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2025 Biennial Groundwater Monitoring Report - Clemens Mill Well Field (G6, G16, G17, G18 and G19)

The Region of Waterloo

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The Region of Waterloo

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1.0 Introduction

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

The Permit to Take Water (PTTW 5552-BUKM94) for the Clemens Mill 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 Clemens Mill Well Field (G6, G16, G17, G18 and G19) is shown in Figure 1 and the production wells in Cambridge are shown in Figure 2 with the monitoring network 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 requirements of their PTTW and to confirm that water taking is sustainable in the long term. The monitoring wells are concentrated near the production wells. The data from these wells and regular measurements of pumping volume obtained from the production wells are used to evaluate the impact of Region pumping on aquifers and potential impacts to private wells, other water takers and the natural environment.

The Region has developed a monitoring program for Clemens Mill Well Field (G6, G16, G17, G18 and G19) in accordance with PTTW 5552-BUKM94 (item 1 of Schedule A) which consists of the following activities:

- Measuring the daily volume pumped from the G6, G16, G17, G18 and G19 production wells (Condition 4.1 of the PTTW);
- Measuring the water levels in monitoring wells, C-CM-OW01-10-A, C-CM-OW02-10-AB, C-CM-OW1-06-ABCDEF, C-CM-OW1-15-ABC, C-CM-OW2-06-ABCDEF, C-CM-OW3-06-ABC, C-CM-OW4-92-ABC, C-CM-OW6-94-ABCD, C-CM-PBOW1-06-ABCDEF, C-CM-PLOW1-06-AB and C-CM-TW3-05-ABC (Condition 4.2 of the PTTW);
- Measure the water level in piezometers C-CM-DP2-21-AB and C-CM-DP4-21-A (item 1 of Schedule A);
- Measure the surface water level at C-CM-SW1-22-Z, C-CM-SW2-21-Z and C-CM-SW4-21-Z (item 1 of Schedule A);

- Review of precipitation data from the nearest GRCA / Environment Canada weather station (Condition 4.3 of the PTTW); and
- Completion of a biennial report (every 2 years) that presents data in compliance with condition 4.3 of the PTTW.

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

2.0 Site Setting

2.1 Well Field Description

The Clemens Mill Well Field is located in eastern Cambridge, nearby the Shade's Mills Well Field located to the south and the Pinebush Well Field to the north (Figure 2). The closest surface water feature to the G6, G16, G17, G18 and G19 site is Mill Creek which runs from northeast to southwest and eventually outlets in the Grand River. The Shade's Mill Dam and reservoir, which is operated by the Grand River Conservation Authority (Figure 3), is located along Mill Creek, south of the Clemens Mill Well Field.

2.1.1 Pumping Wells

Well records for the production wells are found in Appendix B. Production well G19 has not yet been commissioned.

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

Table 1: Production Well Construction Details

Well Name	Year Built	Casing Diameter (mm)	Open Hole Diameter (mm)	Open Hole interval (mbgs)	Aquifer
G6	1959	305	305	28.4-82.6	Middle Guelph to Upper Gasport
G16	1992	305	305	28.4-82.6	Middle Guelph to Lower Gasport
G17	1994	337	304	61.7-120.7	Lower Guelph to Middle Gasport

Well Name	Year Built	Casing Diameter (mm)	Open Hole Diameter (mm)	Open Hole interval (mbgs)	Aquifer
G18	1991	203	254	37.0-92.7	AFD1 to Upper Gasport
G19	2006	304	304	34.1-120.5	Contact to Lower Gasport

The water taking volumes for the Clemens Mill G6, G16, G17, G18 and G19 Well Field are regulated by Condition 3.2 of the PTTW and are summarized in Table 2 below.

Table 2: Annual Water Taking 2024 / 2025

	PTTW Details	2024			2025		
Well	Permitted Max. Daily Water Taking (m^3)	Avg. Daily Water Taking (m^3)	Max Taken per Day (m^3)	Total Volume Pumped (m^3)	Avg. Daily Water Taking (m^3)	Max Taken per Day (m^3)	Total Volume Pumped (m^3)
G6	13,032	282	1,180	103,082	452	1,296	164,940
G16	13,032	708	1,743	258,296	541	1,462	197,331
G17	13,032	922	2,472	336,629	1,051	2,592	383,549
G18	13,032	1,194	2,592	435,740	1,068	2,592	389,805
G19	13,032	Not Commissioned			Not Commissioned		
Combined	13,032	3,106	6,747*	1,133,747	3,111	7,782*	1,135,535

*Combined daily maximum occurred on September 17, 2024 and June 17, 2025

The PTTW allows all five wells to be pumped concurrently to a maximum rate of 9,050 L/min. Pumping of production wells G6, G16, G17 and G18 varies from day to day, and all four wells are sometimes pumped on the same day. 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. Total pumping volumes from the well field ranged from 53,580 m^3/month to 114,074 m^3/month in 2024, and from 53,366 m^3/month to 154,071 m^3/month in 2025. In total, 1,133,747 m^3 was produced at this well field in 2024 and 1,135,535 m^3 was produced in 2025. Pumping over the

previous three years (2021–2023) was similar and ranged from approximately 979,699 m³ to 1,126,794 m³ per year. Overall, pumping remains well below the permitted annual volume of 4,756,680 m³ and appears comparable to recent historical levels.

2.1.2 Monitoring Wells

Construction and monitoring well details are provided in Appendix B - Table B1. Well records for the monitoring wells are provided in Appendix B.

2.2 Regional Geology and Hydrostratigraphy

The following sections provide a brief overview of the regional geology and hydrogeology of the Clemens Mill Well Field. The surficial geology based on regional OGS mapping is provided in Figure 4. Representative cross-sections showing the stratigraphy in the vicinity of the Clemens Mill Well Field are included as Figures 5, 6 and 7 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 Clemens Mill Well Field. The layers displayed were generated from results of the Tier 3 Well Field Assessment Update Project and associated hydrogeological modelling work (Aqua Insight Inc et al, 2023). There were no significant changes to bedrock picks in the Clemens Mill well field and as a result, the previous Tier 3 Water Budget and Local Area Risk Assessment (Golder 2011) provides detailed information on the hydrostratigraphic interpretation for the Clemens Mill Well Field (Aqua Insight Inc et al, 2023). Surfaces used for the cross-section were obtained as detailed in the Technical Memorandum (Aqua Insight Inc, 2026).

2.2.1 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 Mill, 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 Quaternary Geology of the Cambridge area (Lotowater 1997, Karrow 1987 and Bajc and Shirota, 2007) is below.

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 inter-bedded 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 thicknesses 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.

2.2.2 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). 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).

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, pseudonodular, 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 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.

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. Upper, middle and lower hydrostratigraphic units of the Gasport have been defined to allow for general representation of the vertical distribution of the more transmissive reef mound and coquina bed lithofacies. Highly transmissive reef mounds, crinoidal grainstones and coquina beds are generally present in the upper and middle portions of the formation, and are largely absent from the lower 10 m to 20 m.

The lower portion of the Gasport Formation has been grouped with the Rochester, Irondequoit, Rockway, and Merriton Formations due to the difficulty in distinguishing the various units from available borehole data and geophysical logs. All four formations, as well as the base of the Gasport Formation, are relatively less permeable than the upper sections of the Gasport Formation.

2.3 Local Geology

Figure 3 displays the Clemens Mill Well Field well plan and cross-section locations. Representative cross-sections are included as Figures 5, 6 and 7 to visualize the stratigraphy described in this section.

The overburden at the well field is approximately 30 m thick and consists of sandy outwash materials inter-layered with less permeable material associated with the Port Stanley Till (ATB1).

2.3.1 Bedrock Geology

Based on the results of drilling investigations, the bedrock surface is encountered at approximately 30 mbgs (Appendix B). Based on the borehole logs for C-CM-OW2-06, C-CM-PB-OW1-06, C-CM-TW3-05, C-CM-OW3-06 and C-CM-OW1-15 the Guelph Formation, Eramosa member, Gasport formation, Rochester Formation, Irondequoit / Rockway-Merritton and the Cabot Head are present at thicknesses as described in Table 3.

Table 3: Summary of Bedrock Formations at Clemens Mill Well Field

Formation	Description	Thickness (m)
Guelph	Dolostone – grey, moderately porous, some large voids.	18-32
Eramosa / Reformatory Quarry Member	Dolostone – dark grey, slightly to very porous with some large voids.	4-24
Goat Island	Dolostone – grey, slightly porous with some large voids.	5-17
Gasport	Dolostone - grey, fine crystalline, slightly to very porous, moderately to richly fossiliferous, mottled, few vugs.	39-56
Rochester	Dolostone - grey horizontal layers, no crystals, not porous.	1
Irondequoit	Dolostone - dark grey, slightly porous, fine crystalline.	2
Rockway-Merritton	Dolostone - dark grey, slightly porous, finely crystalline.	2
Cabot Head	Shale – grey and red layered	> 6

3.0 2024 / 2025 Results

In accordance with conditions 4.2 of the PTTW, water levels were measured in all listed monitoring wells.

The following sections summarize groundwater levels in the monitoring wells by well field 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 Clemens Mill well field is the Shade's Mills Dam station located approximately 1.5 km south of the well field. The closest Environment Canada station is Waterloo International Airport (WIA) located about 9.5 km northwest from the well field. The locations of the meteorological stations are shown on 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. Monthly precipitation data for the past 10 years at Shades Mills Dam are shown on Figure D.1, Appendix D. At the Shade's Mills Dam station, the long-term average was calculated from when measurements started until the end of 2025. The Region of Waterloo International Airport (WIA) has "Climate Normals" calculated by Environment Canada for 1981 to 2010.

Annual 2024 / 2025 precipitation data for the GRCA and Environment Canada meteorological station closest to the Shade's Mills well field are presented in Table 4 below. In 2024 WIA was missing 6 days of data and 6 days in 2025. As a result, the precipitation totals may be under reported at this location.

Table 4: Summary of Precipitation Data

Station	2024 Precipitation (mm)	2024 Deviation (mm)	Long-Term Average (mm)	2025 Precipitation (mm)	2025 Deviation (mm)
Region of Waterloo International Airport (1)	874	+23	851(A)	723	-128
Shade's Mills Dam (2)	976	+67	909(B)	895	-14

Sources: Environment Canada (1), GRCA (2),
A 1991 to 2020 Normal
B Average annual precipitation since monitoring began to the end of 2025

Water levels typically follow a seasonal trend with highest levels occurring in the spring with the depth and water content of the snowpack having a significant influence on water levels. Lowest levels occurring in July / August. Widespread synoptic rainfall events can also result in Region-wide water level responses. Summer thunderstorms tend to be

short lived and occur over a smaller area resulting in short term, localized water level rises not typically seen in the monitoring wells.

The 2024 total precipitation at Shade's 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 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-CM-OW01-10-A

Water level monitoring is completed using electronic data logger at C-CM-OW01-10-A. The well is completed in the overburden (AFB1) and is situated 11 m from G6. Water levels are stable within a 0.9 m range. There is no water level response to pumping and a seasonal response is observed. Water levels observed in 2024 / 2025 were consistent with historical values. Additionally, 2024 / 2025 precipitation records from the Shade's Mills weather station indicate that water level fluctuations corresponded with storm events such as the 82 mm rain event seen on June 27, 2025.

C-CM-OW02-10-AB

C-CM-OW02-10-AB is located approximately 85 m northwest of G18. Monthly manual water level monitoring is conducted at C-CM-OW02-10-AB. The A screen is located in the deep overburden (ATB3) directly above the top of the bedrock. Water levels in the A screen respond to pumping of the Clemens Mill Well Field and typically vary within a 4.8 m range.

B screen is located in the shallow overburden (ATB3). Water levels at this well are stable within a 1 m range. There is no correlation of water levels to pumping and a seasonal response is observed.

Water levels observed in both screens in 2024 / 2025 were consistent with historical values.

C-CM-OW1-06-ABCDEF

The closest well to C-CM-OW1-06-ABCDEF is G16 which is located 710 m to the northeast.

Water level monitoring is completed using an electronic data logger at C-CM-OW1-06-A. The A screen is located in the lower to middle Gasport Formation. Water levels in the A screen respond to pumping and typically vary within a 2 m range. In 2024 / 2025, the highest water levels are seen in March / April 2025 when pumping of G16 was reduced.

Monthly manual water level monitoring is conducted at C-CM-OW1-06-BCDE. The B and C screens are located in the Guelph Formation while the D and E screen are located in the overburden (AFD1 and AFA2 respectively). Water levels do not appear to respond to pumping, but do respond to seasonal trends. Water levels during 2024 and 2025 were within the historical range.

Water level monitoring is completed using an electronic data logger at C-CM-OW1-06-F, which is screened in the overburden (AFA2). Water levels do not appear to respond to pumping but do respond to seasonal trends. Analysis of 2024 / 2025 precipitation records from the Shade's Mills weather station demonstrated that water level fluctuations at C-CM-OW1-06-F corresponded with storm events. Water levels during 2024 and 2025 were within the historical range.

C-CM-OW1-15-ABC

Monthly manual water level monitoring is conducted at C-CM-OW1-15-ABC which is located 548 m south of G18. The A screen is an open hole in the Gasport formation, the B screen is in the Goat Island to Upper Gasport while the C screen is located in the Guelph Formation.

Water levels in the three screens follow the same trends and are influenced by pumping of G18, as levels rose by approximately 5 m during the well field shutdown in early 2020. Water levels do not appear to respond to seasonal trends. Water levels decreased by approximately 2 m in May and June 2025 when water taking at G18 increased. Water levels during 2024 and 2025 were within the historical range.

C-CM-OW2-06-ABCDEF

C-CM-OW2-06-ABCDEF is located about 1,370 m southeast of G16. Water level monitoring is completed using an electronic data logger at C-CM-OW2-06-ACF with monthly manual water level monitoring conducted at C-CM-OW2-06-BDE. Water levels in all screens during 2024 and 2025 were within the historical range.

The A screen monitors the lower to middle Gasport Formation. Water levels in the A screen respond to pumping and typically vary within a 2 m range. Water levels between March and May 2025 rose about 1m due to decreased pumping.

The B screen is in the Guelph Formation, C screen is in the Guelph Formation, D screen is in ATB3, E screen is in AFB1 and the F screen is in AFA2. The water levels in the BCDEF screens do not appear to respond to pumping but do respond to seasonal trends. Analysis of 2024 / 2025 precipitation records from the Shade's Mills weather station indicate that water level fluctuations at C-CM-OW2-06-F respond to storm events.

C-CM-OW3-06-ABC

Monthly manual water level monitoring is conducted at C-CM-OW3-06-ABC which is located 600 m from G16. The A screen, located in the lower to upper Gasport formation responds to pumping by up to 2 m and does not appear to be influenced by seasonal trends.

The B screen is in the lower Guelph formation while the C screen is in the upper Guelph formation. The B and C screen have very similar water level trends. Water levels in both screens show seasonal fluctuations but do not show a correlation to pumping.

Water levels in all screens during 2024 and 2025 were within the historical range.

C-CM-OW4-92-ABC

Water level monitoring is completed using electronic data loggers at C-CM-OW4-92- ABC which is located about 600 m from G16. The A screen is located in the Guelph Formation, B screen in the deep overburden (ATB3) and the C screen monitors water levels in the shallow overburden (ATB1, AFA2 to AFB1). Water levels during 2024 and 2025 were within the historical range.

Water levels in 2024 / 2025 are stable within a 1 m range. Water levels in all screens show seasonal fluctuations but do not show a correlation to pumping. Analysis of 2024 / 2025 precipitation records from the Shade's Mills weather station indicate that water level fluctuations at C-CM-OW4-92-ABC correspond with storm events.

C-CM-OW6-94-ABCD

Monthly manual water level monitoring is conducted at C-CM-OW6-94-ABCD which is located 6 m from G17. The A screen is located in the Lower Gasport Formation, B screen in the Middle Gasport Formation, C screen is in the Upper Gasport Formation and the D screen is located in the Reformatory Quarry Formation. Water levels during 2024 and 2025 were within the historical range.

Water levels in the A screen rise when the well field is offline in 2020, however later responses to changes in pumping are muted in comparison to the other screens. The water level trends in the C and D screens at C-CM-OW6-94 show a similar pattern with responses to pumping. No seasonal trend is observed. Water levels in June 2025 were lower due to the increase in G17 pumping.

