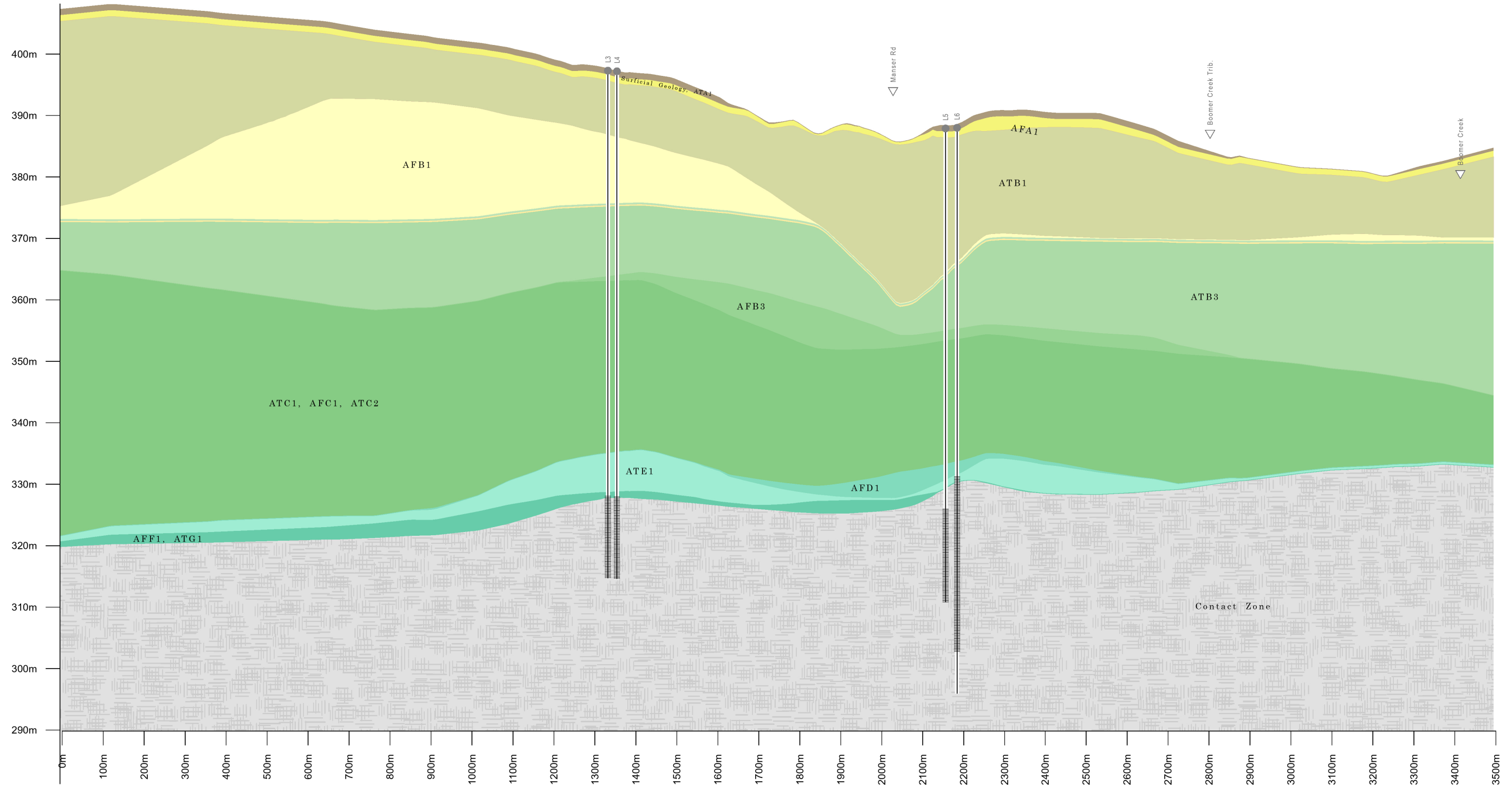
Client
REGION OF WATERLOO

Figure Title
**GEOLOGIC CROSS SECTION
REGION OF WATERLOO**
Linwood
Cross Section A - A'

Drawn PS	Checked DH	Date 2026/06/02	Figure No. 5
Horizontal Scale 1:10,000		Project No.	
Vertical Ex.:15x		HA046402	

B

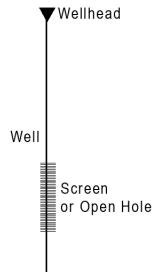
B'



Wells

- Production Well (Decommissioned)

Surficial Geology, Whittlesey Clay (ATA1)	Upper Waterloo Moraine Stratified Sediments & Equivalents (AFB1)	Lower Maryhill Till & Stratified Equivalents (ATB3)	Pre-Catfish Creek Coarse-Grained Glaciofluvial/Lacustrine Deposits (AFD1)	Weathered Bedrock
Whittlesey Sand (AFA1)	Middle Maryhill Till & Equivalents (ATB2)	Lower Waterloo Moraine Stratified Sediments or Catfish Creek Till Outwash (AFB3)	Canning Drift, Till & Fine Textured Glaciolacustrine Deposits (ATE1)	
Upper Maryhill, Port Stanley, Tavistock, Mornington, & Stratford Tills (ATB1)	Middle Waterloo Moraine Stratified Sediments & Equivalents (AFB2)	Upper/Main Catfish Creek Till (ATC1), Middle Catfish Creek Stratified Deposits (AFC1), Lower Catfish Creek Till (ATC2)	Pre-Canning Coarse Textured Glaciofluvial / Glaciolacustrine Deposits (AFF1), Pre-Canning Coarse Textured Till (ATG1)	



Client
REGION OF WATERLOO

Figure Title
**GEOLOGIC CROSS SECTION
REGION OF WATERLOO**
Linwood
Cross Section B - B'

Drawn	Checked	Date	Figure No. 6
PS	DH	2026/06/02	
Horizontal Scale 1:10,000		Project No.	
Vertical Ex.:15x		HA046402	



BURNSIDE

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Appendix A

Permit To Take Water



PERMIT TO TAKE WATER

Ground Water

NUMBER 2680-B8HT58

Reference Number 7678-B7DLKJ

Pursuant to Section 34.1 of the Ontario Water Resources Act, R.S.O. 1990 this Permit To Take Water is hereby issued to:

The Regional Municipality of Waterloo
150 Frederick St
Kitchener, Ontario, N2G 4J3
Canada

For the water taking L1A (WWR# 6505840) and L2 (WWR# 6505510)
from:

Located at: Lot 10, Concession 11, Geographic Township of Wellesley
Wellesley, Regional Municipality of Waterloo

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 34.1, 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, Conservation and Parks.

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

(e) "Permit" means this Permit to Take Water No. 2680-B8HT58 including its Schedules, if any, issued in accordance with Section 34.1 of the OWRA.

(f) "Permit Holder" means The Regional Municipality of Waterloo.

(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:

TERMS AND CONDITIONS

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 6, 2018 and signed by Richard Wootton, 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 **January 29, 2029**. 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	L1A (WWR# 6505840)	Well Drilled	Municipal	Water Supply	727	24	1,046,880	365	17 522197 4825625
2	L2 (WWR# 6505510)	Well Drilled	Municipal	Water Supply	727	24	1,046,880	365	17 522138 4825659
						Total Taking:	1,046,880		

3.3 Notwithstanding Table A, the maximum combined rate and maximum combined total daily amount taken for Well L1A and Well L2 shall be 727 L/min and 1,046,880 L/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 measure and record water levels once a month in the following monitoring well:

WY-LW-OW1-09.

