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**2025 Biennial Groundwater Monitoring
Report - Hespeler Well Field (H4A)**

The Region of Waterloo

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The Region of Waterloo

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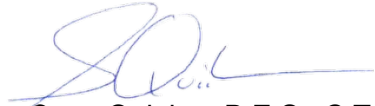
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1.0 Introduction

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 1008-BW6L62) for H4A in the Hespeler Well Field 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 condition of the PTTW for 2024 and 2025. A copy of the PTTW is included in Appendix A.

The location of the Hespeler Well Field is shown in Figure 1 and the production wells in Cambridge are shown in Figure 2 with the monitoring network for H4A 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 but are also located in known aquifer recharge areas. 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 Hespeler Well Field (H4A) in accordance with PTTW 1008-BW6L62 which consists of the following activities:

- Measuring the daily volume pumped from the H4A production well (Condition 4.1 of the PTTW);
- Measuring the water levels in monitoring wells C-HP-OW1-08-ABCD, and C-HP-OW2-95-ABCD (Condition 4.2 of the PTTW);
- Review of precipitation data from the nearest GRCA / Environment Canada weather station to assist in assessing changes in water levels in the supply aquifer(s) (Condition 4.3); 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 H4A production well site is located north of the Highway 401 corridor on a pie-shaped parcel of land at the intersection of Hungerford Road and Black Street in the City of Cambridge (formerly the Town of Hespeler). The H4A well is located about 2 km north of the Pinebush Well Field (Figure 2). Other wells in the Hespeler Well Field include H3 and H3A located about 1.5 km to the west, and the H5 and H5A wells found about 2.5 km to the northwest. Each well field is permitted under a separate PTTW. The wells are in an urban area that is municipally serviced. The closest surface water feature to the H4A site is the Speed River located 730 m to the Northwest (Figure 3).

2.1.1 Pumping Wells

Well records for the production wells are found in Appendix B. Well H4 was constructed in 1950 and was used exclusively until 2013. In January 2013 well H4A came online and H4 was decommissioned in April 2017.

H4A was constructed in 2008. It is cased through the entire Guelph Formation and is screened within the Goat Island and Gasport formation, drawing most of its water from the Gasport Formation from 51.8 to 121.0 mbgs (189.8 to 259.0 masl). The most productive interval is the upper 10 m of the Gasport Formation.

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

Table 1: Production Well Construction Details

Production Well Name	Year Built	Casing Diameter (mm)	Open Hole Diameter (mm)	Open Hole interval (mbgs)	Aquifer
H4A	2008	305	305	51.8-121.0	Goat Island - Gasport

The water taking volumes for the Hespeler H4A Well Field are regulated by Condition 3.2 of the PTTW and are summarized in Table 2 below. 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. Pumping volumes from H4A ranged from 29,983 m³/month to 32,141 m³/month in 2024, and from 22,313 m³/month to 32,141 m³/month in 2024. In total, 375,782 m³ was produced at H4A in 2024 and 367,140 m³ was produced in 2025. These volumes are within the historical range for this well field and below the permitted volume of 756,864 m³ per year (Table C-1).

Table 2: Annual Water Taking 2024 / 2025

	PTTW Details	2024			2025		
Well	Permitted Max. Daily Water Taking (m3)	Avg. Daily Water Taking (m3)	Max Taken per Day (m3)	Total Volume Pumped (m3)	Avg. Daily Water Taking (m3)	Max Taken per Day (m3)	Total Volume Pumped (m3)
H4A	2,073.6	1,027	1,080	375,782	1,006	1,080	367,140

2.1.2 Monitoring Wells

Observation wells C-HP-OW1-08-A, C-HP-OW1-08-B, C-HP-OW1-08-C, C-HP-OW1-08-D are located adjacent to well H4A ,and wells C-HP-OW2-95-A, C-HP-OW2-95-B, C-HP-OW2-95-C and C-HP-OW2-95-D are located approximately 670 m southwest of H4A in Woodland Park (Figure 3).

Construction and monitoring details of C-HP-OW1-08-A, C-HP-OW1-08-B, C-HP-OW1-08-C, C-HP-OW1-08-D, C-HP-OW2-95-A, C-HP-OW2-95-B, C-HP-OW2-95-C and C-HP-OW2-95-D are described in the table below. Well records for the monitoring wells are provided in Appendix B.

Table 3: Monitoring Well Construction Details

Monitoring Well Name	Year Built	Screened Depth (mbgs)	Screened Formation	Distance to H4A (m)
C-HP-OW2-95-A	1995	120.4-125.0	Lower Gasport	670
C-HP-OW2-95-B	1995	88.4-102.1	Upper to Middle Gasport	670
C-HP-OW2-95-C	1995	41.5-53.6	Lower Guelph to Reformatory Quarry Mbr.	670
C-HP-OW2-95-D	1995	16.5-17.1	AFD1 to contact)	670
C-HP-OW1-08-A	2008	100.0-110.0	Cabot Head to Middle Gasport	15
C-HP-OW1-08-B	2008	52.0-62.0	Upper Gasport to Goat Island	15
C-HP-OW1-08-C	2008	25.0-28.0	Upper Guelph	15
C-HP-OW1-08-D	2008	10.4-13.4	AFB1	15

2.2 Regional Geology and Hydrostratigraphy

The following sections provide a brief overview of the regional geology and hydrogeology of the study area. The surficial geology based on regional OGS mapping is provided in Figure 4. Representative cross-sections showing the stratigraphy in the vicinity of the Hespeler Well Field (H4A) are included as Figures 5 and 6 to visualize the stratigraphy described in this section.

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 Hespeler Well Field.

The recently completed Tier Three Assessment Update Project (Aqua Insight et al, 2023) has revised the stratigraphic interpretation of the bedrock lithology at the Hespeler Wellfield. The Ontario Geological Survey (OGS) (Brunton and Brintnell (2020), have indicated that at H3 / H3A and H5 / H5A the Goat Island Formation is much thicker than previously interpreted and the underlying Gasport Formation is interpreted to be thinner. Reef mounds are now interpreted as part of the Goat Island Formation rather than the previously interpreted Gasport Formation. The lithological layers shown in the cross sections were updated in accordance with documentation provided in the Numerical Model Surface Transfer memorandum (Aqua Insight Inc, 2026).

2.3 Surficial Geology and Conceptual Hydrostratigraphy

The surficial geology of the Study Area has been mapped and described by Karrow (1987). Along the eastern side of the Grand River and the south side of the Speed River, the surficial geology (Figure 4) largely consists of sand and gravel outwash deposits (Units 7a and 7b in Figure 4). Ice-contact kame stratified sands and gravels (Unit 6 in Figure 4) are present east of the outwash deposits and extend towards Puslinch Lake.

The thickness of overburden deposits generally range from approximately 5 to 10 m in areas of outwash deposits, however, can be up to approximately 30 to 40 m thick in areas of the Paris and Galt moraines to the east of Cambridge. In the vicinity of the Shade's Mills, Clemens Mill and Pinebush Well Fields, the overburden thickness is generally 20 to 40 m. In the Hespeler Well Field area in northern Cambridge adjacent to the Speed River, overburden thickness is generally less than 20 m and the overburden is thin or absent in the Speed River valley.

The key Ontario Geologic Survey (OGS) model hydrostratigraphic units present in the Cambridge area are described in more detail below from youngest to oldest (Golder, 2011). The Tier 3 Update Project was focused on bedrock picks and the previous model conceptualization of the overburden remains the same (Aqua Insight et al, 2023).

Aquitard ATA2 - Wentworth Till

The Wentworth Till was deposited by the last glacier to advance in the area. It is described as a stony, sandy silt to sand textured till, and is often interbedded with sand and gravel. In the Cambridge area, the Wentworth Till is generally less than 10 m thick. Due to the loose, coarse-grained nature of the till, the unit behaves as a leaky aquitard or poor aquifer that is readily recharged from precipitation.

Aquifer AFA2 - Outwash Deposits

The outwash sand and gravel sediments of AFA2 are present within the Grand River Valley and vicinity, however extensive deposits have also been identified underlying the Wentworth Till in the Paris and Galt moraines. These outwash deposits are interpreted as the main production aquifer for the Shade's Mills municipal wells.

Aquitard ATB1 - Port Stanley Till

The Port Stanley Till is a sandy silt to silty sand till, with occasional stony texture. The Port Stanley Till was deposited by ice advancing from the Erie-Ontario ice lobe. In other parts of the Region, Bajc and Shirota (2007) have also used unit ATB1 to represent Tavistock, Mornington and Upper Maryhill Tills. In the Grand River and Speed River valleys this unit has been largely removed by erosion. This unit is generally finer grained than the Wentworth Till and behaves as an aquitard.

Aquifer AFB1 - Upper Waterloo Moraine Stratified Sediments and Equivalents

Significant thickness of aquifer AFB1 are interpreted to occur southeast of the Speed River and west of Puslinch Lake and generally corresponds with mapped surficial ice contact sands and gravels. AFB1 is generally fine sand with some gravel and is often slightly finer grained than unit AFA2, which typically contains greater amounts of gravel. Since AFB1 and AFA2 both behave as aquifers, differentiation of these units is not critical from a hydraulic perspective, although it is necessary to represent AFB1 separately from AFA2 to allow sequential layers for aquifer units both above and below the Port Stanley Till (ATB1), where this situation occurs. Where AFB1 is not present, Port Stanley Till may directly overlie Maryhill Till and Catfish Creek Till (described below), forming a single combined aquitard unit composed of these tills.

Aquitard ATB3 - Lower Maryhill Till

Fine grained till and glaciolacustrine deposits of the Lower Maryhill Till ATB3 generally separate AFB1 from the underlying Catfish Creek Till. The Lower Maryhill Till is described as a dense, dark brown, clayey silt to silty clay till and is interpreted to be present in the Fountain Street (Well P16) well field area above the Catfish Creek and below the Port Stanley Till. Aquitard ATB3 can be difficult to distinguish from ATB1 throughout most of the study area due to the similar lithologies of these units. Lotowater (1997) grouped the Port Stanley and Maryhill Tills as a single aquitard hydrostratigraphic unit, which is a reasonable approach where no significant thickness of sand and gravel separate these units.

Aquitard ATC1 – Upper / Main 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. The Catfish Creek Till is a dense, stony, sandy silt to silty sand till with little clay content. Although originally deposited over the entire Cambridge area, erosion, glaciations and meltwater events have removed areas of the Catfish Creek Till and it is now discontinuous. In the Cambridge Area, the thickness of this unit ranges from approximately 5 m in areas east of the Grand River, to approximately 20 m west of the Grand River, and is usually found immediately overlying bedrock and beneath clayey sediments. 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.

2.4 Bedrock Geology and Conceptual Hydrostratigraphy

The stratigraphy discussed below is consistent with the revised stratigraphic framework described by the OGS (Brunton, 2009) and is also used in the Tier 3 Study of the area (Golder, 2011). The thickness of the Goat Island and Gasport Formations in the vicinity of H4A has been revised based on the Tier Three Assessment Update Project (Aqua Insight et al, 2023). A brief description (from Stantec, 2013) of each bedrock formation and conceptual hydrostratigraphic units typically present in Cambridge is provided below (from youngest to oldest). The formations present in the vicinity of H4A are shown on the cross sections in Figures 5 and 6.

The bedrock that sub crops beneath the Hespeler area was deposited in a marine environment during the Silurian Period. The thick deposits of carbonate rock, the source of water for all of the bedrock wells in Cambridge, is referred to as the Guelph / Gasport aquifer and is subdivided into Guelph, Eramosa and Gasport Formations.

Guelph Formation

The Guelph Formation is a cream-coloured fossiliferous dolostone that represents an important aquifer in the Cambridge and Guelph area, where it is most often the uppermost bedrock unit.

Eramosa Formation

The Upper Eramosa Formation is described by Brunton (2009) as light brown to cream coloured, pseudo nodular, thickly bedded and coarsely crystalline dolostone. The formation consists of the Reformatory Quarry Member, and the Vinemount Member.

The Reformatory Quarry Member is susceptible to karstification due to its uniform fine dolomite crystallinity (Brunton, 2009), and also often contains mud-rich and microbial mat bearing lithofacies. As a result, this unit generally represents a poor aquifer or poor aquitard. This unit was described as either the Guelph Formation or Eramosa Member in previous studies within the Region.

The Vinemount Member is comprised of thinly bedded, fine crystalline dolostone with shaley beds that give off a distinctive petroliferous odour when broken (Brunton, 2009). This unit represents an aquitard when present within the Cambridge and Guelph areas.