C-CM-PBOW1-06-ABCDEF

C-CM-PBOW1-06-ABCDEF is located about 1540 m from G16. Water level monitoring was completed using an electronic data logger at C-CM-PBOW1-06-A. The A screen is located in the upper Gasport to Lower Gasport Formation. Water levels in the A screen respond to pumping and typically vary within a 2 m range. Water levels rose about 1.3 m in April / May 2025 when G16 pumping is reduced. Water levels in all screens during 2024 and 2025 were within the historical range.

Monthly manual water level monitoring is conducted at C-CM-PBOW1-06-BCD. The B and C screens are located in the Guelph Formation while the D (AFD1 to contact) and E (ATB3) screen are located in the overburden. Water levels do not appear to respond to pumping but do respond to seasonal trends.

Water level monitoring is completed using an electronic data logger at C-M-OW1-06-F (ATA2 to AFA2) is screened in the overburden. Water levels do not appear to respond to pumping but do respond to seasonal trends. Analysis of 2024 / 2025 precipitation records from the Shades Mill's weather station indicate that water level fluctuations at C-CM-PBOW1-06-F correspond with storm events.

C-CM-PLOW1-06-AB

Water level monitoring is completed using electronic data loggers at C-CM-PLOW1-06-AB which is about 3,230 m from G16. The A and B wells are screened in the overburden in the AFA2 and ATA2 units respectively. Water levels during 2024 and 2025 were within the historical range.

Water levels do not respond to pumping but do respond to seasonal trends. Analysis of 2024 / 2025 precipitation records from the Shade's Mills weather station demonstrated that water level fluctuations at C-CM-PLOW1-06-AB corresponded with storm events.

C-CM-TW3-05-ABC

Monthly manual water level monitoring is conducted at C-CM-TW3-05-ABC, which is about 900 m from G16. The A screen is in the middle to lower Gasport Formation and the B and C screens are located in the Guelph formation. Water levels during 2024 and 2025 in all monitoring well screens were within the historical range.

Water levels in the A and B screens are almost the same, follow the same trends and appear to be influenced by pumping, as levels rose by approximately 1 m during the well field shutdown in early 2020 and during reduced pumping of G16 from September 2021 to May 2022. The C screen follows a similar, but muted trend as screens A and B.

C-CM-DP2-21-AB and C-CM-SW2-21-Z

Water level monitoring was conducted using electronic data loggers at C-PB-DP2-21-AB and C-CM-SW2-21-Z. Both C-CM-DP2-21-A and C-CM-DP2-21-B are shallow overburden piezometers located in the creek close to the bank, while C-CM-DP2-21-Z is a surface water monitoring station on Mill Creek located about 970 m from G19. Water levels in the A and B screens and the surface water station (Z) follow the same pattern. Water levels in the A screen are approximately 0.15 m higher than in the B screen. A seasonal trend was not observed and there was no measurable response to pumping in 2024 and 2025. The data logger in the B screen malfunctioned during the sumer of 2025. The water levels in both surface water and the A and B monitoring screens are influenced by precipitation events. A similar response to precipitation events is observed at all three monitoring locations.

C-CM-DP4-21-A and C-CM-SW4-21-Z

Water level monitoring using electronic data loggers at C-PB-DP4-21-A and C-PB-SW4-21-Z in June 2022. C-PB-DP4-21-A is a shallow overburden piezometer located in the middle of Mill Creek, while C-PB-SW4-21-Z is a surface water monitoring station on Mill Creek located approximatley 690 m from G19. Water levels in the A screen are approximately 0.8 meters higher than the surface water. Both the A screen and surface water levels fluctuated by about 0.3 meters over the monitoring period. Seasonal trends and a response to pumping are not evident and further monitoring is required. Water levels in both surface water and the A screens are influenced by precipitation events. The surface water levels exhibit a more rapid response to rainfall than the A screen.

C-CM-SW1-22-Z

Surface water levels at Puslinch Lake were manually measured using a staff gauge between November 2016 and July 2019,. However, the gauge (P-CM-PSLCH-LK-16-Z) suffered damage from ice and was subsequently replaced in October 2022 with surface water monitoring location C-CM-SW1-22-Z, equipped with an electronic data logger for recording surface water levels. Surface water levels fluctuated by 0.5 m from

Novmeber 2016 to July 2019, and similar fluctuations of 0.5 m were observed at C-CM-SW1-22-A. The data suggests the presence of seasonal trend, however no response to pumping is evident. Puslinch Lake water levels do not respond quickly to precipitation due to the lake's substantial size and volume. The large surface area and water volume of the lake create a buffering effect, which dampens the immediate impact of rainfall on surface water levels.

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.”

There are no other non-municipal groundwater takings registered in the MECP PTTW database within 2 km Clemens Mill Well Field.

All properties within 500 m of the Clemens Mill well field are serviced with municipal water. When a well interference complaint is received, the Region has a Well Interference Policy in place. A copy of the policy is presented in Appendix F of the 2019 Biennial Groundwater Monitoring Report – Multiple Well Fields (Burnside, 2020). There were no well interference complaints related to pumping of G6, G16, G17, G18 and G19 received in 2024 and 2025.

4.2 Aquifer Response to Pumping and Precipitation

Groundwater level responses observed during 2024/2025 indicate that water level declines due to pumping at the Clemens Mill well field were greatest in the deeper bedrock aquifers closest to the production wells and became progressively less with increasing distance from the production well and shallower depth.

Water levels in the Reformatory Quarry Member showed a clear response to pumping where monitoring locations were located immediately adjacent to production wells. Water levels declined by 13 metres during pumping, indicating that pumping effects extend into this unit within the central portion of the well field.

The Gasport Formation showed the most consistent and widespread response to pumping and represents the primary aquifer affected by production well pumping. Monitoring locations closest to pumping wells showed the largest water level declines (5 m), while locations several hundred metres away showed smaller responses (2 m). This pattern indicates that pumping effects are largely controlled by distance from the well field.

Water level responses in the Guelph Formation were more limited and variable. Measurable drawdown was observed at locations closer to production wells, while little to no response was observed at more distant locations. Overall, pumping effects in this unit were less than those observed in the Gasport Formation.

The Cabot Head Formation exhibited localized responses to pumping (11 m), primarily at monitoring locations situated very close to production wells. Away from the immediate well field, water level changes were minor (2 m).

Overburden aquifers showed the least response to pumping. Water levels in these units were generally stable and did not show consistent pumping-related drawdown, except at isolated locations near production wells. In general, overburden water levels were more strongly influenced by recharge conditions than by pumping of the bedrock aquifers.

Review of precipitation data from the Shade’s Mills weather station showed that short-term water level changes associated with storm events were most evident in the overburden and shallow piezometer monitoring locations. These recharge-related fluctuations were less apparent in the deeper bedrock aquifers, where pumping was the primary control on water level behaviour.

In summary, pumping-related drawdown at the Clemens Mill well field was greatest in the Gasport Formation and deeper bedrock units near the production wells and decreased with distance and shallower depth. This pattern is consistent with the expected zone of influence of the well field and indicates that pumping effects are largely confined to the deeper bedrock aquifers.

5.0 Conclusions

Impacts from pumping at the Clemens Mill Well Field (G6, G16, G17, G18 and G19) 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 5552-BUKM94;
- 2024 and 2025 pumping volumes were within the permitted range;
- There were no reported well interference complaints arising from water taking at the Clemens Mill well field;
- Water levels in several wells screened across ATB3, Guelph, Eramosa, Gasport Formations show a measurable response to nearby pumping, however, water levels are stable;
- Seasonal water level trends are observed at most overburden and shallow bedrock wells; and
- Further monitoring of the new piezometers and stream monitoring locations is necessary to evaluate the groundwater and surface water interactions.

6.0 References

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BURNSIDE

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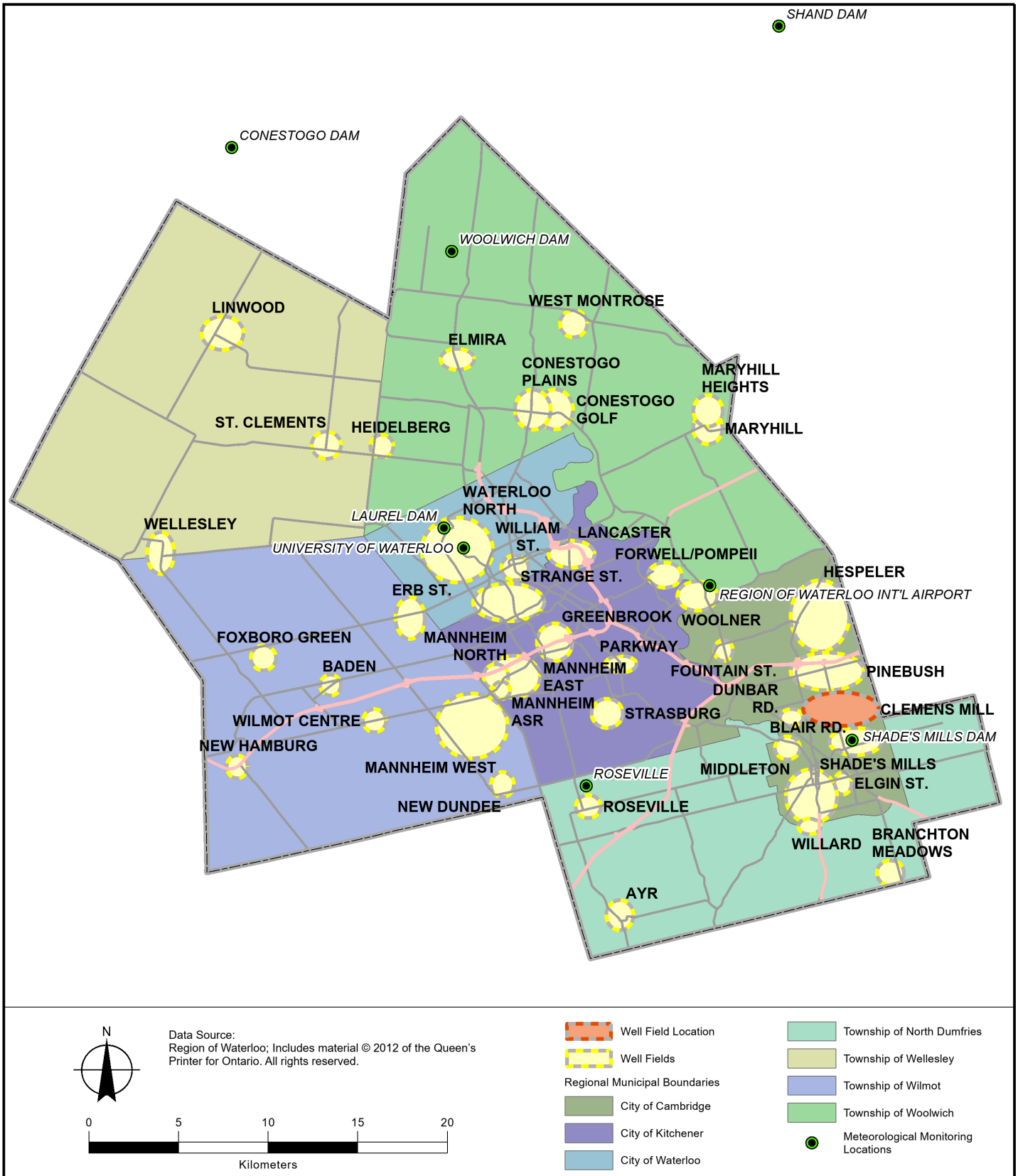
Figures



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Map Title

2025 GROUNDWATER MONITORING REPORT - CLEMENS MILL WELL FIELD

WELL FIELD LOCATION MAP

Client

REGION OF WATERLOO

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HN	SQ	February 2026	1
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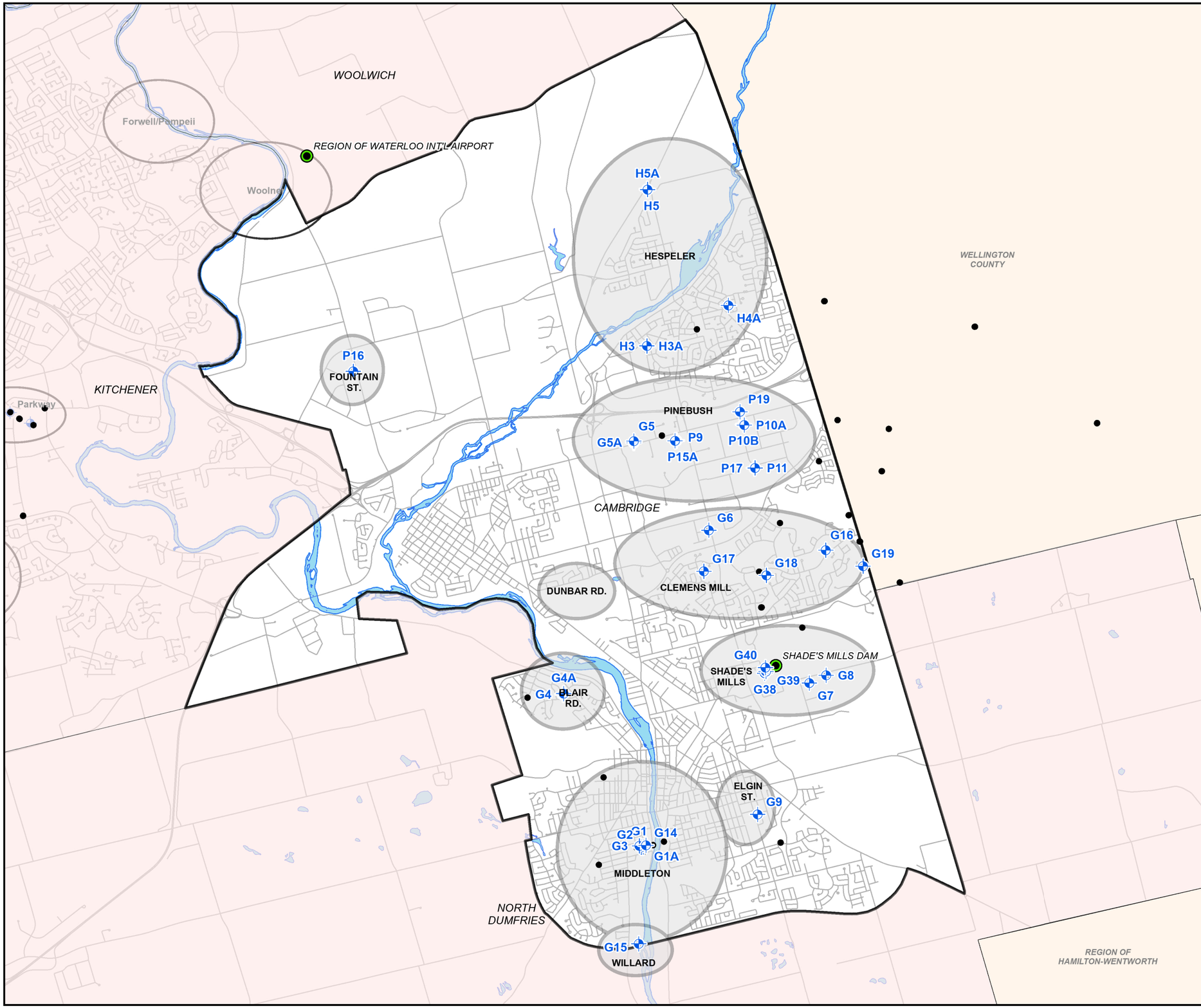

LEGEND

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

Sources:

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

Datum: North American 1983 CSRS

Coord. System: NAD 1983 CSRS UTM Zone 17N

N

0 1 2 3 4 5
Kilometers

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REGION OF WATERLOO

Figure Title

2025 GROUNDWATER MONITORING REPORT - CLEMENS MILL WELL FIELD

CAMBRIDGE WELL FIELDS AND MONITORING NETWORK

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Legend

- PTTW Monitoring Well Location
- Nearby Monitoring Well Location
- Nearby Production Well Location
- Decommissioned Production Well Location
- Surface Water
- Piezometer
- Cross Section Orientation
- Provincial Highway
- Municipal Roads
- Local Roads
- Waterbody: Permanent (OHN)
- Watercourse (GRCA)
- Region of Waterloo Municipal Boundary

Sources:

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.

