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**2025 Biennial Groundwater Monitoring
Report - New Hamburg Well Field
(NH3, NH4)**

The Region of Waterloo



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Report - New Hamburg Well Field
(NH3, NH4)**

The Region of Waterloo

**R.J. Burnside & Associates Limited
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R.J. Burnside & Associates Limited

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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) for the New Hamburg Well Field (PTTW 7021-AQRK39) 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 New Hamburg Well Field is shown in Figure 1 and the production wells in Wilmot Township are shown in Figure 2 with the monitoring network for NH3 and NH4 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 Permits to Take Water (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 the New Hamburg Well Field in accordance with PTTW 7021-AQRK39 which consists of the following activities:

- Measuring the daily volume pumped from the NH3 and NH4 production wells (Condition 4.1 of the PTTW);
- Measuring the water levels in monitoring wells WT-NH-OW01-09-A, WT-NH-OW5-95-AB and WT-NH-TW6-95-AB (Condition 4.2 of the PTTW);
- Review of precipitation data from the nearest GRCA / Environment Canada weather station; 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 New Hamburg Well Field is located in the southwest portion of Wilmot Township. Wells NH3 and NH4 are located to the south of the Village of New Hamburg. The closest municipal well fields are Foxboro Green, Baden (inactive) and Wilmot Centre, located about 5 km to the north, 6 km northeast, and 7 km east respectively (Figure 2). The closest surface water feature to the NH3 and NH4 site is the the Nith River located approximately 300 m north of NH3 and NH4 (Figure 3).

2.1.1 Pumping Wells

The New Hamburg Well Field consists of two wells (NH3 and NH4). Well records for the production wells are found in Appendix B. NH3 was constructed in 1995 and connected to the system in 1997. NH3 was rehabilitated in 2012 and in 2013 a 254 mm stainless steel liner was grouted into place to secure the well casing (Golder, 2017). NH4 was connected to the municipal system in 2019 and is used as a secondary supply well to NH3. Both wells obtain water from dolostone of the Salina Formation Bedrock Aquifer, which is the uppermost bedrock formation in this area.

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
NH3	1995	300	300	57.6 – 76.2	Salina Formation
NH4	2019	254	241	57.8 – 62.5	Salina Formation

The water taking volumes for the New Hamburg 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

Well	PTTW	2024			2025		
		Avg. Daily Water	Max Taken	Total Volume	Avg. Daily Water	Max Taken	Total Volume
	Permitted Max. Daily						

Well	PTTW	2024			2025		
		Taking (m ³)	per Day (m ³)	Pumped (m ³)	Taking (m ³)	per Day (m ³)	Pumped (m ³)
NH3	3,543	1,222	2,363	445,877	806	2,872	294,101
NH4	3,543	623	1,988	227,288	1,053	2,572	384,329
Total	3,543	1,844	2,363	673,165	1,859	2,872	678,430

Condition 3.3 of the PTTW specifies that the combined total daily water taking from the well field must not exceed a daily average of 3,543 m³/day. As shown in Table 2, this requirement was met in both 2024 and 2025.

The Region of Waterloo's SCADA system records total daily water taking volumes including the dates and times of water takings, the rates of pumping, and calculations of the total amounts of water pumped per day for each supply well, which complies with condition 4.1 of the PTTW.

Pumping volumes from the well field ranged from 50,042 m³/month to 61,294 m³/month in 2024, and from 48,170 m³/month to 62,938 m³/month in 2025. In total, 673,165 m³ was produced at this well field in 2024 and 678,430 m³ was produced in 2025. These volumes are higher than volumes pumped in the previous five years and well below the permitted volume of 1,293,195 m³ per year (Table C-1).

2.1.2 Monitoring Wells

The Region updated their well naming protocol in 2017 and as a result, the well names in EQulS may vary from the names listed on the PTTW. The well names on the PTTW are shown below along with the updated name that is used by the Region. The updated Region names 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
WT-NH-OW01-09	WT-NH-OW01-09-A
WT-NH-TW5A-95	WT-NH-OW5-95-A
WT-NH-TW5B-95	WT-NH-OW5-95-B
WT-NH-TW6A-95	WT-NH-TW6-95-A
WT-NH-TW6B-95	WT-NH-TW6-95-B

Construction and monitoring details of WT-NH-OW01-09-A, WT-NH-OW5-95-AB and WT-NH-TW6-95-AB are described in the table below. Well records for the monitoring wells are provided in Appendix B and the locations of the observation wells are shown in Figure 3.

Table 4: Monitoring Well Construction Details

Monitoring Well ID	Year Built	Screened Depth (mbgs)	Screened Formation	Approx. Distance to NH3 / NH4 (m)
WT-NH-OW01-09-A	2009	19.8 – 22.8	AFD1	300
WT-NH-OW5-95-A	1995	64 - 67	Salina	800
WT-NH-OW5-95-B	1995	49 - 52	Salina	800
WT-NH-TW6-95-A	1995	73.8 – 76.8	Salina	10
WT-NH-TW6-95-B	1995	63.4 – 66.4	Salina	10

2.2 Regional Geology and Hydrostratigraphy

The surficial geology based on regional OGS mapping is provided in Figure 4. Representative cross-sections showing stratigraphy in the vicinity of the New Hamburg Well Field 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 New Hamburg Well Field. 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 of the Study Area has been mapped and described by the Ontario Geological Survey (2003) and updated in Bajc and Shirota (2007). The village of New Hamburg is located about 6 km west of Waterloo Moraine and just to the southeast of the Macton Moraine as shown in Karrow (1993). 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 east edge of the moraine is found just west of New Hamburg. The surficial geology of the New Hamburg Well Field is characterized primarily by glaciolacustrine derived silty to clayey till sediments (Figure 4). Modern Alluvial deposits are present north of the well field along the Nith River.

The Quaternary units typically present in the vicinity of the New Hamburg Well Field area are briefly described below, in order from youngest to oldest.

Aquifer AFA1 - Whittlesey Sand

This very fine to coarse sand unit is interpreted as glaciolacustrine Whittlesey sand (Bajc and Shirota, 2007). AFA1 is continuous aquifer that facilitates groundwater flow within the upper overburden sequence. The unit was not identified in the borehole logs.

Aquitard ATB1 – Maryhill Till

This unit consists of low permeability, spatially discontinuous surficial till units. In the vicinity of New Hamburg this unit corresponds to the Upper Maryhill and Port Stanley Tills (Bajc and Shirota, 2007). The approximate boundary between the Upper Maryhill and Port Stanley Tills is generally considered along Highway 7/8. The unit is considered an aquitard and, where present, acts to restrict recharge to the lower aquifers.

Perched Aquifer - AFA2

Outwash deposits consisting of well bedded sands and gravels restricted to the valleys of the Conestogo, Grand, Nith and Speed Rivers.

Aquifer AFB1 – Upper Waterloo Moraine Stratified Sediments and Equivalents

Aquifer AFB1 can vary from a layered silt and fine sand to coarse sand and gravel (Unit 6 on Figure 4). Throughout the core areas of the Moraine, AFB1 corresponds to a thick, laterally extensive sand and / or gravel aquifer overlying ATB3. Along the flanks of the Moraine, AFB1 generally thins as the ground surface elevation decreases and approaches ATB3.

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.

Aquitard ATC1 / ATC2 – Catfish Creek Till

The Catfish Creek Till was deposited by a major glacial advance from the north to northeast that covered all of southern Ontario. 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. Bajc and Shirota (2007) divided this unit into an upper (ATC1) and lower aquitard (ATC2), with an aquifer (AFC1) found occasionally between the two units. The texture of this unit is stony, silty to sandy till.

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 Till and represents the main supply aquifer in several production wells in the Cities of Kitchener and Waterloo.

Aquitard ATE1 – Pre-Catfish Creek Till and Canning Drift

This unit is found primarily in the central, northern and western areas of the Region, and along the Nith River in the west and southwest. 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 can be quite thin (<5 m) or discontinuous. 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

Bedrock in the area is comprised of interbedded grey and brown dolostone of the Salina Formation. Interbeds of green and red shale and gypsum are common. The Salina Formation is underlain by the Bass Islands Formation to the west. The bedrock surface is generally flat with a gentle dip to the southwest.

2.3 Local Geology

The following description of local geology is based on drilling investigations for the installation of the production well NH3 (Terraqua Investigation Ltd, 1995b), the borehole log for WT-NH-OW01-09-A (Appendix B) and the PTTW renewal for NH4 (Golder, 2017). Borehole logs for the New Hamburg Well Field are included in Appendix B.

Maryhill Till (ATB1) – This unit was identified at surface at NH3 and NH4 and is described as silty clay and clay sandy silt. Where present, it ranges in thickness from 12.2 m to 18.9 m. This unit is absent at WT-NH-OW01-09-A, which is located approximately 300 m north of the production wells.

Perched Aquifer (AFA2) - This unit is described as a clayey silt to medium to fine sand in the log for WT-NH-OW01-09-A extending from surface to 5.1 mbgs. The unit was not identified at the production wells.

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Catfish Creek Till (ATC1 / ATC2) – This unit was identified underlying ATB1 at NH3 and NH4, and underlying AFA2 at WT-NH-OW01-09-A. It is described as silty fine sand to silt and clayey silt till and is between 11.2 m to 36.6 m in thickness.

Pre- Catfish Creek Sand and Gravel (AFD1) – This unit is identified underlying ATC1 / ATC2 in the log for WT-NH-OW01-09-A, and is described as sand, gravel and cobbles. It extends from 16.3 mbgs to 22.86 mbgs, or 6.56 m thick. The unit is not differentiated from ATC1 / ATC2 in the logs for NH3 and NH4.

Canning Drift (ATE1/ATG1) – This unit was identified as a layer of sandy silt and gravel till overlying the bedrock. The layer was 0.6 m thick at NH3 and 7 m at NH4. At WT-NH-OW01-09-A it was described as clayey silt with a thickness of 1.4 m.

Bedrock – Bedrock was encountered at 55 mbgs at NH3 and NH4. The bedrock is comprised of interbedded grey and brown dolostone and is the production aquifer for NH3 and NH4.

3.0 2024 / 2025 Results

The following sections summarize groundwater levels at monitoring wells in relation to precipitation and water taking from the aquifer (in accordance with condition 4.3 of the PTTW).

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, University of Waterloo (U of W) or Environment Canada station located closest to the production wells are used. The closest GRCA weather station relative to the New Hamburg well field is Laurel Creek station located 16.5 km from the well field. The closest Environment Canada station is the Roseville station (19.5 km southeast of the well field). 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 all GRCA locations, the long-term average was calculated from when measurements started until the end of 2025. The Roseville station has “Climate Normals” calculated by Environment Canada for 1971 to 2000.

Annual 2024 / 2025 precipitation data for the closest meteorological stations are presented in Table 5 below. In 2024 Roseville was missing 5 days of data and 20 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)
Laurel Dam ⁽¹⁾	907	-31	938 ^A	894	-44
Roseville Station ⁽²⁾	856	-63	919 ^B	786	-133
Sources: GRCA (1), Environment Canada (2)					
^Average annual precipitation since monitoring began to the end of 2025, ^B 1991 to 2020 Normal					

Water levels typically follow a seasonal trend with highest levels occurring in the spring following the snowmelt and 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.

The Laurel Dam weather station is the closest station to the New Hamburg Well Field. Monthly precipitation data for the past 10 years at Laurel Dam are shown on Figure D.1 in Appendix D. The total precipitation measured in 2024 at the Laurel Dam weather station was 907 mm, which is 31 mm below the long-term average. A similar below long-term average trend is noted at the Roseville 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 Laurel Dam weather station was 894 mm which is 44 mm below the long-term average. Similarly, the total precipitation at the Roseville station was 133 mm below the long-term average, indicating 2025 was a drier than average year. 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 at each monitoring well over the past 10 years are provided in Appendix C. The method used to collect the water levels (manual or electronic) is indicated on the graphs in Appendix C.

WT-NH-OW01-09-A

Monitoring well WT-NH-OW01-09-A is completed in a gravel layer (AFD1) with a screened interval between 19.8 and 22.8 mbgs. Water levels are collected electronically using an automatic water level meter. Water levels in 2024 / 2025 were within historical ranges. Water levels generally fluctuate within a seasonal 2 m range with the lowest water levels seen during the summer months and the highest levels in the spring and

winter. The water levels at this well respond to individual precipitation events and spring melt events.

WT-NH-TW6-95-AB

WT-NH-TW6-95-AB is located adjacent to production wells NH3 and NH4 and monitors two intervals in the Salina Formation. Both intervals are completed within the open hole elevation interval of NH3 and above the open hole elevation interval of NH4. It should be noted that the main fracture zones observed at production well NH3 were not observed at WT-NH-TW6-95 (Terraqua, 1995b). Monthly manual water level measurements are collected at WT-NH-TW6-95-AB. Water levels in 2024 / 2025 were within historical ranges.