4.3 The Permit Holder shall prepare and submit an electronic copy of a report every two years by June 30th, that presents the results of the well field water level monitoring for the two preceding calendar years, assesses changes in water levels in the supply aquifer(s) in relation to precipitation and water taking from the aquifer(s), and provides a summary for all interference complaints received by the Permit Holder related to this permit and reported in the District Office in accordance with Condition 5.1 and the manner in which the Permit Holder has dealt with the complaint. Any application for an amendment or renewal shall be accompanied by the most recent biennial report.

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 and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 101 of the Ontario Water Resources Act, R.S.O. 1990, as amended, provides that the Notice requiring the 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:

- a. The name of the appellant;
- b. The address of the appellant;
- c. The Permit to Take Water number;
- d. The date of the Permit to Take Water;
- e. The name of the Director;
- f. 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) 326-5370
ERTTribunalsecretary@ontario.ca

AND

The Director, Section 34.1,
Ministry of the Environment, Conservation and
Parks
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) 212-6349
Toll Free 1(866) 448-2248

by Fax at
(416) 326-5370
Toll Free 1(844) 213-3474

by e-mail at
www.ert.gov.on.ca

This Permit cancels and replaces Permit Number 2287-8VQGV4, issued on 2012/06/29.

Dated at Hamilton this 29th day of January, 2019.



Cynthia Doughty
Director, Section 34.1

Ontario Water Resources Act, R.S.O. 1990

Schedule A

This Schedule “A” forms part of Permit To Take Water 2680-B8HT58, dated January 29, 2019.

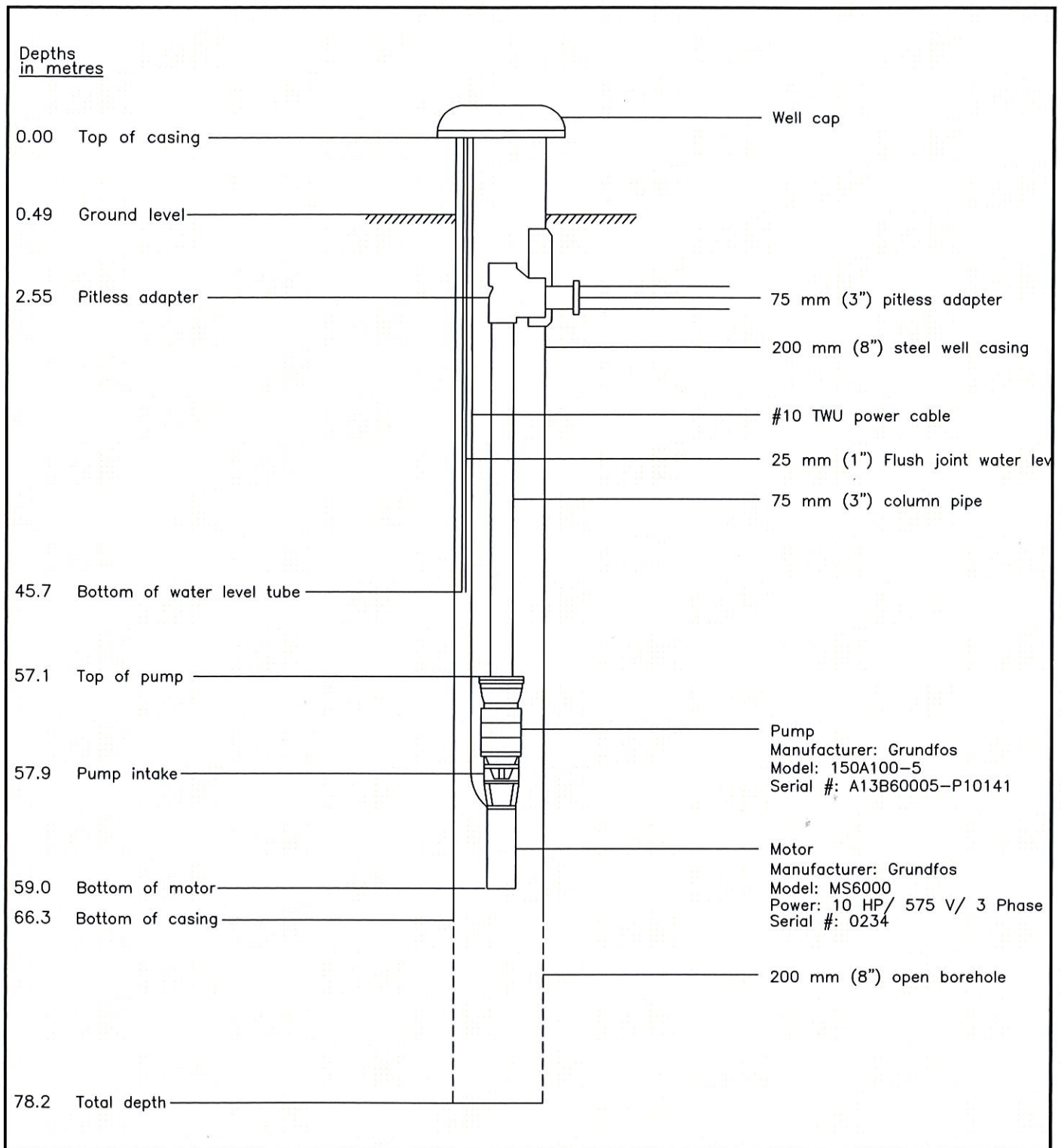


BURNSIDE

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Appendix B

Well Records



CLIENT
REGIONAL MUNICIPALITY OF WATERLOO

TITLE
Linwood Well L1A
Pump Installation Drawing

PROJECT No. 006—314			G:\...\006 Region of Waterloo\314 Linwood1A\7.Technical\Pump on Maass J Style Pitless			FIGURE 4
DESIGN			REVISION No. 2014/06/17	SCALE N.T.S.		
DRAWN	EH	2014/05/20				
CHECKED						



Ministry
of the
Environment

Ontario

The Ontario Water Resources Act

WATER WELL RECORD

6505510

MUNICIPALITY: 10 14 15 22 23 24
CONTRACTOR: 11

1. PRINT ONLY IN SPACES PROVIDED
2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

COUNTY OR DISTRICT Waterloo	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE Wellesley W.S. Twp.	CON. BLOCK, TRACT, SURVEY, ETC. Con. 11	LOT PT 10
OWNER (SURNAME FIRST) LINWOOD WATER SYSTEM	ADDRESS c/o Conestoga-Rovers & Associates Ltd., 651 Colby Dr., Waterloo, Ont. N2V 1C2	DATE COMPLETED 3 Jan. 84	DAY 3 MO Jan. YR 84