Datum: North American 1983

N

0 200 400 600 800 1,000

Metres

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REGION OF WATERLOO

Figure Title

2025 GROUNDWATER MONITORING REPORT

CLEMENS MILL WELL PLAN AND CROSS SECTION LOCATIONS

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HN	SQ	April 2026	3
Scale		Project No.	
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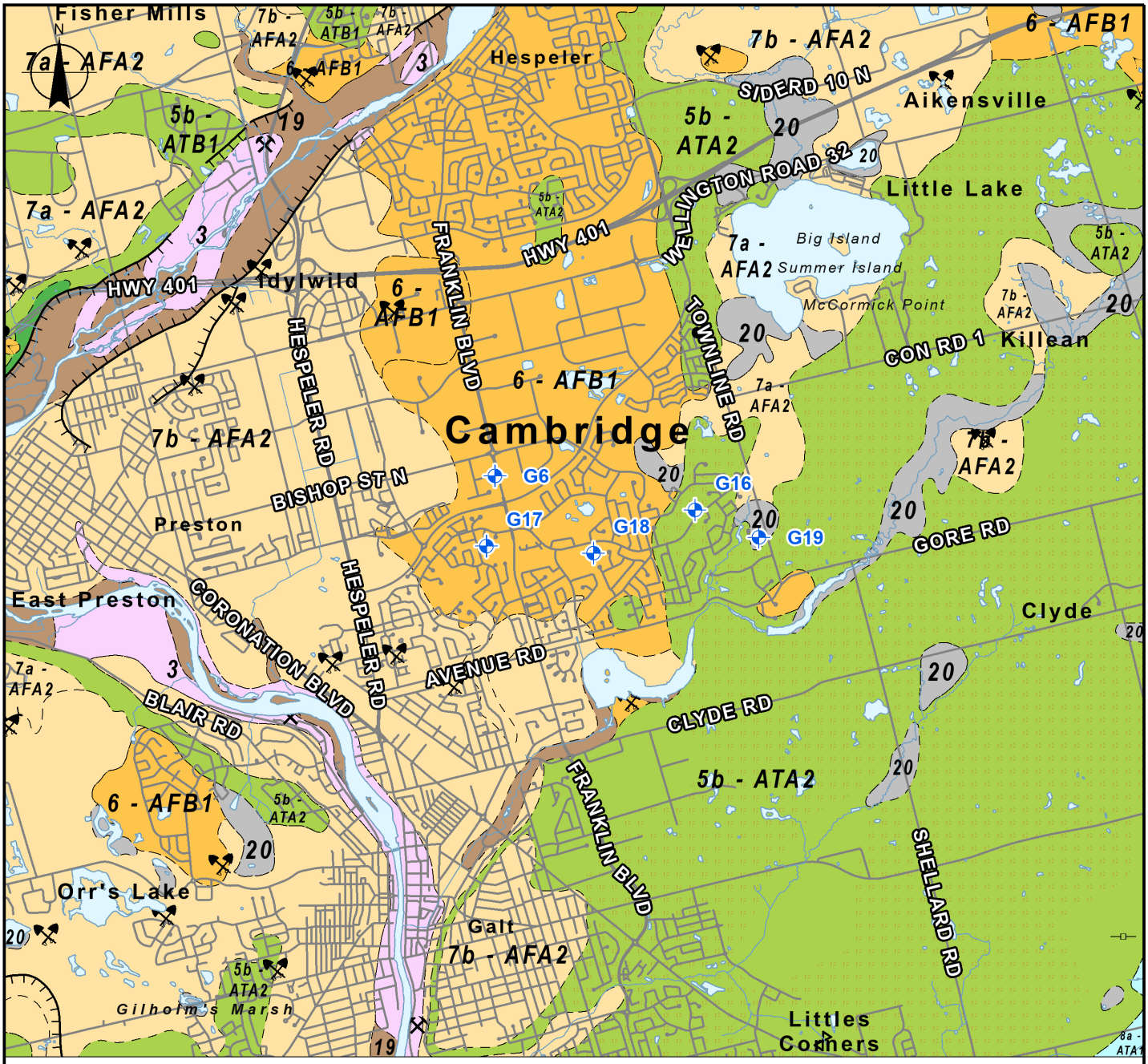

Data Source:
1. Ontario Geological Survey 2003. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.
2. Region of Waterloo GIS

0 1,000 2,000 3,000 4,000 5,000
Meters

RMOW 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)
8a: Fine-textured glaciolacustrine deposits: Massive-well laminated (ATA1)
19: Modern alluvial deposits
20: Organic deposits
Quarry (Point)
Sand and Gravel Pit
Esker: Direction of Flow Known
Terrace
Delta, glaciolacustrine
Drumlin or drumlinoid ridges (point)
Sample Location
Hummocky Topography
Unit Contact Boundary

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Map Title
2025 GROUNDWATER MONITORING REPORT - CLEMENS MILL WELL FIELD

SURFICIAL GEOLOGY

Client
REGION OF WATERLOO

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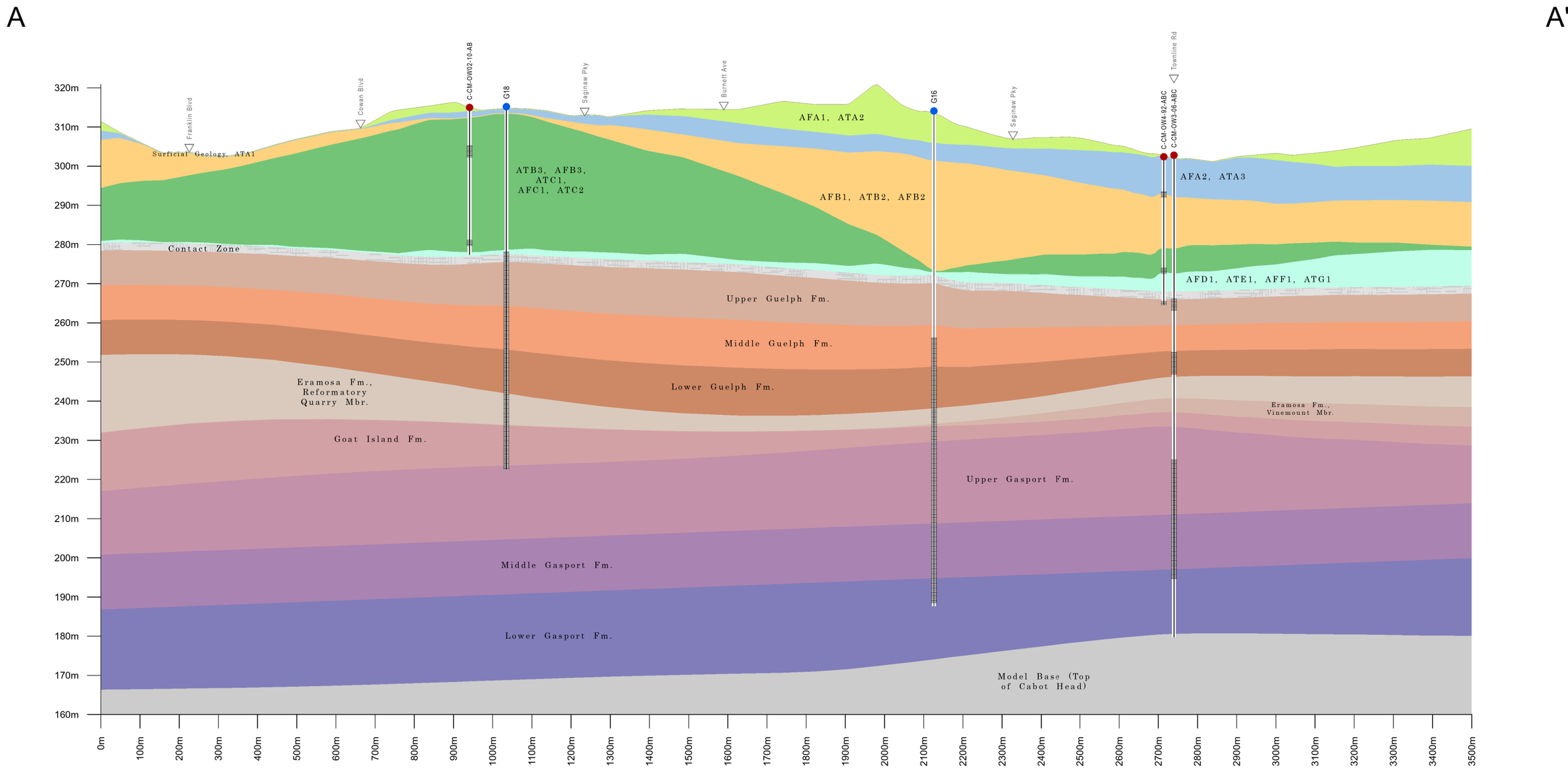

Wells

- Production Well (Active)
- Monitoring Well

Cambridge Model 2026

- Surficial Geology, Whittlesey Clay (ATA1)
- Whittlesey Sand (AFA1), Wenthworth 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

BURNSIDE

Client

REGION OF WATERLOO

Figure Title

GEOLOGIC CROSS SECTION REGION OF WATERLOO

Clemens Mill

Cross Section A - A'

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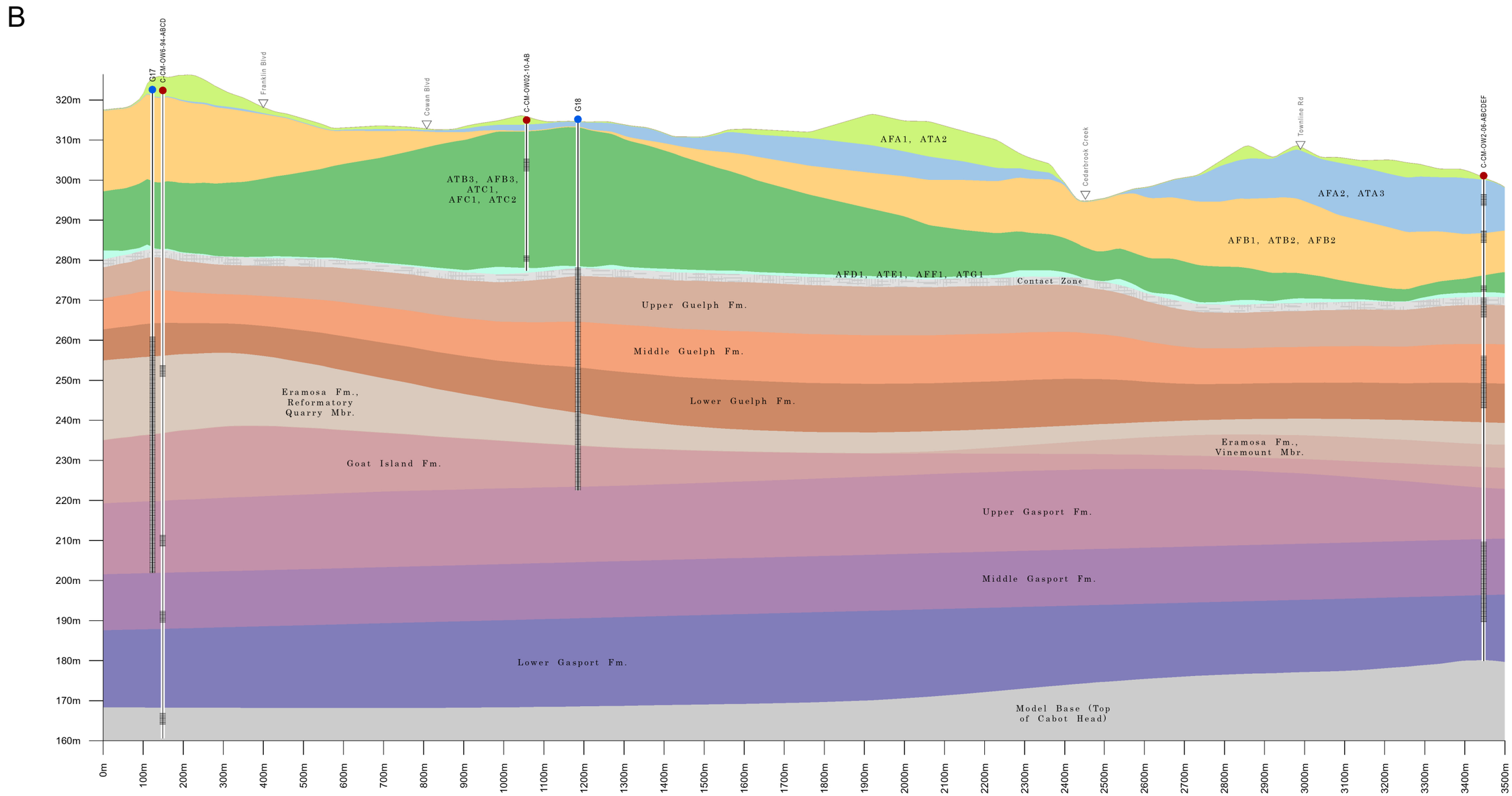

Wells

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- Monitoring Well

Cambridge Model 2026

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- Whittlesey Sand (AFA1), Wenthworth Till (ATA2)
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- 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

BURNSIDE

Client

REGION OF WATERLOO

Figure Title

GEOLOGIC CROSS SECTION REGION OF WATERLOO

Clemens Mill
Cross Section B - B'

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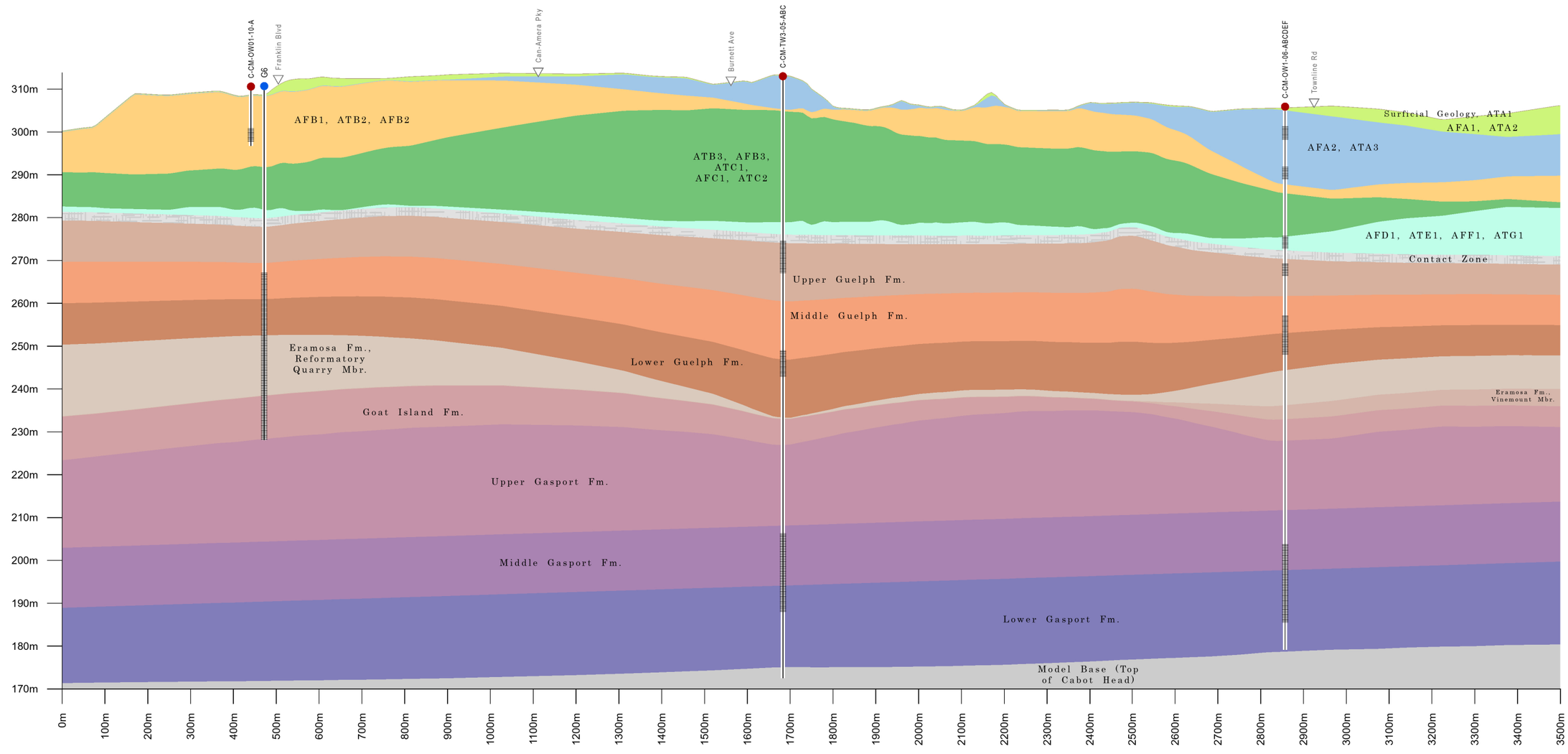