Goat Island Formation

The Goat Island Formation consists of the upper Ancaster Member and lower Niagara Falls Member. The Ancaster Member is a chert rich, finely crystalline dolostone that is medium to ash grey in colour. The Niagara Falls Member is a finely crystalline and cross laminated crinoidal grainstone with small reef mounds. The finely crystalline nature of these Members results in a lower hydraulic conductivity and transmissivity compared to the underlying Gasport Formation (Brunton, 2009). Conceptually, the two members of the Goat Island Formation are treated as a single hydrostratigraphic unit. Based on an updated interpretation provided by the Ontario Geological Survey (OGS; Brunton and Brintnell, 2020), the interpreted Goat Island Formation is about 50 m thicker at H5 / H5A than previously interpreted and the underlying Gasport Formation is interpreted to be thinner. Reef mounds are now interpreted to be associated with the Goat Island Formation. As a result, the highly transmissive reef mounds, crinoidal grainstones and coquina beds originally used to delineate the Upper and Middle portions of the Gasport Formation are now considered part of the Goat Island Formation. The Goat Island Formation is interpreted to represent the main supply aquifer for production well H4A.

Gasport (Amabel) Formation

The Gasport Formation is a cross-bedded crinoidal grainstone-packstone with sequences of reef mound and coquina (shell bed) lithofacies. This unit has commonly been referred to as the Amabel Formation in previous studies in the Region and is now interpreted to be much thinner than previously thought (Aqua Insight et al, 2023).

2.5 Local Geology

Figure 3 displays the Hespeler well plan and cross section locations. Representative cross-sections are included as Figures 5 and 6 to visualize the stratigraphy described in this section.

2.5.1 Overburden Geology

Investigations at the H4A site (Burnside, 2010) indicate that the overburden is approximately 15.3 m thick, and consists of layers of coarse grained sand and gravel as well as finer grained till deposits. The on site continuously cored overburden borehole (C-HP-OW1-08-D) revealed the overburden includes significant thicknesses of finer grained silt and clay, from depths of 2.7 to 4.3; 7.3 to 8.8 and 13.7 to 15.2 mbs, within the sand and gravel indicated on the original borehole log for well H4. These silt and clay layers likely provide greater localized protection from surface contaminant sources than previously thought for this location.

The thickness of the overburden in the general vicinity of the H4A well site is reported to be 18 m to the west in the area of C-CA-OW2-95.

2.5.2 Bedrock Geology

Rock core collected at the H4A site was originally logged by the OGS at the time of drilling in 2008. Table 4 is a summary of the formations encountered, as logged by the OGS. The Eramosa Formation is not present at H4A. The values in brackets are the reinterpreted thicknesses of the Guelph, Goat Island, Gasport and Rochester, Irondequoit and Rockway-Merritton Formations.

Table 4: Summary of Bedrock Formations at Hespeler Well Field (H4A)

Formation	Description	Thickness (m)	H4A Water Production (m bgs)
Overburden	Interbedded sand / Gravel and silt / clay	15.2	NA
Guelph	Dolostone – grey, crystalline, fossiliferous	38.7 (33.19)	Well casing extends to 52.4
Goat Island*		4.0 (50)	

Formation	Description	Thickness (m)	H4A Water Production (m bgs)
Gasport	Dolostone - grey, crystalline, slightly porous, moderately fossiliferous, mottled, vugs. 67.0 55, 70	67.0 (64.0)	55, 70, 100
Irondequoit	Dolostone - dark grey, slightly porous, sparsely fossiliferous, mottled, bedded, vugs.	2.6**	-
Rockway	Dolostone - dark grey, not fossiliferous, not vuggy or crystalline	1.7**	-
Merritton	Dolostone - dark grey, not fossiliferous, not vuggy or crystalline	0.7**	-
Cabot Head	Shale – grey and red layered	>3.2	-

*Not identified by OGS in 2008

**The combined thickness of the Rochester, Irondequoit and Rockway-Merritton Formations is now interpreted to be 5.06 m

The thicknesses of the Guelph and Gasport Formations at the H4A well site were re-interpreted to be 33.2 m and 64 m thick respectively. This is relatively consistent with a total thickness of 105 m for the Guelph / Goat Island / Gasport Formation identified 700 m to the southwest at C-CA-OW2-95 (Lotowater, 1997).

3.0 2024 / 2025 Results

In accordance with condition 4.2 of the PTTW, water levels were measured and recorded once a month in all listed monitoring wells.

The following sections summarize groundwater levels in the monitoring wells in relation to precipitation, 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 and Environment Canada station located closest to the production wells are used. The closest GRCA weather station relative to the Hespeler H4A well field is the Shades Mills Dam station located 6 km south. The closest Environment Canada station is the Waterloo International Airport (WIA) located 7.5 km to the west. 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 the Shades Mills Dam station, the long-term average was calculated from when measurements started until the end of 2025. The WIA has “Climate Normals” calculated by Environment Canada for 1971 to 2000.

Annual 2024 / 2025 precipitation data for the meteorological stations closest to the Hespeler H4A 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 these stations 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 ^(A)	874	+23	851	723	-128
Shades Mills Dam ^(B)	976	+67	909 ^A	895	-14
Sources: Environment Canada (1), GRCA (2) ^A 1991 to 2020 Normal ^B 1998-2024 data ^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 Shades Mills station was 976 mm, which is 67 mm above the long-term average, indicating 2024 was wetter-than-average at the well field. A similar 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 was 895 mm, which is 14 mm below the long-term average. Similarly, the total precipitation at the WIA station was 128 mm below the long-term average, indicating 2025 was a drier-than-average year. 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 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.

C-HP-OW2-95

C-HP-OW2-95 is located 670 m southwest of H4A and monitoring at the well nest started in 2001. There are numerous municipal supply wells within 2 km of C-HP-OW2-95-ABC that are completed at similar depths. Frequent water level monitoring during long-term pumping tests (Burnside, 2012) indicates that water levels in the A, B and C screens declined in response to pumping of H3 / H3A (about 5 m) at 40 L/s, H4 / H4A (about 4 m) at 55 L/s, and H5 / H5A (about 1.5 m) at 40L/s.

Water levels in 2024 / 2025 varied within a 3 m range with no obvious correlation to H4A pumping. Water levels observed in 2024 / 2025 were consistent with historical values. Monthly manual water levels in screens A, B (both in Gasport formation) and C (Lower Guelph formation to Reformatory Quarry Member), display similar trends (Hydrographs presented in Appendix C). Water level elevations in the A and B screen are almost identical while water levels in the C screen are about 0.4 m higher. There is no response to reduced pumping in H4A in December 2025. Monthly manual water levels in screen D (overburden / Guelph Formation bedrock contact) indicate minor seasonal fluctuations and no measurable response to pumping.

C-HP-OW1-08

C-HP-OW1-08 is located adjacent to H4A and monitoring at the well nest started in 2010. C-HP-OW1-08 includes three nested bedrock wells (A, B, and C screens) and an overburden well (D screen) completed in an adjacent borehole. The well cluster is located on the H4A property and all screens responded to pumping during the testing of H4A. Water levels have been collected at this location since December 2010.

Hydrographs are presented in Appendix C.

Water levels in the A, B and C screens have shown a declining trend from January 2021 to December 2025 although pumping has remained relatively stable. Water levels observed in 2024 / 2025 were consistent with historical values. Water level monitoring at the A and D screens is completed using monthly manual measurements. Monitoring of the B and C screens is completed using electronic dataloggers.

In January 2013, H4A replaced H4 as the primary well, and since then water levels in all screens show a direct response to pumping. The magnitude of response appears to be the most significant in the B screen (up to 15 m based on the August / September 2018 shutdown) which has resulted in a reversal in the hydraulic gradients between the B and C screens. As would be expected, periods of increased pumping correspond to lower

water levels across all screens while periods of reduced pumping or shut down correspond to higher water levels / recovery.

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.

All properties within 500 m of the H4A well are serviced with municipal water. 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). There were no well interference complaints related to H4A received in 2024 and 2025, therefore both condition 5.1 and 5.2 were met.

Other non-municipal groundwater and surface water takings registered in the MECP's PTTW database within 2 km of the well field are mapped in Figure 3 and summarized below in Table 6. The PTTW database identified two permits for Puslinch Lake Golf Course located to the east.

Table 6: PTTWs (Groundwater) in Vicinity of Hespeler Well Field (H4A)

Permit Number	Permit Holder	Purpose	Source	Max Liters per Day	Distance (km) from H4A Supply Wells	Expiry Date
6555-CUTKDL	Puslinch Lake Golf Course	Golf Irrigation	Irrigation Well	982,080	1.7	2026-02-28
6555-CUTKDL	Puslinch Lake Golf Course	Golf Irrigation	Irrigation Pond	1,022,040	1.7	2026-02-28

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 commencing June 30, 2020, 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)".

Levels in the Upper Gasport Aquifer, the main water supply aquifer for H4A, are primarily influenced by pumping at H4A in the vicinity of the well field. A clear response to pumping has been noted, with drawdown of up to approximately 14 m and rapid recovery when pumping decreased in December 2025, as observed in hydrographs from monitoring wells such as C-HP-OW1-08-ABC. Precipitation data was not found to correlate with any specific water level responses, and therefore the aquifer levels are not indicative of major seasonal influences.

5.0 Conclusions

Impacts from pumping the municipal wells at the Hespeler Well Field (H4A) 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 1008-BW6L62;
- There were no reported well interference complaints arising from water taking at the Hespeler H4A well field;
- Groundwater levels at C-HP-OW2-95-ABC and C-HP-OW1-08-ABCD in 2024/2025 are in line with historical data;
- Onsite monitors completed in deep / intermediate bedrock respond to pumping; and
- The onsite monitor in the overburden followed seasonal trends with a response to pumping of up to 1 m.

6.0 References

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R.J. Burnside & Associates Limited, 2009. Production Well H4A Construction and Testing Report, Regional Municipality of Waterloo.

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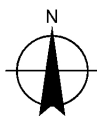
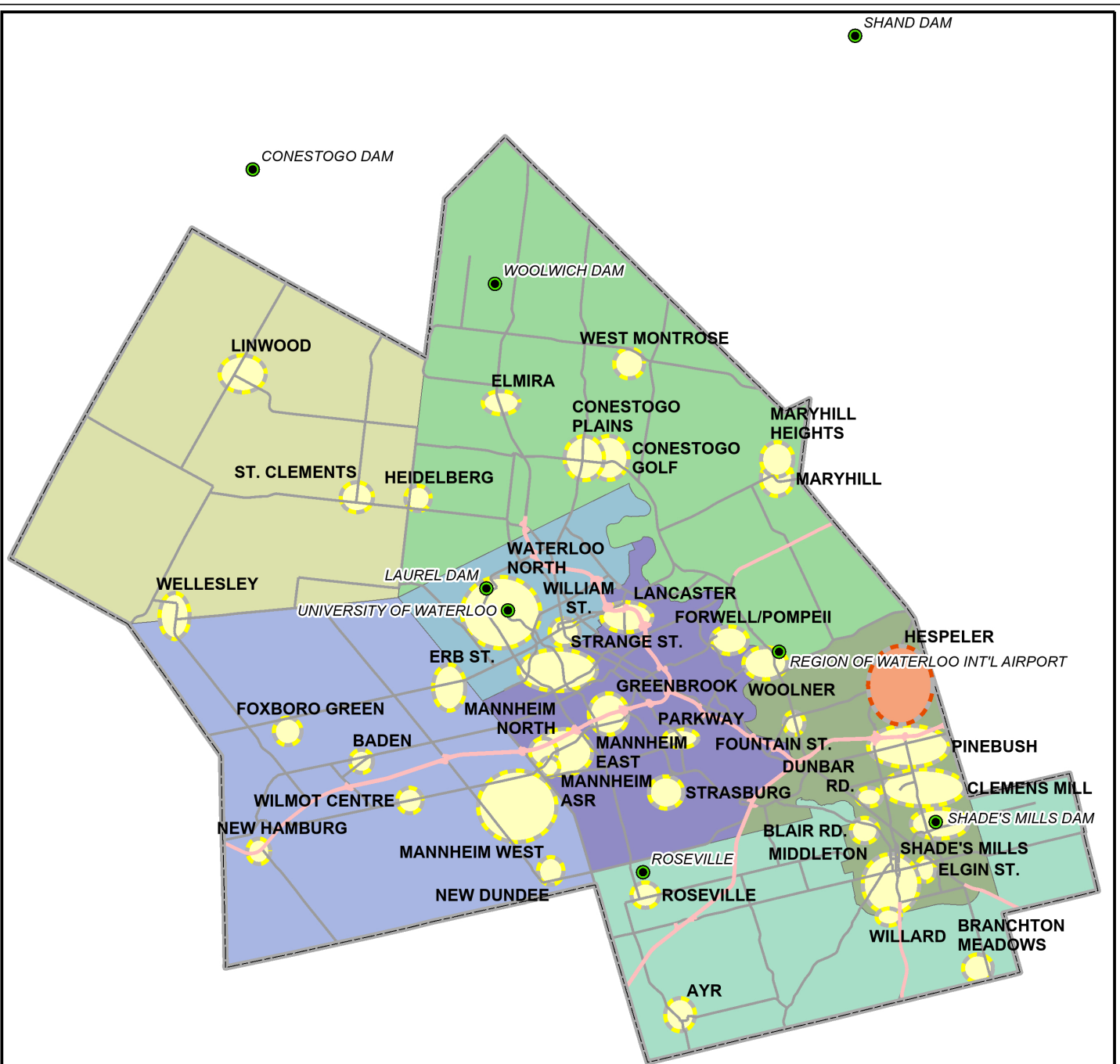