Both wells show similar water level trends; however, the water levels in the A screen fluctuate within a 1.5 m range, whereas the B screen levels vary within a 4 m range. Water levels at both wells respond to pumping at NH3 / NH4 but do not show any long term declines in water levels as a result of pumping. Spikes in levels shown on the graph are likely the result of measurements taken when no pumping was occurring.

WT-NH-OW5-95-AB

Monitoring well nest WT-NH-OW5-95 is located approximately 800 m east of NH3 / NH4 and manual water level measurements are collected monthly. The wells monitor two levels in the Salina Formation within the same elevation interval as the open hole portion of NH3. Water levels in 2024 / 2025 were within historical ranges.

Trends at these wells are similar to WT-NH-TW6-95-AB showing a response to pumping of NH3 / NH4 with the greatest water level fluctuations observed in the B screen in response to changes in pumping. Water levels do not show any long term declines as a result of pumping.

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."

PTTW Condition 5.2 states: "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."

Most of the Village of New Hamburg is municipally serviced for water, however there are some private wells still in use in the local vicinity of the New Hamburg Well Field. When 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). There were no well interference complaints related to pumping of NH3 and NH4 received in 2024 and 2025.

A review of the MECP PTTW database did not identify any registered water takings within 2 km of the wellfield (Figure 3).

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 30. The report shall present 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)".

Monitoring wells completed in the bedrock aquifer respond to pumping of NH3 and NH4. Stable water levels indicate there are no long-term impacts observed in the bedrock aquifer as a result from pumping at the production wells.

Seasonal fluctuations in AFD1 at WT-NH-OW01-09-A are observed with the highest and lowest levels observed in spring and late summer / fall, respectively. The water levels at this well respond to individual precipitation events and spring melt events.

5.0 Conclusions

Impacts from pumping the municipal wells at the New Hamburg Well Field (NH3, NH4) 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 7021-AQRK39;

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- 2024 and 2025 pumping volumes were within the permitted range;
- There were no reported well interference complaints arising from water taking at the New Hamburg well field; and
- Water levels in the monitoring wells have been stable for the past 10 years indicating that current pumping rates have not caused any adverse long-term impacts to water levels in the aquifer.

6.0 References

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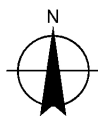
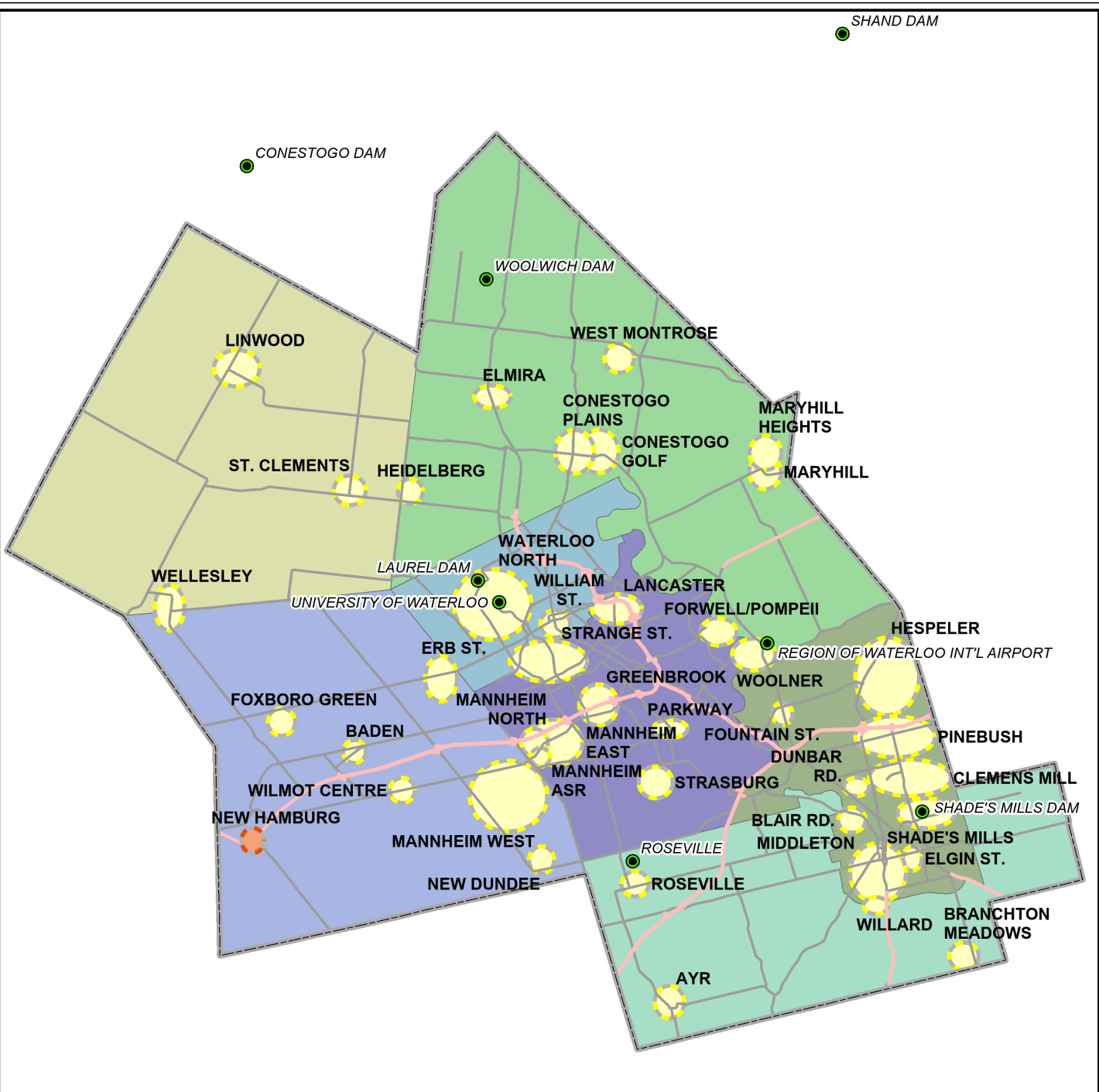


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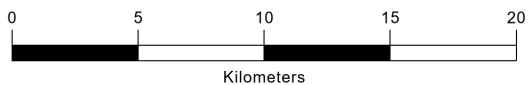
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Figures



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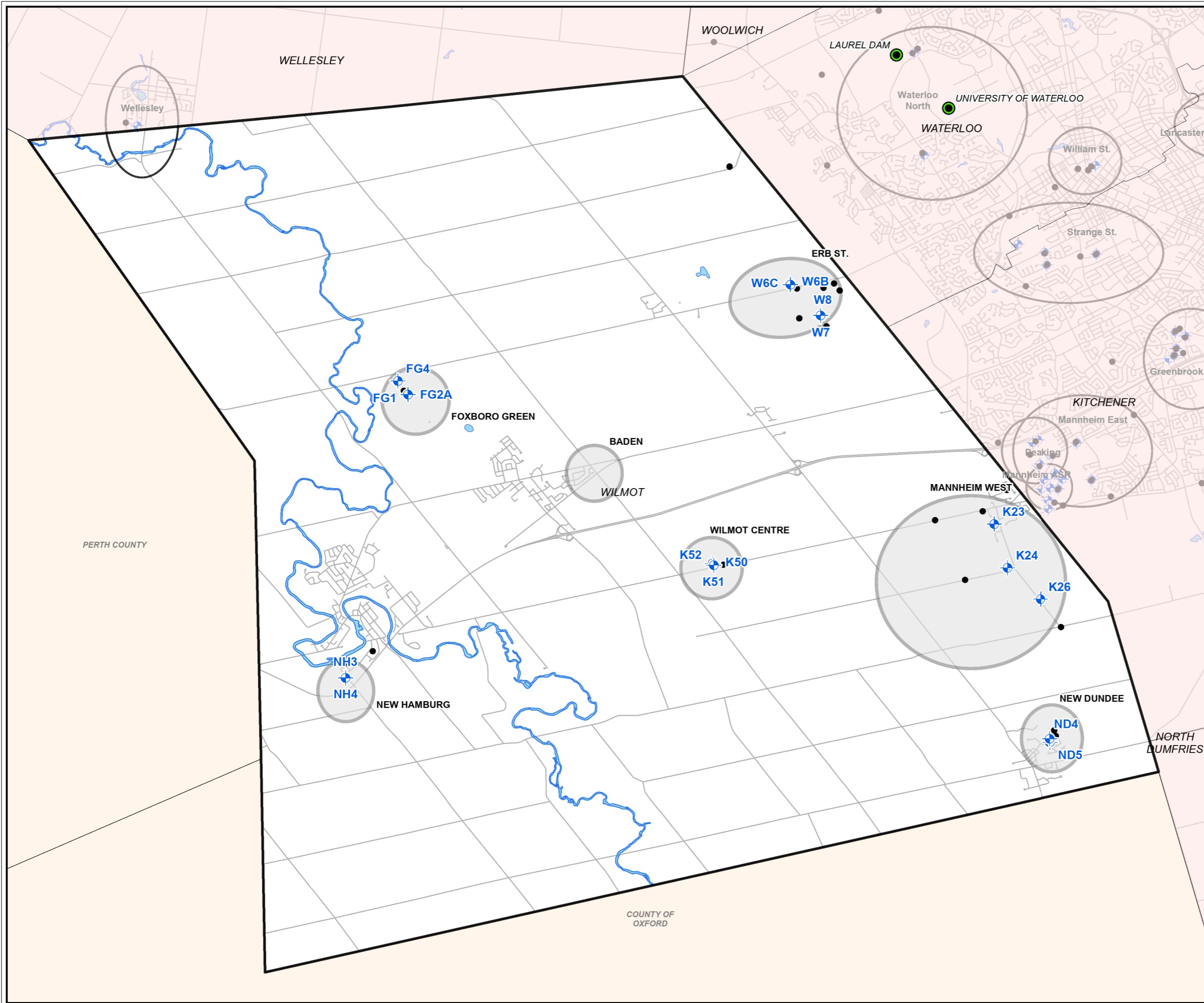
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- Well Fields
- Regional Municipal Boundaries
- City of Cambridge
- City of Kitchener
- City of Waterloo
- Township of North Dumfries
- Township of Wellesley
- Township of Wilmot
- Township of Woolwich
- Meteorological Monitoring Locations



Map Title
**2025 GROUNDWATER MONITORING REPORT -
NEW HAMBURG WELL FIELD**
WELL FIELD LOCATION MAP

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Drawn	Checked	Date	Figure No. 1
HN	SQ	February 2026	
Scale	Project No.		
1:300,000		HA0464020	



LEGEND

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

Sources:

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

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

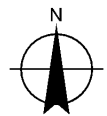
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REGION OF WATERLOO