Wells

● Production Well (Active) ● Monitoring Well

Cambridge Model 2026

- Surficial Geology, Whittlesey Clay (ATA1)
- Whittlesey Sand (AFA1), Wenthworth Till (ATA2)
- Grand River Valley Outwash Deposits (AFA2), Fine Grain Deposits in the Grand River Valley (ATA3)
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- 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)
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- 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

BURNSIDE

Client

REGION OF WATERLOO

Figure Title

GEOLOGIC CROSS SECTION
REGION OF WATERLOO
Clemens Mill
Cross Section C - C'

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Appendix A

Permit To Take Water

Ontario

Ministry of the Environment, Conservation and Parks
Ministère de l'Environnement, de la Protection de la nature et des Parcs

AMENDED PERMIT TO TAKE WATER
Ground Water
NUMBER 5552-BUKM94

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
Floor 7 - 150 Frederick St
Kitchener, Ontario, N2G 4J3
Canada

For the water taking from: Clemens Mill Well Field; G6, G16, G17, G18, and G19

Located at: 1098 Franklin Blvd
Cambridge, Regional Municipality of Waterloo

720 Saginaw Pky
Cambridge, Regional Municipality of Waterloo

1037 Elgin St N Turnbull Reservoir
Cambridge, Regional Municipality of Waterloo

335 Saginaw Pky
Cambridge, Regional Municipality of Waterloo

Cedarbrook Crt Lot 1 Concession 12
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. 5552-BUKM94 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 July 23, 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	G6, G16, G17 (Thorbull), G18, G19	Well Drilled	Municipal	Water Supply	9,050	24	13,032,000	365	17 556356 4805058
						Total Taking:	13,032,000		

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**.** The Permit Holder shall keepall 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 complete the monitoring plan as described in item 1 of Schedule A. The Permit Holder shall measure and record water levels hourly in the following monitoring wells:

P-CM-PSLCH_LK-16-Z
C-CM-OW01-10-A
C-CM-OW02-10-AB
C-CM-OW1-06-ABCDEF
C-CM-OW1-15-ABC

C-CM-OW2-06-ABCDEF
C-CM-OW3-06-ABC
C-CM-OW4-92-ABC
C-CM-OW6-94-ABCD
C-CM-PBOW1-06-ABCDEF
C-CM-PLOW1-06-AB
C-CM-TW3-05-ABC

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

5. Impacts of the Water Taking

5.1 Notification

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

5.2 For Groundwater Takings

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

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

6. Director May Amend Permit

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

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

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

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

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

In accordance with Section 100 of the Ontario Water Resources Act, R.S.O. 1990, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 101 of the Ontario Water Resources Act, R.S.O. 1990, as amended, provides that the Notice requiring the hearing shall state:

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

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

a. The name of the appellant;
b. The address of the appellant;
c. The Permit to Take Water number;
d. The date of the Permit to Take Water;
e. The name of the Director;
f. The municipality within which the works are located;

This notice must be served upon:

The Secretary
Environmental Review Tribunal
655 Bay Street, 15th Floor
Toronto ON
M5G 1E5
Fax: (416) 326-5370
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	by Fax at	by e-mail at
(416) 212-6349	(416) 326-5370	www.ert.gov.on.ca
Toll Free 1(866) 448-2248	Toll Free 1(844) 213-3474	

This Permit cancels and replaces Permit Number 8842-9FDJUC, issued on 2014/01/16.

Dated at Toronto this 2nd day of November, 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 5552-BUKM94, dated November 2, 2020.

1. “Monitoring Plan – Cambridge East Well Fields (Pinebush and Clemens Mill) PTTW Applications” dated April 22, 2020 and prepared by Golder Associates."

April 22, 2020 Project No. 19119485

Karl Belan, M.A.Sc., P.Geo., Hydrogeologist
Regional Municipality of Waterloo
Water Services
150 Fredrick Street, 7th Floor
Kitchener, ON N2G 4J3

MONITORING PLAN – CAMBRIDGE EAST WELL FIELDS (PINEBUSH AND CLEMENS MILL) PTTW APPLICATIONS

Dear Mr. Belan,

In support of the Region of Waterloo's Permit to Take Water (PTTW) applications to the Ministry of the Environment, Conservation and Parks (MECP) for the Pinebush and Clemens Mill well fields, the following letter presents the monitoring plan to be completed by the Region in support of the updated PTTWs. This letter follows the completion of the Cambridge East Water Supply Class Environmental Assessment (EA) (Golder, 2018), which recommended the addition of water supply from wells P10A, P10B and P19 in the Pinebush well field and from G19 in the Clemens Mill well field. This letter provides additional details on the recommended monitoring program provided in the EA documentation (Golder, 2018).

Background – Pinebush Well Field

The Region currently has a Permit for wells P11 and P17 (PTTW No. 7343-9FFJBX) for 120 L/s in the Pinebush well field. This permit was issued in January 2014 and expires on May 31, 2024. Wells P10, P11 and P17 supply the Pinebush Water Treatment Plant (WTP). Well P10 was constructed prior to the Ontario Water Resources Act and therefore is not listed on the PTTW. In 2010 and 2011 new test wells P10A, P10B, P19 (previously referred to as PBTW1-10) were constructed, a steel well casing liner was installed in P17 and P11 was re-drilled and re-constructed. Following testing of the new and existing wells in 2010/2011 (Stantec, 2013), groundwater modelling (Golder, 2017) and the completion of the Class EA (Golder, 2018), the Region is applying for a PTTW renewal for the Pinebush well field which will include P10, P10A, P10B, P11/P17 and P19. P10B is intended as a replacement for P10 which will be decommissioned once these new wells are brought online. Wells P10A and P19 were constructed to restore municipal well capacity that has declined at P11 and P17.

Background – Clemens Well Field

The Regional currently has a Clemens Mill well field permit for wells G6, G16, G17 and G18 (PTTW No. 8842-9FDJUC) for 150.8 L/s. This permit was issued in January 2014 and expires on May 31, 2024. These wells supply the Turnbull WTP. Following the completion of the Class EA (Golder, 2018), the Region is applying for a PTTW renewal for the Clemens well field, which will include wells G6, G16, G17, G18 and G19 (previously referred to as CMPW2-06 or Cedarbrook Well). As part of the Hydrogeological and Natural Environment Report,

an assessment of the sustainability of the new takings was completed and a monitoring program was recommended (Golder, 2017); a copy of this report is included with the application (electronic).

Monitoring Program

As required in the current PTTWs, monthly annual monitoring is completed at five wells in Pinebush and 13 wells in Clemens Mills, as shown in Table 1 and on Figure 1.

Table 1: Monitoring Included in Current PTTW

Pinebush Well Field	Clemens Mill Well Field
C-PB-OW1A-11	C-CM-OW6ABCD-94
C-PB-OW1B-11	C-CM-OW02A-10
C-PB-OW1A-92	C-CM-OW02B-10
C-PB-OW1BC-92	C-CM-OW01A-10
	C-CM-OW4A-92
	C-CM-OW4BC-92
	C-CM-OW3ABC-06

Recommended Additional Monitoring – Existing Locations

As part of the Hydrogeological and Natural Environment Report (Golder, 2017), a monitoring program was recommended for the Pinebush and Clemens Mills well fields. The following additional recommended monitoring is consistent with the recommendations included in the Cambridge East Class EA.

1) Groundwater monitoring should be completed at the locations listed in Table 2 (appended) and shown on Figure 1. Groundwater monitoring should be completed using dataloggers set to record at 1-hour intervals. As per the protocol in the Region's Groundwater Monitoring Program (GMP), manual measurements will be completed to backup the dataloggers.

   - It is noted that the following proposed monitoring locations have already been incorporated by the Region into their GMP: CMOW1-06, CMOW2-10, PBOW1-06, PBOW2-06, and PLOW1-06.

2) Monitoring should continue at the following wells: TW9-78, TW10-78 and MW09-T3-01. These wells are currently being monitored by the Township of Puslinch.

3) Water levels in Puslinch Lake (LWL) should be monitored at a higher frequency (datalogger for continuous measurement during ice-free conditions).

Recommended Monitoring - New Locations

1) The locations of proposed new monitoring locations are shown on Figure 1. The Region has initiated discussions with the property owners at these locations. The final locations of these proposed monitoring stations will be dependent on receipt of signed access agreements with the property owners.

2) As ongoing water level monitoring is limited primarily in the area west of Puslinch Lake, the following additional monitoring wells were recommended as part of the Class EA to better define groundwater gradients and groundwater level changes around the lake:
    - A multi-level deep monitoring well nest installed near Irish Creek north of Puslinch Lake (Well A);
    - A multi-level deep monitoring well nest installed to the northeast/east of Puslinch Lake (Well B);
    - A multi-level deep monitoring well nest installed further east of PBOW1-06 along Concession 1, in the vicinity of Mill Creek to better define the eastern limits of the zone of influence of pumping (Well C); and
    - Additional shallow drivepoint piezometers installed in accessible locations in the vicinity of the Puslinch Lake shoreline.
3) A shallow streambank piezometer is recommended east of CMOW2-06 along Shellard Road, south of Gore Road and adjacent to Mill Creek.
4) A stream gauging station is recommended on Irish Creek for continuous flow gauging, during ice-free conditions; additional spot baseflow measurements are also recommended for Irish Creek.
5) A shallow streambank piezometer should be installed adjacent to Irish Creek to assess shallow groundwater gradients.
6) A shallow piezometer along Cedarbrook Creek (H7-06) should be reinstalled at an historic monitoring location and included in the monitoring program.

Operational Testing and Adaptive Management

Details about the Operational Testing and Adaptive Management Plan are provided in the Hydrogeological and Natural Environment Report (Golder, 2017) and in the Class Environmental Assessment Project File Report (Golder, 2018)

To ensure that the optimized pumping rates are sustainable, an operational testing program should be carried out, which is recommended to include the following steps:

- Continue pumping of only the existing wells and P10B with expanded monitoring to collect baseline data;
- Increase pumping from new wells in the Pinebush well field (P10A and P19); and
- Increase pumping from new wells in the Pinebush well field (P10A and P19) and the Clemens Mill well field (G19).

After each step, a report will be completed with an updated adaptive management plan. Quarterly data reports at key monitoring locations will also be completed. The pumping duration of each operational step will be up to five years and the monitoring results will be available to the public and provided to the Township of Puslinch. The total supply increase of 38 L/s is not required until the year 2031 and the Region would have the flexibility to gradually increase takings in the period leading up to this time.

Reporting on progress of operational testing will be provided every two years in the form of Biennial Monitoring Reports incorporated into the Region's existing Groundwater Monitoring Program.

Well Interference Policy

The Region's well interference policy can be found on their website at www.regionofwaterloo.ca/protectwater.

A revised well interference Policy Area was developed as part of the Class Environmental Assessment, considering the new wells in the Pinebush and Clemens Mill well fields. The revised well interference Policy Area is presented on Figure 11 of the Class Environmental Assessment Project File Report (Golder, 2018). This Revised Policy Area will be added to the policy prior to new wells coming online. Although impacts to private wells are not expected from the increased taking, an enhanced level of response will be given to any well complaints within these policy areas.

Closure

We trust that this information is suitable to support the PTTW application. Please do not hesitate to contact us if you have any questions or concerns.

Sincerely,

Golder Associates Ltd.

Jennifer Hancox, M.Sc., P.Geo.
Hydrogeologist

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

JLH/JAP/ll

Attachments: Figure 1 – Monitoring Locations in Pinebush and Clemens Mill Well Fields
Table 2 – Proposed Cambridge East Monitoring Locations

https://golderassociates.sharepoint.com/sites/105935/project files/6 deliverables/cambridge east pttw support/04_final letter_2020apr22/19119485_cambridge east pttw monitoring support_2020apr22.docx

References

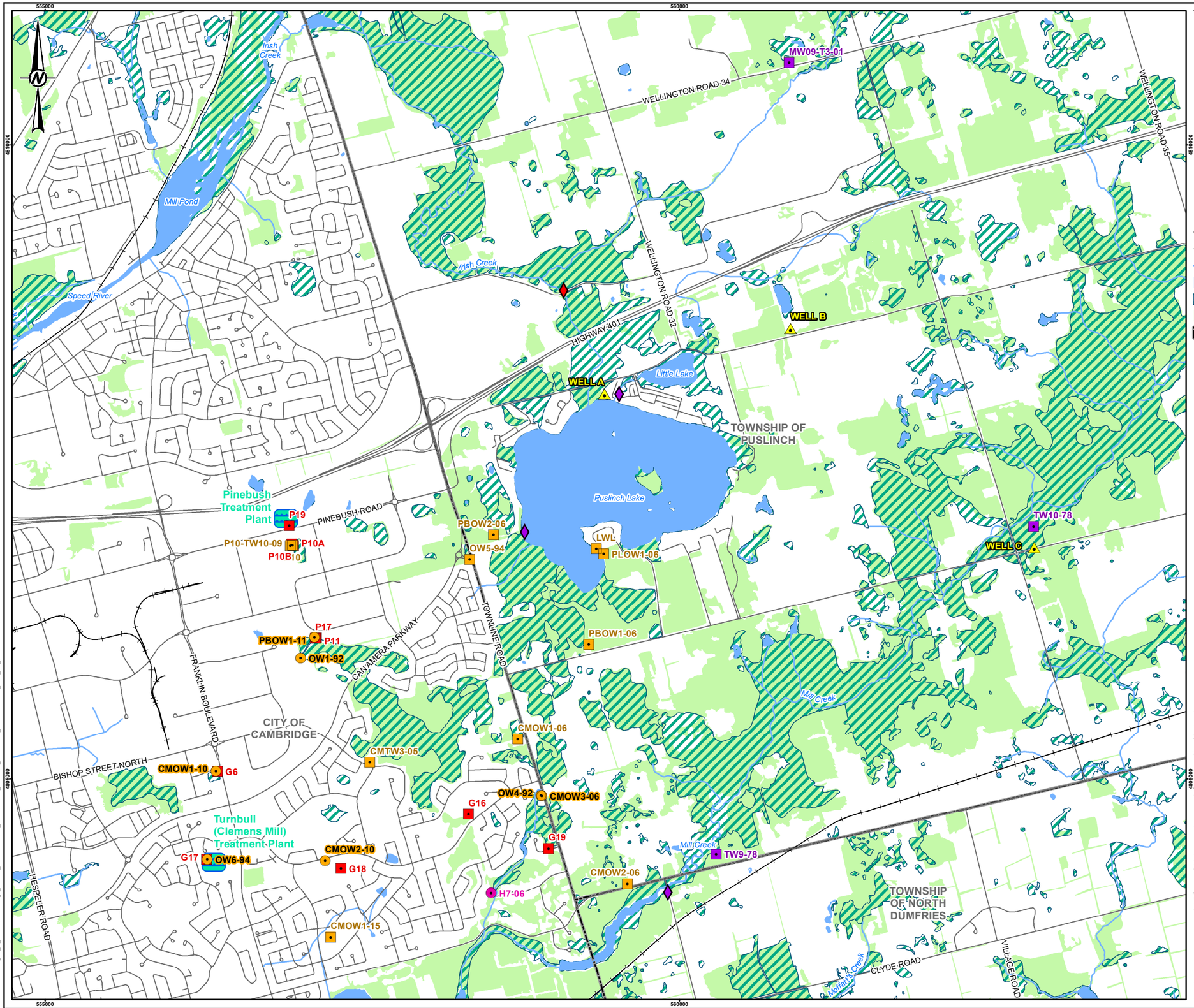
Golder Associates Ltd. (Golder), 2018. Regional Municipality of Waterloo Cambridge East Water Supply Class Environmental Assessment – Project File Report. Submitted to The Regional Municipality of Waterloo. Dated April 2018.

Golder Associates Ltd. (Golder), 2017. Regional Municipality of Waterloo Cambridge East Water Supply Class Environmental Assessment – Hydrogeological and Natural Environment Report. Submitted to The Regional Municipality of Waterloo. Dated December 2017.