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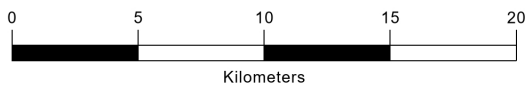
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Figures



Data Source:
Region of Waterloo; Includes material © 2012 of the Queen's
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- Well Field Location
- 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 -
HESPELER H4A WELL FIELD**

WELL FIELD LOCATION MAP

Client

REGION OF WATERLOO

Drawn

HN

Scale

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Checked

SQ

Date

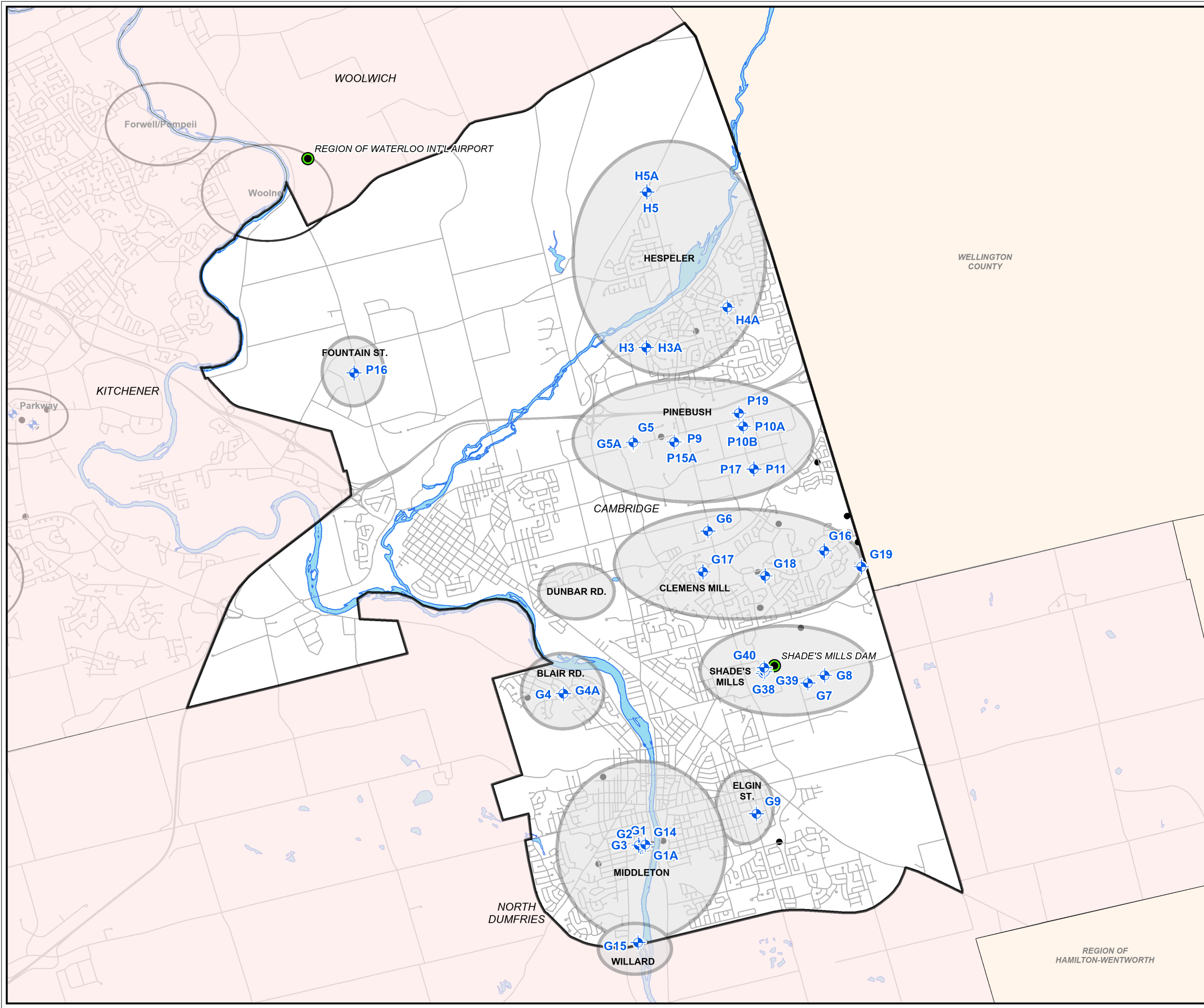
February 2026

Project No.

HA0464020

Figure No.

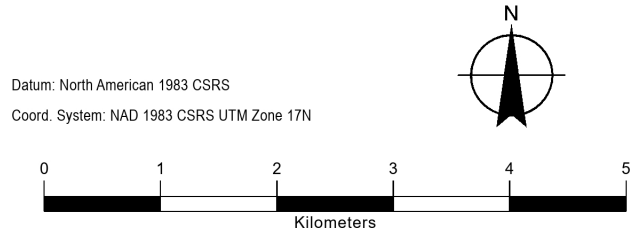
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- LEGEND**
- Production Well Location
 - Monitoring Well Location
 - Well Fields
 - Cambridge Municipal Boundary
 - Meteorological Monitoring Locations

Sources:

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



Client

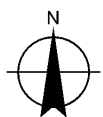
REGION OF WATERLOO

Figure Title

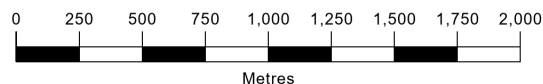
**2025 GROUNDWATER MONITORING
REPORT - HESPELER H4A WELL FIELD**

**CAMBRIDGE WELL FIELDS AND
MONITORING NETWORK**

Drawn	Checked	Date	Figure No.
HN	SQ	February 2026	
Scale		Project No.	
1:65,000		HA0464020	



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.



- ◆ PTTW Monitoring Well Location
- ◆ Nearby Monitoring Well Location
- ◆ Nearby Production Well Location
- ◆ Abandoned Well Location

Additional MECP PTTW Locations

- ◆ Groundwater
- ◆ Cross Section Orientation
- ◆ Intermittent Creek
- ◆ Creek
- ◆ Waterbody

- ◆ Provincially Significant Wetland (MNR)
- ◆ Provincial Highway
- ◆ Regional Road
- ◆ Local Road
- ◆ Private / Other Road
- ◆ Region of Waterloo Boundary



Map Title

2025 GROUNDWATER MONITORING REPORT - HESPELER H4A WELL FIELD

WELL LOCATION MAP

Client

REGION OF WATERLOO

Drawn

HN

Scale

1:30,000

Checked

SQ

Date

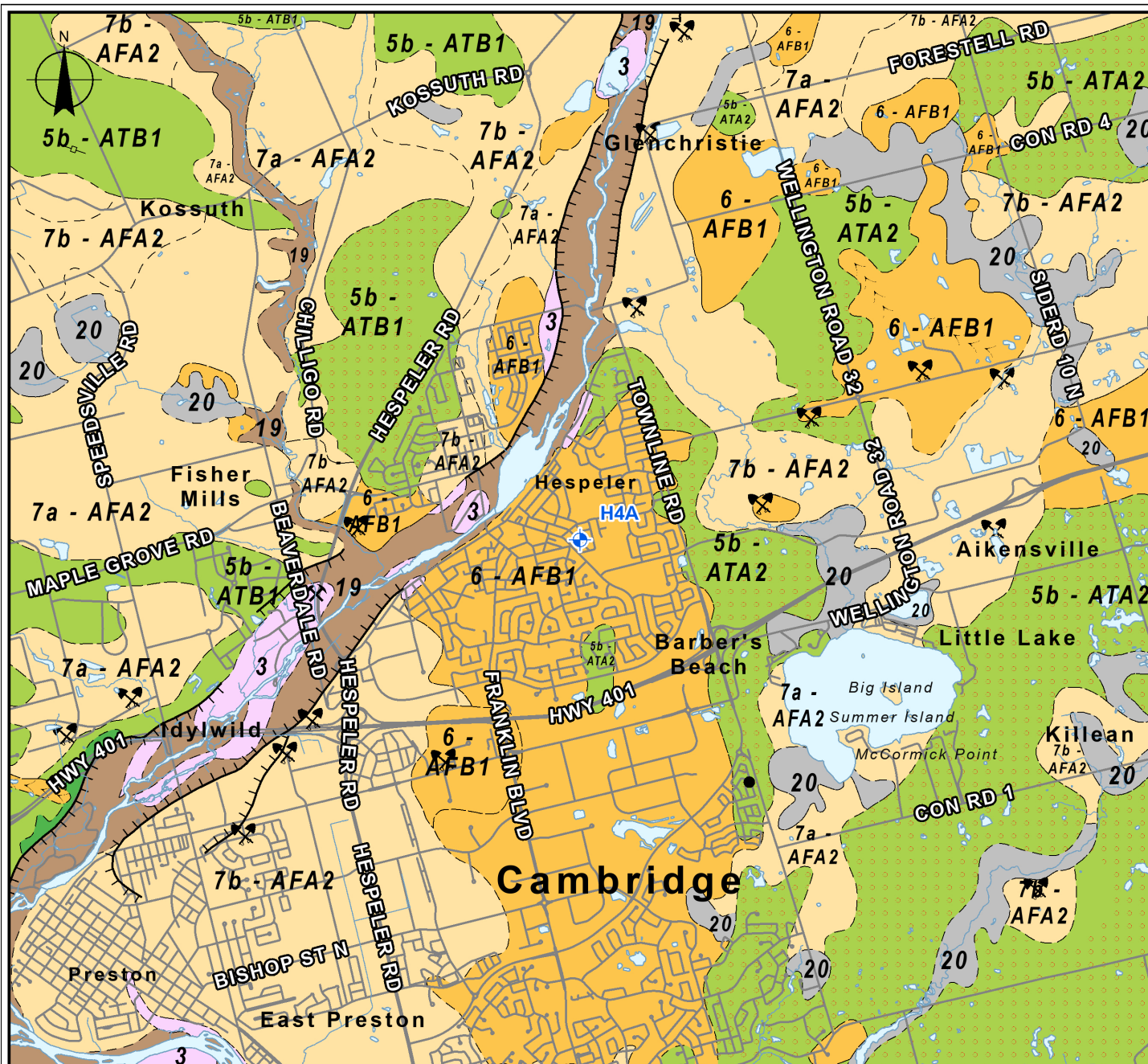
February 2026

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

RMOV Supply Well
 Watercourse
 Waterbody

Surficial Geology

3: Paleozoic bedrock

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)
 19: Modern alluvial deposits

20: Organic deposits
 Quarry (Point)
 Sand and Gravel Pit
 Esker: Direction of Flow Known
 Terrace
 Drumlin or drumlinoid ridges (point)

Sample Location
 Hummocky Topography
 Unit Contact
 Boundary



Map Title

2025 GROUNDWATER MONITORING REPORT - HESPELER H4A WELL FIELD

SURFICIAL GEOLOGY

Client

REGION OF WATERLOO

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Date

February 2026

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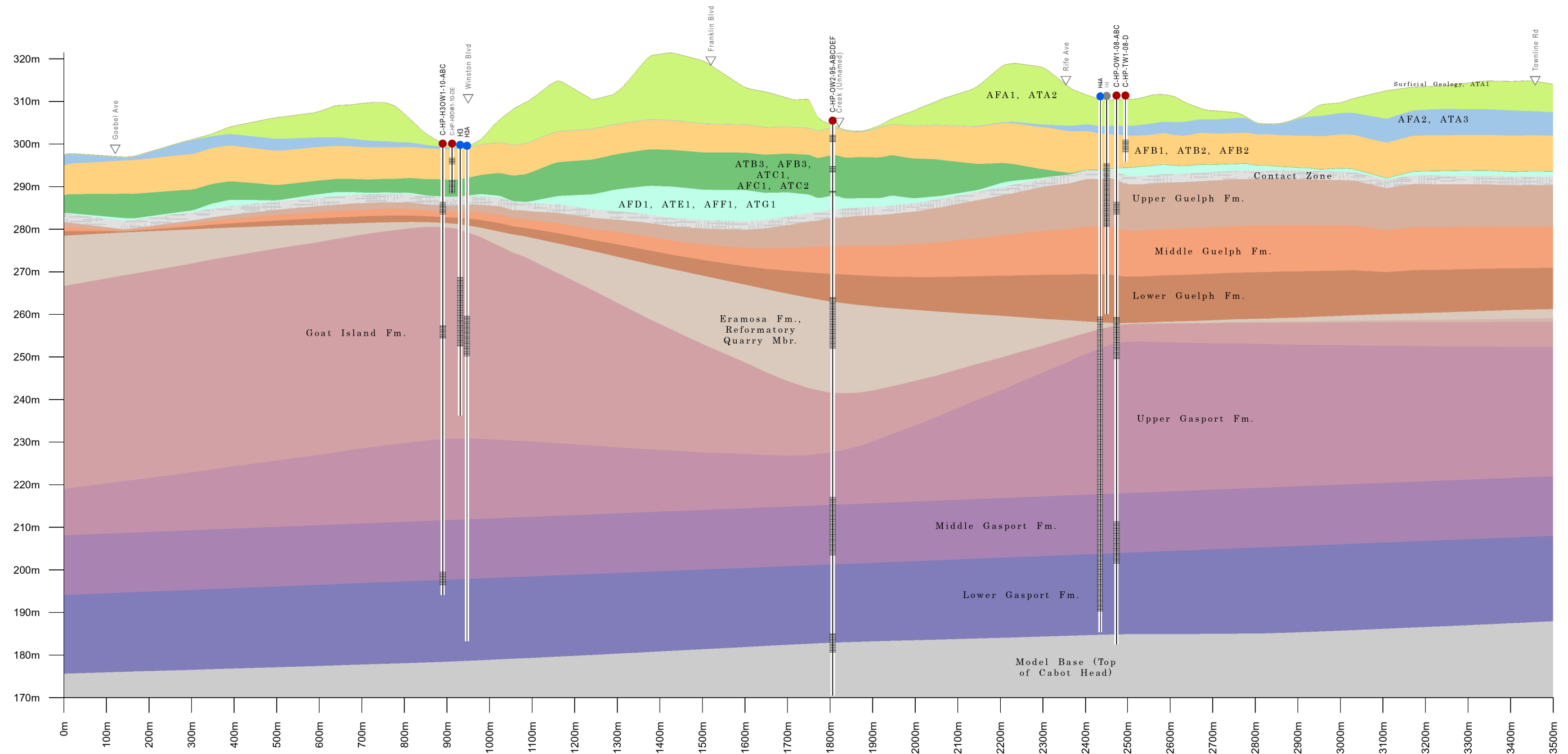
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Figure No.