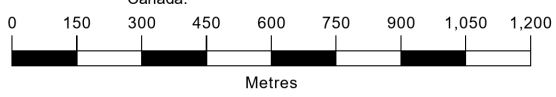
Figure Title

2025 GROUNDWATER MONITORING REPORT - NEW HAMBURG WELL FIELD
WILMOT WELL FIELDS AND MONITORING NETWORK

Drawn	Checked	Date	Figure No.
HN	SQ	March 2026	2
Scale	Project No.		
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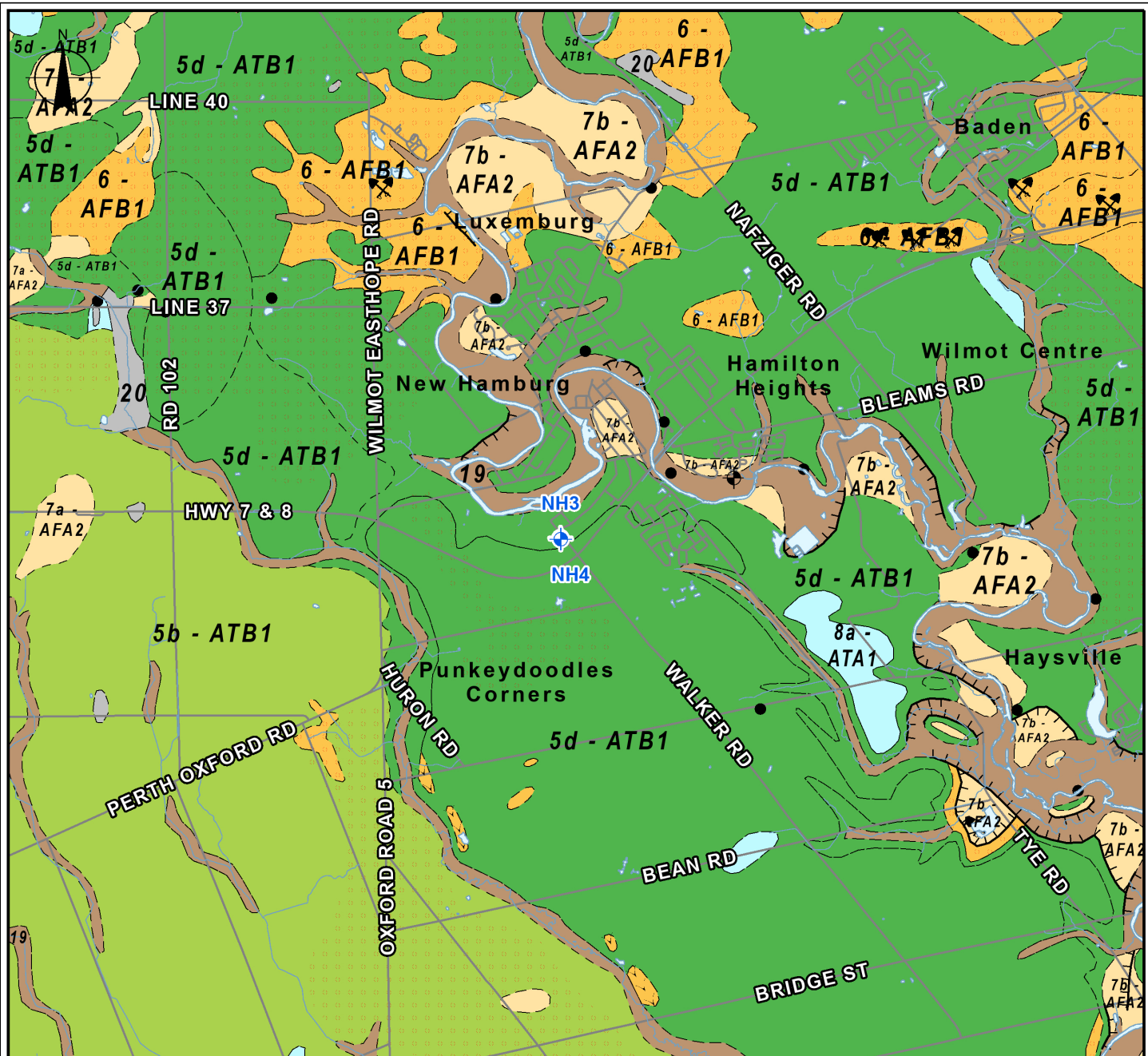
- PTTW Monitoring Well Location
- Production Well Location
- Nearby Monitoring Well Location
- Decommissioned Production Well Location
- Cross Section Orientation
- Intermittent Creek
- Creek
- Waterbody
- Provincial Highway
- Regional Road
- Local Road
- Private / Other Road



Map Title
**2025 GROUNDWATER MONITORING
 REPORT - NEW HAMBURG WELL FIELD**
 WELL LOCATION MAP

Client
REGION OF WATERLOO

Drawn	Checked	Date	Figure No. 3
HN	SQ	March 2026	
Scale		Project No.	
1:17,500		HA0464020	



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



- | | |
|--|--|
| <ul style="list-style-type: none"> Rmow Supply Well Watercourse Waterbody <p>Surficial Geology</p> <ul style="list-style-type: none"> 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 | <ul style="list-style-type: none"> Hummocky Topography Unit Contact Boundary |
|--|--|
- | |
|---|
| <ul style="list-style-type: none"> 20: Organic deposits Sand and Gravel Pit Esker: Direction of Flow Known Terrace Drill Hole Sample Location |
|---|



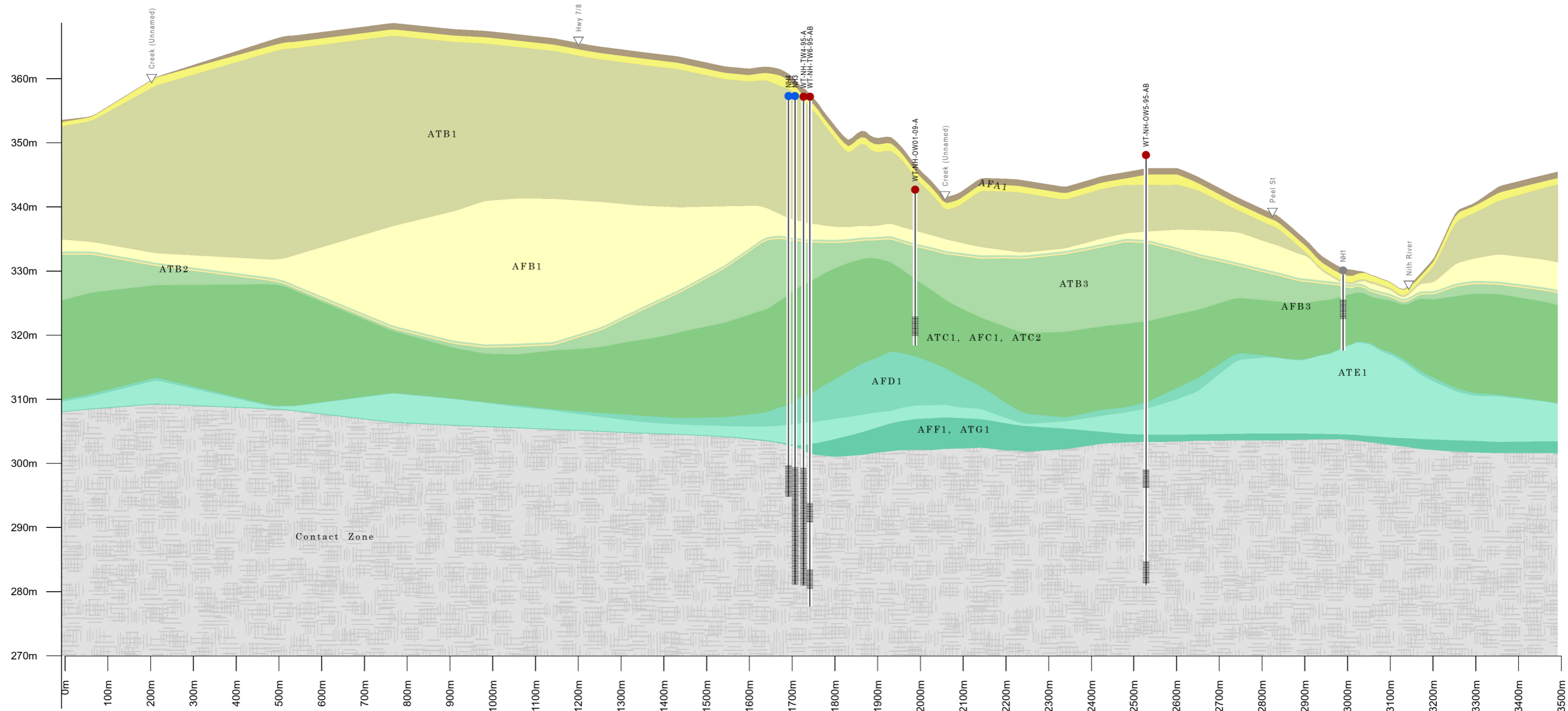
Map Title
2025 GROUNDWATER MONITORING REPORT - NEW HAMBURG WELL FIELD
 SURFICIAL GEOLOGY

Client
REGION OF WATERLOO

Drawn	Checked	Date	Figure No. 4
HN	SQ	February 2026	
Scale	Project No.		
1:60,000	HA0464020		

A

A'

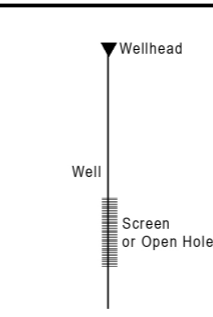


Wells

- Production Well (Active)
- Production Well (Decommissioned)
- 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)	



BURNSIDE

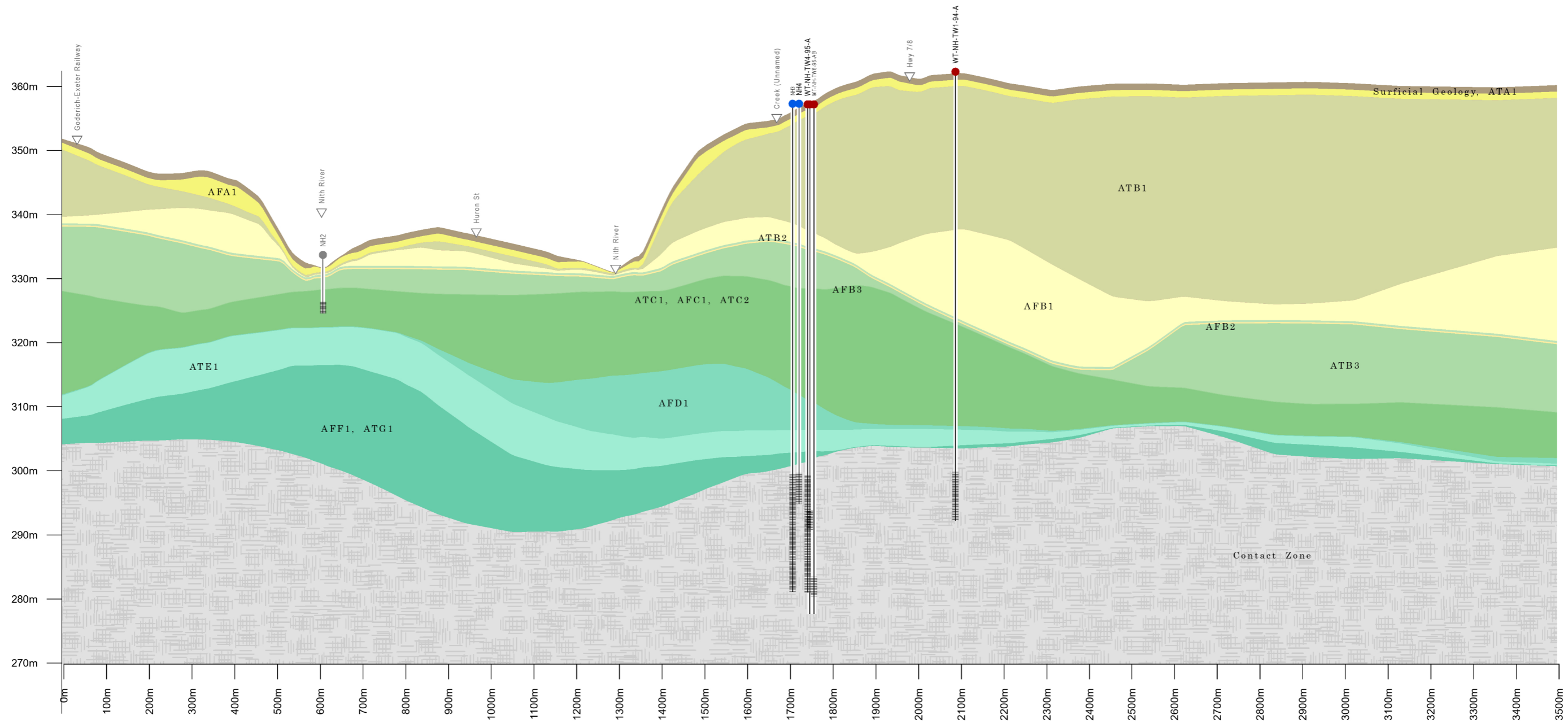
Client

REGION OF WATERLOO

Figure Title				Figure No.
GEOLOGIC CROSS SECTION REGION OF WATERLOO				
New Hamburg Cross Section A - A'				
Drawn	Checked	Date	Project No.	5
PS	DH	2026/06/02		
Horizontal Scale 1:10,000		HA046402		
Vertical Ex.:15x				

B

B'

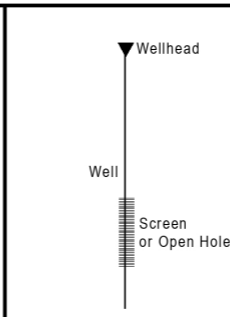


Wells

- Production Well (Active)
- Production Well (Decommissioned)
- 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)	



BURNSIDE

Client
REGION OF WATERLOO

Figure Title GEOLOGIC CROSS SECTION REGION OF WATERLOO New Hamburg Cross Section B - B'			
Drawn PS	Checked DH	Date 2026/06/02	Figure No. 6
Horizontal Scale 1:10,000		Project No. HA046402	
Vertical Ex.:15x			



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Appendix A

Permit To Take Water

Appendix A

AMENDED PERMIT TO TAKE WATERGround Water
NUMBER 7021-AQRK39

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 7th Floor
Kitchener, Ontario, N2G 4J3

For the water taking from: Municipal Well NH3 (WWR #6507832)
Municipal Well NH4 (WWR #7273187)

Located at: Lot 25, Concession GERMAN BLOCK SOUTH OF BLEEMS ROAD, Geographic Township of Wilmot
Wilmot, 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 and Climate Change.
- (d) "District Office" means the Guelph District Office.
- (e) "Permit" means this Permit to Take Water No. 7021-AQRK39 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 August 8, 2017 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 **May 31, 2027**. 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	NH3 - 6507832	Well Drilled	Municipal	Water Supply	2,460	24	3,543,000	365	17 523181 4801555
2	NH4 - 7273187	Well Drilled	Municipal	Water Supply	2,460	24	3,543,000	365	17 523185 4801566
							Total Taking:	3,543,000	

3.3 Notwithstanding the Maximum Taken per Day specified in the Table A of Condition 3.2, the Taking from the well field (in any combination of the listed two wells) shall not exceed a daily average of 3,543,000 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 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 wells:

WT-NH-OW01-09
WT-NH-TW5A-95
WT-NH-TW5B-95
WT-NH-TW6A-95
WT-NH-TW6B-95

4.3 The Permit Holder shall prepare and submit a report every two years by June 30th commencing June 30, 2018, 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.