21	ZONE U M 10	EASTING 12	NORTHING 18	RC 25	ELEVATION 26	RC 30	BASIN CODE 31	II	III	IV	47
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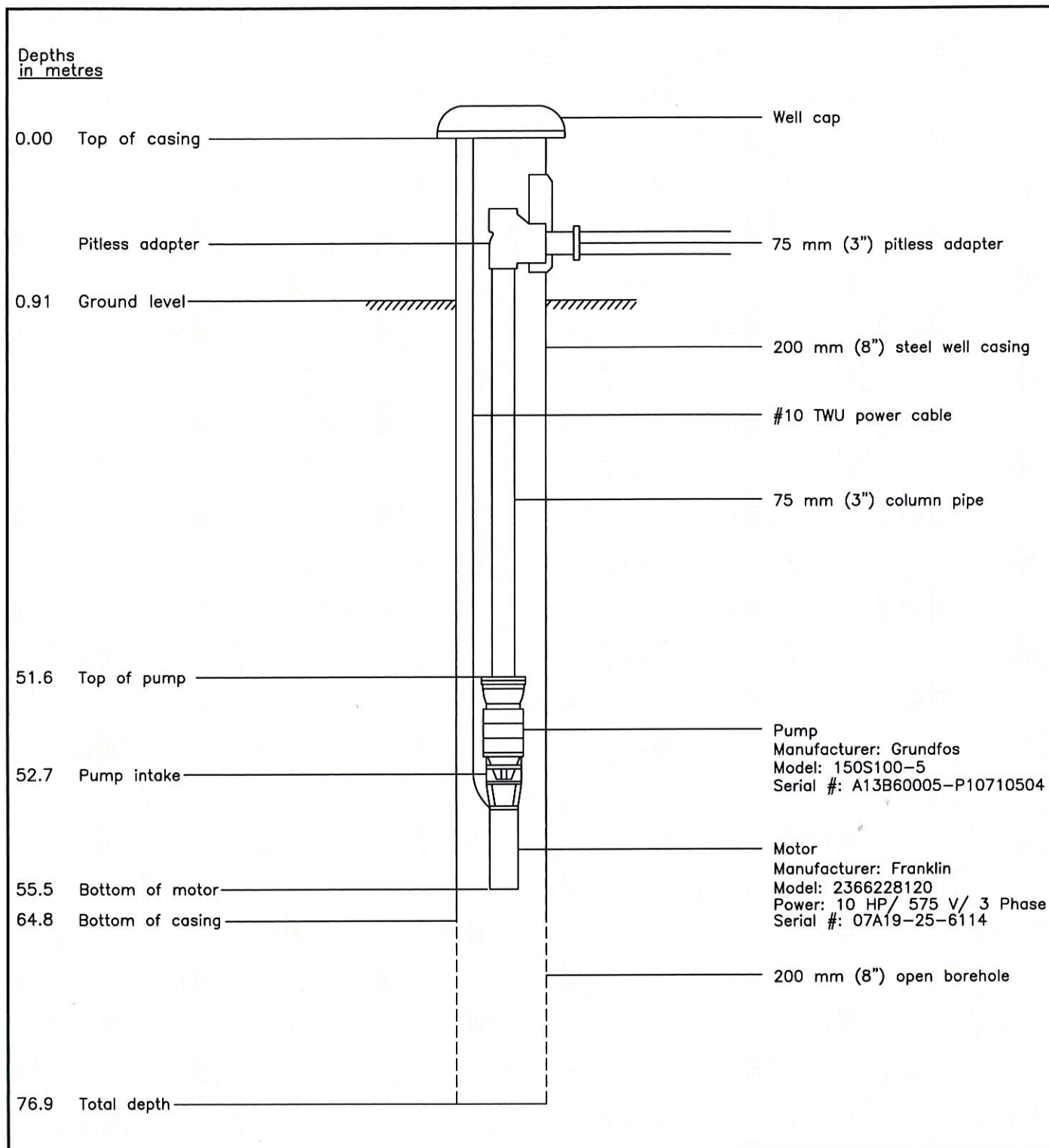
LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)					
GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET	
				FROM	TO
	Topsoil			0	1
Brown	Sand	Silt	Soft	1	6
Brown	Clay		Soft	6	17
Grey	Clay		Medium soft	17	104
Grey	Clay	Gravel, stones	Soft, mixed	104	153
Grey	Clay	Stones	Hard	153	172
	Boulders	Silt	Hard	172	179
	Gravel	Silt, boulders	Mixed	179	206
Lt. Brown	Limestone		Soft	206	219
Grey	Limestone	Shale	Soft	219	231
Brown	Limestone		Soft & Hard	231	247
Grey	Shale	Limestone	Soft, layered	247	258

31	10 14 15 21 32 43 54 65 75 80
32	10 14 15 21 32 43 54 65 75 80

41 WATER RECORD WATER FOUND AT - FEET 211-214 237-246 KIND OF WATER 1 ☒ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL 15-18 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL 20-23 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL 25-28 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL 30-33 1 ☐ FRESH 3 ☐ SULPHUR 2 ☐ SALTY 4 ☐ MINERAL	51 CASING & OPEN HOLE RECORD INSIDE DIAM. INCHES 8 MATERIAL 1 ☒ STEEL 2 ☐ GALVANIZED 3 ☐ CONCRETE 4 ☐ OPEN HOLE WALL THICKNESS INCHES .264 DEPTH - FEET FROM TO 0 210.5 210.5 258	61 PLUGGING & SEALING RECORD DEPTH SET AT - FEET FROM TO 10-13 14-17 18-21 22-25 26-29 30-33 MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
---	--	---

71 PUMPING TEST PUMPING TEST METHOD 1 ☒ PUMP 2 ☐ BAILER PUMPING RATE 125 Imp. GPM DURATION OF PUMPING 72 HOURS 15-16 HOURS 17-18 MINS STATIC LEVEL 69.6 FEET WATER LEVEL END OF PUMPING 147.9 FEET WATER LEVELS DURING 15 MINUTES 82.3 FEET 30 MINUTES 80.9 FEET 45 MINUTES 80.4 FEET 60 MINUTES 79.8 FEET IF FLOWING, GIVE RATE 203 SPM RECOMMENDED PUMP TYPE ☐ SHALLOW ☒ DEEP RECOMMENDED PUMP SETTING 180 FEET RECOMMENDED PUMPING RATE 125 Imp. GPM	LOCATION OF WELL IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW. 510' 95' WELL VILLAGE OF LINWOOD DRILLERS REMARKS
---	--

FINAL STATUS OF WELL 1 ☒ WATER SUPPLY 2 ☐ OBSERVATION WELL 3 ☐ TEST HOLE 4 ☐ RECHARGE WELL 5 ☐ ABANDONED, INSUFFICIENT SUPPLY 6 ☐ ABANDONED, POOR QUALITY 7 ☐ UNFINISHED	WATER USE 1 ☐ DOMESTIC 2 ☐ STOCK 3 ☐ IRRIGATION 4 ☐ INDUSTRIAL 5 ☐ COMMERCIAL 6 ☒ MUNICIPAL 7 ☐ PUBLIC SUPPLY 8 ☐ COOLING OR AIR CONDITIONING 9 ☐ NOT USED	METHOD OF DRILLING 1 ☐ CABLE TOOL 2 ☒ ROTARY (CONVENTIONAL) 3 ☐ ROTARY (REVERSE) 4 ☒ ROTARY (AIR) 5 ☐ AIR PERCUSSION 6 ☐ BORING 7 ☐ DIAMOND 8 ☐ JETTING 9 ☐ DRIVING
CONTRACTOR NAME OF WELL CONTRACTOR Davidson Well Drilling Limited LICENCE NUMBER 1727 ADDRESS Box 486, Wingham, Ontario. NOG 2W0 NAME OF DRILLER OR BORER G. Reavie LICENCE NUMBER SIGNATURE OF CONTRACTOR SUBMISSION DATE 6 Jan. 84	OFFICE USE ONLY DATA SOURCE DATE OF INSPECTION INSPECTOR REMARKS 06 06 84 CSS.ES	