4

A

A'

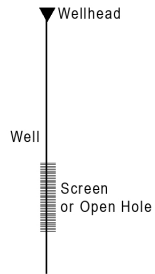


Wells

● Production Well (Active) ● Production Well (Decommissioned) ● Monitoring Well

Cambridge Model 2026

Surficial Geology, Whittlesey Clay (ATA1)	Upper Waterloo Moraine Stratified Sediments & Equivalents (AFB1), Middle Maryhill Till & Equivalents (ATB2), Middle Waterloo Moraine Stratified Sediments & Equivalents (AFB2)	Pre-Catfish Creek Coarse-Grained Glaciofluvial/ Lacustrine Deposits (AFD1), Canning Drift: Till & Fine Textured Glaciolacustrine Deposits (ATE1), Pre-Canning Coarse-Textured Glaciofluvial/ Glaciolacustrine Deposits (AFF1), Pre-Canning Coarse-Textured Till (ATG1)	Bedrock: Upper Guelph Fm.	Bedrock: Eramosa Fm., Vinemount Mbr.	Bedrock: Middle Gasport Fm.
Whittlesey Sand (AFA1), Wentworth Till (ATA2)	Lower Maryhill Till & stratified Equivalents (ATB3), Lower Waterloo Moraine Stratified Sediments or Catfish Creek Till Outwash (AFB3), Upper / Main Catfish Creek Till (ATC1), Middle Catfish Creek Stratified Deposits (AFC1), Lower Catfish Creek Till (ATC2)	Weathered Bedrock	Bedrock: Middle Guelph Fm.	Bedrock: Goat Island Fm.	Model Base (Top of Cabot Head)
Grand River Valley Outwash Deposits (AFA2), Fine Grain Deposits in the Grand River Valley (ATA3)			Bedrock: Lower Guelph Fm.	Bedrock: Lower Gasport Fm.	
			Bedrock: Eramosa Fm., Reformatory Quarry Mbr.	Bedrock: Upper Gasport Fm.	



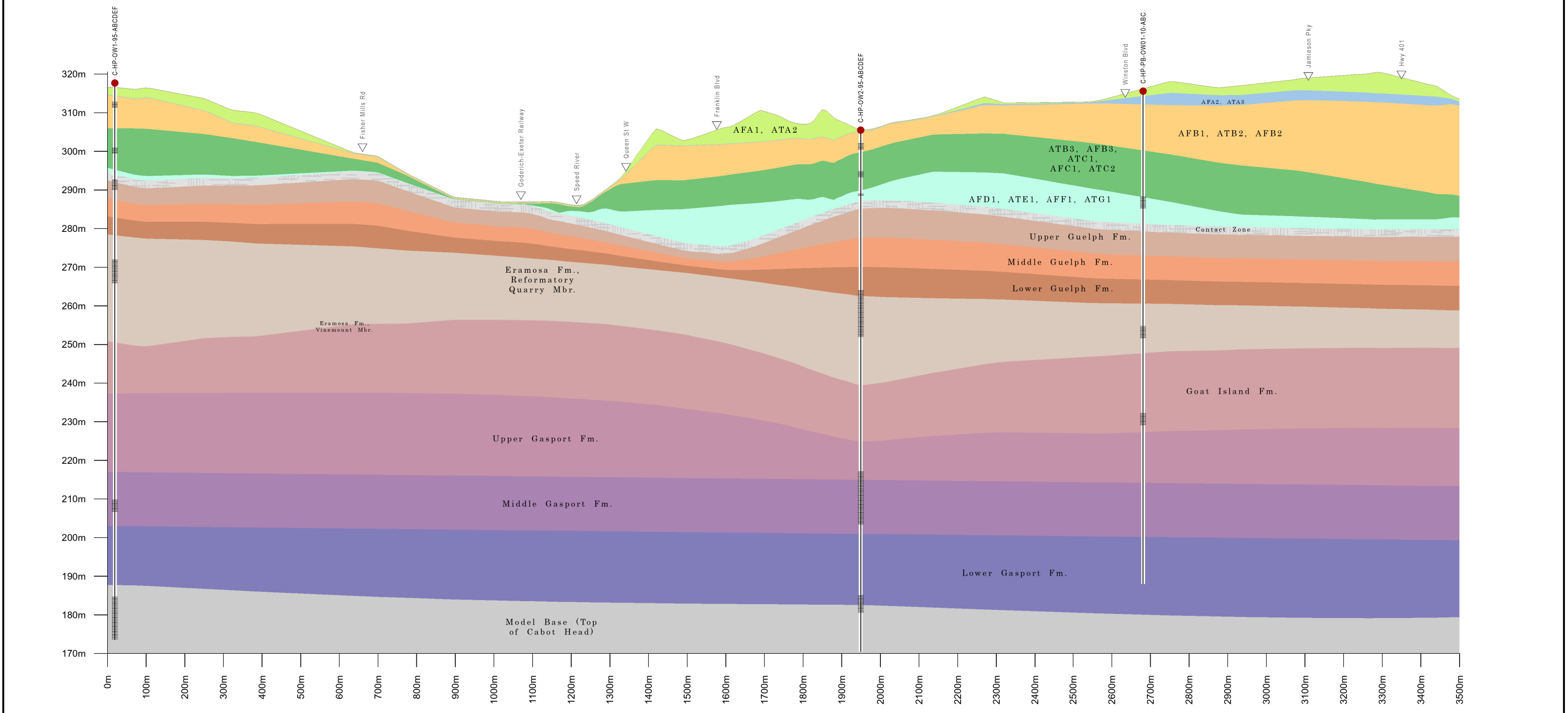
Client
REGION OF WATERLOO

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

Drawn	Checked	Date	Figure No.
PS	DH	2026/06/01	5
Horizontal Scale 1:10,000		Project No.	
Vertical Ex.:10x		HA046402	

B

B'



- Wells
- Monitoring Well

Cambridge Model 2026

Surficial Geology, Whittlesey Clay (ATA1)

Whittlesey Sand (AFA1), Wentworth Till (ATA2)

Grand River Valley Outwash Deposits (AFA2), Fine Grain Deposits in the Grand River Valley (ATA3)

Upper Waterloo Moraine Stratified Sediments & Equivalents (AFB1), Middle Maryhill Till & Equivalents (ATB2), Middle Waterloo Moraine Stratified Sediments & Equivalents (AFB2)

Lower Maryhill Till & stratified Equivalents (ATB3), Lower Waterloo Moraine Stratified Sediments or Catfish Creek Till Outwash (AFB3), Upper / Main Catfish Creek Till (ATC1), Middle Catfish Creek Stratified Deposits (AFC1), Lower Catfish Creek Till (ATC2)

Pre-Catfish Creek Coarse-Grained Glaciofluvial/ Lacustrine Deposits (AFD1), Canning Drift: Till & Fine Textured Glaciolacustrine Deposits (ATE1), Pre-Canning Coarse-Textured Glaciofluvial/ Glaciolacustrine Deposits (AFF1), Pre-Canning Coarse-Textured Till (ATG1)

Weathered Bedrock

Bedrock: Upper Guelph Fm.

Bedrock: Middle Guelph Fm.

Bedrock: Lower Guelph Fm.

Bedrock: Eramosa Fm., Reformatory Quarry Mbr.

Bedrock: Eramosa Fm., Vinemount Mbr.

Bedrock: Goat Island Fm.

Bedrock: Lower Gasport Fm.

Bedrock: Upper Gasport Fm.

Bedrock: Middle Gasport Fm.

Model Base (Top of Cabot Head)

Wellhead

Well

Screen or Open Hole

Client

REGION OF WATERLOO

Figure Title

**GEOLOGIC CROSS SECTION
REGION OF WATERLOO**
Hespeler
Cross Section B - B'

Drawn

Checked

Date

Figure No.

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2026/06/01

6

Horizontal Scale 1:10,000

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Appendix A

Permit To Take Water

AMENDED PERMIT TO TAKE WATER

Ground Water
NUMBER 1008-BW6L62

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 from: One Well (H4A)

Located at: Lot 9, Concession 3 Beasley Lower Block, Geographic Township of Cambridge
Cambridge, 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. 1008-BW6L62 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 February 26, 2020 and signed by Karl Belan, 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, 2030**. 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	H4A	Well Drilled	Municipal	Water Supply	1,440	24	2,073,600	365	17 556689 4808868
						Total Taking:	2,073,600		

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:
- C-HP-OW1-08-A
C-HP-OW1-08-B
C-HP-OW1-08-C
C-HP-OW1-08-D
C-HP-OW2-95-A
C-HP-OW2-95-B
C-HP-OW2-95-C
C-HP-OW2-95-D
- 4.3 The Permit Holder shall prepare and submit a report every two years by June 30 commencing June 30, 2022, 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, Conservation
and Parks
Floor 1, 135 St Clair Ave W
Toronto, ON
M4V 1P5*

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 4627-BQVJE9, issued on 2020/06/26.

Dated at Toronto this 10th day of December, 2020.



Gregory Meek
Director, Section 34.1
Ontario Water Resources Act , R.S.O. 1990

Schedule A

This Schedule “A” forms part of Permit To Take Water 1008-BW6L62, dated December 10, 2020.



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Appendix B

Well Records

LOG OF DRILLING OPERATIONS

H4-TW2A-08

Page 1 of 6



BURNSIDE

R.J. Burnside & Associates Limited
15 Tremaine, Orangeville, Ontario L9W 3R4
telephone (519) 941-5331 fax (519) 941-8120

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 27/05/2008	Static Water Level (m amsl):
Drilling Method: Mud Rotary	Date Completed: 30/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)		SAMPLE				Depth Scale (ft) (m)
					Num.	Type	Int.		
0.0	TOPSOIL - black, moist.		0.30						0.0
1.0	SILTY SAND - fine, light brown, dry.								1.0
5.0									5.0
2.0									2.0
10.0	SILTY CLAY - light brown, moist to wet.		2.74						10.0
3.0									3.0
4.0									4.0
15.0	SILT - fine, brown, dry.		4.27						15.0
5.0	SILTY SAND - with some gravel, moist to wet.		4.88						5.0
20.0									20.0
6.0									6.0
7.0									7.0
25.0	SILT - dense, brown, moist.		7.32						25.0
8.0									8.0
30.0	SAND - medium grained with trace of gravel, brown, moist.		8.84						30.0
10.0									10.0
35.0									35.0
11.0									11.0
40.0									40.0
12.0									12.0
13.0									13.0
45.0	SILTY CLAY - with gravel, grey brown, wet.		13.72						45.0
14.0									14.0
50.0	DOLOSTONE - grey		15.24						50.0
16.0									16.0
55.0									55.0
17.0									17.0
60.0									60.0
18.0									18.0
19.0									19.0
65.0									65.0
20.0									20.0
70.0									70.0
21.0									21.0

steel casing

NR

open hole bedrock

WC

Prepared By: **S. Quinlan**Checked By: **J. Baxter**Date Prepared: **12/06/2008**

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LEGEND

- ▼ Water found @ time of drilling
 ▽ Static Water Level -

MONITORING WELL DATA

Pipe:
Screen:

SAMPLE TYPE

- AC Auger Cutting
 CS Continuous
 RC Rock Core
 SS Split Spoon
 AR Air Rotary
 WC Wash Cuttings