Stantec Consulting Ltd. (Stantec), 2015. Pinebush Road Well Field Construction and Testing of Test Wells P10A, P10B, TW1-10 and Production Wells P11 and P17. Prepared for Regional Municipality of Waterloo. Dated September 6, 2013.

FIGURE

Figure 1 – Monitoring Locations in Pinebush and Clemens Mill Well Fields



LEGEND

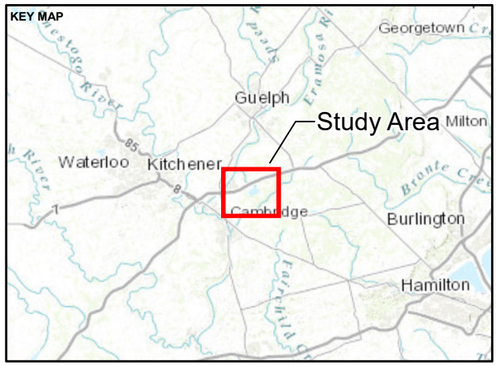
PROPOSED NEW MONITORING LOCATIONS

- PROPOSED MULTILEVEL WELLS
- PROPOSED STAFF GAUGE AND MINI-PIEZOMETER
- PROPOSED MINI-PIEZOMETER

EXISTING MONITORING LOCATIONS

- ONGOING TOWNSHIP OF PUSLINCH MONITORING LOCATIONS
- MUNICIPAL SUPPLY WELL
- NEW LONG-TERM MONITORING LOCATION
- CURRENT PTTW MONITORING WELL
- MINI-PIEZOMETER
- ROAD
- RAILWAY
- WATERCOURSE
- WATER BODY
- GRCA WETLAND
- WOODED AREA
- MUNICIPAL BOUNDARY

KEY MAP



0 550 1,100

1:30,000 METRES

REFERENCE(S)

1. BASE DATA: LIO MNRF OBTAINED 2019
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N
3. BASE MAP: SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT

REGIONAL MUNICIPALITY OF WATERLOO

PROJECT

REGIONAL MUNICIPALITY OF WATERLOO, CAMBRIDGE EAST PERMITS TO TAKE THE WATER

TITLE

MONITORING LOCATIONS IN PINEBUSH AND CLEMENS MILL WELL FIELDS

CONSULTANT

GOLDER

YYYY-MM-DD	2020-01-07
DESIGNED	PR/LMM
PREPARED	LMM/ST
REVIEWED	JLH
APPROVED	JAP

PROJECT NO.	CONTROL	REV.	FIGURE
19119485	-	-	1

PATH: S:\Clients\Region_of_Waterloo\Cambridge_East\99_PROJ\19119485_WaterlooNorth_PTTW\40_PROD\0001_PTTW19119485_0001_CS_0002.mxd PRINTED ON: 2020-01-07 AT: 1:44:07 PM

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

25mm

TABLE

Table 2 – Proposed Cambridge East Monitoring Locations

Well Name	Sys_Loc Code	Region Name	Easting	Northing	Screened Interval (mbgs)	Formation Screened	Well Field	Notes
CMOW3A-06	9202639A	C-CM-OW3-06-A	558916.3	4804866.4	77.7 - 108.2	Gasport	Clemens Mill	Existing PTTW - Clemens Mill
CMOW3B-06	9202639B	C-CM-OW3-06-B			50.3 - 56.1	Guelph		Existing PTTW - Clemens Mill
CMOW3C-06	9202639C	C-CM-OW3-06-C			36.6 - 39.6	Guelph		Existing PTTW - Clemens Mill
CMOW1-10	9205505A	C-CM-OW01-10-A	556344.5	4805060.2	9.8 - 12.8	Shallow Overburden	Clemens Mill	Existing PTTW - Clemens Mill
CMOW2A-10	9205506A	C-CM-OW02-10-A	557206.2	4804356.0	33.8 - 35.4	Deep Overburden	Clemens Mill	Existing PTTW - Clemens Mill
CMOW2B-10	9205507B	C-CM-OW02-10-B	557208.1	4804356.7	9.7 - 12.7	Shallow Overburden		Existing PTTW - Clemens Mill
OW4A-92	1000389A	C-CM-OW4-92-A	558908.1	4804869.3	36.9 - 37.8	Guelph	Clemens Mill	Existing PTTW - Clemens Mill
OW4B-92	1000390B	C-CM-OW4-92-B	558910.8	4804870.2	28.4 - 29.9	Deep Overburden		Existing PTTW - Clemens Mill
OW4C-92	1000390C	C-CM-OW4-92-C			8.8 - 10.4	Shallow Overburden		Existing PTTW - Clemens Mill
OW6A-94	6507562A	C-CM-OW6-94-A	556277.2	4804365.8	155.5 - 158.5	Cabot Head	Clemens Mill	Existing PTTW - Clemens Mill
OW6B-94	6507562B	C-CM-OW6-94-B			130.0 - 133.0	Gasport		Existing PTTW - Clemens Mill
OW6C-94	6507562C	C-CM-OW6-94-C			111.0 - 114.0	Gasport		Existing PTTW - Clemens Mill
OW6D-94	6507562D	C-CM-OW6-94-D			68.6 - 71.6	Guelph		Existing PTTW - Clemens Mill
OW1A-92	1000383A	C-PB-OW1-92-A	557014.6	4805951.6	29.5 - 84.1	Guelph - Gasport	Pinebush	Existing PTTW - Pinebush
OW1B-92	1000382B	C-PB-OW1-92-B			18.3 - 21.3	Deep Overburden		Existing PTTW - Pinebush
OW1C-92	1000382C	C-PB-OW1-92-C			7.3 - 10.4	Shallow Overburden		Existing PTTW - Pinebush
PBOW1-11A	9205806A	C-PB-OW1-11-A	557123.0	4806116.0	19.8 - 22.9	Deep Overburden	Pinebush	Existing PTTW - Pinebush
PBOW1-11B	9205807A	C-PB-OW1-11-B			6.1 - 7.62	Shallow Overburden		Existing PTTW - Pinebush
CMOW1A-06	9202637A	C-CM-OW1-06-A	558725.7	4805314.2	102.1 - 120.4	Gasport	Clemens Mill	GMP
CMOW1B-06	9202637B	C-CM-OW1-06-B			48.8 - 57.9	Guelph		GMP
CMOW1C-06	9202637C	C-CM-OW1-06-C			36.6 - 39.6	Guelph		GMP
CMOW1D-06	9202664D	C-CM-OW1-06-D	558724.0	4805313.1	30.2 - 33.1	Deep Overburden		GMP
CMOW1E-06	9202665E	C-CM-OW1-06-E	558723.0	4805312.4	14.0 - 17.1	Intermediate Overburden		GMP
CMOW1F-06	9202666F	C-CM-OW1-06-F	558724.8	4805313.7	4.6 - 7.6	Shallow Overburden		GMP
CMOW2A-06	9202638A	C-CM-OW2-06-A	559589.2	4804173.7	91.4 - 111.6	Gasport	Clemens Mill	GMP
CMOW2B-06	9202638B	C-CM-OW2-06-B			45.0 - 58.2	Guelph		GMP
CMOW2C-06	9202638C	C-CM-OW2-06-C			30.5 - 35.4	Guelph		GMP
CMOW2D-06	9202667D	C-CM-OW2-06-D	559589.8	4804173.5	27.4 - 29.0	Deep Overburden		GMP
CMOW2E-06	9202668E	C-CM-OW2-06-E	559588.2	4804174.2	13.7 - 16.8	Intermediate Overburden		GMP
CMOW2F-06	9202669F	C-CM-OW2-06-F	559590.5	4804173.0	4.6 - 7.6	Shallow Overburden		GMP
CMTW3A-05	9202049A	C-CM-TW3-05-A	557560.0	4805132.0	106.7 - 125.0	Gasport	Clemens Mill	GMP
CMTW3B-05	9202049B	C-CM-TW3-05-B			64.0 - 70.1	Guelph		GMP
CMTW3C-05	9202049C	C-CM-TW3-05-C			38.4 - 46.0	Guelph		GMP

Table 2 - Proposed Cambridge East Monitoring Locations

Well Name	Sys_Loc Code	Region Name	Easting	Northing	Screened Interval (mbgs)	Formation Screened	Well Field	Notes
CMOW1A-15	9207189A	C-CM-OW1-15-A	557250.5	4803752.0	93.0 - 96.0	Gasport	Clemens Mill	GMP
CMOW1B-15	9207190B	C-CM-OW1-15-B	557244.0	4803751.0	77.1 - 80.2	Goat Island		GMP
CMOW1C-15	9207190C	C-CM-OW1-15-C			30.5 - 33.5	Guelph		GMP
PBOW1A-06	9202643A	C-PB-OW1-06-A	559285.9	4806058.2	91.4 - 109.1	Gasport	Pinebush	GMP
PBOW1B-06	9202643B	C-PB-OW1-06-B			48.2 - 54.3	Guelph		GMP
PBOW1C-06	9202643C	C-PB-OW1-06-C			35.4 - 41.5	Guelph		GMP
PBOW1D-06	9202670D	C-PB-OW1-06-D	559284.4	4806058.2	32.0 - 35.5	Deep Overburden		GMP
PBOW1E-06	9202671E	C-PB-OW1-06-E	559283.1	4806058.4	19.0 - 22.9	Intermediate Overburden		GMP
PBOW1F-06	9202672F	C-PB-OW1-06-F	559281.8	4806058.7	8.2 - 11.3	Shallow Overburden		GMP
PBOW2A-06	9202673A	C-PB-OW2-06-A	558534.8	4806923.5	91.4 - 109.8	Gasport	Pinebush	GMP
PBOW2B-06	9202673B	C-PB-OW2-06-B			48.9 - 55.0	Reformatory Quarry		GMP
PBOW2C-06	9202673C	C-PB-OW2-06-C			33.5 - 44.4	Guelph		GMP
PBOW2D-06	9202674D	C-PB-OW2-06-D	558535.9	4806925.7	33.2 - 36.3	Deep Overburden		GMP
PBOW2E-06	9202675E	C-PB-OW2-06-E	558536.3	4806926.8	25.0 - 28.0	Intermediate Overburden		GMP
PBOW2F-06	9202676F	C-PB-OW2-06-F	558534.4	4806922.1	14.0 - 17.1	Shallow Overburden		GMP
PLOW1A-06	9202647A	C-PB-PLOW1-06-A	559402.9	4806775.2	9.1 - 10.7	Shallow Overburden	Pinebush	GMP
PLOW1B-06	9202647B	C-PB-PLOW1-06-B	559403.1	4806774.7	3.8 - 5.3	Shallow Overburden		GMP
OW5A-94	9200572A	C-PB-OW5-94-A	558345.8	4806730.4	137.0 - 140.0	Cabot Head	Pinebush	GMP
OW5B-94	9200572B	C-PB-OW5-94-B			104.0 - 110.0	Gasport		GMP
OW5C-94	9200572C	C-PB-OW5-94-C			53.3 - 59.7	Reformatory Quarry - Goat Island		GMP
OW5D-94	9200572D	C-PB-OW5-94-D			43.3 - 48.3	Guelph		GMP
OW5E-94	9200572E	C-PB-OW5-94-E			36.3 - 39.3	Deep Overburden		GMP
OW5F-94	9200572F	C-PB-OW5-94-F			6.1 - 9.1	Shallow Overburden		GMP
OW5G-94	9200572G	C-PB-OW5-94-G			14.8 - 17.8	Shallow Overburden		GMP
LWL	9202660	P-LWL-06	559343.8	4806815.2	surface water	Puslinch Lake	Pinebush	GMP

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

Well Records

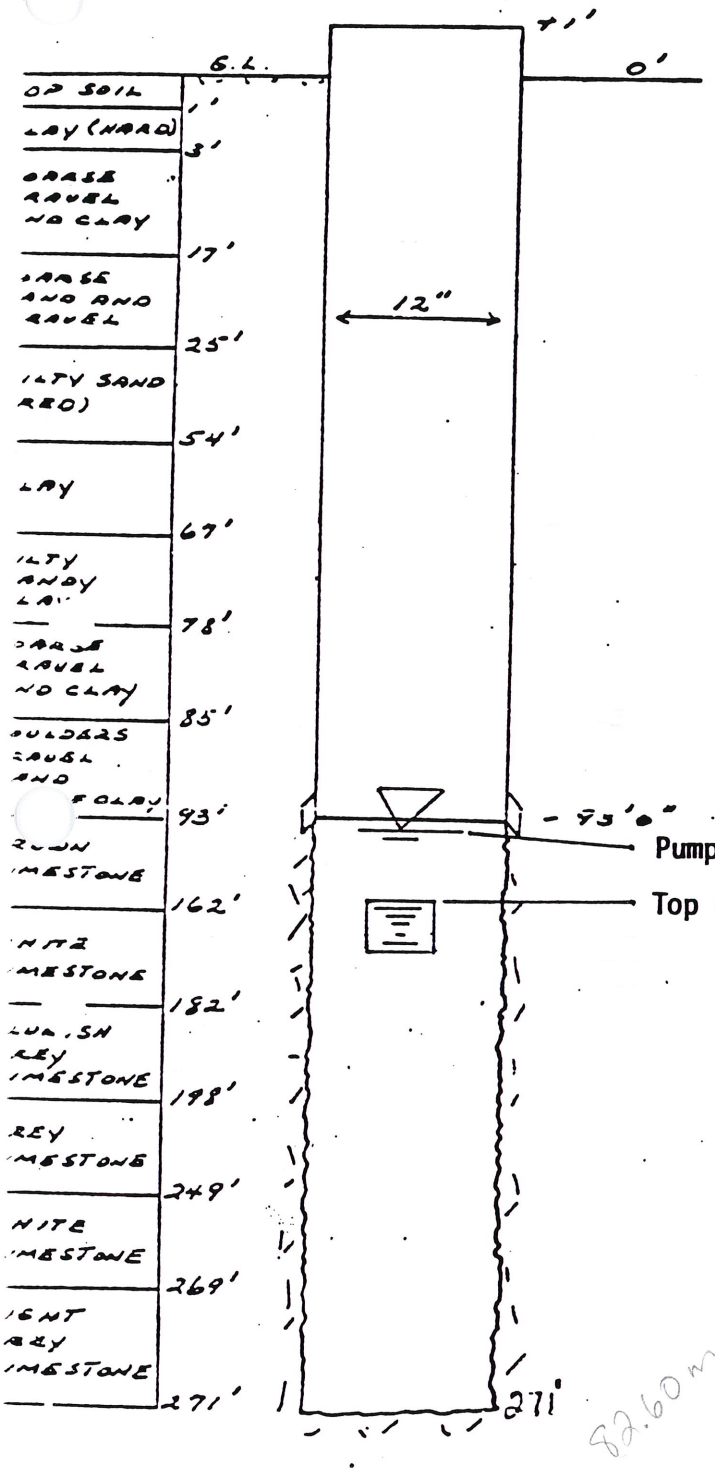
Table B1: Construction Details

Monitoring Well ID	Year Built	Screened Depth (mbgs)	Screened Formation	Distance to closest active production well (m)
C-CM-OW01-10-A	2010	9.8-12.8	AFB1	11 (G6)
C-CM-OW02-10-A	2010	33.8-35.4	ATB3	139 (G18)
C-CM-OW02-10-B	2010	9.7-12.7	ATB3	139 (G18)
C-CM-OW1-06-A	2006	102.1-120.4	Middle Gasport to Cabot Head	710 (G16)
C-CM-OW1-06-B	2006	48.8-57.9	Middle to Lower Guelph	710 (G16)
C-CM-OW1-06-C	2006	36.6-39.6	Upper Guelph	710 (G16)
C-CM-OW1-06-D	2006	30.2-33.1	AFD1	710 (G16)
C-CM-OW1-06-E	2006	14.0-17.1	AFA2	710 (G16)
C-CM-OW1-06-F	2006	4.6-7.6	AFA2	710 (G16)
C-CM-OW1-15-A	2015	93.0-96.0	Upper Gasport	548 (G18)
C-CM-OW1-15-B	2015	77.1-80.2	Goat Island to Upper Gasport	548 (G18)
C-CM-OW1-15-C	2015	30.5-33.5	Upper Guelph	548 (G18)
C-CM-OW2-06-A	2006	91.4-111.6	Middle Gasport to Cabot Head	1,368 (G16)
C-CM-OW2-06-B	2006	45.0-58.2	Middle to Lower Guelph	1,368 (G16)
C-CM-OW2-06-C	2006	30.5-35.4	Contact to Upper Guelph	1,368 (G16)
C-CM-OW2-06-D	2006	27.4-29.0	ATB3	1,368 (G16)