 **Lotowater**
TECHNICAL SERVICES INC.

CLIENT

REGIONAL MUNICIPALITY OF WATERLOO

TITLE

**Linwood Well 2
Pump Installation Drawing**PROJECT No. **006-311**

G:\Lotowater Projects\006 Region of Waterloo\311 Linwood2\7.Technical\Small Sub Pump on Maass J Style Pitless

DESIGN

DRAWN

EH**2014/05/20**

REVISION No. 1

SCALE

N.T.S.**FIGURE****4**

CHECKED

PROJECT: 08-1112-0150

BOREHOLE LOG OF: WY-LW-OW01-09

SHEET 1 OF 4

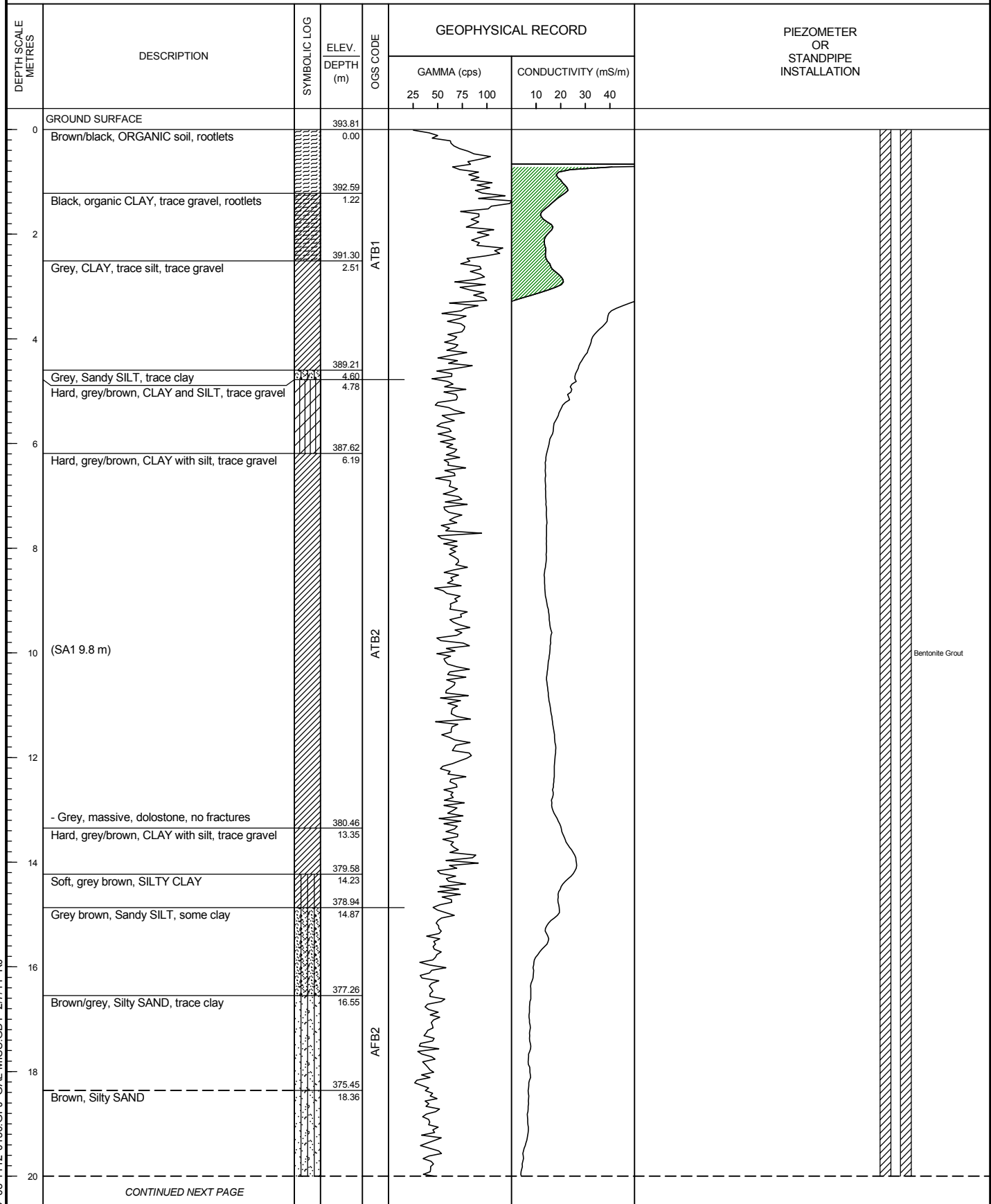
LOCATION: N 4825609.0 ; E 521753.0

DRILLING DATE: August 26-31, 2009

DATUM: NAD83

DRILL RIG: PQ Coring

DRILLING CONTRACTOR: Davidson Well Drilling



MIS-HYD 009 08-1112-0150.GPJ GAL-MISS.GDT 2/7/11 RJ

DEPTH SCALE

1 : 100



LOGGED: SC/BH

CHECKED: DN

PROJECT: 08-1112-0150

BOREHOLE LOG OF: WY-LW-OW01-09

SHEET 2 OF 4

LOCATION: N 4825609.0 ;E 521753.0

DRILLING DATE: August 26-31, 2009

DATUM: NAD83

DRILL RIG: PQ Coring

DRILLING CONTRACTOR: Davidson Well Drilling

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	OGS CODE	GEOPHYSICAL RECORD		PIEZOMETER OR STANDPIPE INSTALLATION
					GAMMA (cps)	CONDUCTIVITY (mS/m)	
					25 50 75 100	10 20 30 40	
20	--- CONTINUED FROM PREVIOUS PAGE --- Brown, Silty SAND						
22				AFB2			
	Hard, brown/grey, SILTY CLAY		371.34				
	Hard, brown/grey, SILTY CLAY, trace gravel		22.47				
			22.71				
24				ATB3			
	(SA2 25-25.9 m)						
26							
28	Brown/grey, Sandy SILT, some gravel, large shale boulder at 29.62 m		365.92				
			27.89				
30							
	Dense, grey, Sandy SILT, small pebbles, trace gravel, large cobble at 30.78 m (TILL)		363.14				
			30.67				
32	Dense, dark grey to grey brown, SILT, few sandy lenses (TILL)		361.66				
			32.15				
34	Very dense, dark grey to brown, SILT, trace to some clay lenses, trace cobbles (TILL) (SA 3 33.8-34.8 m)		360.13				
			33.68	ATC1			
	Dense, grey brown, SILT, fine sand (TILL)		358.61				
			35.20				
36							
	Loose, light grey brown, sandy SILT, trace clay		357.11				
			36.70				
38							
	Loose, light grey brown, medium to fine SAND, trace clay		355.31				
			38.50				
	Dense, grey, SILT, trace clay (TILL)		354.60				
			39.21				
40	Light grey brown, sandy SILT, trace clay		354.03				
			39.78				
	CONTINUED NEXT PAGE						