BHLOG GUELPH P:\GINT\PROJECTS\MTA14155\H4 TW1A & TW2A.GPJ TEMPLATE.GDT 16/12/08



BURNSIDE

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15 Tremaine, Orangeville, Ontario L9W 3R4
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LOG OF DRILLING OPERATIONS

H4-TW2A-08

Page **2** of **6**

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 27/05/2008	Static Water Level (m amsl):
Drilling Method: Mud Rotary	Date Completed: 30/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)	SAMPLE				Depth Scale (ft) (m)
				Num.	Type	Int.		
75.0 23.0								75.0 23.0
80.0 24.0					WC			80.0 24.0
85.0 25.0								85.0 25.0
90.0 26.0					WC			90.0 26.0
95.0 27.0								95.0 27.0
100.0 28.0								100.0 28.0
105.0 29.0	DOLOSTONE - light grey		28.96		WC			105.0 29.0
110.0 30.0								110.0 30.0
115.0 31.0								115.0 31.0
120.0 32.0					WC			120.0 32.0
125.0 33.0								125.0 33.0
130.0 34.0					WC			130.0 34.0
135.0 35.0	DOLOSTONE - grey		35.05					135.0 35.0
140.0 36.0					WC			140.0 36.0
145.0 37.0								145.0 37.0
150.0 38.0								150.0 38.0
155.0 39.0					WC			155.0 39.0
160.0 40.0								160.0 40.0
165.0 41.0								165.0 41.0
170.0 42.0								170.0 42.0
175.0 43.0					WC			175.0 43.0

open hole bedrock

Prepared By: **S. Quinlan** Checked By: **J. Baxter** Date Prepared: **12/06/2008**

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LEGEND

- Water found @ time of drilling
- Static Water Level -

MONITORING WELL DATA

Pipe:
Screen:

SAMPLE TYPE

- AC Auger Cutting
- CS Continuous
- RC Rock Core
- SS Split Spoon
- AR Air Rotary
- WC Wash Cuttings

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LOG OF DRILLING OPERATIONS

H4-TW2A-08

Page **3** of **6**

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 27/05/2008	Static Water Level (m amsl):
Drilling Method: Mud Rotary	Date Completed: 30/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)		SAMPLE				Depth Scale (ft) (m)
					Num.	Type	Int.		
145.0									145.0
45.0									45.0
150.0						WC			150.0
46.0									46.0
47.0									47.0
155.0	DOLOSTONE - dark grey		47.24						155.0
48.0									48.0
160.0						WC			160.0
49.0									49.0
50.0									50.0
165.0	DOLOSTONE - light grey		50.29						165.0
51.0									51.0
170.0						WC			170.0
52.0									52.0
53.0									53.0
175.0									175.0
54.0									54.0
180.0						WC			180.0
55.0				open hole bedrock					55.0
185.0									185.0
56.0									56.0
190.0						WC			190.0
57.0									57.0
195.0									195.0
58.0									58.0
200.0						WC			200.0
59.0									59.0
205.0									205.0
60.0	DOLOSTONE - grey		59.44						60.0
210.0									210.0
61.0						WC			61.0
215.0									215.0
62.0									62.0
220.0									220.0
63.0									63.0
225.0									225.0
64.0						WC			64.0
230.0									230.0
65.0									65.0
235.0	DOLOSTONE - light grey		65.53						235.0

Prepared By: **S. Quinlan** Checked By: **J. Baxter** Date Prepared: **12/06/2008**

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LEGEND

- ▼ Water found @ time of drilling
- ▽ Static Water Level -

MONITORING WELL DATA

Pipe:
Screen:

SAMPLE TYPE

- | | | | | | |
|----|--|---------------|----|--|---------------|
| AC | | Auger Cutting | SS | | Split Spoon |
| CS | | Continuous | AR | | Air Rotary |
| RC | | Rock Core | WC | | Wash Cuttings |

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H4-TW2A-08

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 27/05/2008	Static Water Level (m amsl):
Drilling Method: Mud Rotary	Date Completed: 30/05/2008	Sand Pack (m amsl):

P:\GINT\PROJECTS\MIMTA14155\H4 TW1A & TW2A.GPJ TEMPLATE.GDT 16/12/08

Date Prepared: 12/06/2008

LEGEND

MONITORING WELL DATA

Pipe:

Screen:

SAMPLE TYPE

AC

CS

RC

 Auger Cutting Continuous Rock Core

SS

AR

WC

 Split Spoon

 Air Rotary

 Wash Cuttings



BURNSIDE

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LOG OF DRILLING OPERATIONS

H4-TW2A-08

Page **5** of **6**

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 27/05/2008	Static Water Level (m amsl):
Drilling Method: Mud Rotary	Date Completed: 30/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)			SAMPLE				Depth Scale (ft) (m)
						Num.	Type	Int.		
290.0	DOLOSTONE - grey		102.11		open hole bedrock		WC			290.0
89.0										89.0
295.0										295.0
90.0										90.0
91.0										91.0
300.0							WC			300.0
92.0										92.0
305.0										305.0
93.0										93.0
94.0										94.0
310.0							WC			310.0
95.0										95.0
315.0										315.0
96.0										96.0
97.0										97.0
320.0							WC			320.0
98.0										98.0
325.0										325.0
99.0										99.0
100.0										100.0
330.0							WC			330.0
101.0										101.0
335.0										335.0
102.0										102.0
340.0							WC			340.0
103.0										103.0
345.0										345.0
104.0										104.0
350.0							WC			350.0
105.0										105.0
355.0										355.0
106.0										106.0
360.0							WC			360.0
107.0										107.0
365.0										365.0
108.0										108.0
370.0										370.0
109.0										109.0
375.0										375.0
110.0										110.0

Prepared By: **S. Quinlan** Checked By: **J. Baxter** Date Prepared: **12/06/2008**

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LEGEND

- Water found @ time of drilling
- Static Water Level -

MONITORING WELL DATA

Pipe:
Screen:

SAMPLE TYPE

- | | | | |
|----|---------------|----|---------------|
| AC | Auger Cutting | SS | Split Spoon |
| CS | Continuous | AR | Air Rotary |
| RC | Rock Core | WC | Wash Cuttings |

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LOG OF DRILLING OPERATIONS

H4-TW2A-08

Page **6** of **6**

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 27/05/2008	Static Water Level (m amsl):
Drilling Method: Mud Rotary	Date Completed: 30/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)	SAMPLE				Depth Scale (ft) (m)
				Num.	Type	Int.		
365.0 111.0	DOLOSTONE - dark grey		117.35					365.0 111.0
370.0 112.0					WC			370.0 112.0
375.0 113.0								375.0 113.0
380.0 114.0					WC			380.0 114.0
385.0 115.0								385.0 115.0
390.0 116.0					WC			390.0 116.0
395.0 117.0	open hole bedrock		125.73					395.0 117.0
400.0 118.0					WC			400.0 118.0
405.0 119.0								405.0 119.0
410.0 120.0					WC			410.0 120.0
415.0 121.0								415.0 121.0
420.0 122.0					WC			420.0 122.0
425.0 123.0								425.0 123.0
430.0 124.0								430.0 124.0
435.0 125.0								435.0 125.0

Prepared By: **S. Quinlan**

Checked By: **J. Baxter**

Date Prepared: **12/06/2008**

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LEGEND

- Water found @ time of drilling
- Static Water Level -

MONITORING WELL DATA

Pipe:
Screen:

SAMPLE TYPE

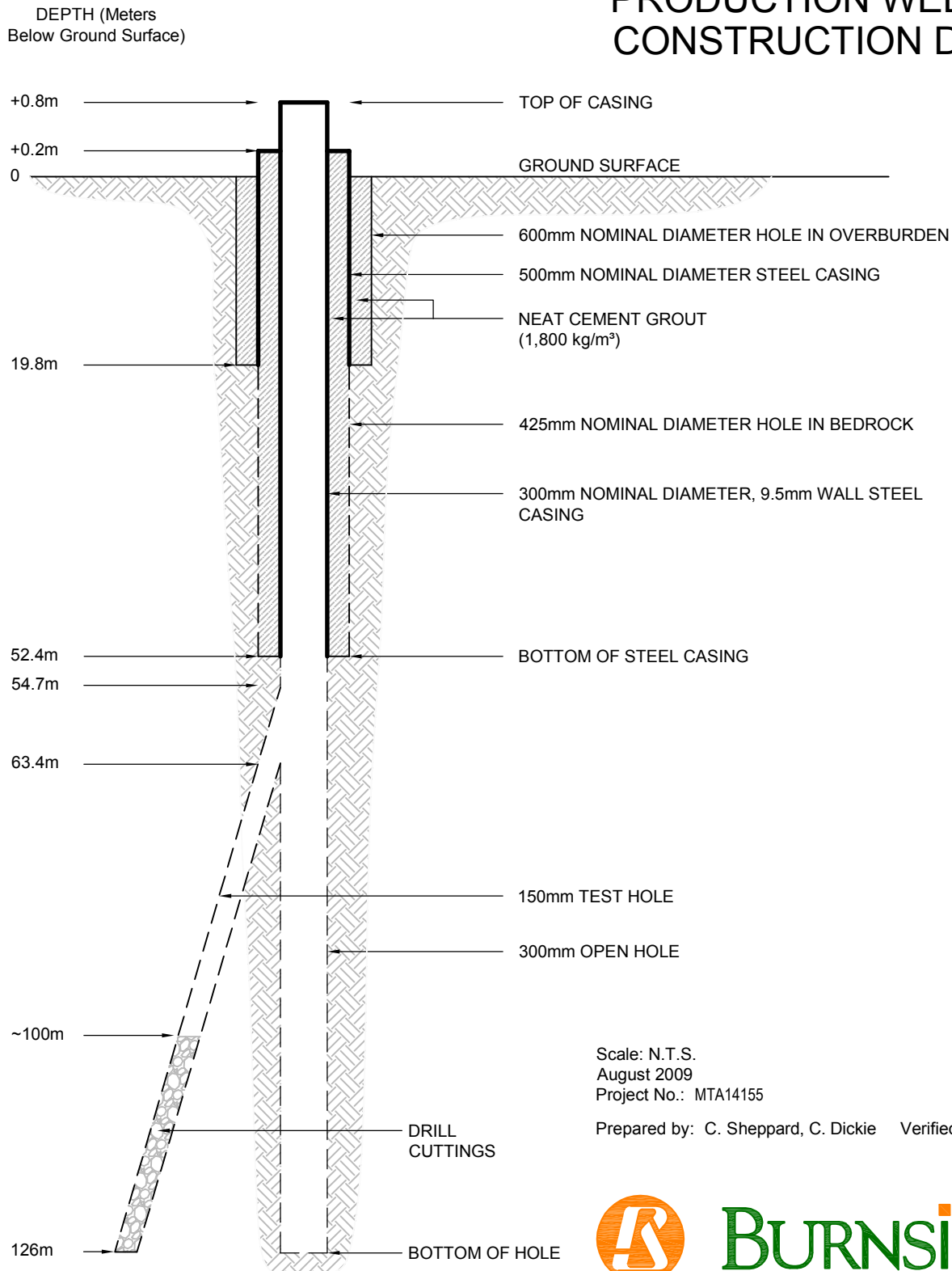
- AC Auger Cutting
- CS Continuous
- RC Rock Core
- SS Split Spoon
- AR Air Rotary
- WC Wash Cuttings