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
Email: ERTTribunalsecretary@ontario.ca*

AND

*The Director, Section 34.1, Ministry of the
Environment and Climate Change
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:

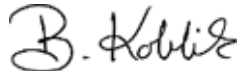
by Telephone at
(416) 212-6349
Toll Free 1(866) 448-2248

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 8556-8M5QAL, issued on 2011/11/29.

Dated at Hamilton this 7th day of September, 2017.



Belinda Koblik
Director, Section 34.1
Ontario Water Resources Act , R.S.O. 1990

Schedule A

This Schedule "A" forms part of Permit To Take Water 7021-AQRK39, dated September 7, 2017.

Report by Golder Associates Ltd. dated May 30, 2017, titled "Scientific Study in Support of a PTTW Renewal, 2017 Municipal Well Construction and Testing, New Hamburg NH4 Site" signed by Gregory Padusenko, M.Sc., P.Geol. and George Schneider, M.Sc., P.Geol.



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Appendix B

Well Records

**TERRAQUA INVESTIGATIONS LTD.
HYDROGEOLOGY SPECIALISTS**

BOREHOLE NO.: NH3

PROJECT : Baden-New Hamburg Contingency Plan
 PROJECT NO.: TA459A
 LOCATION: Twsp. Rd 11A, N. of Hwy. 7&8
 DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
 DRILLING METHOD: Mud Rotary

DATE: August 8-18, 1995
 SUPERVISOR: C. Johnston
 GEOGRAPHIC INFORMATION: (Source)
 UTM COORDINATES: 523160 4801335 (1:10,000)
 GROUND ELEVATION: 356 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES			PRODUCTION WELL CONSTRUCTION
	ft	m		#	type	interval	
	0	0	356				
SILTY CLAY: possible till, trace of gravel, brown		2		GS	1.5 m		<p>356.4 m</p> <p>324 mm O.D. STEEL CASING</p> <p>445 mm DIA. BOREHOLE</p> <p>CEMENT-BENTONITE GROUT</p>
	10	4					
	20	6		GS	1.5 m		
		8					
	30	10					
		12	345.0	GS	1.5 m		
	40	14					
		16		GS	1.5 m		
	50	18					
	60	20	337.1	GS	1.5 m		
CLAYEY SANDY SILT: possible till, occasional F-M sand and clay seams		22		GS	1.5 m		
		24					
	80	26					
		28		GS	1.5 m		
	90	30					
		32					
	100			GS	1.5 m		
	110						
	SILTY FINE SAND: occasional fine to medium sand and silt seams, brown to grey						

**TERRAQUA INVESTIGATIONS LTD.
HYDROGEOLOGY SPECIALISTS**

BOREHOLE NO.: NH3

2 of 3

PROJECT : Baden-New Hamburg Contingency Plan
 PROJECT NO.: TA459A
 LOCATION: Twsp. Rd 11A, N. of Hwy. 7&8
 DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
 DRILLING METHOD: Mud Rotary

DATE: August 8-18, 1995
 SUPERVISOR: C. Johnston
 GEOGRAPHIC INFORMATION: (Source)
 UTM COORDINATES: 523160 4801335 (1:10,000)
 GROUND ELEVATION: 356 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES				PRODUCTION WELL CONSTRUCTION	
	ft	m		#	type	interval	rec		
SILTY FINE SAND: occasional fine to medium sand and silt seams, brown to grey		34							
		36							
	120			GS	X	1.5 m			
		38							
		40							
	130								
		42							
		44		GS	X	1.5 m			
	140								
		46							
	48								
	50		GS	X	1.5 m				
	52								
	54		GS	X	1.5 m				
	56	301.1 300.5							
SANDY SILT AND GRAVEL: possible sandy silt gravel till,		58		GS	X	1.5 m			
	60			GS	X	1.5 m			
DOLOSTONE BEDROCK: Brown to grey dolostone, changing to buff dolostone @ 58.5 m. Below 74.5 m brown dolostone		62		GS	X	1.5 m			
Fracture @ 57.9 - 58.2 m (produced approx. 7.5 L/s of very dirty water)		64		GS	X	1.5 m			
Fracture @ 60.4 - 61.6 m		66		GS	X	1.5 m			
Fracture @ 62.2 - 62.8 m	210			GS	X	1.5 m			
Fracture @ 64.3 - 64.9 m				GS	X	1.5 m			
	220								

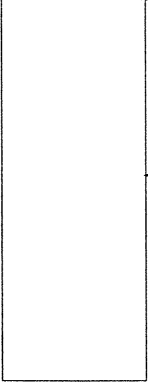
**TERRAQUA INVESTIGATIONS LTD.
HYDROGEOLOGY SPECIALISTS**

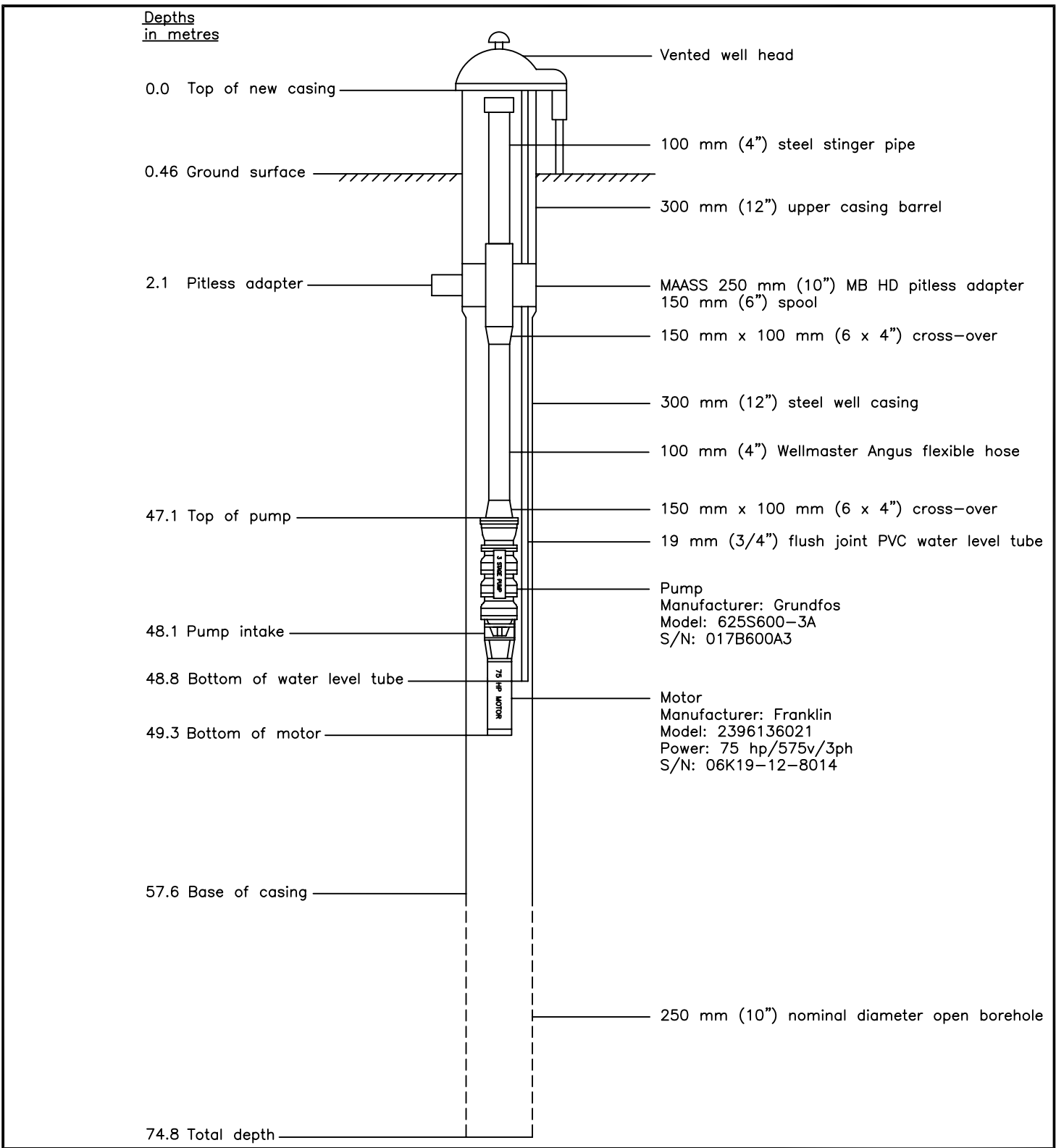
BOREHOLE NO.: NH3

3 of 3

PROJECT : Baden-New Hamburg Contingency Plan
 PROJECT NO.: TA459A
 LOCATION: Twsp. Rd 11A, N. of Hwy. 7&8
 DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
 DRILLING METHOD: Mud Rotary

DATE: August 8-18, 1995
 SUPERVISOR: C. Johnston
 GEOGRAPHIC INFORMATION: (Source)
 UTM COORDINATES: 523160 4801335 (1:10,000)
 GROUND ELEVATION: 356 m AMSL (1:10,000)

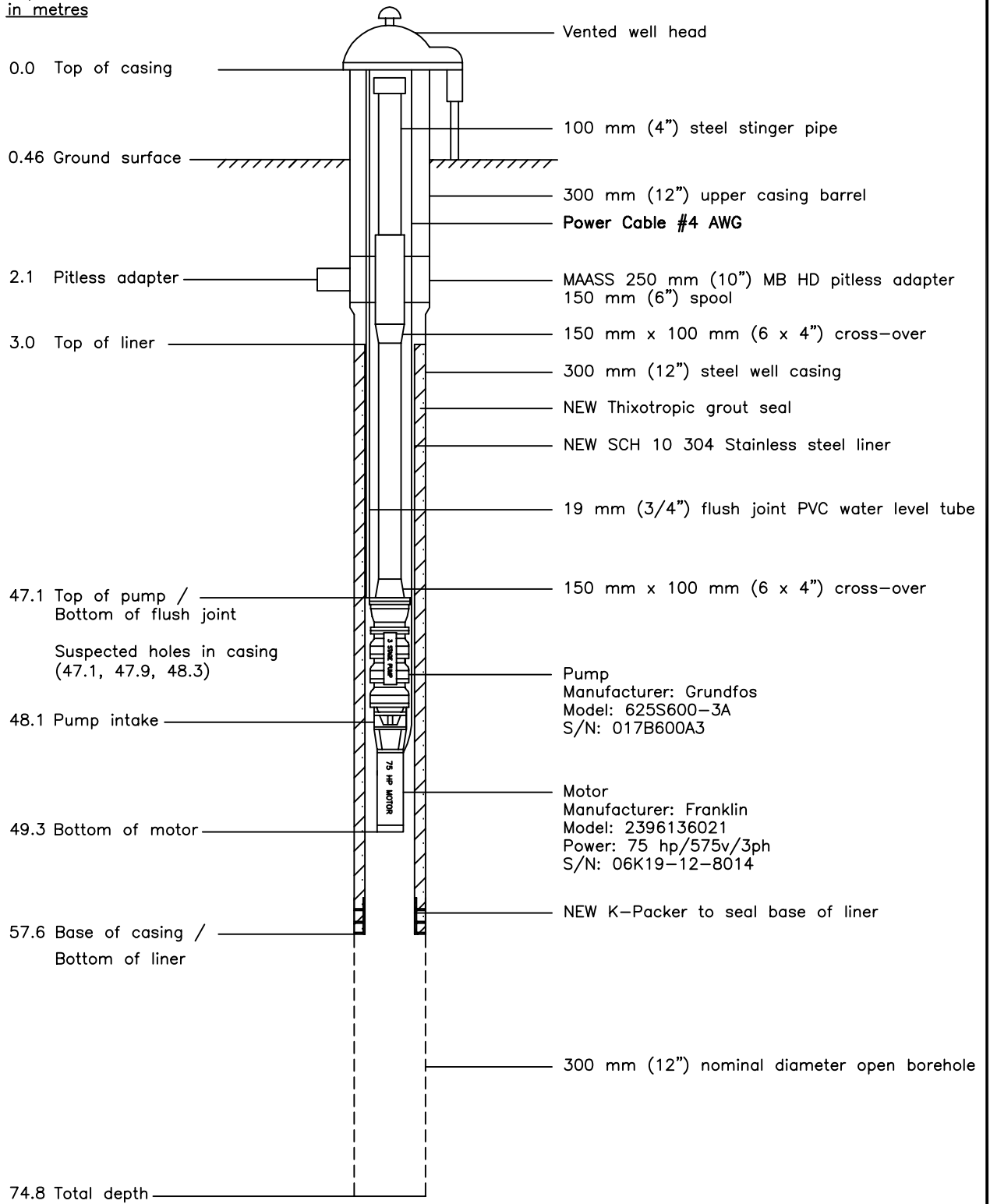
GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES				PRODUCTION WELL CONSTRUCTION	
	ft	m		#	type	interval	rec		
DOLOSTONE BEDROCK: Brown to grey dolostone, changing to buff dolostone @ 58.5 m. Below 74.5 m brown dolostone to 68.28 m Fracture @ 67.7 - 68.9 m Fracture @ 72.8 - 74.5 m Fracture @ 74.7 - 75.9 m End of Borehole @ 75.6 m		68	280.4		GS	1.5 m			
						GS	1.5 m		
	230	70				GS	1.5 m		
						GS	1.5 m		
		72				GS	1.5 m		
	240					GS	1.5 m		
		74				GS	1.5 m		
						GS	1.5 m		
		76				GS	1.5 m		
	250								