 10/11/2009
567.95

Bentonite Grout

MIS-HYD 009 08-1112-0150.GPJ GAL-MASS.GDT 2/7/11 RJ

DEPTH SCALE

1 : 100



LOGGED: SC/BH

CHECKED: DN

PROJECT: 08-1112-0150
 LOCATION: N 4825609.0 ; E 521753.0

BOREHOLE LOG OF: WY-LW-OW01-09

SHEET 3 OF 4
 DATUM: NAD83

DRILLING DATE: August 26-31, 2009
 DRILL RIG: PQ Coring
 DRILLING CONTRACTOR: Davidson Well Drilling

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	OGS CODE	GEOPHYSICAL RECORD		PIEZOMETER OR STANDPIPE INSTALLATION
					GAMMA (cps)	CONDUCTIVITY (mS/m)	
					25 50 75 100	10 20 30 40	
40	--- CONTINUED FROM PREVIOUS PAGE ---		353.58 40.23				
	Light grey brown, medium to fine sandy SILT, sand lenses, trace clay						
42	Dense, grey brown, SILT, trace clay (TILL)		352.05 41.76				
	Becoming soft silty clay						
44	Light grey brown, sandy SILT, trace clay		349.46 44.35	ATC2			
	Boulders at 44.57 m and 45.49 m						
46	Core lost from 46.81 m to 47.85 m						
48							
50	Dense, grey/brown, SILT, trace sand, clay clasts (TILL)		344.89 48.92				
52	Hard, brown/grey, SILTY CLAY, trace sand and gravel		343.34 50.47	ATG1			
54	(SA4 53.0-54.0 m)						
56							
58							
60	CONTINUED NEXT PAGE						

Bentonite Grout

MIS-HYD 009 08-1112-0150.GPJ GAL-MISS.GDT 27/11 RJ

DEPTH SCALE
 1 : 100



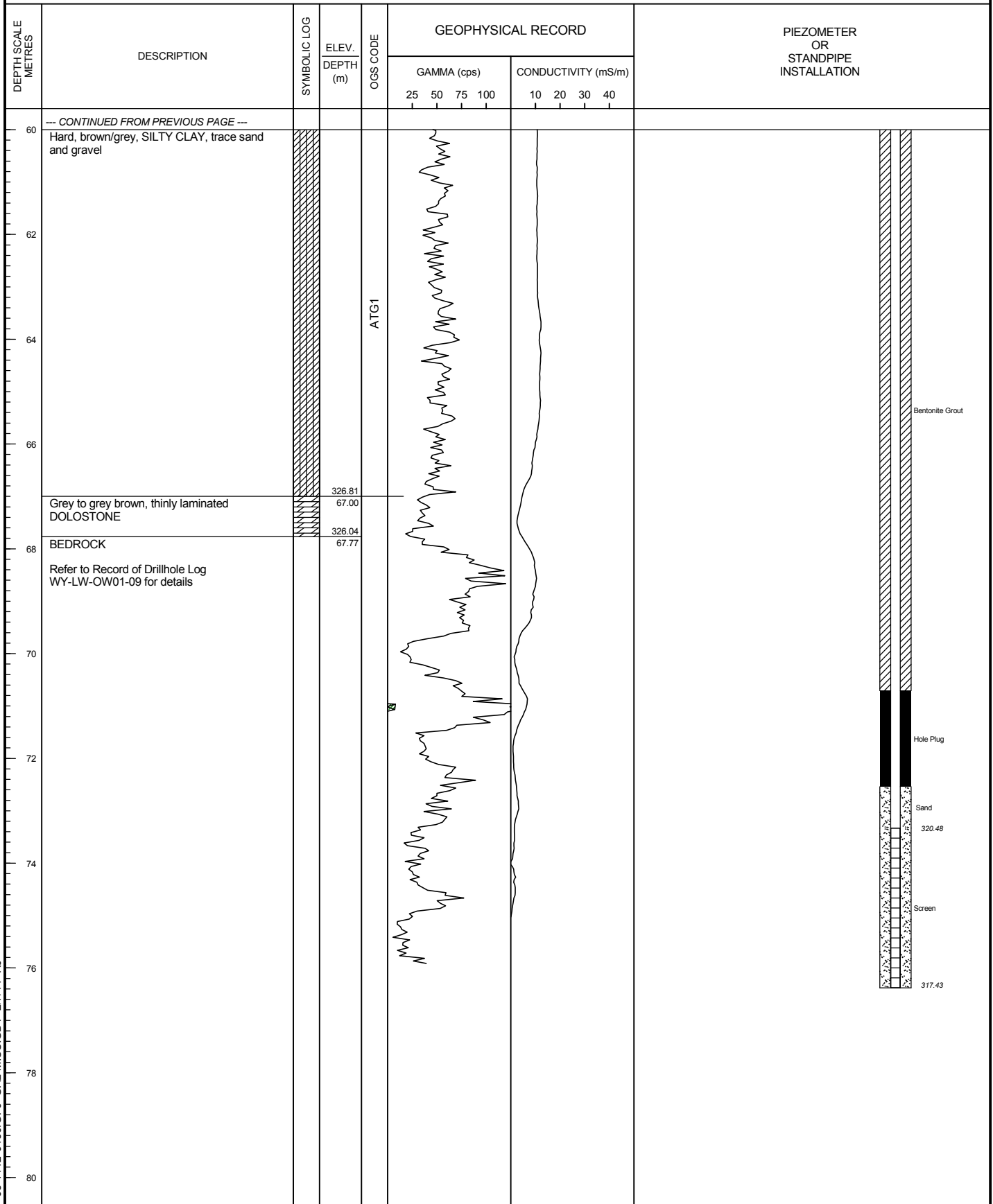
LOGGED: SC/BH
 CHECKED: DN

PROJECT: 08-1112-0150
 LOCATION: N 4825609.0 ; E 521753.0

BOREHOLE LOG OF: WY-LW-OW01-09

SHEET 4 OF 4
 DATUM: NAD83

DRILLING DATE: August 26-31, 2009
 DRILL RIG: PQ Coring
 DRILLING CONTRACTOR: Davidson Well Drilling