BHLOG GUELPH P:\GINT\PROJECTS\MTA14155\H4 TW1A & TW2A.GPJ TEMPLATE.GDT 16/12/08

FIGURE 8

REGION OF WATERLOO
CITY OF CAMBRIDGE

WELL H4A CONSTRUCTION & TESTING REPORT

PRODUCTION WELL H4A
CONSTRUCTION DETAIL

Scale: N.T.S.
August 2009
Project No.: MTA14155

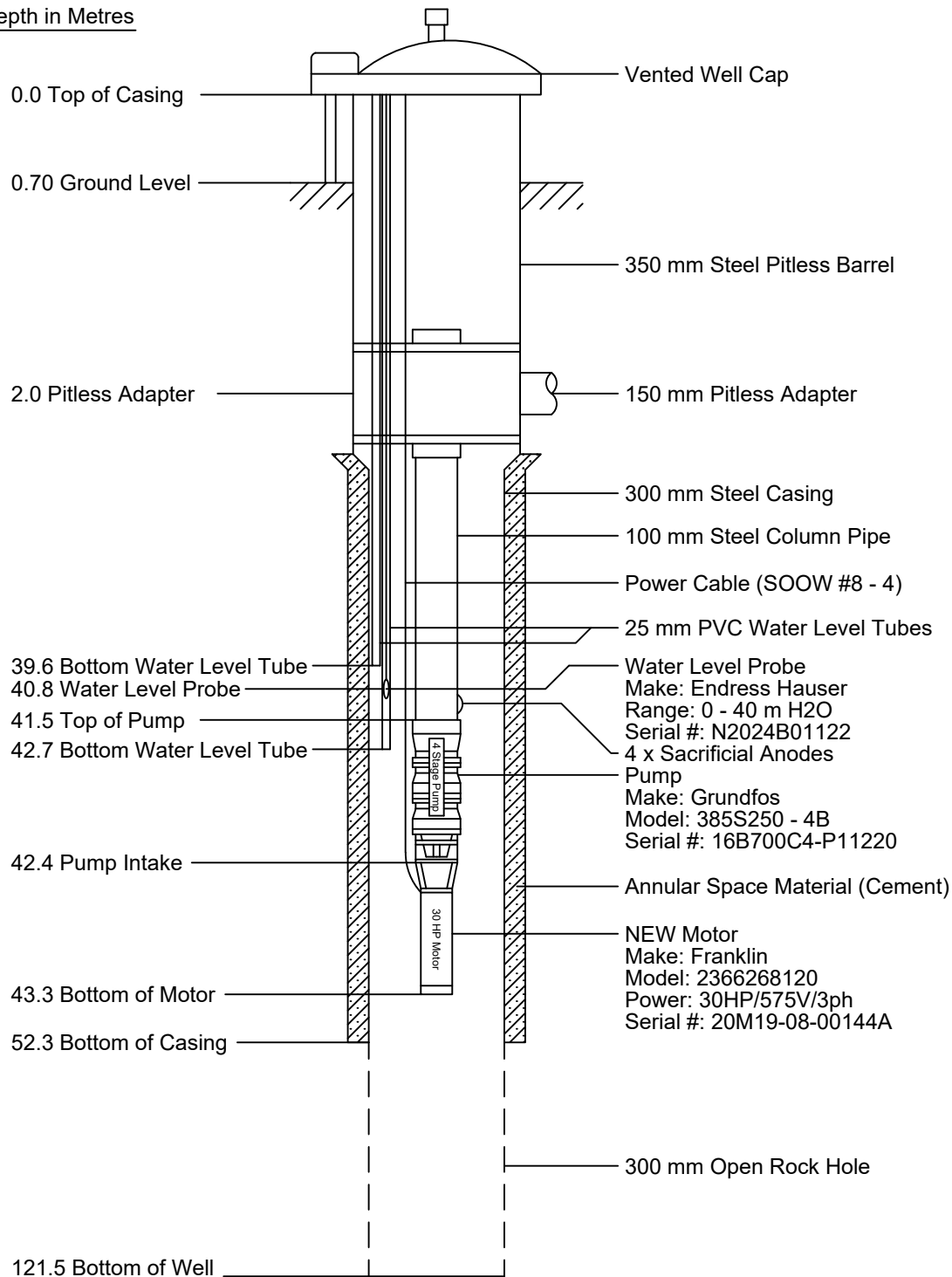
Prepared by: C. Sheppard, C. Dickie Verified by: J. Baxter



BURNSIDE

MTA14155 H4A WELL CONSTRUCTION & TESTING DETAIL.dwg

Depth in Metres



CLIENT

REGIONAL MUNICIPALITY OF WATERLOO

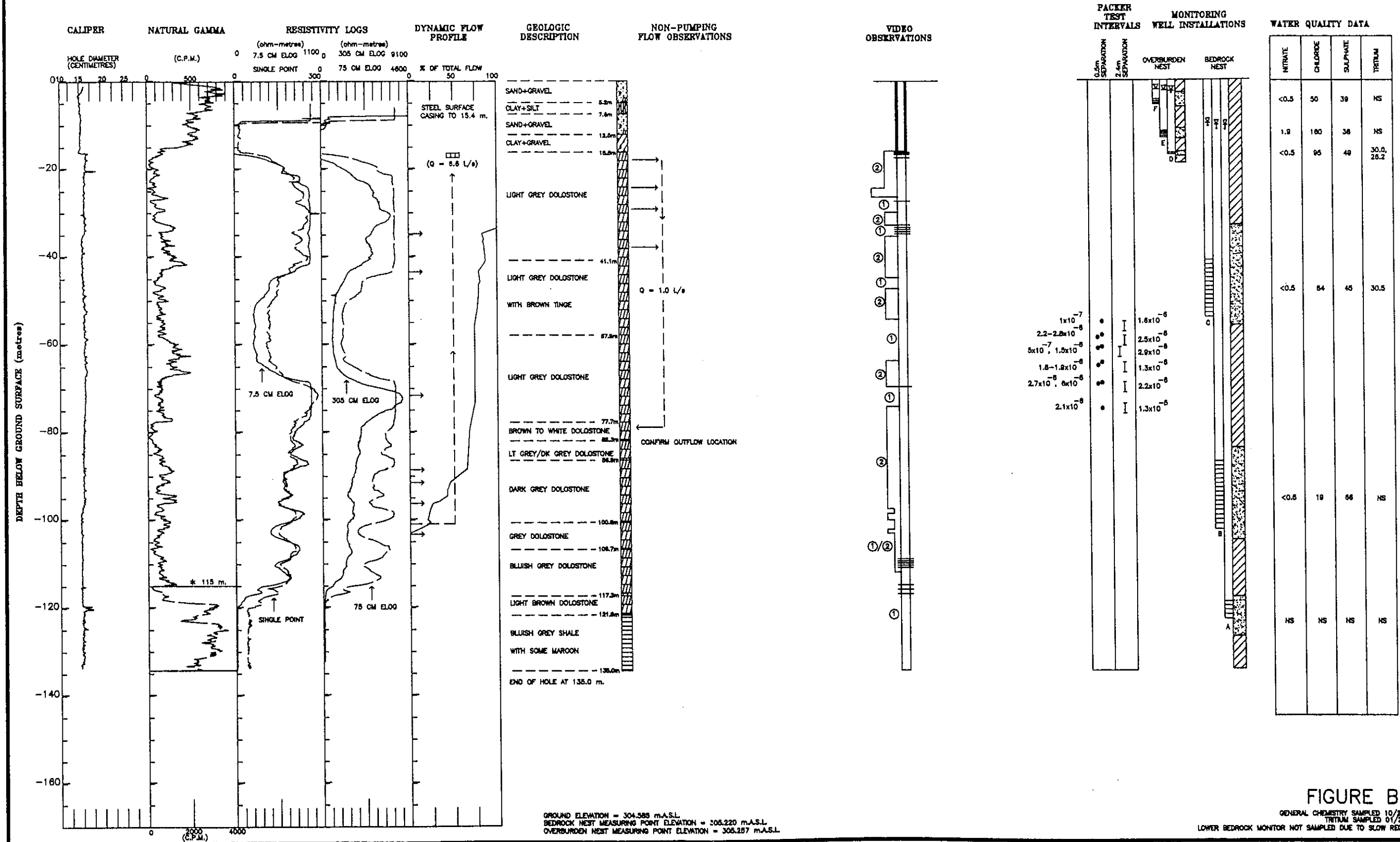
TITLE

WELL H4A
PUMP INSTALLATION DRAWING

PROJECT #: 006-497			G:\Lotowater Projects\006 Region of Waterloo\497 Well H4A Service\Pump Install.dwg		
DESIGN			REVISION No. 2021-01-15	SCALE N.T.S	FIGURE 3
DRAWN	EH	2021/01/15			
CHECKED	BP	2021/01/20			

93.11 (10003.1)

TEST HOLE/MONITORING WELL OW2/95 WOODLAND PARK



LOG OF DRILLING OPERATIONS

H4-TW1A-08

Page 1 of 6



BURNSIDE

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15 Lawrence Gardens, Oranmore, Co. DU
telephone (01518) 941-5031 fax (01518) 941-8120

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 15/05/2008	Static Water Level (m amsl):
Drilling Method: PQ Coring	Date Completed: 23/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)		SAMPLE				Depth Scale (ft) (m)
					Num.	Type	Int.	%Recov.	
1.0	TOPSOIL - black, moist.		0.30						1.0
5.0	SILTY SAND - fine, light brown, dry.								5.0
10.0	SILTY CLAY - light brown, moist to wet.		2.74						10.0
15.0	SILT - fine, brown, dry.		4.27						15.0
20.0	SILTY SAND - with some gravel, moist to wet.		4.88						20.0
25.0	SILT - dense, brown, moist.		7.32						25.0
30.0	SAND - medium grained with trace of gravel, brown, moist.		8.84						30.0
35.0									35.0
40.0									40.0
45.0									45.0
50.0	SILTY CLAY - with gravel, grey brown, wet.		13.72						50.0
55.0	DOLOSTONE - grey, crystalline, few fractures.		15.24						55.0
60.0									60.0
65.0									65.0
70.0									70.0

steel casing

NR

0

open hole bedrock

RC

100

Prepared By: S. Quinlan

Checked By: J. Baxter

Date Prepared: 12/06/2008

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LEGEND

▼ Water found @ time of drilling
▽ Static Water Level -

MONITORING WELL DATA

Pipe:
Screen:

SAMPLE TYPE

AC Auger Cutting
CS Continuous
RC Rock Core
SS Split Spoon
AR Air Rotary
WC Wash Cuttings



R. J. Burnside & Associates Limited
15 Tremblay, Burlington, Ontario L7R 3H4
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LOG OF DRILLING OPERATIONS

H4-TW1A-08

Page 2 of 6

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 15/05/2008	Static Water Level (m amsl):
Drilling Method: PQ Coring	Date Completed: 23/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)	SAMPLE				Depth Scale (ft) (m)
				Num.	Type	Int.	%Recov.	
75.0-23.0	DOLOSTONE - light grey, crystalline, small vugs, massive		21.95		RC		100	75.0-23.0
80.0-24.0								80.0-24.0
85.0-25.0	DOLOSTONE - grey-blue, crystalline, few vugs, porous, massive.		24.99		RC		100	85.0-25.0
90.0-26.0								90.0-26.0
95.0-27.0	DOLOSTONE - light grey-blue,		27.74		RC		100	95.0-27.0
100.0-28.0								100.0-28.0
105.0-29.0					RC		100	105.0-29.0
110.0-30.0								110.0-30.0
115.0-31.0	DOLOSTONE - tan-light grey, crystalline, massive, porous, coral reef structure.		34.14		RC		100	115.0-31.0
120.0-32.0								120.0-32.0
125.0-33.0					RC		100	125.0-33.0
130.0-34.0	DOLOSTONE - grey, porous, vuggy, coral.		39.17		RC		100	130.0-34.0
135.0-35.0	DOLOSTONE - dark grey, crystalline, porous		40.54					135.0-35.0
140.0-36.0	DOLOSTONE - light grey, crystalline, vuggy, slightly porous.		42.06		RC		100	140.0-36.0
143.0-37.0								143.0-37.0

Prepared By: **S. Quinlan** Checked By: **J. Baxter** Date Prepared: **12/06/2008**

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LEGEND

- Water found @ time of drilling
- Static Water Level -

MONITORING WELL DATA

Pipe:
Screen:

SAMPLE TYPE

- | | | | |
|----|---------------|----|---------------|
| AC | Auger Cutting | SS | Split Spoon |
| CS | Continuous | AR | Air Rotary |
| RC | Rock Core | WC | Wash Cuttings |

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15 Eglinton Avenue East, Toronto, ON M4P 1B4
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LOG OF DRILLING OPERATIONS

H4-TW1A-08

Page 3 of 6

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 15/05/2008	Static Water Level (m amsl):
Drilling Method: PQ Coring	Date Completed: 23/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)	SAMPLE				Depth Scale (ft) (m)
				Num.	Type	Int.	%Recov.	
145.0					RC		100	145.0
150.0								150.0
155.0								155.0
160.0	DOLOSTONE - dark grey, crystalline, moderately porous.		48.16		RC		100	160.0
165.0	DOLOSTONE - light grey, fine crystalline, slightly porous.		49.88					165.0
170.0					RC		100	170.0
175.0								175.0
180.0	DOLOSTONE - dark grey, medium crystalline, slightly porous.		53.98		RC		100	180.0
185.0	DOLOSTONE - grey, fine crystalline, slightly porous, vugs.		55.47					185.0
190.0	DOLOSTONE - light grey, fine crystalline, slightly porous.		57.30		RC		100	190.0
195.0								195.0
200.0					RC		100	200.0
205.0								205.0
210.0					RC		100	210.0
215.0	DOLOSTONE - white, fine crystalline, slightly porous.		64.92					215.0

open hole bedrock

Prepared By: S. Quinlan	Checked By: J. Baxter	Date Prepared: 12/06/2008
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LEGEND Water found @ time of drilling Static Water Level -	MONITORING WELL DATA Pipe: Screen:	SAMPLE TYPE AC Auger Cutting CS Continuous RC Rock Core SS Split Spoon AR Air Rotary WC Wash Cuttings
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BHLOG GUELPH P:\GINT\PROJECTS\MMTA14155\H4 TW1A & TW2A.GPJ TEMPLATE.GDT 16/12/08