	CLIENT	REGIONAL MUNICIPALITY OF WATERLOO
	TITLE	New Hamburg Well NH3 Pump Installation Drawing (As-Installed)

PROJECT No.	006-230	G:\Lotowater Projects\006 Region of Waterloo\230 NH3 Well Service\7. Technical\		FIGURE 5
DESIGN		REVISION No. 2012-06-07	SCALE N.T.S.	
DRAWN	MG 2012/05/30			
CHECKED	BB 2012/06/27			

Depths
in metres



CLIENT
REGIONAL MUNICIPALITY OF WATERLOO

TITLE
New Hamburg Well NH3
Liner Installation

PROJECT No. 006-269		G:\Lotowater Projects\006 Region of Waterloo\269 NH3 Liner\7. Technical\		FIGURE 2
DESIGN		REVISION No. 2013/04/04	SCALE N.T.S.	
DRAWN	EH 2013/02/28			
CHECKED				

PROJECT: 1547812
 LOCATION: New Hamburg

RECORD OF BOREHOLE: NH-TW1-16

SHEET 1 OF 4
 DATUM:

BORING DATE: September 17, 2016

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa				WATER CONTENT PERCENT					
								20	40	60	80	nat V. +	rem V. ⊕			Q - ●	U - ○
0		GROUND SURFACE		0.00													
0 to 6.10		CH, CLAY, trace sand, brown to grey, cohesive, moist, very soft to hard			1												
6.10 to 12.19		CL, SILTY CLAY, trace to some sand, trace fine gravel (20-30mm), grey brown, cohesive		6.10	3												
12.19 to 18.29	Air Rotary	SC, SAND, some gravel, trace clay, trace silt, grey brown, cohesionless		12.19	5												
18.29 to 20		SAND and GRAVEL, trace silt, brown, cohesionless, loose		18.29	7												
CONTINUED NEXT PAGE																	

150 mm Steel Casing

GTA-BHS 001 S:\CLIENTS\REGION OF WATERLOO\NEW_HAMBURG\02_DATA\GINT\NEW_HAMBURG.GPJ GAL-MIS.GDT 5/30/17



RECORD OF BOREHOLE: NH-TW1-16

BORING DATE: September 17, 2016

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa				WATER CONTENT PERCENT					
								20 40 60 80 nat V. + Q - ● rem V. ⊕ U - ○				10 ⁻⁶ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³ Wp ——— W ——— WI					
20	Air Rotary	-- CONTINUED FROM PREVIOUS PAGE --															
		SAND and GRAVEL, trace silt, brown, cohesionless, loose			7												
22		CL, CLAY, some silt, trace sand and gravel, grey brown		21.34	8												
24																	
26		SM, gravelly SAND, fine to medium grained, trace to some silt, brown		24.38	9												
28		SM, silty SAND and GRAVEL, fine grained, sub round to sub angular gravel, brown		27.43	10												
30																	
32					11												
34		SM, silty SAND, fine grained, brown		33.53	12												
36					13												
38					14												
40																	
		CONTINUED NEXT PAGE															

150 mm Steel Casing

GTA-BHS 001 S:\CLIENTS\REGION OF WATERLOO\NEW_HAMBURG\02_DATA\GINT\NEW_HAMBURG.GPJ GAL-MIS.GDT 5/30/17



PROJECT: 1547812
 LOCATION: New Hamburg

RECORD OF BOREHOLE: NH-TW1-16

SHEET 3 OF 4
 DATUM:

BORING DATE: September 17, 2016

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa				WATER CONTENT PERCENT					
								20		40		60				80	
40	Air Rotary	-- CONTINUED FROM PREVIOUS PAGE --															
42		SM, silty SAND, fine grained, brown															
44				14													
46		15															
48		16															
50		ML, SILT TILL, some fine gravel, some fine to coarse sand, trace clay, brown		48.77												150 mm Steel Casing	
52		17															
54		18															
56		DOLOSTONE, brown, fractures from 55.78 m to 56.39 m and from 57.3 m to 57.61 m and at 58.2-58.32 m, 59.48 m, 59.82 m and 60.52 m		55.78													
58		19															
60		20													Open Hole		
CONTINUED NEXT PAGE																	

GTA-BHS 001 S:\CLIENTS\REGION OF WATERLOO\NEW_HAMBURG\02_DATA\GINT\NEW_HAMBURG.GPJ GAL-MIS.GDT 5/30/17



PROJECT: 1547812
 LOCATION: New Hamburg

RECORD OF BOREHOLE: NH-TW1-16

SHEET 4 OF 4
 DATUM:

BORING DATE: September 17, 2016

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa				WATER CONTENT PERCENT					
								20		40		60		80			10 ⁻⁶
60	Air Rotary	-- CONTINUED FROM PREVIOUS PAGE --															
		DOLOSTONE, brown, fractures from 55.78 m to 56.39 m and from 57.3 m to 57.61 m and at 58.2-58.32 m, 59.48 m, 59.82 m and 60.52 m			20												
62					21											Open Hole	
		END OF BOREHOLE			62.48												
64																	
66																	
68																	
70																	
72																	
74																	
76																	
78																	
80																	

GTA-BHS 001 S:\CLIENTS\REGION OF WATERLOO\NEW_HAMBURG02_DATA\GINT\NEW_HAMBURG.GPJ GAL-MIS.GDT 5/30/17



Driller Log

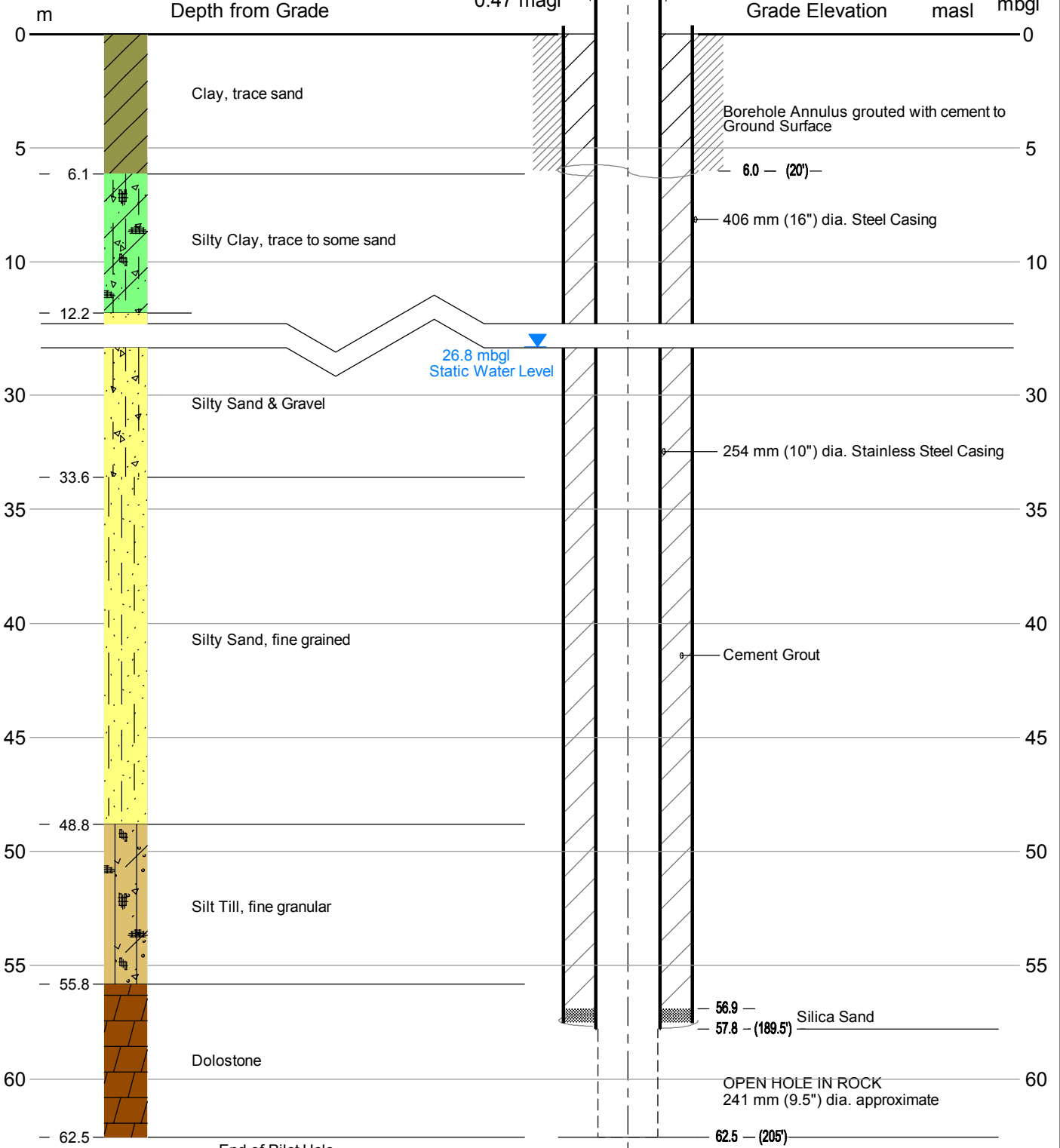
Pilot Hole NH-TW1-16 (Summary)
Refer to Appended Log for full Details

Top of Casing (Stick-up)
0.47 magl

As-Built

Protective Cap

Depth
mbgl



26.8 mbgl
Static Water Level

End of Pilot Hole
Pilot Hole September 17, 2016 by Les Forages L.B.M. Inc

*Note:
Depths from metres to feet nominal 1 foot intervals
All depths are metres below ground level unless otherwise stated.
Construction Completed 29 September 2016 by Les Forages L.B.M. Inc

CLIENT
REGIONAL MUNICIPALITY OF WATERLOO

PROJECT
NEW HAMBURG WELL CONSTRUCTION

CONSULTANT



YYYY-MM-DD 2017-05-29
PREPARED JPR
DESIGN
REVIEW
APPROVED GP

TITLE
**WELL NH4
CONSTRUCTION AS-BUILT**

PROJECT No. 000 4_N Phase - Rev. 01 Figure 7

Path: \\golder\gdm\Mississauga\SIM\Clients\Region_of_Waterloo\09_PROJECTS\0004_New_Hamburg_NH4_Well_Construction | File Name: 1547812-0003-CH-WEL.Ldwg