MIS-HYD 009 08-1112-0150.GPJ GAL-MISS.GDT 2/7/11 RJ

DEPTH SCALE
 1 : 100



LOGGED: SC/BH
 CHECKED: DN

SHEET 1 OF 1

DATUM: NAD83

DRILLING CONTRACTOR: Davidson Well Drilling

CHECKED: DN

MIS-RCK 004 08-1112-0150.GPJ GAL-MISS.GDT 2/7/11 RJ



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Appendix C

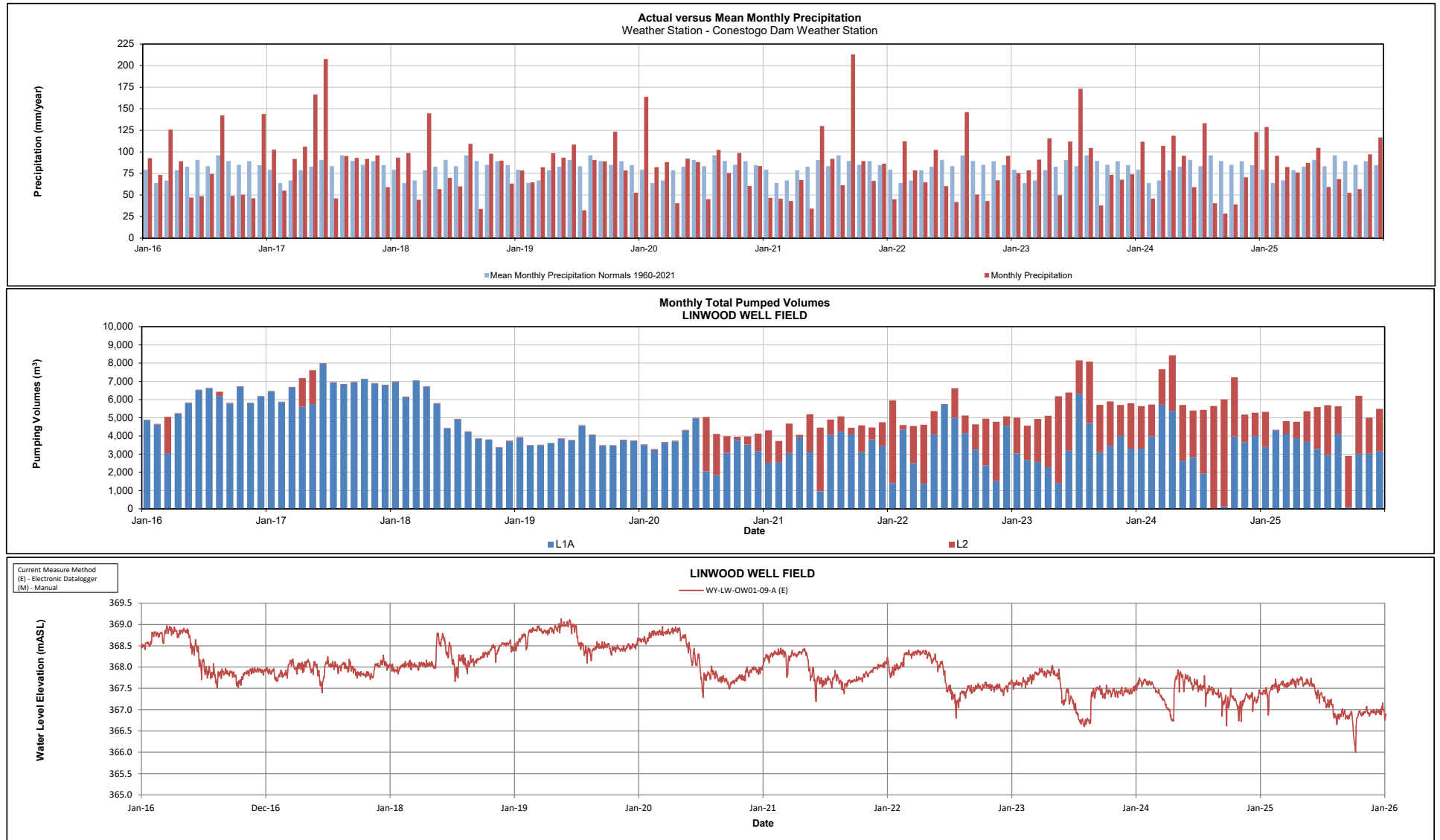
Monitoring Data (Pumped Volumes and Hydrographs)

TABLE C-1
WELL FIELD WATER PRODUCTION SUMMARY
REGION OF WATERLOO - 2025 GROUNDWATER MONITORING REPORT

Well Field	Major or Minor Supply	Production Well Name	Status	Permit to Take Water Details			2021 Production Summary			2022 Production Summary			2023 Production Summary			2024 Production Summary			2025 Production Summary		
				MOE Permit Number ¹	Permitted Capacity (total m ³ /year)*	Permitted Rate (L/s)*	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)
Linwood	Minor	L1A L2	Supply Supply	2680-B8HT58	382,111	12.1	38,976	107	1.2	40,320	110	1.3	40,070	110	1.3	37,571	103	1.2	38,981	107	1.2
				2680-B8HT58	382,111	12.1	15,698	43	0.5	21,716	59	0.7	31,477	86	1.0	35,744	98	1.1	22,140	61	0.7
				Well Field Total	382,111	12.1	54,674	150	1.7	62,036	170	2.0	71,547	196	2.3	73,315	201	2.3	61,121	167	1.9
				The maximum combined rate and maximum combined total daily amount taken shall be 727 L/min and 1,046,880 L/day.																	

Notes:
- = no applicable data
n/a = data not available
* = rates and volumes based on permitted L/day
¹ = Current Permit

REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
LINWOOD





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Appendix D

Precipitation Data

Table D-1
Precipitation Variation from Average
Region of Waterloo - 2025 Groundwater Monitoring Report

Year	Kitchener/Waterloo Weather Station Established 1966		
	Annual Precipitation (mm)	30-yr NORMAL Precipitation 1981-2010 (mm)	Difference (mm)
2016	748	851	-103
2017	818	851	-33
2018	749	851	-102
2019	695	851	-156
2020	689	851	-162
2021	772	851	-79
2022	438	851	-413
2023	813	851	-38
2024	874	851	23
2025	723	851	-128

Year	University of Waterloo Station Established 1988		
	Annual Precipitation (mm)	Average Precipitation 1998-2024 (mm)	Difference (mm)
2016	891	871	20
2017	989	871	118
2018	950	871	79
2019	923	871	52
2020	953	871	82
2021	1022	871	151
2022	578	871	-293
2023	959	871	88
2024	763	871	-108
2025	943	871	72

Year	Shand Dam Established 1939		
	Annual Precipitation (mm)	Average Precipitation 1940-2025 (mm)	Difference (mm)
2016	976	926	50
2017	1093	926	167
2018	849	926	-77
2019	1081	926	155
2020	1017	926	91
2021	876	926	-50
2022	798	926	-128
2023	1015	926	89
2024	994	926	68
2025	995	926	69

Year	Conestogo Dam Established 1961		
	Annual Precipitation (mm)	Average Precipitation 1961-2025 (mm)	Difference (mm)
2016	983	990	-7
2017	1210	990	220
2018	962	990	-28
2019	992	990	2
2020	1021	990	31
2021	975	990	-15
2022	907	990	-83
2023	1053	990	63
2024	972	990	-18
2025	1025	990	35

Year	Woolwich Dam Established 1960		
	Annual Precipitation (mm)	Average Precipitation 1960-2025 (mm)	Difference (mm)
2016	844	835	9
2017	986	835	151
2018	869	835	34
2019	824	835	-11
2020	862	835	27
2021	649	835	-186
2022	668	835	-167
2023	859	835	24
2024	793	835	-42
2025	732	835	-103

Year	Shade's Mills Dam Established 1960		
	Annual Precipitation (mm)	Average Precipitation 1960-2025 (mm)	Difference (mm)
2016	934	909	24
2017	1092	909	183
2018	1042	909	133
2019	1059	909	150
2020	848	909	-62
2021	1020	909	111
2022	682	909	-227
2023	982	909	73
2024	976	909	67
2025	895	909	-14

Year	Laurel Dam Established 1960		
	Annual Precipitation (mm)	Average Precipitation 1960-2025 (mm)	Difference (mm)
2016	985	938	47
2017	1062	938	124
2018	1071	938	133
2019	940	938	2
2020	938	938	0
2021	1027	938	89
2022	689	938	-249
2023	921	938	-17
2024	907	938	-31
2025	894	938	-44