R. J. Burnside & Associates Limited
15 Burnside Drive, Burnside, SA 5061
Telephone: 08 836 5031 Fax: 08 836 9011

LOG OF DRILLING OPERATIONS

H4-TW1A-08

Page 4 of 6

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 15/05/2008	Static Water Level (m amsl):
Drilling Method: PQ Coring	Date Completed: 23/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)	SAMPLE				Depth Scale (ft) (m)
				Num.	Type	Int.	%Recov.	
220.0 - 67.0	DOLOSTONE - light grey, slightly porous, fine crystalline, moderately fossiliferous, vugs.		67.97		RC		100	220.0 - 67.0
225.0 - 68.0					RC		100	225.0 - 68.0
230.0 - 69.0					RC		100	230.0 - 69.0
235.0 - 70.0	DOLOSTONE - dark grey, crystalline, slightly porous, moderately fossiliferous, mottled, vugs.		74.98		RC		100	235.0 - 70.0
240.0 - 71.0					RC		100	240.0 - 71.0
245.0 - 72.0					RC		100	245.0 - 72.0
250.0 - 73.0	open hole bedrock				RC		100	250.0 - 73.0
255.0 - 74.0					RC		100	255.0 - 74.0
260.0 - 75.0					RC		100	260.0 - 75.0
265.0 - 76.0					RC		100	265.0 - 76.0
270.0 - 77.0					RC		100	270.0 - 77.0
275.0 - 78.0					RC		100	275.0 - 78.0
280.0 - 79.0					RC		100	280.0 - 79.0
285.0 - 80.0					RC		100	285.0 - 80.0
290.0 - 81.0					RC		100	290.0 - 81.0

Prepared By: **S. Quinlan** Checked By: **J. Baxter** Date Prepared: **12/06/2008**
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LEGEND	MONITORING WELL DATA	SAMPLE TYPE
Water found @ time of drilling	Pipe:	AC Auger Cutting
Static Water Level -	Screen:	CS Continuous
		RC Rock Core
		SS Split Spoon
		AR Air Rotary
		WC Wash Cuttings

BHLOG GUELPH P:\GINT\PROJECTS\MTA14155\H4 TW1A & TW2A.GPJ TEMPLATE.GDT 16/12/08



R.J. Burnside & Associates Limited
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LOG OF DRILLING OPERATIONS

H4-TW1A-08

Page 5 of 6

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 15/05/2008	Static Water Level (m amsl):
Drilling Method: PQ Coring	Date Completed: 23/05/2008	Sand Pack (m amsl):

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)	SAMPLE				Depth Scale (ft) (m)
				Num.	Type	Int.	%Recov.	
290.0 89.0								290.0 89.0
295.0 90.0					RC		100	295.0 90.0
300.0 91.0								300.0 91.0
305.0 92.0					RC		100	305.0 92.0
310.0 93.0								310.0 93.0
315.0 94.0	DOLOSTONE - black, fine crystalline, slightly porous, richly fossiliferous, bedded, vugs.		94.18		RC		100	315.0 94.0
320.0 95.0								320.0 95.0
325.0 96.0					RC		100	325.0 96.0
330.0 97.0								330.0 97.0
335.0 98.0					RC		100	335.0 98.0
340.0 99.0								340.0 99.0
345.0 100.0					RC		100	345.0 100.0
350.0 101.0								350.0 101.0
355.0 102.0					RC		100	355.0 102.0
360.0 103.0								360.0 103.0
365.0 104.0					RC		100	365.0 104.0
370.0 105.0								370.0 105.0
375.0 106.0					RC		100	375.0 106.0
380.0 107.0	DOLOSTONE - light grey, fine crystalline, slightly porous, sparsely fossiliferous, vugs.		106.38					380.0 107.0
385.0 108.0					RC		100	385.0 108.0
390.0 109.0								390.0 109.0
395.0 110.0								395.0 110.0

Prepared By: S. Quinlan	Checked By: J. Baxter	Date Prepared: 12/06/2008
This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.		

LEGEND ▼ Water found @ time of drilling ▽ Static Water Level -	MONITORING WELL DATA Pipe: Screen:	SAMPLE TYPE AC Auger Cutting CS Continuous RC Rock Core SS Split Spoon AR Air Rotary WC Wash Cuttings
---	---	--

BHLOG QUELPH P:\GINTY\PROJECTS\MMTA14155\H4 TW1A & TW2A.GPJ TEMPLATE.GDT 18/12/08



R. J. Burnside & Associates Limited
15 Avenue Road, Suite 100, 3rd Fl.
Toronto, ON M5E 1B5 Tel: (416) 591-5122

LOG OF DRILLING OPERATIONS

H4-TW1A-08

Page 6 of 6

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Davidson Drilling Limited	Date Started: 15/05/2008	Static Water Level (m amsl):
Drilling Method: PQ Coring	Date Completed: 23/05/2008	Sand Pack (m amsl):

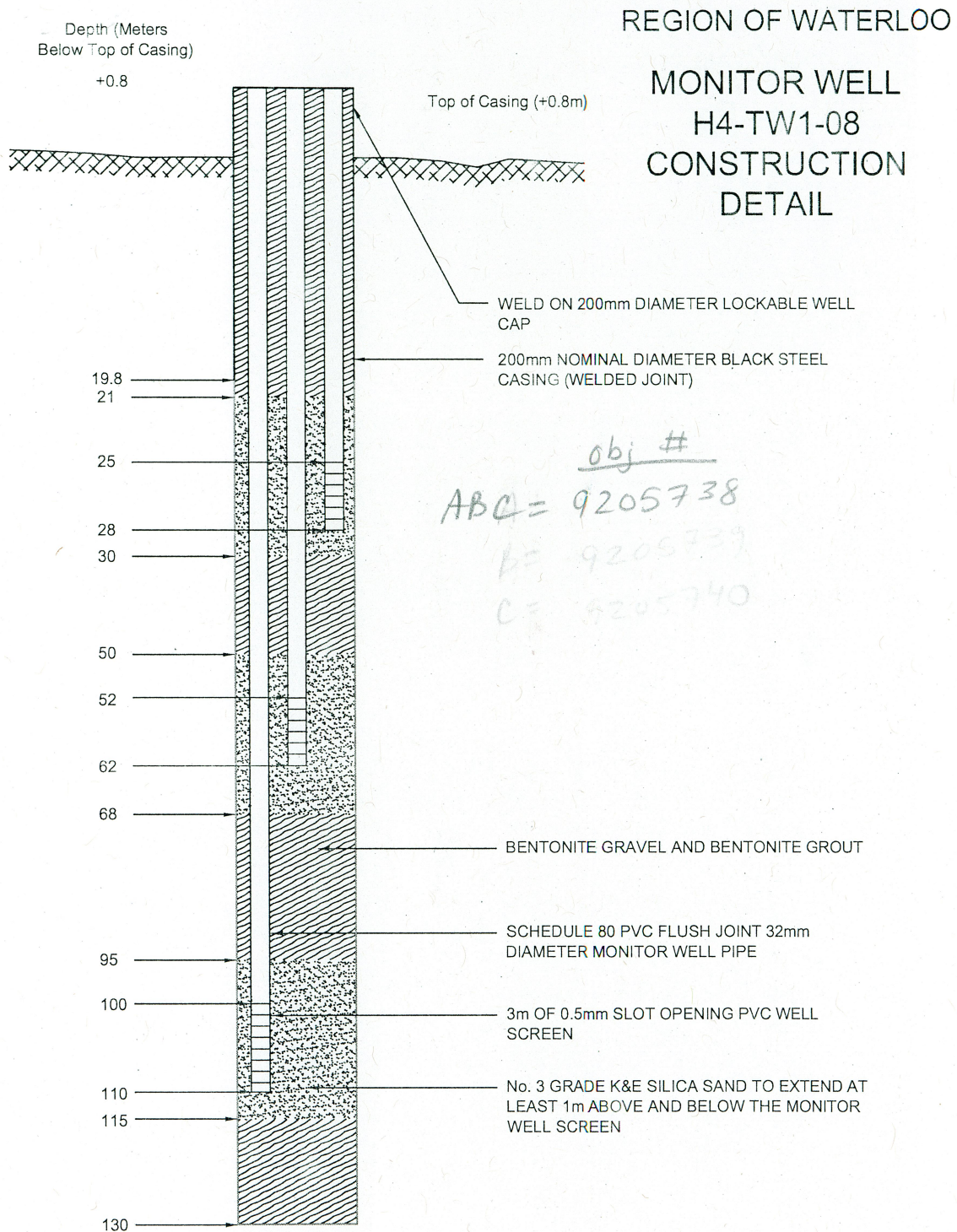
Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)	SAMPLE				Depth Scale (ft) (m)
				Num.	Type	Int.	%Recov.	
365.0 - 111.0					RC		100	365.0 - 111.0
370.0 - 113.0	DOLOSTONE - light grey, moderately porous, sparsely fossiliferous, mottled, bedded, vugs.		112.17		RC		100	370.0 - 113.0
375.0 - 114.0	DOLOSTONE - dark grey, slightly porous, sparsely fossiliferous, mottled, bedded, vugs.		113.84					375.0 - 114.0
380.0 - 116.0					RC		100	380.0 - 116.0
385.0 - 117.0								385.0 - 117.0
390.0 - 119.0					RC		100	390.0 - 119.0
395.0 - 120.0								395.0 - 120.0
400.0 - 122.0					RC		100	400.0 - 122.0
405.0 - 123.0								405.0 - 123.0
410.0 - 125.0	DOLOSTONE - dark grey, not fossiliferous, not vuggy or crystalline.		123.44					410.0 - 125.0
415.0 - 126.0	SHALE - dark grey, layered.		126.03		RC		100	415.0 - 126.0
420.0 - 128.0								420.0 - 128.0
129.0	SHALE - red, slightly porous, dark grey layers.		128.93 129.24		RC		100	129.0

Prepared By: **S. Quinlan** Checked By: **J. Baxter** Date Prepared: **12/06/2008**
This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND	MONITORING WELL DATA	SAMPLE TYPE
Water found @ time of drilling	Pipe:	AC Auger Cutting
Static Water Level -	Screen:	CS Continuous
		RC Rock Core
		SS Split Spoon
		AR Air Rotary
		WC Wash Cuttings

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C-HPW-H4-TW1ABC-08



August 2008
N.T.S.
FILE NO.: MTA14155

NOTES:
DEPTHS SHOWN ARE NOT TO SCALE



LOG OF DRILLING OPERATIONS



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15 Townline, Orangeville, Ontario L9W 3R4
telephone (519) 941-5331 fax (519) 941-8120

H4-TW1B-08

Page 1 of 1

Client: Region of Waterloo	Project Name: Well Optimization	Logged by: S. Quinlan
Project No.: MTA14155.0	Location: Cambridge	Ground (m amsl):
Drilling Co.: Geoenergy Solutions Inc.	Date Started: 01/05/2008	Static Water Level (m amsl):
Drilling Method: Sonic Drilling	Date Completed: 01/05/2008	Sand Pack (m amsl): 9.75 - 13.41

Depth Scale (ft) (m)	Stratigraphic Description	Strat. Plot	Depth (m)		SAMPLE				Depth Scale (ft) (m)
					Num.	Type	Int.	%Recov.	
0.0	TOPSOIL - black, moist.		0.30	silica sand pack		CS		100	0.0
1.0	SILTY SAND - fine, light brown, dry.					CS		100	1.0
2.0						CS		100	2.0
3.0	SILTY CLAY - light brown, moist to wet		2.74			CS		100	3.0
4.0						CS		100	4.0
5.0	SILT - fine, brown, dry.		4.27	grout		CS		100	5.0
6.0	SILTY SAND - with some gravel, moist to wet.		4.88			CS		100	6.0
7.0	SILTY SAND - with trace of gravel, brown, wet.		5.79			CS		100	7.0
8.0						CS		100	8.0
9.0	SILT - dense, brown, moist.		7.32			CS		100	9.0
10.0				bentonite seal		CS		100	10.0
11.0	SAND - medium grained with trace of gravel, brown, moist.		8.84			CS		100	11.0
12.0				silica sand pack		CS		100	12.0
13.0						CS		100	13.0
14.0	SILTY CLAY - with gravel, grey brown, wet.		13.72			CS		100	14.0
15.0				bentonite seal		CS		100	15.0
15.0	BEDROCK - LIMESTONE, saturated.		15.24			CS		100	15.0
			15.54						

Prepared By: **S. Quinlan**Checked By: **J. Baxter**Date Prepared: **05/05/2008**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND

- ▼ Water found @ time of drilling
 ▽ Static Water Level - 06/04/2008

MONITORING WELL DATA

Pipe: **51 mm dia. PVC**
 Screen: **51 mm dia. PVC #10 slot**

SAMPLE TYPE

- AC Auger Cutting
 CS Continuous
 RC Rock Core
 SS Split Spoon
 AR Air Rotary
 WC Wash Cuttings

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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