Monitoring Well ID	Year Built	Screened Depth (mbgs)	Screened Formation	Distance to closest active production well (m)
C-CM-OW2-06-E	2006	13.7-16.8	AFB1	1,368 (G16)
C-CM-OW2-06-F	2006	4.6-7.6	AFA2	1,368 (G16)
C-CM-OW3-06-A	2006	77.8-108.2	Upper Gasport to Cabot Head	599 (G16)
C-CM-OW3-06-B	2006	50.3-56.1	Lower Guelph to Reformatory Quarry	599 (G16)
C-CM-OW3-06-C	2006	36.6-39.6	Contact to Upper Guelph	599 (G16)
C-CM-OW4-92-A	1992	36.9-37.8	Upper Guelph	591 (G6)
C-CM-OW4-92-B	1992	25.4-29.9	ATB3	591 (G6)
C-CM-OW4-92-C	1992	8.8-10.4	AFA2 to AFB1	591 (G6)
C-CM-OW6-94-A	1994	155.5-158.5	Cabot Head	6 (G17)
C-CM-OW6-94-B	1994	130-133	Middle Gasport	6 (G17)
C-CM-OW6-94-C	1994	111.0-114.0	Upper Gasport	6 (G17)
C-CM-OW6-94-D	1994	68.6-71.6	Reformatory Quarry	6 (G17)
C-CM-PBOW1-06-A	2006	91.4-109.1	Upper to Lower Gasport	1,640 (G16)
C-CM-PBOW1-06-B	2006	48.2-54.3	Lower Guelph	1,640 (G16)
C-CM-PBOW1-06-C	2006	35.4-41.5	Contact to Upper Guelph	1,640 (G16)
C-CM-PBOW1-06-D	2006	32.0-35.5	AFD1 to contact	1,640 (G16)
C-CM-PBOW1-06-E	2006	19.8-22.7	ATB3	1,640 (G16)
C-CM-PBOW1-06-F	2006	8.2-11.3	ATA2 to AFA2	1,640 (G16)

Monitoring Well ID	Year Built	Screened Depth (mbgs)	Screened Formation	Distance to closest active production well (m)
C-CM-PLOW1-06-A	2006	9.1-10.7	AFA2	3,232 (G18)
C-CM-PLOW1-06-B	2006	3.8-5.3	ATA2	3,232 (G18)
C-CM-TW3-05-A	2005	106.7-125.0	Middle Gasport to Cabot Head	901 (G16)
C-CM-TW3-05-B	2005	64.0-70.1	Middle to Lower Guelph	901 (G16)
C-CM-TW3-05-C	2005	38.4-46.0	Contact to Upper Guelph	901 (G16)
Piezometer Monitoring ID	**Year Built**	**Screened Depth (mbgs)**	**Screened Formation**	**Closest Production well Distance (m)**
C-CM-DP2-21-A	2021	1.9-2.3	Shallow Overburden	970 (G19)
C-CM-DP2-21-A	2021	1.1-1.5	Shallow Overburden	970 (G19)
C-CM-DP4-21-A	2021	1.2-1.6	Shallow Overburden	690 (G19)
Surface Water Monitoring ID	**Year Built**			**Closest Production well Distance (m)**
C-CM-SW1-22-Z	2022			2,430 (G16)
C-CM-SW2-21-Z	2021			970 (G19)
C-CM-SW4-21-Z	2021			690 (G19)

COWAN GALT G6



Well Material

Outer Casing 94'6" OF 12" WELDED

Inner Casing

Screen

Plug

Gravel

Pump

No.	41075	Setting BP-MB	160'
No. Stages	5	Length Bowl	4'-10½"
Bowl	10"	Size & Lgth. Suction	none
Head	SDH	Size Column	6" x 1½" x 1"

Materials or setting details other than standard:
Impellers: Trim

Motor

Make	U.S.E.N.	Phase	3
H. P.	30	Cycles	60
R. P. M.	1800	Volts	550
Type	TU - 3	Amps.	20.6
Frame	326 UP	Serial	20490-9

Bearing Nos. Upper Brg. 1-7220N
Lower Brg. 1-6211

Special Equipment

G-6 6500131 verified S.T.

Well No. 1-59

B.P. referred to original ground level

Clear depth below B. P. 274'-2"

Started 9/1/59 Final Test 60

Preliminary Test 10/7/59 Static Level 67' 3½"

Final Test Pumping Level 166' 11 3/4"

Guarantee IGPM Capacity 461 IGPM

Contract Pressure = Pressure Pump =

Length Air Line 164'2" Main =

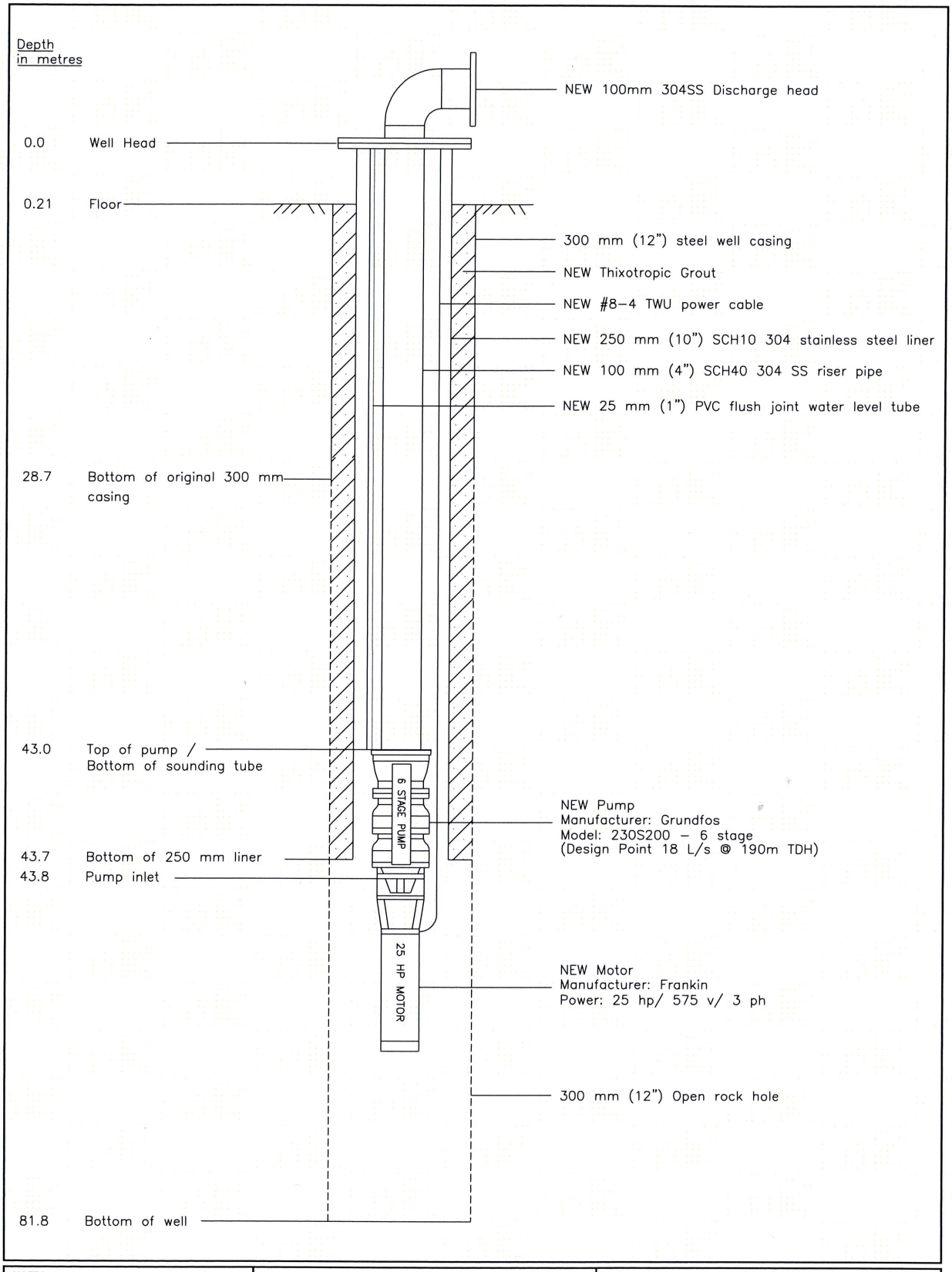
INTERNATIONAL WATER SUPPLY LTD.

MONTREAL LONDON, CANADA SASKATOON
OAKVILLE WATER SUPPLY CONTRACTORS VANCOUVER

GALT, ONTARIO

DRILLED BY C. MURLOW DRAWN BY J. W.
INSTALLED BY J. Hartman APPROVED BY

G6



NOTES

(1) All measurements below top of casing which is 0.21 m above floor.

Lotowater TECHNICAL SERVICES INC.

CLIENT: Regional Municipality of Waterloo

TITLE: Well G6 Pump and Liner Installation Drawing

PROJECT No. 006-279			G:\Lotowater Projects\006 Region of Waterloo\279 RMOW Liner Porject 2013\Well G6\Proposed Liner.dwg		
DESIGN	BP		REVISION No. 2014/08/20	SCALE N.T.S.	FIGURE 6
DRAWN	EH	2014/06/24			
CHECKED	BP	2014/07/29			

G6

Production Well: C-CM-G6-59

Project: 2013 Well Construction and Testing
Client: Regional Municipality of Waterloo
Location: Region of Waterloo; Clemens Mill Well Field
Number: 1609-00734

Field Investigator: N/A
Contractor: International Water Supply Ltd./ Lotowater Technical Services Inc.
Drilling method: N/A
Date started/completed: 01-Sep-1959 / 08-Oct-1959

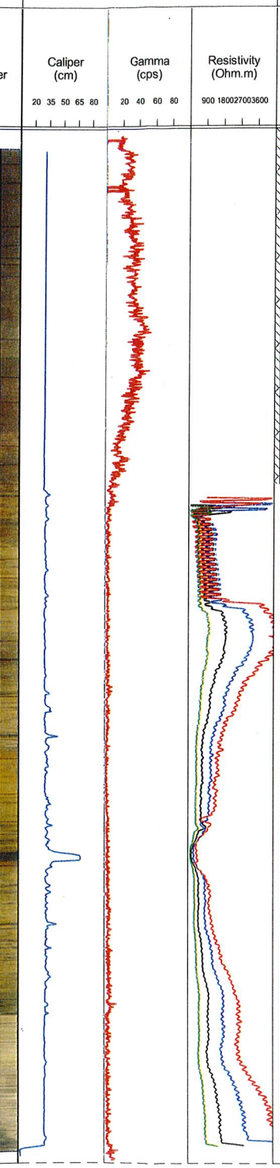
Ground surface elevation: 309.23 m AMSL
Top of casing elevation: 309.52 m AMSL
Easting: 556355.45
Northing: 4805062.24

SUBSURFACE PROFILE

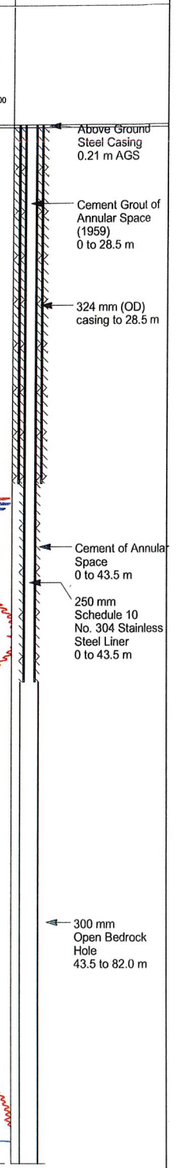
Depth (ft)	Depth (m)	Lithologic Description	Elevation (m AMSL) / Depth (m BGS)
		Ground Surface	309.44
		TOPSOIL	309.23 / 0.00
5	2	CLAY hard	308.92 / 0.30
10	4	GRAVEL AND CLAY coarse grained	308.31 / 0.91
15	6	SAND AND GRAVEL coarse grained	304.05 / 5.18
20	8	SILTY SAND medium grained	301.61 / 7.62
25	10		
30	12		
35	14		
40	16		292.77 / 16.46
45	18	CLAY	
50	20		288.81 / 20.42
55	22	SILTY SANDY CLAY	
60	24		285.45 / 23.77
65	26	GRAVEL AND CLAY coarse grained	283.32 / 25.91
70	28	BOULDERS AND GRAVEL little clay	280.88 / 28.35
75	30	LIMESTONE brown	
80	32		
85	34		
90	36		
95	38		
100	40		
105	42		
110	44		
115	46	horizontal ring feature at 45.66 m BGS	
120	48	vertical fracture 47.5 to 48.5 m BGS	
125	50	horizontal ring feature at 49.17 m BGS LIMESTONE white	259.85 / 49.38
130	52	horizontal ring feature at 49.93 m and 54.2 m BGS	
135	54	vug in rock wal at 54.85 m BGS	253.76 / 55.47
140	56	LIMESTONE bluish grey horizontal ring feature at 57.25 m BGS	
145	58	vug in rock wall at 57.65 m BGS	248.88 / 60.35
150	60	large void, cavern at 58.40 m BGS LIMESTONE grey	
155	62	horizontal ring feature at 60.90 m, 61.60 m, 64.00 m, and 67.55 m BGS	
160	64		
165	66		
170	68	vug in rock wall at 67.58 m, 68.44 m, and 70.27 m BGS	
175	70		
180	72	horizontal ring feature at 71.20 m BGS	
185	74		
190	76	LIMESTONE white horizontal ring feature at 79.12 m BGS	233.33 / 75.90
195	78		
200	80		
205	82	horizontal ring feature at 81.23 m BGS LIMESTONE light grey	227.24 / 81.99
210	84	End of Borehole	226.63 / 82.60

Optical Televiewer

GEOPHYSIC DETAILS



WELL DETAILS



Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing

n/a - not available/applicable

Geophysics completed on June 24, 2014
Original WRAS Object Number: 6500131
Liner Modification WRAS Object Number: 9207090
Stratigraphy description from MOE WWR
Fracture details from well video (July 17, 2014)

Stantec

Drawn By/Checked By: AD/NS/ LV

Sheet 1 of 1

STANTEC BOREHOLE AND WELL - MASTER 17X11 160900734_MASTER_LOGS.GPJ STANTEC - DATA TEMPLATE.GDT 2/5/15 NSPINA

Ministry of the Environment
Ontario

The Ontario Water Resources Act

WATER WELL RECORD

G16

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507

COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON. BLOCK, TRACT, SURVEY, ETC.	LOT
Waterloo	City of Cambridge		

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
Regional Mun. of Waterloo	c/o Lotowater Ltd. Box 451, Paris, ON N3L 3T5	DAY 18 MO Aug. YR 92.

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION		DEPTH - FEET FROM	TO
Brown	Sand	Silt, gravel, boulders	Hard	0 - 5.8m	0	19
Grey	Gravel	Boulders	Hard	5.8 - 8.5	19	28
Grey	Sand	Silt, gravel	Soft	8.5 - 13.1	28	43
Grey	Boulders	Gravel	Hard	13.1 - 20.1	43	66
Grey	Sand	Silt, gravel	Soft	20.1 - 26.5	66	87
Grey	Silt	Clay, gravel	Soft	26.5 - 30.2	87	99
Grey	Sand	Gravel, boulders	Soft	30.2 - 40.5	99	133
Lt.Brn.	Limestone		Hard	40.5 - 52.1	133	171
Grey	Limestone		Hard	52.1 - 100	171	328

WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER	
156, 168, 197, 206	☐ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS
210-211, 220	☐ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS
224, 229	☐ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS
238-239, 271	☐ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS
288, 319	☐ FRESH ☐ SALTY	☐ SULPHUR ☐ MINERALS ☐ GAS

CASING & OPEN HOLE RECORD

INSIDE DIAM. INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
12	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE ☐ PLASTIC	.375	+2-4	152-10
12	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☒ OPEN HOLE ☐ PLASTIC		152-10	328
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE ☐ PLASTIC			

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
0	152-10	Neat Cement Annular grout

PUMPING TEST

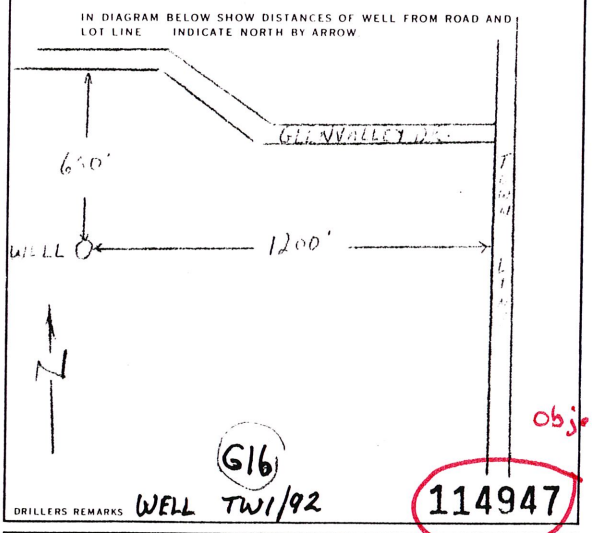
PUMPING TEST METHOD	PUMPING RATE	DURATION OF PUMPING
☒ PUMP ☐ BAILER	600-545 GPM	8 HOURS ___ MINS.