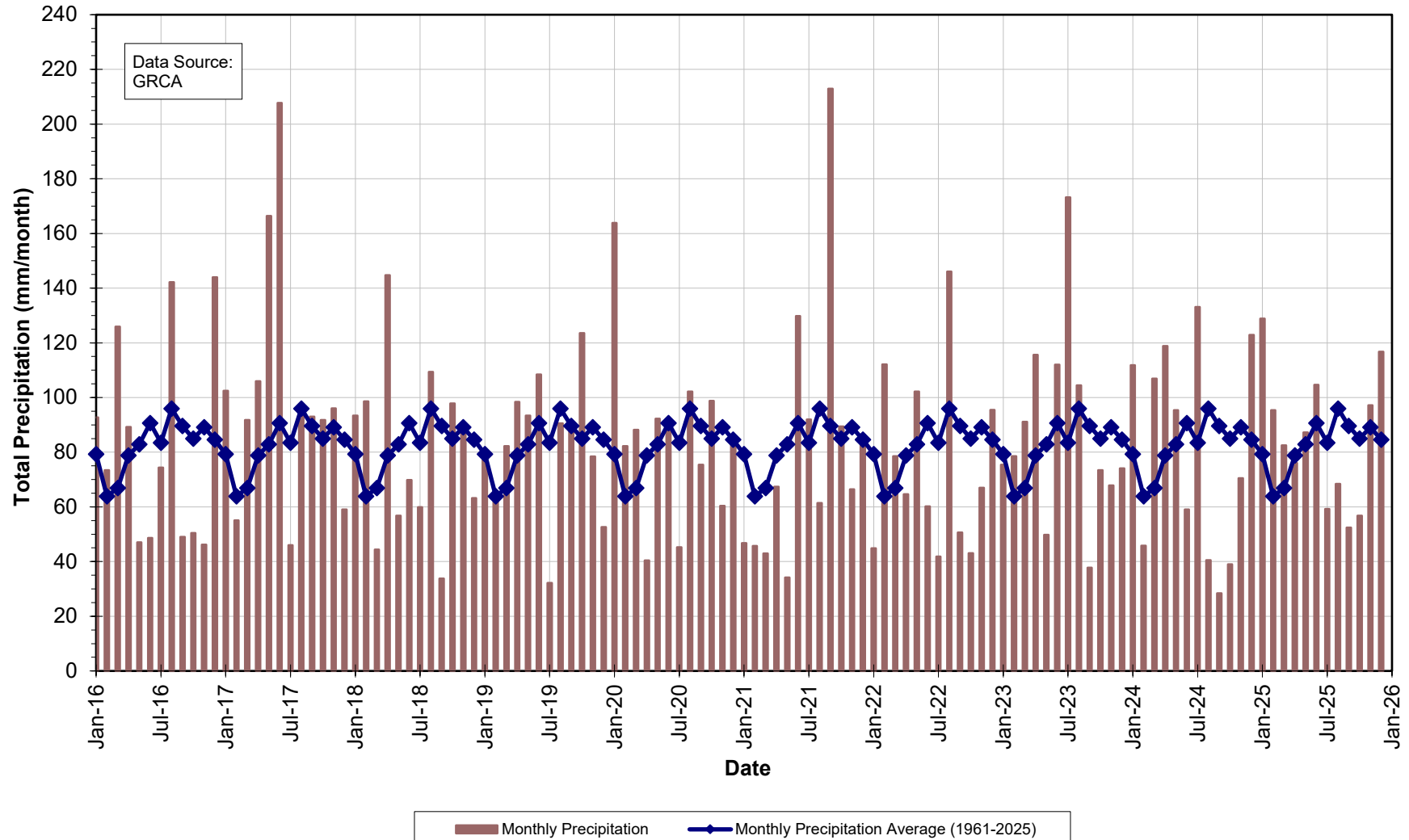
Year	Roseville Weather Station Established 1972		
	Annual Precipitation (mm)	30-yr NORMAL Precipitation 1981-2010 (mm)	Difference (mm)
2016	899	919	-20
2017	882	919	-37
2018	905	919	-14
2019	957	919	38
2020	817	919	-102
2021	832	919	-87
2022	637	919	-282
2023	945	919	26
2024	856	919	-63
2025	786	919	-133

NOTES:

WIA station data is not subject to review by the National Climate Archives, therefore, undergoes very limited quality checking.
 GRCA Dam stations data is not reviewed extensively and undergoes limited quality checking.

Region of Waterloo – 2025 Groundwater Monitoring Report

Figure D.1
Conestogo Dam
Monthly Precipitation





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Appendix E

Monitoring Program Overview

GROUNDWATER LEVEL MONITORING PROGRAM PROCEDURES

E.1 Overview

The Region of Waterloo (Region) collects water level measurements at specific monitoring wells to ensure sustainable long-term water supply and to meet monitoring and reporting requirements for the Region's water-taking permits. The goal of the program is to manage and protect the Region's groundwater supply and to assess the potential impact of municipal pumping on the groundwater and surface water resources in the Region. The ongoing collection and assessment of groundwater level data is integral to assess any changes to the water resources that may occur due to pumping.

E.1.1 Production Well Pumping and Water Levels

In 2023 the Region managed approximately 132 production wells with status defined as:

- Commissioned – Active wells
- New Not-Commissioned – Well are inactive or locked out until future demand or repairs/maintenance of other wells requires activating them

The well fields are referred to as Urban (Kitchener, Waterloo, and Cambridge) and Rural (North Dumfries, Woolwich, Wilmot, and Wellesley). Well fields in Kitchener, Waterloo, and Cambridge are referred to as the Integrated Urban System (IUS).

The Region's active production wells are monitored through the Region's SCADA (Supervisory Control and Data Acquisition) system, which reads and records the volume pumped on a daily basis. A few wells do not have their own meter but are combined with other nearby well(s) in the well field and the combined flow is divided into a record for each source. Water level measurements are obtained from the production wells where required. All manual measurements are obtained using either an air line or a water level tape.

E.1.2 Monitoring Wells and Surface Water levels

Water levels are measured at monitoring wells and at some surface water features. The objective of this monitoring is to collect data to ensure that the Region's water taking has minimal impact on the environment and on private water takers.

Water levels in the Region's monitoring wells are measured either electronically or manually. Most of the wells that are monitored electronically use datalogger equipment manufactured by *In-Situ Inc.*® LevelTROLLs® and RuggedTROLLs®, as well as, by *Van Essen Instruments (formerly Schlumberger Water Services)* Mini-Divers®, Micro-Divers®, and TD-Divers®; or by *Solinst*® Levelloggers®. The datalogger pressure sensor models used may be either vented (gauged) or non-vented (absolute) for *In-Situ Inc.*®; whereas, for *Van Essen Instruments* and for *Solinst*®, non-vented (absolute) models are used. Barometric dataloggers by each manufacturer suspended in select well locations are also used with the non-vented (absolute) models to provide the required barometric pressure compensation necessary in producing the water level data. Manual monitoring is done using a *Solinst*® and/or *Heron Instruments Inc.* electronic water level meter with both visual and audio indicators.

The electronically monitored wells are typically measured every hour, with increased frequency as required. At the hourly frequency, the following trends can be distinguished in an individual monitoring well:

- Seasonal climate trends;
- Water level changes in the aquifer that is being pumped;
- Water level changes in aquifers connected to the pumped aquifer; and
- Individual precipitation events in unconfined aquifers.

The manually monitored wells are measured once per month. At this frequency only the first three responses listed above can be distinguished.