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

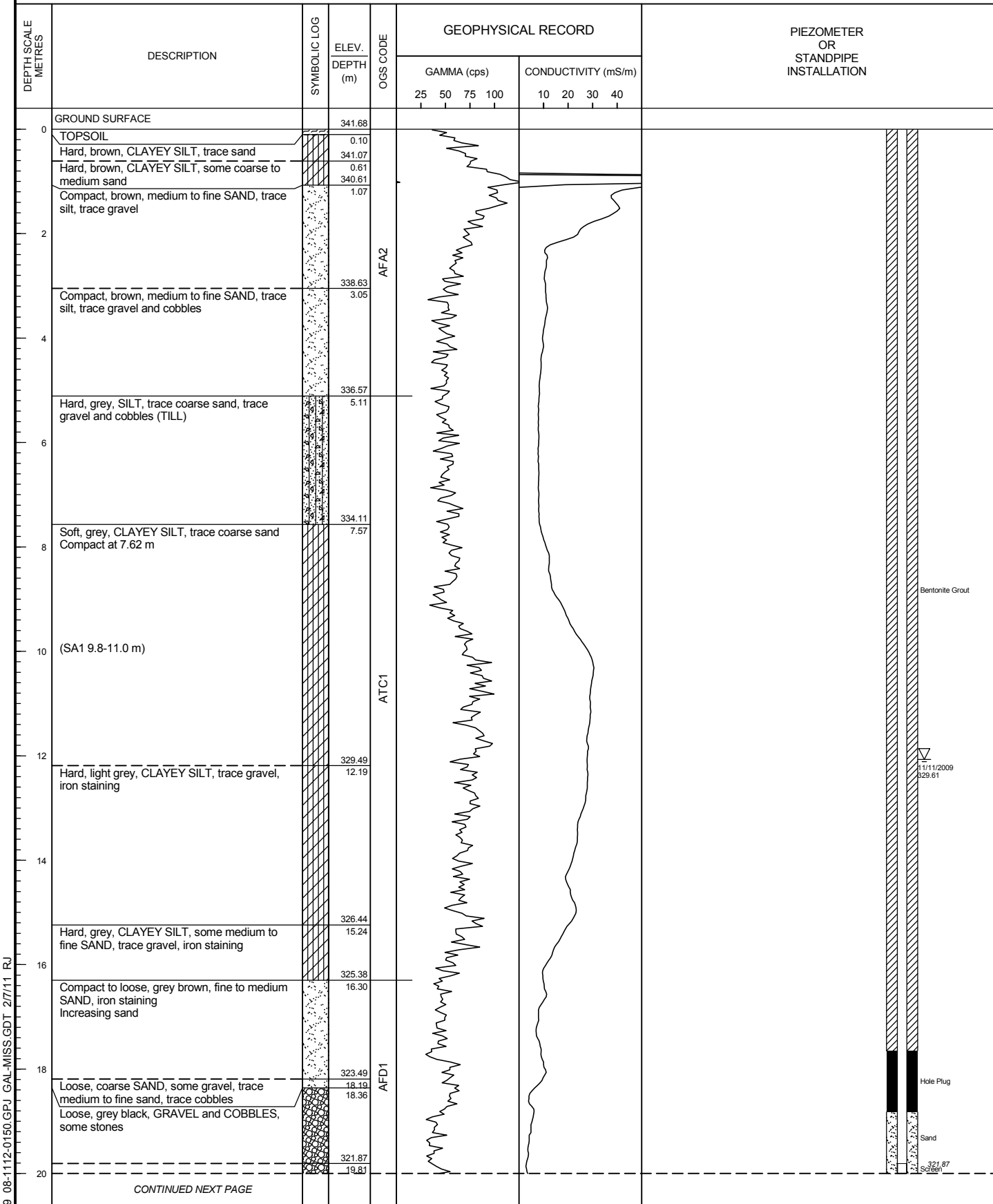
25 mm

PROJECT: 08-1112-0150
 LOCATION: N 4801853.0 ; E 523236.0

BOREHOLE LOG OF: WT-NH-OW01-09

SHEET 1 OF 2
 DATUM: NAD83

DRILLING DATE: October 6-7, 2009
 DRILL RIG: PQ Coring
 DRILLING CONTRACTOR: Procure Drilling & Davidson Well Drilling



CONTINUED NEXT PAGE

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

DEPTH SCALE
 1 : 100



LOGGED: BH
 CHECKED: DN

PROJECT: 08-1112-0150
 LOCATION: N 4801853.0 ; E 523236.0

BOREHOLE LOG OF: WT-NH-OW01-09

SHEET 2 OF 2
 DATUM: NAD83

DRILLING DATE: October 6-7, 2009
 DRILL RIG: PQ Coring
 DRILLING CONTRACTOR: Procure Drilling & 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 --- Loose, grey, GRAVEL and COBBLES, trace medium to coarse sand, trace stones		320.34 21.34	AFD1									<p>Screen 318.82 Sand Hole Plug</p>
22	Loose, grey, GRAVEL and COBBLES, trace stones		318.82 22.86	ATE1									
24	Grey, CLAYEY SILT, some coarse sand, trace medium to fine sand		317.40 24.28										
	END OF BOREHOLE												
26													
28													
30													
32													
34													
36													
38													
40													

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

DEPTH SCALE
1 : 100



LOGGED: BH
CHECKED: DN

TERRAQUA INVESTIGATIONS LTD.
HYDROGEOLOGY SPECIALISTS

BOREHOLE NO.: NH-TW5-95

PROJECT : Baden-New Hamburg Contingency Plan
PROJECT NO.: TA459A
LOCATION: New Hamburg Reservoir
DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
DRILLING METHOD: Mud Rotary

DATE: May 1-2, 1995
SUPERVISOR: C. Johnston
GEOGRAPHIC INFORMATION: (Source)
UTM COORDINATES: 523730 4801870 (1:10,000)
GROUND ELEVATION: 349 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES			TEST WELL CONSTRUCTION
	ft	m		#	type	Interval	
	0	0	349				
CLAY: possible till, trace of gravel, brown changing to grey below 4.26 m		2		GS	1.5 m		<p>349.3 m</p> <p>BENTONITE HOLE PLUG</p> <p>158 mm ID STEEL CASING</p> <p>216 mm DIAM. BOREHOLE</p> <p>DRILL CUTTINGS</p>
	10	4					
		6		GS	1.5 m		
		8					
		10	338.9				
		12		GS	1.5 m		
		14					
		16		GS	1.5 m		
		18					
		20	329.5	GS	1.5 m		
SILTY CLAY: possible till, gravel, brown, hard to drill.		22		GS	1.5 m		
		24					
		26	323.7	GS	1.5 m		
		28					
CLAYEY SILT TO SILTY CLAY: possible till, gravel and cobbles, grey, hard to drill		30		GS	1.5 m		
		32					
		32					
SANDY SILT AND GRAVEL: possible till, slightly clayey with gravel and cobbles, grey, hard to drill.		30		GS	1.5 m		
		32					
		32					
		32					
	110						

PROJECT : Baden-New Hamburg Contingency Plan
 PROJECT NO.: TA459A
 LOCATION: New Hamburg Reservoir
 DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
 DRILLING METHOD: Mud Rotary

DATE: May 1-2, 1995
 SUPERVISOR: C. Johnston
 GEOGRAPHIC INFORMATION: (Source)
 UTM COORDINATES: 523730 4801870 (1:10,000)
 GROUND ELEVATION: 349 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES				TEST WELL CONSTRUCTION
	ft	m		#	type	interval	rec	
SANDY SILT AND GRAVEL: possible till, slightly clayey with gravel and cobbles, grey, hard to drill.		34	310.0					158 mm ID STEEL CASING
	120	36						
		38		GS	1.5 m			
CLAYEY SILT TILL possible till, gravel, and cobbles, brown.	130	40	304.2					216 mm DIAM. BOREHOLE
		42						
	140	44		GS	1.5 m			
DOLOSTONE BEDROCK: dark brown to grey, changing to buff brown sandy dolostone at 46.3 to 53.9 m. Fracture @ 50.9 - 51.2 m Fracture @ 52.4 - 52.6 m Fracture @ 53.0 - 53.9 m	150	46	304.2					BENTONITE HOLEPLUG
		48		GS	1.5 m			
		50		GS	1.5 m			
	160	52		GS	1.5 m			
		54		GS	1.5 m			
		56		GS	1.5 m			
		58		GS	1.5 m			
170	54	295.0					SILICA SAND GRAVEL PACK	
	56		GS	1.5 m				
Grey dolostone Fracture @ 54.7 m	180	58	292.0					50 mm ID PVC WELL SCREEN
	58	GS		1.5 m				
Dark brown dolostone - fracture @ 57.0 m	190	58	291.1					BENTONITE HOLEPLUG
	60	GS		1.5 m				
Light brown to buff dolostone Fracture @ 59.1 m Fracture @ 60.7 m	200	62	288.1					SILICA SAND GRAVEL PACK
	64	GS		1.5 m				
SHALEY DOLOSTONE: ark grey.		66	282.2					50 mm ID PVC WELL SCREEN
		68		GS	1.5 m			
	210	66		GS	1.5 m			
END OF BOREHOLE @ 66.8 m	220							

TERRAQUA INVESTIGATIONS LTD.
HYDROGEOLOGY SPECIALISTS

BOREHOLE NO.: NH-TW6-95

PROJECT: Baden-New Hamburg Contingency Plan
PROJECT NO.: TA459A
LOCATION: Twsp. Rd 11A, N. of Hwy. 7&8
DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
DRILLING METHOD: Mud Rotary

DATE: July 26 - Aug. 1, 1995
SUPERVISOR: C. Johnston
GEOGRAPHIC INFORMATION: (Source)
UTM COORDINATES: 523160 4801335 (1:10,000)
GROUND ELEVATION: 355.5 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES				TEST WELL CONSTRUCTION
	ft	m		#	type	Interval	rec	
	0	0	355.5					355.9 m
SILTY CLAY: possible till, trace of gravel, brown		2	344.5	GS	X	1.5 m		BENTONITE HOLE PLUG
	10	4						
		6						
	20	8		GS	X	1.5 m		
		10						
	30	12		GS	X	1.5 m		
		14						
	40	16		GS	X	1.5 m		
		18						
	50	20		GS	X	1.5 m		
CLAYEY SANDY SILT: possible till, occasional F-M sand and clay seams		22	336.6	GS	X	1.5 m		158 mm ID STEEL CASING 216 mm DIAM. BOREHOLE DRILL CUTTINGS
		24						
	60	26		GS	X	1.5 m		
		28						
	70	30		GS	X	1.5 m		
		32						
	80	30		GS	X	1.5 m		
		32						
	90	28		GS	X	1.5 m		
		30						
SILTY FINE SAND: occasional fine to medium sand and silt seams, brown to grey		30	336.6	GS	X	1.5 m		
		32						
	100	30		GS	X	1.5 m		
		32						
	110							

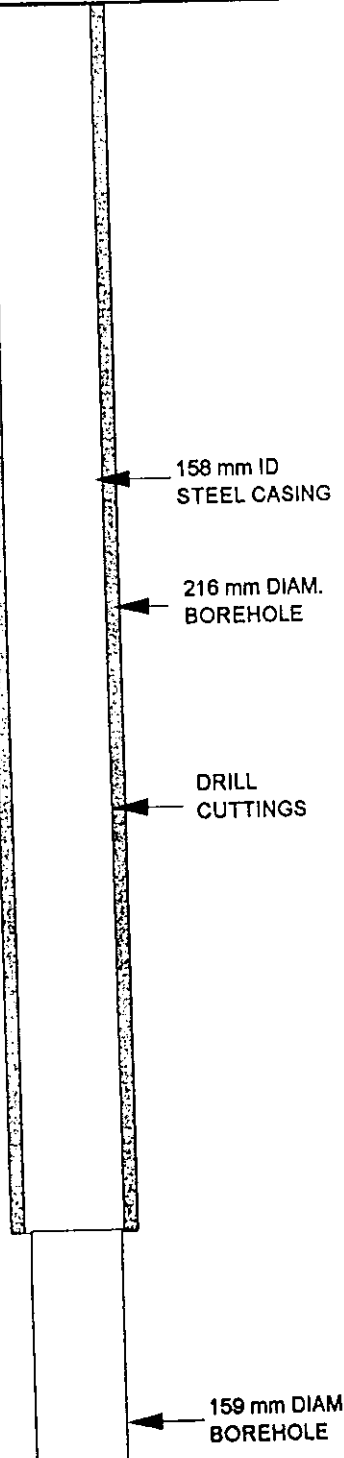
**TERRAQUA INVESTIGATIONS LTD.
HYDROGEOLOGY SPECIALISTS**

BOREHOLE NO.: NH-TW6-95

PROJECT: Baden-New Hamburg Contingency Plan
PROJECT NO.: TA459A
LOCATION: Twsp. Rd 11A, N. of Hwy. 7&8
DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
DRILLING METHOD: Mud Rotary

DATE: July 26 - Aug. 1, 1995
SUPERVISOR: C. Johnston
GEOGRAPHIC INFORMATION: (Source)
UTM COORDINATES: 523160 4801335 (1:10,000)
GROUND ELEVATION: 355.5 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES				TEST WELL CONSTRUCTION
	ft	m		#	type	interval	rec	
SILTY FINE SAND: occasional fine to medium sand and silt seams, brown to grey		34						
		36						
		120						
		38			GS	1.5 m		
		130						
		40						
		42						
		140						
		44			GS	1.5 m		
		150						
	46							
	48							
	160							
	60			GS	1.5 m			
	170							
	52			GS	1.5 m			
	54							
	180		300.6					
SANDY SILT AND GRAVEL: possible sandy silt gravel till,		56	299.1					
DOLOSTONE BEDROCK: Brown to grey dolostone with white shale partings. At 64.3 m sandy buff brown dolostone changing to grey dolostone at 64.9 m. Fracture @ 57.0 - 57.3 m Fracture @ 58.2 - 58.5 m lost approx. .10 m of mud Fracture @ 59.1 - 59.3 m lost circulation Fracture @ 62.5 m Fracture @ 63.1 - 63.4 m		58		GS	1.5 m			
		190		GS	1.5 m			
		60		GS	1.5 m			
		200		GS	1.5 m			
		62		GS	1.5 m			
		210		GS	1.5 m			
		64		GS	1.5 m			
		66		GS	1.5 m			
	220							




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HYDROGEOLOGY SPECIALISTS**

BOREHOLE NO.: NH-TW6-95

PROJECT: Baden-New Hamburg Contingency Plan
 PROJECT NO.: TA459A
 LOCATION: Twsp. Rd 11A, N. of Hwy. 7&8
 DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
 DRILLING METHOD: Mud Rotary