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING ☐ PUMPING ☐ RECOVERY			
		15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
33 FEET	103 FEET	107 FEET	110 FEET	111.4 FEET	111.5 FEET

IF FLOWING GIVE RATE	PUMP INTAKE SET AT	WATER AT END OF TEST
GPM	TEST WELL FEET	☒ CLEAR ☐ CLOUDY
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☐ DEEP	RECOMMENDED PUMP SETTING FEET	RECOMMENDED PUMPING RATE GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS: WELL TW1/92

G16

114947

object # 1000277

FINAL STATUS OF WELL	WATER USE	METHOD OF CONSTRUCTION
☒ WATER SUPPLY	☐ DOMESTIC	☐ CABLE TOOL
☐ OBSERVATION WELL	☐ STOCK	☒ ROTARY (CONVENTIONAL)
☐ TEST HOLE	☐ IRRIGATION	☐ ROTARY (REVERSE)
☐ RECHARGE WELL	☐ INDUSTRIAL	☒ ROTARY (AIR)
☐ ABANDONED, INSUFFICIENT SUPPLY	☐ OTHER	☒ AIR PERCUSSION
☐ ABANDONED, POOR QUALITY	☐ COMMERCIAL	☐ BORING
☐ UNFINISHED	☒ MUNICIPAL	☐ DIAMOND
☐ DEWATERING	☒ PUBLIC SUPPLY	☐ JETTING
	☐ COOLING OR AIR CONDITIONING	☐ DRIVING
	☐ NOT USED	☐ DIGGING ☐ OTHER

CONTRACTOR

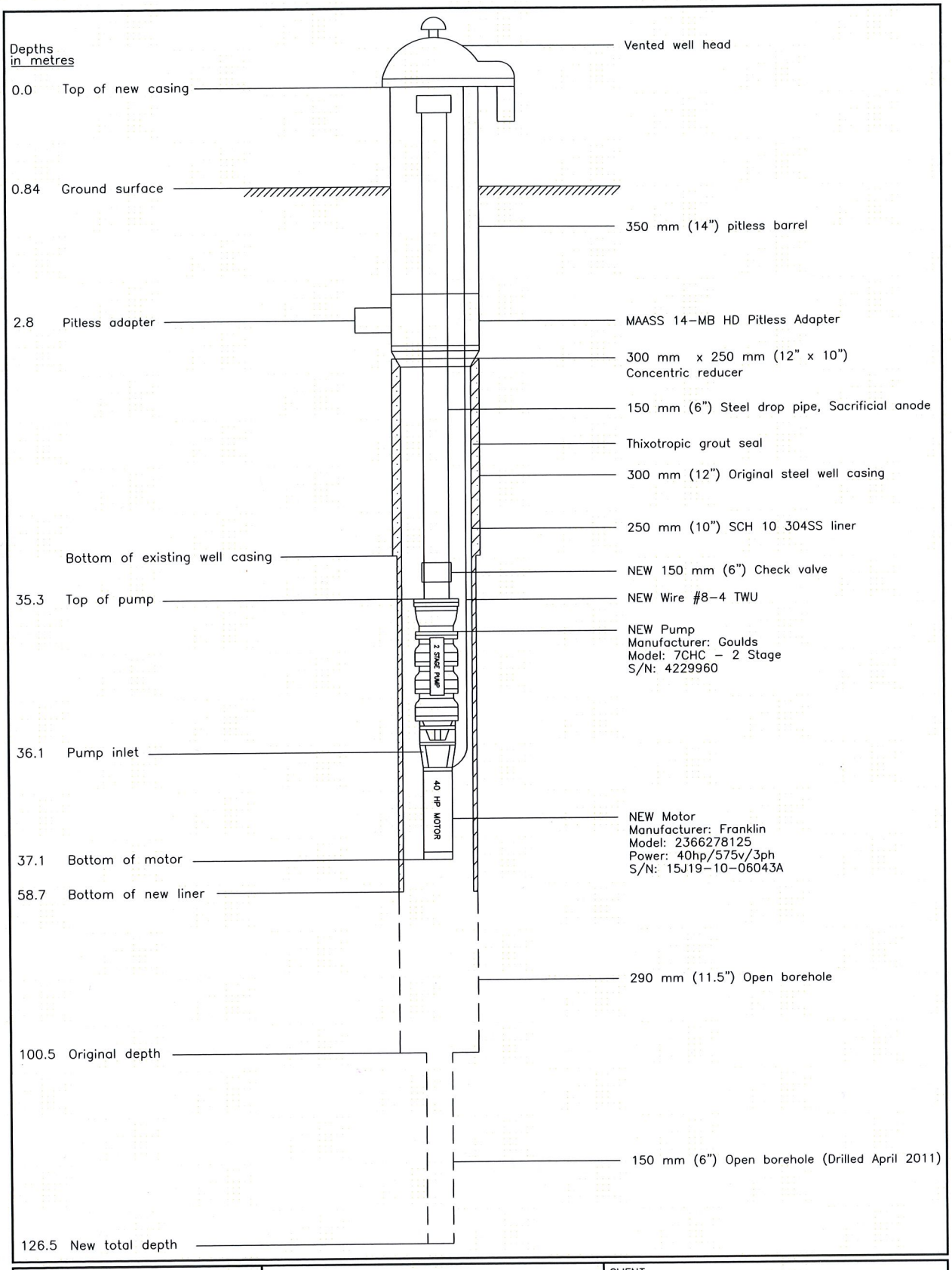
NAME OF WELL CONTRACTOR	WELL CONTRACTOR'S LICENCE NUMBER
Davidson Well Drilling Limited	1737
ADDRESS: Box 486, Wingham, Ontario. N0G 2W0	
NAME OF WELL TECHNICIAN: G. Reavie	WELL TECHNICIAN'S LICENCE NUMBER: T0156
SIGNATURE OF TECHNICIAN/CONTRACTOR	SUBMISSION DATE: DAY 27 MO Aug. YR 92.

OFFICE USE ONLY

OFFICE COPY

FORM NO. 0506 (11/86) FORM 9

G16



NOTES

Lotowater TECHNICAL SERVICES INC.

CLIENT: Regional Municipality of Waterloo

TITLE: Well G16 Pump Installation Drawing

PROJECT No. 006-351			G:\Lotowater Projects\006 Region of Waterloo\351 G16\Pump Installation.dwg		
DESIGN	EH	2011/02/24	REVISION No. 2016-01-19	SCALE N.T.S.	FIGURE 1
DRAWN	EH	2016/01/19			
CHECKED	BP	2016/01/19			

Ministry of the Environment
Ontario

0813M006.MOB

The Ontario Water Resources Act

WATER WELL RECORD

G17

G17
1000017

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

11 6507613 MUNICIP 65507 CON. B.L.B. 02

COUNTY OR DISTRICT	TOWNSHIP BOROUGH CITY TOWN VILLAGE	CON BLOCK TRACT SURVEY ETC	LOT
Region of Waterloo	City of Cambridge	Con. 2 B.L.B.	1

OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED
REGIONAL MUN. OF WATERLOO	150 Frederick St., Kitchener, ON N2G 4J3	DAY 25 MO 03 YR 94

21 ZONE 17 EASTING 556270.6 NORTHING 4804364.7 ELEVATION 320.2

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET FROM	TO
Brown	Silty sand		Soft	0	42
	Gravel			42	43
	Silty sand			43	51
	Sand	Gravel		51	65
	Silty sand			65	81
	Till	Stones, gravel streaks		81	125
Lt.Brown	Limestone		MEd. soft	125	136
Lt.Brown	Limestone		Med. hard	136	339
Grey	Limestone		Med. hard	339	396

31

32

41 WATER RECORD

WATER FOUND AT - FEET	KIND OF WATER
134	FRESH
136	SALTY
~~219-220~~	
229-230	
~~230-238~~	
~~274~~	
279-280	
~~320~~	
341-348	
356-359	
364-369	
380-382	

51 CASING & OPEN HOLE RECORD

INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET FROM	TO
13.25	1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE 5 PLASTIC	.375	+3	202.5 (61.72)
12.25	1 STEEL 2 GALVANIZED 3 CONCRETE 4 OPEN HOLE 5 PLASTIC		202.5	396 (120.70)

SCREEN

SIZE(S) OF OPENING (SLOT NO.)	DIAMETER INCHES	LENGTH FEET
MATERIAL AND TYPE	DEPTH TO TOP OF SCREEN FEET	

61 PLUGGING & SEALING RECORD

DEPTH SET AT - FEET FROM	TO	MATERIAL AND TYPE (CEMENT GROUT, LEAD PACKER, ETC.)
0	202.5	Annular neat cement

71 PUMPING TEST

PUMPING TEST METHOD: ☒ PUMP ☐ BAILER

PUMPING RATE: 660 GPM

DURATION OF PUMPING: 48 HOURS

STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING ☒ PUMPING ☐ RECOVERY	15 MINUTES	30 MINUTES	45 MINUTES	60 MINUTES
42.39 FEET	139.1 FEET	174.9 FEET	148.3 FEET	151.3 FEET	153.7 FEET	155.5 FEET

IF FLOWING, GIVE RATE: GPM

PUMP INTAKE SET AT: FEET

WATER AT END OF TEST: ☒ CLEAR ☐ CLOUDY

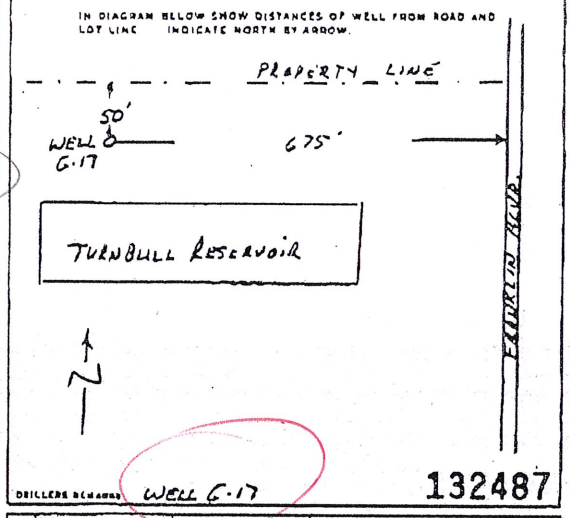
RECOMMENDED PUMP TYPE: ☐ SHALLOW ☒ DEEP

RECOMMENDED PUMP SETTING: 200 FEET (60.96)

RECOMMENDED PUMPING RATE: 660 GPM

LOCATION OF WELL

IN DIAGRAM BELOW SHOW DISTANCES OF WELL FROM ROAD AND LOT LINE. INDICATE NORTH BY ARROW.



DRILLERS REMARKS: WELL G-17

132487

FINAL STATUS OF WELL	WATER USE	METHOD OF CONSTRUCTION
☒ WATER SUPPLY	☐ DOMESTIC	☐ CABLE TOOL
☐ OBSERVATION WELL	☐ STOCK	☒ ROTARY (CONVENTIONAL)
☐ TEST HOLE	☐ IRRIGATION	☒ ROTARY (REVERSE)
☐ RECHARGE WELL	☐ INDUSTRIAL	☒ ROTARY (AIR)
☐ ABANDONED, INSUFFICIENT SUPPLY	☐ OTHER	☐ AIR PERCUSSION
☐ ABANDONED, POOR QUALITY	☐ COMMERCIAL	☐ BORING
☐ UNFINISHED	☒ MUNICIPAL	☐ DIAMOND
☐ DEWATERING	☐ PUBLIC SUPPLY	☐ JETTING
	☐ COOLING OR AIR CONDITIONING	☐ DRIVING
	☐ OTHER	☐ DIGGING ☐ OTHER
	☐ NOT USED	