E.1.3 Climatological Data

To evaluate the reaction of water levels to changes in climatic conditions, precipitation data are monitored at various locations throughout the Region. Within the Region of Waterloo, climate data is collected by Environment Canada at the Region of Waterloo International Airport (WIA) and the Roseville weather station, by the Grand River Conservation Authority (GRCA) at various Dam locations and by the University of Waterloo at a weather station located on the north campus.

E.2 Groundwater Level Collection Protocols

E.2.1 Groundwater Level Monitoring Network Summary Well Checklist

A well checklist and data entry spreadsheet are prepared of all the measuring points where water levels will be collected on a monthly basis. The checklist and spreadsheet are organized by well field so wells in close proximity are grouped together and indicates whether locations are measured with electronic dataloggers or manual measurements only. Once a well is visited, data is entered in the spreadsheet and the well is checked off the list; thus, the checklist and spreadsheet provides an obvious indication that work is unfinished if a location is unchecked and has no data.

E.2.2 Well Inspection

Upon visiting a well for the first time, the well/casing/equipment details are noted, photos taken, and GPS coordinates are recorded in a field book and/or in the monthly data entry spreadsheet. Well/casing/equipment details includes: location, access, condition, materials, diameters, casing security, surface seal condition, requiring repair or not, well/casing stickup measurements from ground level, well total depth, and the type of datalogger and/or sampling equipment installed. Any notable deficiencies, concerns, problems, or changes in the well condition are recorded in a field book and/or in the monthly data entry spreadsheet, as well as, photos are taken. Also, any observed activities taking place around or near the well that are worth noting are recorded in a field book and/or in the monthly data entry spreadsheet.

E.2.3 Monitoring Well Manual Water Level Measurement Procedure

- Unlock well casing and open well casing lid.
- Remove well cap (if present).
- Use an Electronic Water Level meter and lower the probe down the well until the meter beeps to indicate the probe has encountered water.
- The probe is raised up until the beep of the meter stops, indicating the probe is now above the water.
- Then the probe is slowly lowered down until the probe just contacts the water level surface causing the meter to beep.
- At this point the depth (in meters) is read off the water level meter tape from the measuring point of the well (in most cases is the top of the casing or pipe) and this provides the water level depth below the measuring point.
- The date, time, and water level depth measured is recorded in a field book and/or in the monthly data entry spreadsheet.
- This procedure is repeated for each of the well screens inside the well casing.

- Replace well caps.
- Close well casing lid and lock well casing.

E.2.4 Downloading of Water Levels from Electronic Dataloggers Procedure

For Non-Vented (Absolute) Datalogger Models:

In-Situ Inc.® LevelTROLLs® and RuggedTROLLs®, *Van Essen Instruments Divers*®, and *Solinst*® Leveloggers®

- Prior to downloading data from the datalogger, a manual water level is measured in each well screen containing a datalogger.
- The datalogger is pulled out of the well, unthreaded from the cap that is attached to a wire cable and connected to (or placed in) the corresponding datalogger communication device. The communication device is connected to a laptop/tablet PC or a RuggedReader® Handheld PC and the associated datalogger software is started.
- Water level data stored in the datalogger is subsequently downloaded and viewed using the datalogger software and saved on the hard drive/memory.
- Note: downloading data from the datalogger does not automatically stop the datalogger from recording.
- The status of the datalogger is viewed and checked for correct operation and to confirm that the datalogger is hanging in the well water within its operating range.
- Select datalogger details such as the battery level and free/used memory are recorded in a field book and/or in the monthly data entry spreadsheet.
- If the datalogger does not require restarting to free up memory or to change the sample rate, then the datalogger is removed from the communication device and is threaded back onto its cap and lowered back down the well on the wire cable.
- If the datalogger does require restarting to free up memory or to change the sample rate, then the datalogger is stopped, reprogrammed, and restarted using the datalogger software and, as a result, erases the previous data stored in memory on the datalogger.
- This procedure is repeated for each datalogger within each of the well screens inside the well casing.
- After all the non-vented (absolute) dataloggers have been downloaded then the Barometric dataloggers are downloaded following the same procedure as above.

For Vented (Gauged) Datalogger Models:*In-Situ Inc.*® LevelTROLLs®

- Prior to downloading data from the datalogger, a manual water level is measured in each well screen containing a datalogger.
- The desiccant tube is disconnected from the datalogger cable.
- The datalogger cable is connected to a communication cable device that is connected to a laptop/tablet PC or a RuggedReader® Handheld PC and the datalogger software is started.
- Water level data stored in the datalogger is subsequently downloaded and viewed using the datalogger software and saved on the hard drive/memory.
- Note: downloading data from the datalogger does not automatically stop the datalogger from recording.
- The status of the datalogger is viewed and checked for correct operation and to confirm that the datalogger is hanging in the well water within its operating range.
- Select datalogger details such as the battery level, free/used memory, and desiccant condition (colour) are recorded in a field book and/or in the monthly data entry spreadsheet.
- The desiccant tube condition is checked and replaced if necessary.
- If the datalogger does not require restarting to free up memory or to change the sample rate, then the communication cable device is disconnected from the datalogger cable and the desiccant tube is reconnected.
- If the datalogger does require restarting to free up memory or to change the sample rate, then the datalogger is stopped, reprogrammed, and restarted using the datalogger software and, as a result, erases the previous data stored in memory on the datalogger.
- This procedure is repeated for each datalogger within each of the well screens inside the well casing.

E.2.5 Data Entry and Processing into the Burnside MS ACCESS/SQL® Database

- All field data collected (i.e. date, time, manual water level depth measured, comments) and recorded for each well screen and datalogger in a field book is entered into the monthly data entry spreadsheet, unless already entered in the field using a laptop/tablet PC.
- The monthly data entry spreadsheet is checked and reviewed prior to importing the data into a database table using Burnside Water Level Data Tools software. Manual water level depth values are converted into water level elevation values using the software during this import process.
- Any associated well notes, comments, and datalogger details are entered into a database table under the appropriate well and screen.

- Water level data from the dataloggers downloaded to a laptop/tablet PC or a RuggedReader® Handheld PC are transferred to Burnside file folder network upon returning to the office.
- These datalogger water level data files are subsequently read and the data is imported into a database table using Burnside Water Level Data Tools software.
- Using Burnside Water Level Data Tools software, the datalogger water level data are reviewed and processed (as described below) resulting in corrected water level depth values and corrected water level elevation values that are stored in a database table.
- *For Non-Vented (Absolute) Datalogger Models:*
Datalogger water level data is first barometric pressure compensated using selected Barometric datalogger data, then a manual water level depth value measured at the time of the most recent download is applied and used to convert the barometric compensated water level data into corrected water level depth values, which are converted into water level elevation values that are appended to a database table.
- *For Vented (Gauged) Datalogger Models:*
A manual water level depth value measured at the time of the most recent download is applied to the datalogger water level data to convert the water level data into corrected water level depth values, which are converted into water level elevation values that are appended to a database table.
- Temperature data recorded by the dataloggers are also imported into a database table.
- Hydrographs are subsequently created for each well and screen from the water level elevation data in the database for review and presentation. If there are some data points that are erroneous, then these data points are marked as non-reportable (invalid) within the database and/or are removed resulting in them not being plotted on the hydrographs.
- An updated data file is provided to the Region on a quarterly basis for upload into their eWRAS EQUIS database.