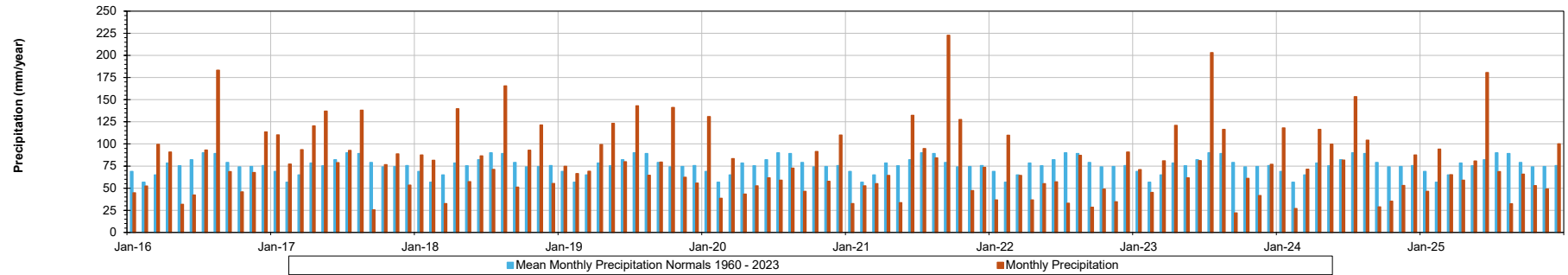


Well Field	Major or Minor Supply	Production Well Name	Status	Permit to Take Water Details			2021 Production Summary			2022 Production Summary			2023 Production Summary			2024 Production Summary			2025 Production Summary		
				MOE Permit Number ¹	Permitted Capacity (total m ³ /year)*	Permitted Rate (L/s)*	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)
Hespeler	Minor	H4A	Connected	1008-BW6L62 Well Field Total	756,864 756,864	24.0 24.0	349,225 349,225	957 957	11.1 11.1	373,562 373,562	1,023 1,023	11.8 11.8	371,985 371,985	1,019 1,019	11.8 11.8	375,782 375,782	1,030 1,030	11.9 11.9	367,140 367,140	1,006 1,006	11.6 11.6

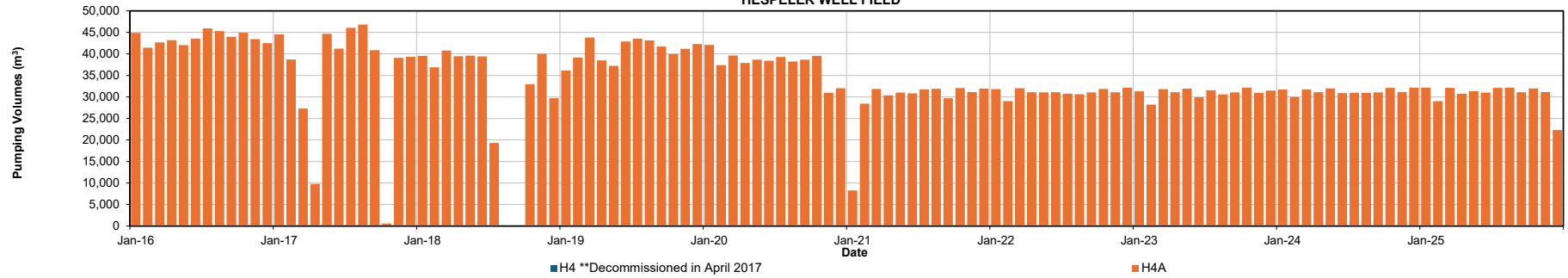
Notes:
- = no applicable data
n/a = data not available
* = rates and volumes based on permitted L/day
¹ = Current Permit

REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT - HESPELER

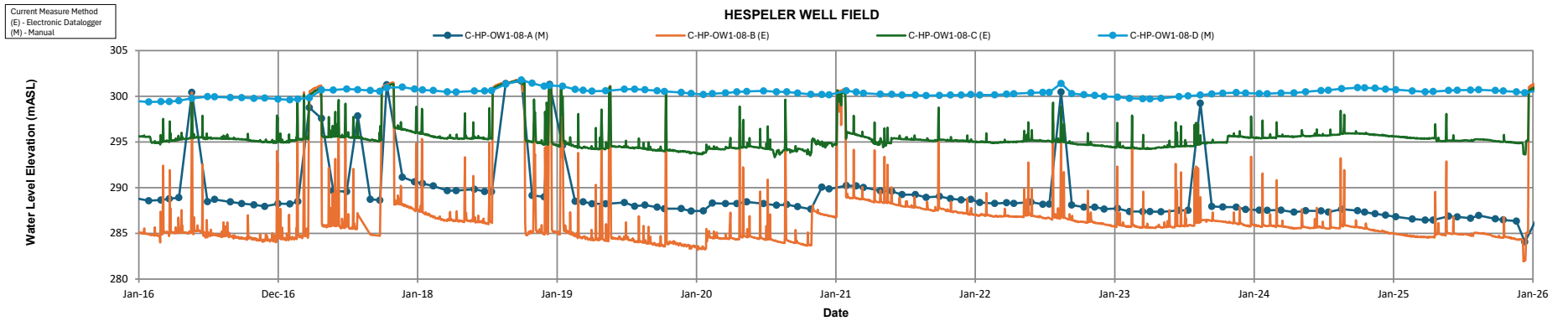
Actual versus Mean Monthly Precipitation
Weather Station - Shades Mills Dam Weather Station



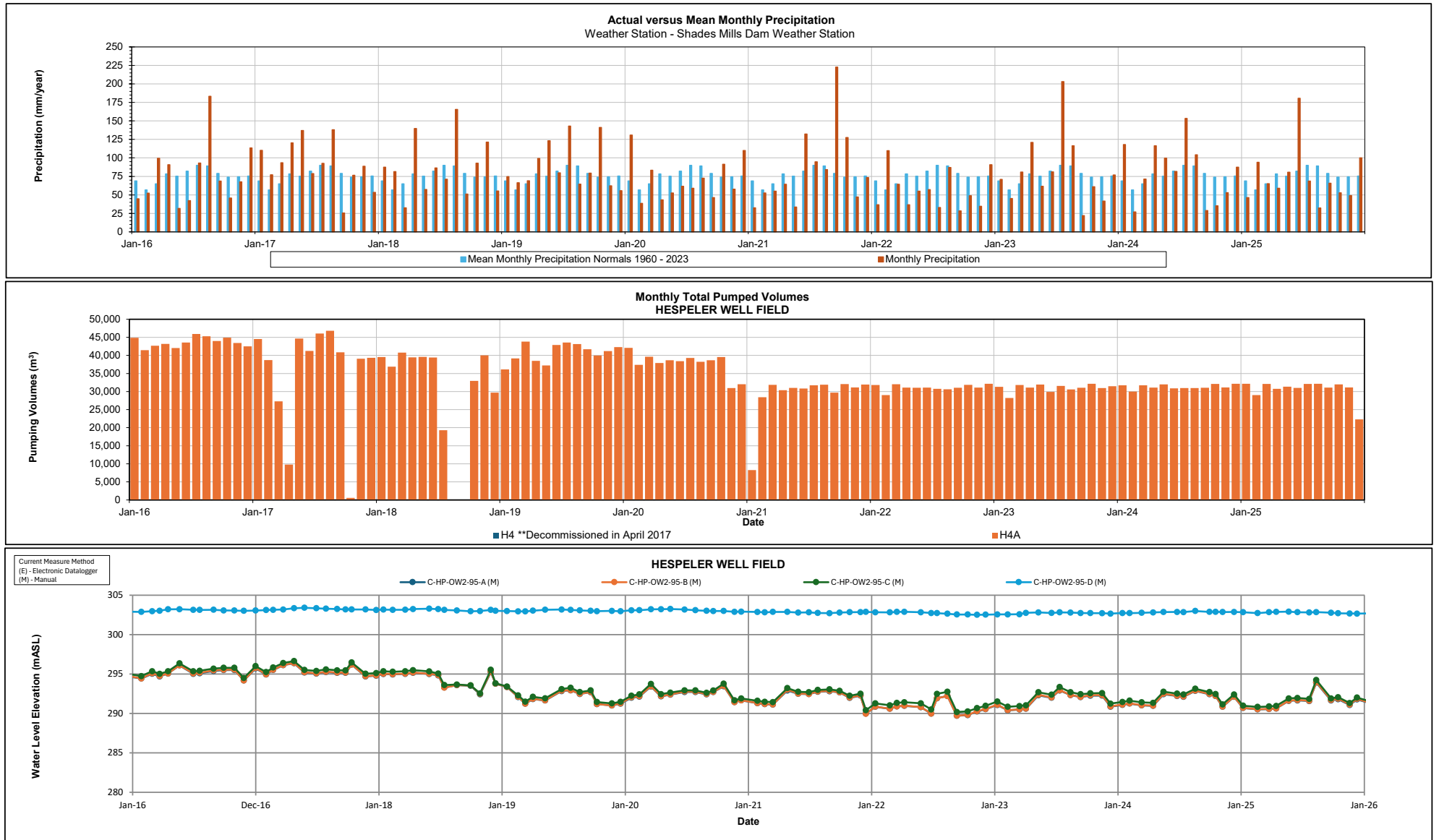
Monthly Total Pumped Volumes
HESPELER WELL FIELD



HESPELER WELL FIELD



REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT - HESPELER





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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

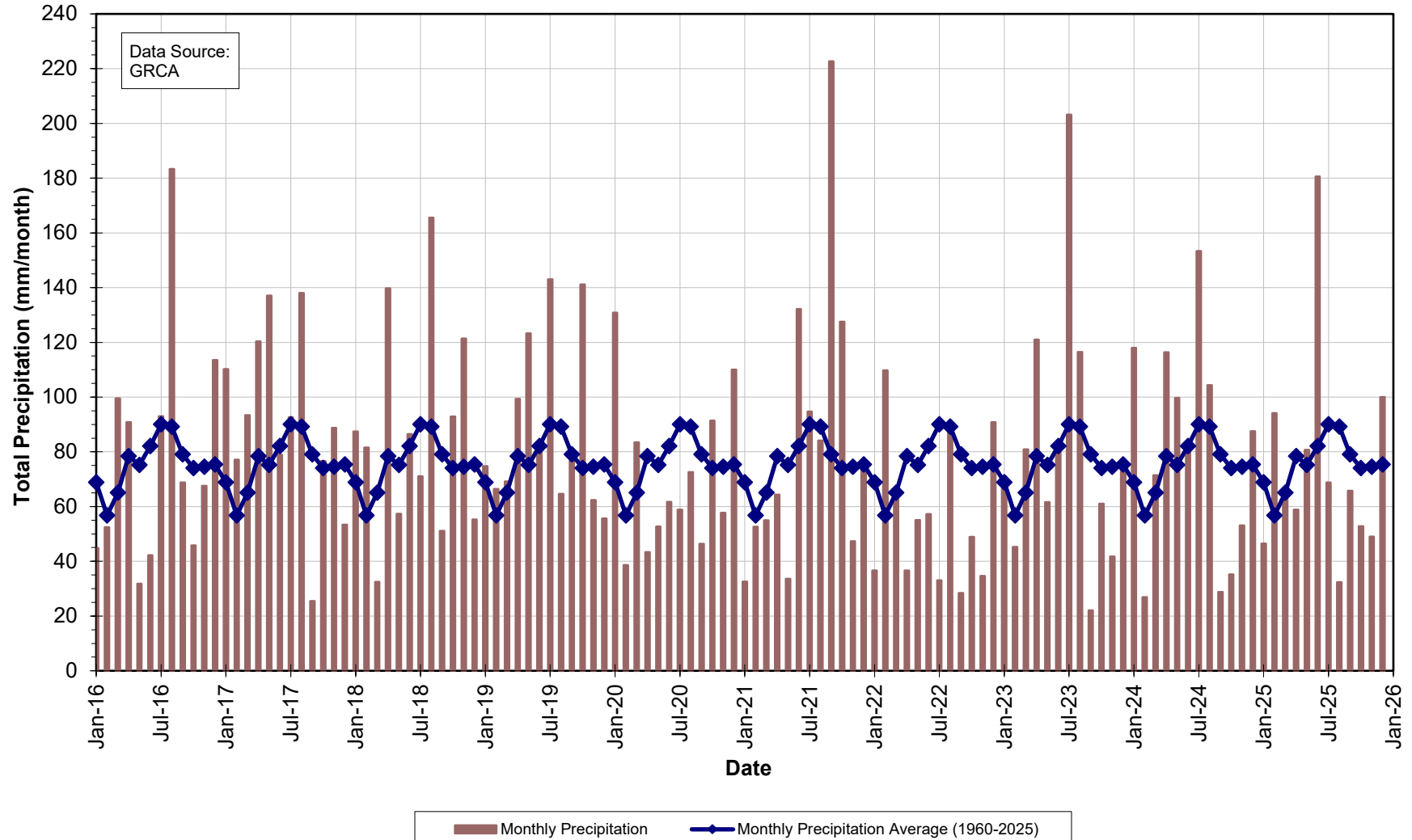
Year	Roseville Weather Station Established 1972		
	Annual Precipitation (mm)	30-yr NORMAL Precipitation 1981-2010 (mm)	Difference (mm)
2016	899	919	-20
2017	882	919	-37
2018	905	919	-14
2019	957	919	38
2020	817	919	-102
2021	832	919	-87
2022	637	919	-282
2023	945	919	26
2024	856	919	-63
2025	786	919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