DATE: July 26 - Aug. 1, 1995
 SUPERVISOR: C. Johnston
 GEOGRAPHIC INFORMATION: (Source)
 UTM COORDINATES: 523160 4801335 (1:10,000)
 GROUND ELEVATION: 355.5 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES				TEST WELL CONSTRUCTION
	ft	m		#	type	Interval	rec	
DOLOSTONE BEDROCK: Brown to grey dolostone. Fractures at 68.6 and 69.9 m		68	285.1	GS	1.5 m			
				GS	1.5 m			
	230	70		GS	1.5 m			
Blue-grey shale and dolostone			281.3	GS	1.5 m			
				GS	1.5 m			
	240	72		GS	1.5 m			
Buff Brown to grey dolostone Fracture at 74.9 m			275.9	GS	1.5 m			
				GS	1.5 m			
	250	74		GS	1.5 m			
Blue-grey shale and dolostone			275.9	GS	1.5 m			
				GS	1.5 m			
	260	76		GS	1.5 m			
End of Borehole @ 79.6 m			275.9	GS	1.5 m			
	270	78		GS	1.5 m			

**TERRAQUA INVESTIGATIONS LTD.
HYDROGEOLOGY SPECIALISTS**

BOREHOLE NO.: NH-TW4-95

PROJECT : Baden-New Hamburg Contingency Plan
 PROJECT NO.: TA459A
 LOCATION: Twsp. Rd 11A, N. of Hwy. 7&8
 DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
 DRILLING METHOD: Mud Rotary

DATE: April 18-20, 1995
 SUPERVISOR: C. Johnston
 GEOGRAPHIC INFORMATION: (Source)
 UTM COORDINATES: 523160 4801335 (1:10,000)
 GROUND ELEVATION: 356 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES				TEST WELL CONSTRUCTION
	ft	m		#	type	interval	rec	
	0	0	356					
SILTY CLAY: possible till, trace of gravel, brown		2		GS	X	1.5 m		<p>356.4 m</p> <p>BENTONITE HOLE PLUG</p> <p>0.16 m ID STEEL CASING</p> <p>0.21 m ID BOREHOLE</p> <p>DRILL CUTTINGS</p>
	10	4						
		6						
	20	8		GS	X	1.5 m		
		10						
	30	12	345.0	GS	X	1.5 m		
		14						
	40	16		GS	X	1.5 m		
		18						
	50	20	337.1	GS	X	1.5 m		
CLAYEY SANDY SILT: possible till, occasional F-M sand and clay seams		22		GS	X	1.5 m		
	60	24						
		26						
	70	28		GS	X	1.5 m		
		30						
	80	32						
		34						
	90	36		GS	X	1.5 m		
		38						
	100	40		GS	X	1.5 m		
SILTY FINE SAND: occasional fine to medium sand and silt seams, brown to grey		42						
	110	44						

**TERRAQUA INVESTIGATIONS LTD.
HYDROGEOLOGY SPECIALISTS**

BOREHOLE NO.: NH-TW4-95

PROJECT : Baden-New Hamburg Contingency Plan
 PROJECT NO.: TA459A
 LOCATION: Twsp. Rd 11A, N. of Hwy. 7&8
 DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
 DRILLING METHOD: Mud Rotary

DATE: April 18-20, 1995
 SUPERVISOR: C. Johnston
 GEOGRAPHIC INFORMATION: (Source)
 UTM COORDINATES: 523160 4801335 (1:10,000)
 GROUND ELEVATION: 356 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES				TEST WELL CONSTRUCTION
	ft	m		#	type	interval	rec	
SILTY FINE SAND: occasional fine to medium sand and silt seams, brown to grey		34						
		36						
		120						
		38			GS	1.5 m		
		130						
		40						
		42						
		140						
		44			GS	1.5 m		
		150						
	46							
	48							
	160							
	50			GS	1.5 m			
	170							
	52			GS	1.5 m			
	54							
	180							
	56	301.1 300.5						
SANDY SILT AND GRAVEL: possible sandy silt gravel till,								
DOLOSTONE BEDROCK: Brown to grey dolostone, changing to buff dolostone @ 58.5 m. Below 74.5 m brown dolostone		58		GS	1.5 m			
		190		GS	1.5 m			
Fracture @ 57.9 - 58.2 m (produced approx. 7.5 L/s of very dirty water)		60		GS	1.5 m			
		200		GS	1.5 m			
Fracture @ 60.4 - 61.6 m		62		GS	1.5 m			
				GS	1.5 m			
Fracture @ 62.2 - 62.8 m				GS	1.5 m			
		210		GS	1.5 m			
Fracture @ 64.3 - 64.9 m				GS	1.5 m			
		66		GS	1.5 m			
		220						

**TERRAQUA INVESTIGATIONS LTD.
HYDROGEOLOGY SPECIALISTS**

BOREHOLE NO.: NH-TW4-95

PROJECT : Baden-New Hamburg Contingency Plan
 PROJECT NO.: TA459A
 LOCATION: Twsp. Rd 11A, N. of Hwy. 7&8
 DRILLING CONTRACTOR: Davidson Well Drilling Ltd.
 DRILLING METHOD: Mud Rotary

DATE: April 18-20, 1995
 SUPERVISOR: C. Johnston
 GEOGRAPHIC INFORMATION: (Source)
 UTM COORDINATES: 523160 4801335 (1:10,000)
 GROUND ELEVATION: 356 m AMSL (1:10,000)

GEOLOGIC DESCRIPTION	DEPTH		ELEV. (mAMSL)	SAMPLES				TEST WELL CONSTRUCTION		
	ft	m		#	type	interval	rec			
DOLOSTONE BEDROCK: Brown to grey dolostone, changing to buff dolostone @ 58.5 m. Below 74.5 m brown dolostone to 68.28 m		68			GS	1.5 m				0.16 m ID BOREHOLE
					GS	1.5 m				
	230	70			GS	1.5 m				
Fracture @ 67.7 - 68.9 m					GS	1.5 m				
		72			GS	1.5 m				
Fracture @ 72.8 - 74.5 m	240				GS	1.5 m				
		74			GS	1.5 m				
Fracture @ 74.7 - 75.9 m					GS	1.5 m				
End of Borehole @ 76.2 m		76			GS	1.5 m				
	250		279.8							



BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

Monitoring Data (Pumped Volumes and Hydrographs)



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

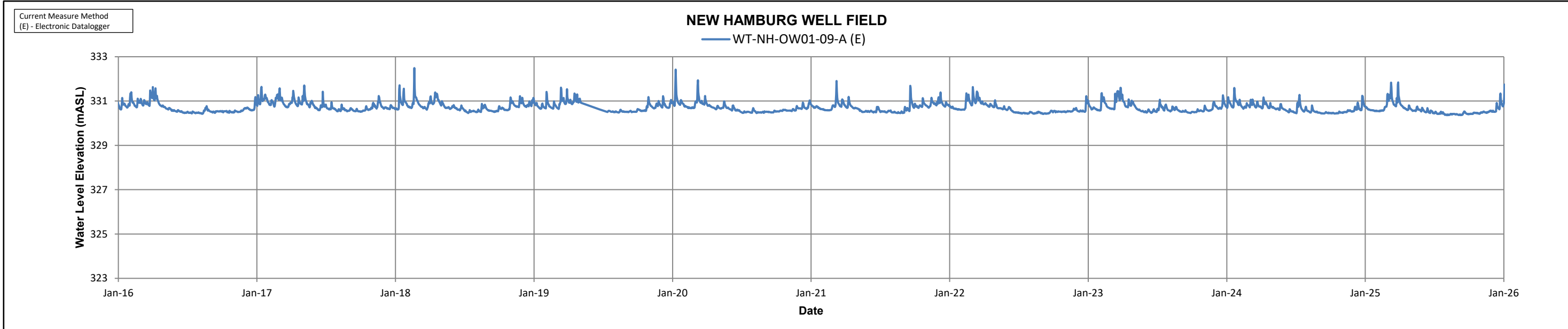
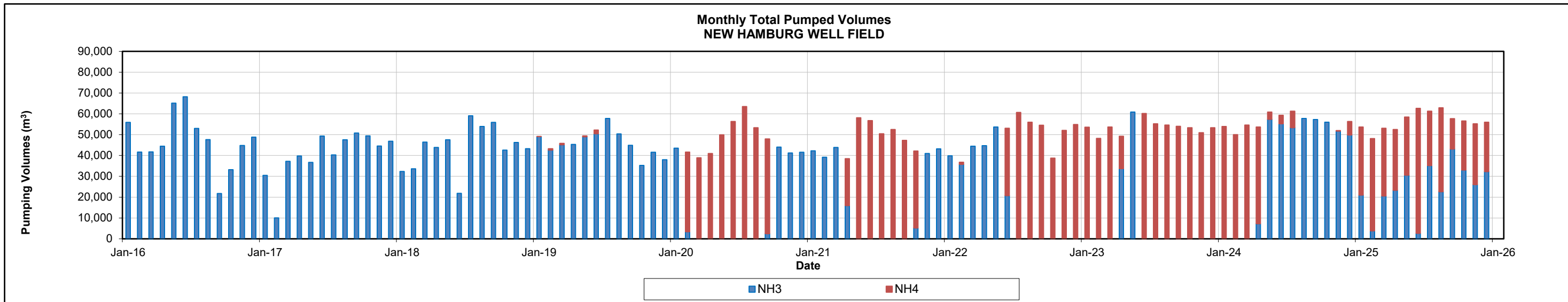
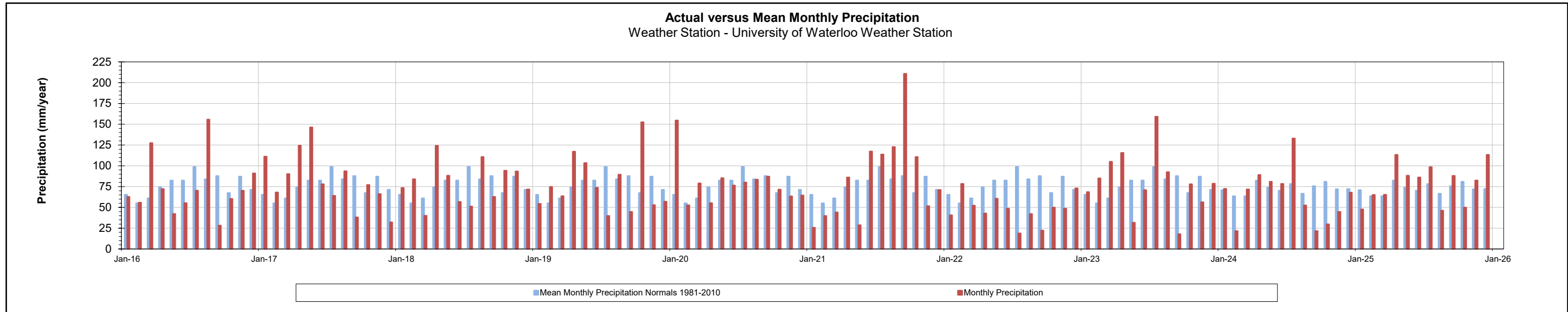


Well Field	Major or Minor Supply	Production Well Name	Permit to Take Water Details			2021 Production Summary			2022 Production Summary			2023 Production Summary			2024 Production Summary			2025 Production Summary		
			MOE Permit Number	Permitted Capacity (total m ³ /year)*	Permitted Rate (L/s)*	Total 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)
New Hamburg	Major	NH3 NH4	7021-AQRK39	Combined rate for PTTW 1,293,195	7021-AQRK	230,555	632	7.3	239,233	655	7.6	94,610	259	3.0	445,877	1,222	14.1	294,101	806	9.3
			7021-AQRK39		324,585	889	10.3	350,365	960	11.1	552,723	1,514	17.5	227,288	623	7.2	384,329	1,053	12.2	
			Well Field Total		555,140	1,521	17.6	589,598	1,615	18.7	647,333	1,774	20.5	673,165	1,844	21.3	678,430	1,859	21.5	

Notes:

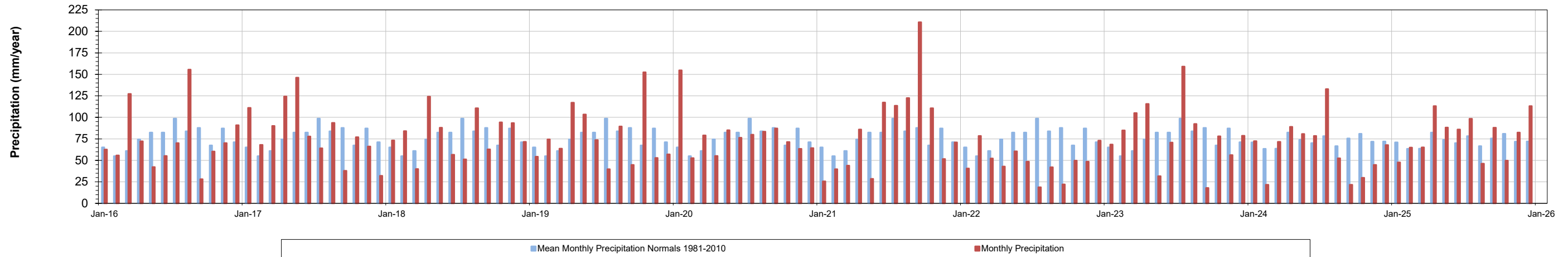
- = no applicable data
- n/a = data not available
- * = rates and volumes based on permitted L/day

REGION OF WATERLOO
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NEW HAMBURG

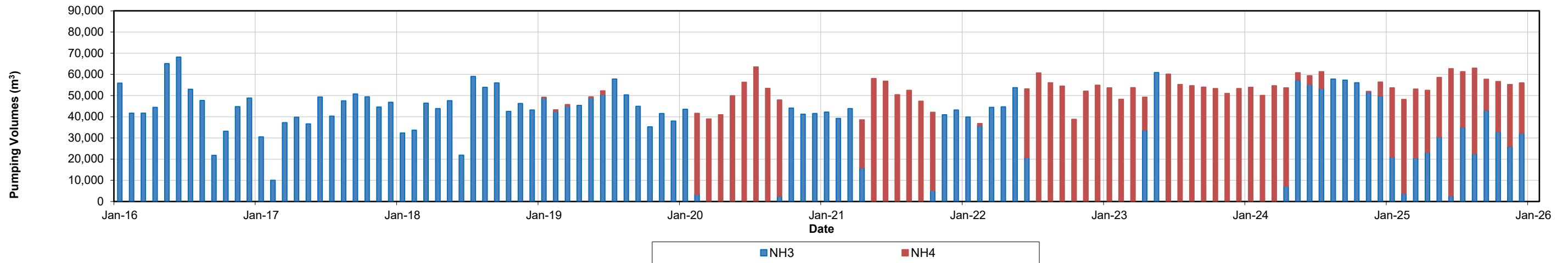


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NEW HAMBURG

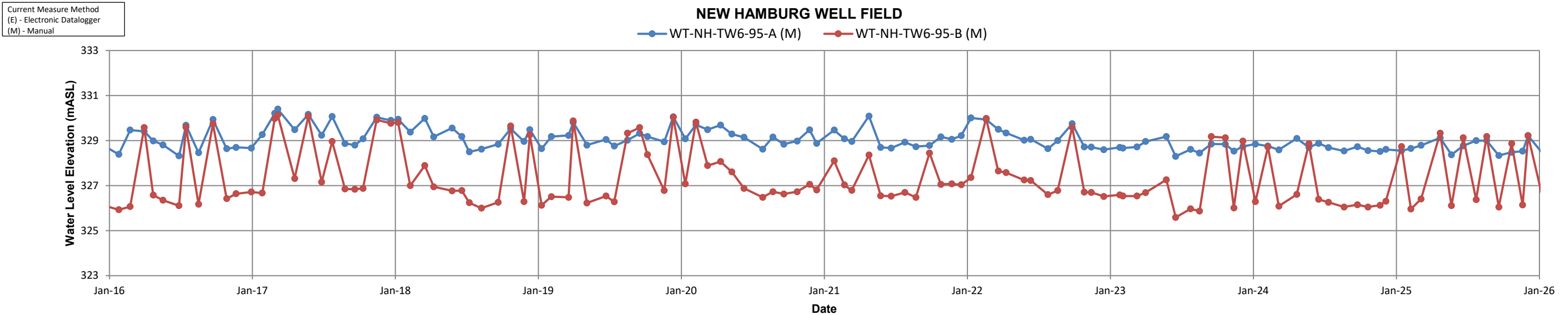
Actual versus Mean Monthly Precipitation
Weather Station - University of Waterloo Weather Station



Monthly Total Pumped Volumes
NEW HAMBURG WELL FIELD

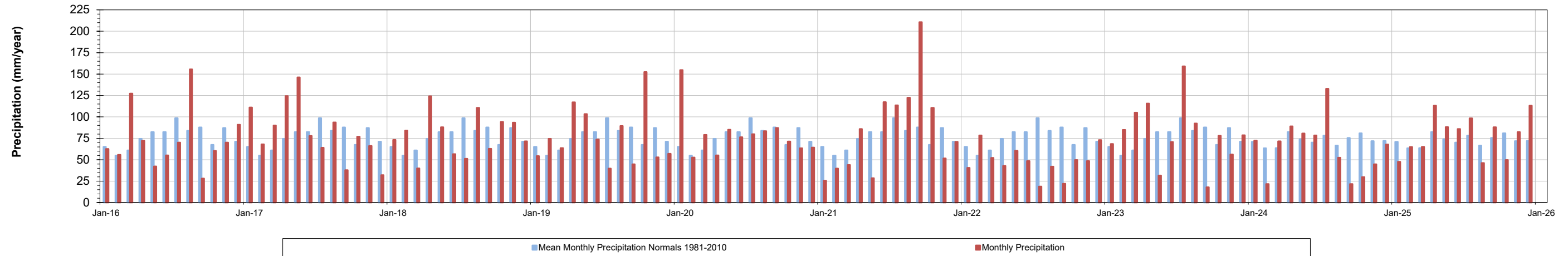


NEW HAMBURG WELL FIELD

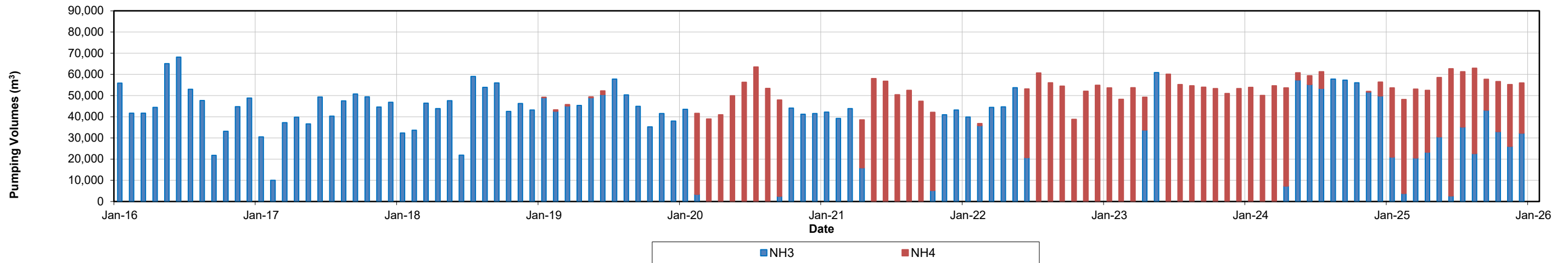


REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
NEW HAMBURG

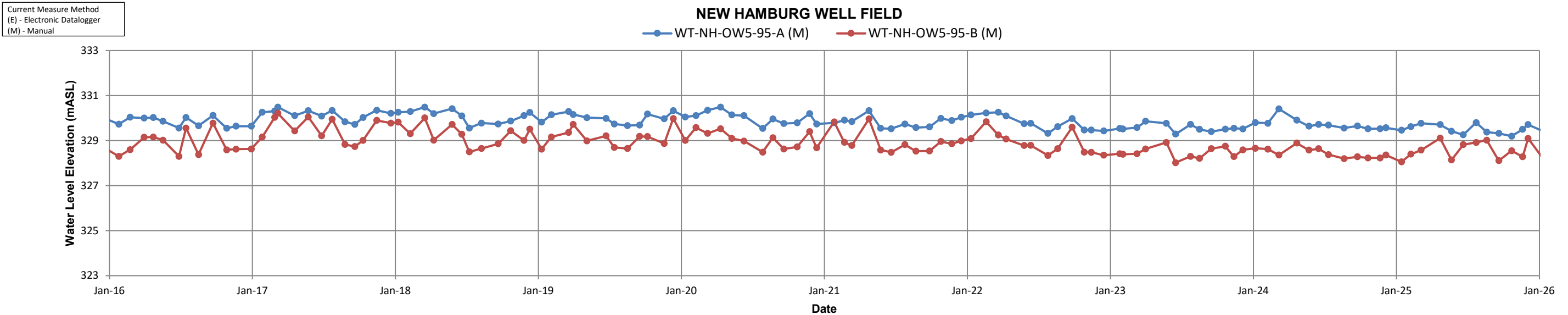
Actual versus Mean Monthly Precipitation
Weather Station - University of Waterloo Weather Station



Monthly Total Pumped Volumes
NEW HAMBURG WELL FIELD



NEW HAMBURG WELL FIELD





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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
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
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
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
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
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
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
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

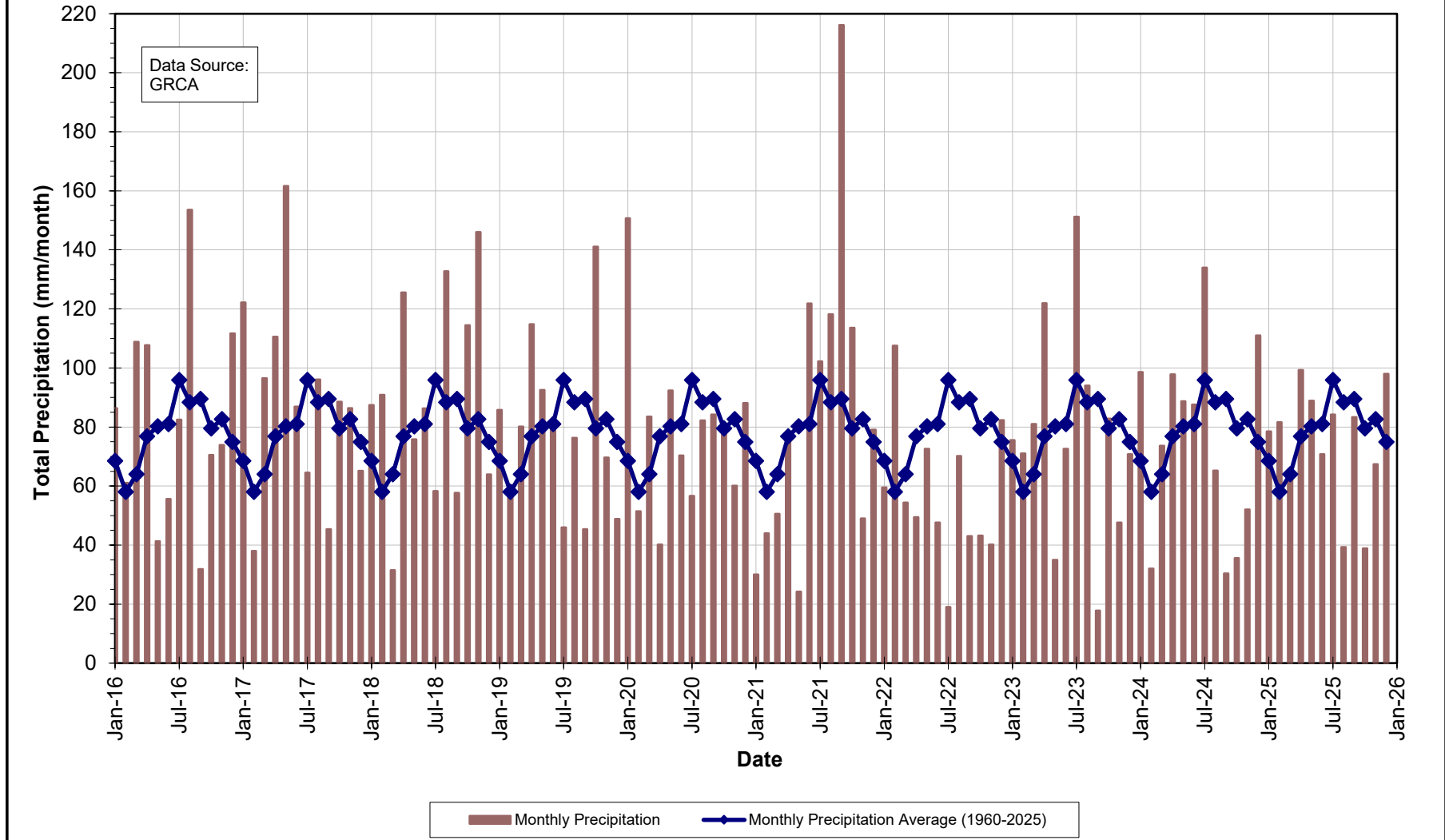
Year	Roseville Weather Station Established 1972		
	Annual Precipitation (mm)	30-yr NORMAL Precipitation 1981-2010 (mm)	Difference (mm)
	2016	899	919
2017	882	919	-37
2018	905	919	-14
2019	957	919	38
2020	817	919	-102
2021	832	919	-87
2022	637	919	-282
2023	945	919	26
2024	856	919	-63
2025	786	919	-133

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
Laurel Creek 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*® Levelloggers®

- 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 unconnected 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.

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- 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.