CONTRACTOR

NAME OF WELL CONTRACTOR: Davidson Well Drilling Limited

WELL CONTRACTOR'S LICENCE NUMBER: 1737

ADDRESS: P.O. Box 486, Wingham, Ontario. N0G 2W0

NAME OF WELL TECHNICIAN: G. REavie

WELL TECHNICIAN'S LICENCE NUMBER: T0156

SIGNATURE OF TECHNICIAN/CONTRACTOR

SUBMISSION DATE: DAY 03 MO 05 YR 94

OFFICE USE ONLY

DATA SOURCE

CONTRACTOR: 1737

DATE RECEIVED: JUL 26 1994

DATE OF INSPECTION

INSPECTOR

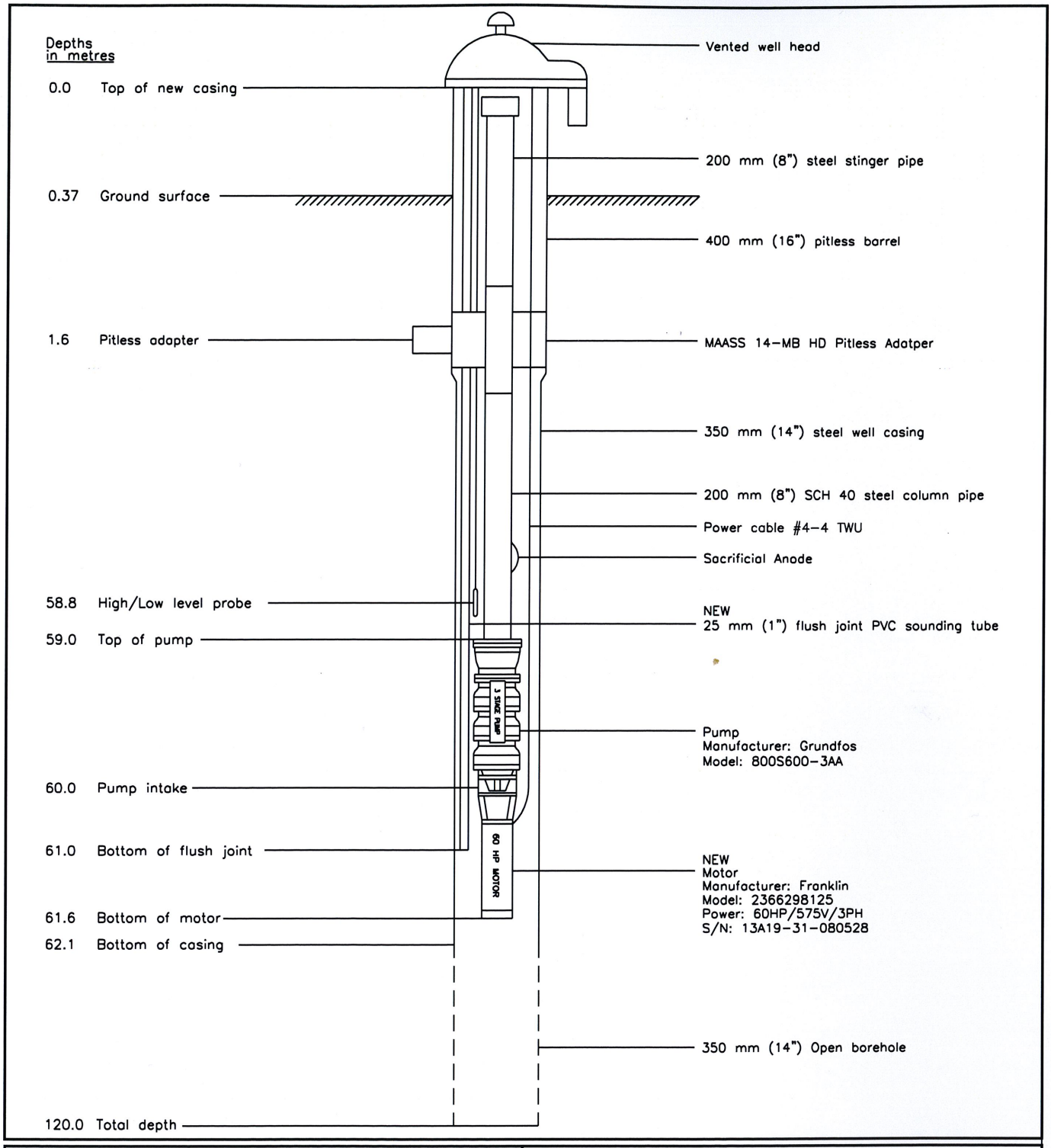
REMARKS

CSS.ES

MINISTRY OF THE ENVIRONMENT COPY

FORM NO. 0506 (11/86) FORM 8

G17

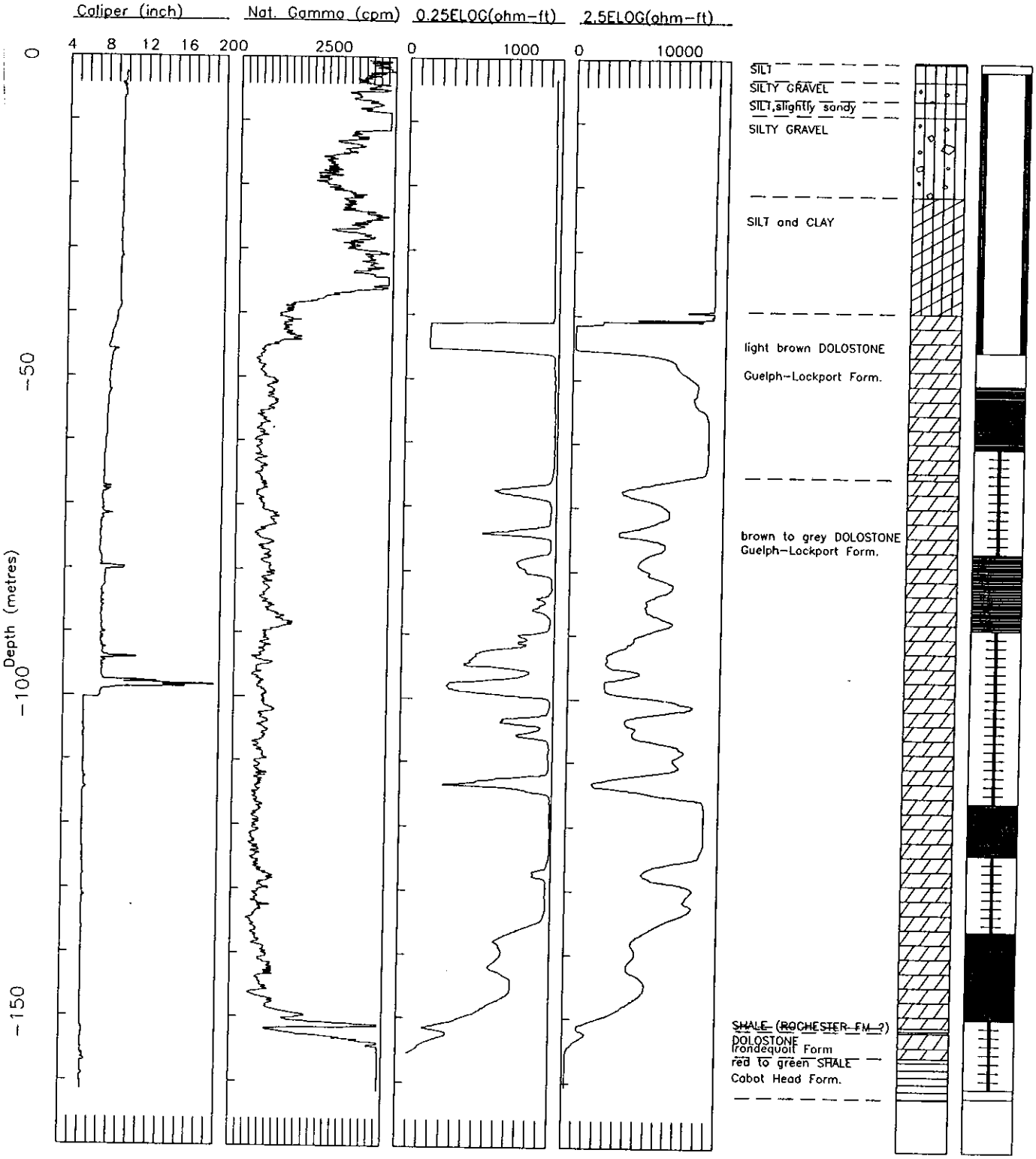


Lotowater TECHNICAL SERVICES INC.

CLIENT
Regional Municipality of Waterloo

TITLE
Well G17
Pump Installation Drawing

PROJECT No. 006-201			G:\Lotowater Projects\006 Region of Waterloo\201 G17 Test and Rehab\Pump Install.dwg		FIGURE
DESIGN					
DRAWN	EH	2013/02/05	REVISION No. 2013/02/05	SCALE N.T.S.	3
CHECKED					



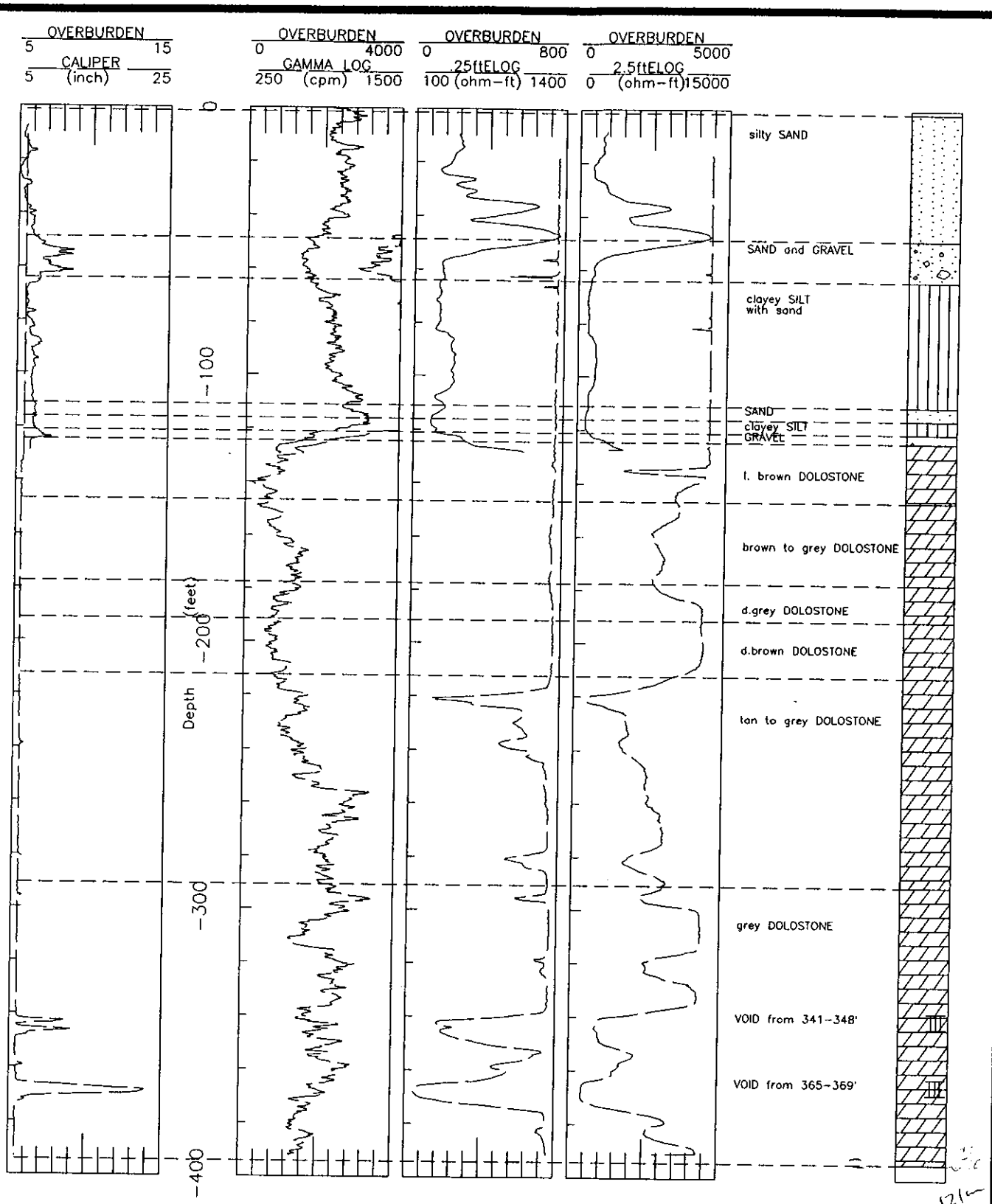
Well Name: TW2-91
File Name: TW2-91
Location: Turnbull Resevoir 320 MASL
Elevation: 0 Reference: Ground Surface

LOTOWATER LTD.

THE REGIONAL MUNICIPALITY OF WATERLOO
TW2/91 MULTILEVEL COMPLETION DETAILS

Project: 011-016 **May 1994** **FIGURE 2**

G17



Well Name: pilot 2
File Name: G17
Location: west of 8"
Elevation: 0 Reference: Surface

LOTOWATER LTD.

THE REGIONAL MUNICIPALITY OF WATERLOO
GEOPHYSICAL AND LITHOLOGIC LOGS OF
THE G17 PILOT HOLE

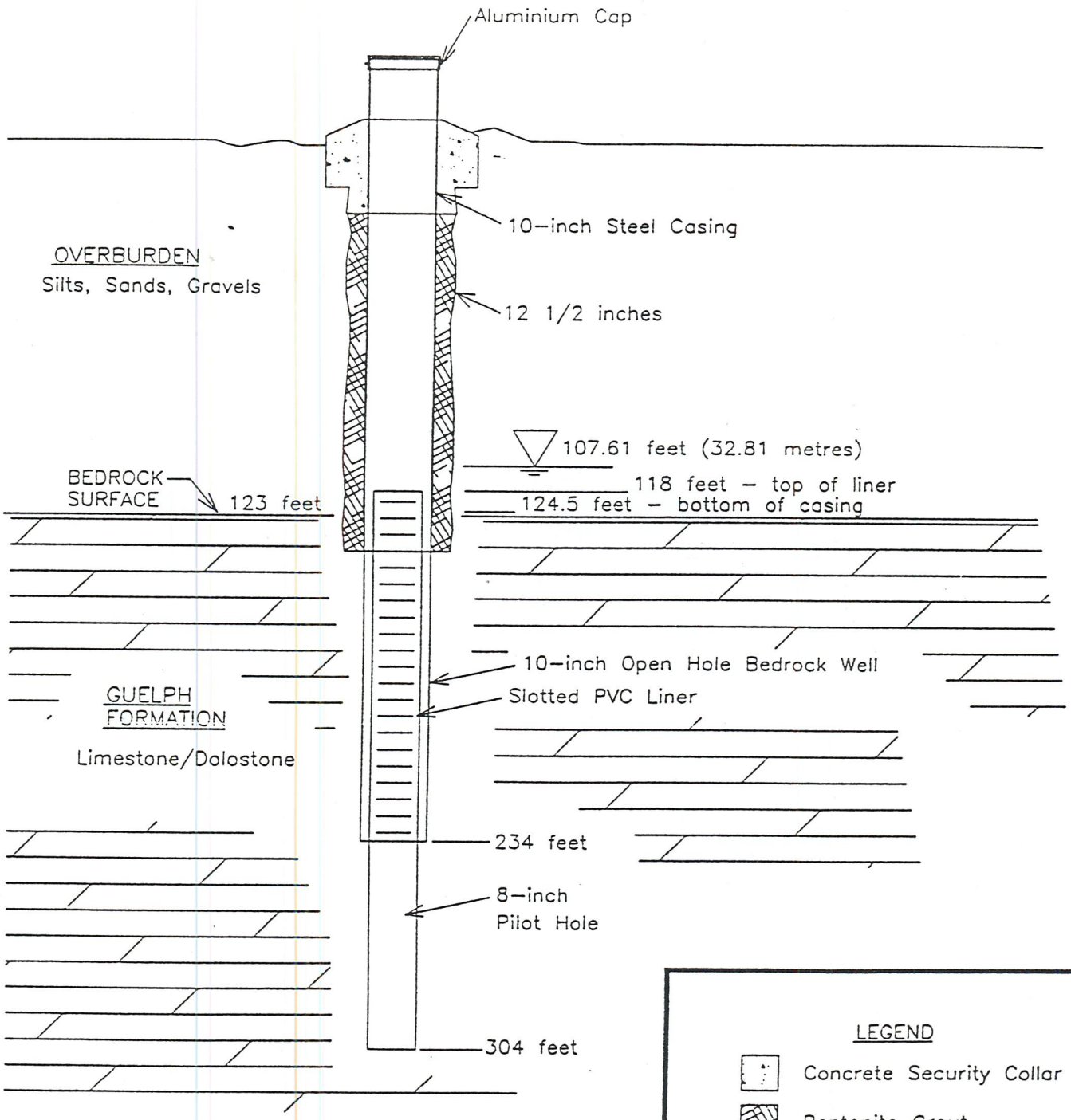
Project: 011-016 **May 1994** **FIGURE 3**

G18

G1B

BOREHOLE SCHEMATIC

Clemens Mill School Site – Heat Pump Source Well



LEGEND

- Concrete Security Collar
- Bentonite Grout

Vertical Scale approx. 1:50
Horizontal – Not to Scale

Date ...Dec....1991....

Project .911–9006.

Golder Associates

Drawn ..D.G.....

Chkd .....

BHSCHEM.DWG

Ontario Ministry of the Environment

Well Tag Numbe A026005

A026005

G19

Well Record

Regulation 903 Ontario Water Resources Act

Instructions for Completing Form

- For use in the **Province of Ontario** only. This document is a permanent **legal** document. Please retain for future reference.
- All Sections **must** be completed in full to avoid delays in processing. Further instructions and explanations are available on the back of this form.
- Questions regarding completing this application can be directed to the Water Well Management Coordinator at 416-235-6203.
- **All metre measurements shall be reported to 1/10th of a metre.**
- Please print clearly in blue or black ink only.

Ministry Use Only

MUN | CON | LOT

Well Owner's Information and Location of Well Information

[redacted]

Region of Waterloo | Town of Cambridge | 1 | 10

RR#/Street Number/Name | City/Town/Village | Site/Compartment/Block/Tract etc. Galt Tract

GPS Reading: NAD 83 | Zone 17 | Easting 558962 | Northing 4804448 | Unit Make/Model magellan | Mode of Operation: ☐ Undifferentiated ☒ Averaged ☐ Differentiated, specify

Log of Overburden and Bedrock Materials (see instructions)

General Colour	Most common material	Other Materials	General Description	Depth From	Metres To
Brown	Sand	Gravel		0	7.62
Brown	Sand	Gravel / Boulders		7.62	24.38
Grey	Silt	Sand / Fragmented Limestone Layers		24.38	32.61
Grey/Brown	Limestone		Layered	32.61	120.39
Blue	Shale			120.39	120.54

Hole Diameter

Depth From	Metres To	Diameter Centimetres
0	6	48.26
6	120.54	30.48

Water Record

Water found at Metres	Kind of Water
69.5 m	☒ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
68 m	☒ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:
93.7 m	☒ Fresh ☐ Sulphur ☐ Gas ☐ Salty ☐ Minerals ☐ Other:

After test of well yield, water was: ☒ Clear and sediment free ☐ Other, specify

Chlorinated ☒ Yes ☐ No

Construction Record

Inside diam centimetres	Material	Wall thickness centimetres	Depth From	Metres To
Casing				
30.48	☒ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	0.952	+ 0.60 m	34.13
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized			
Screen				
Outside diam	☐ Steel ☐ Fibreglass ☐ Plastic ☐ Concrete ☐ Galvanized	Slot No.		
No Casing or Screen				
	☒ Open hole		34.13	120.54

Test of Well Yield

Pumping test method: pump

Pump intake set at - (metres): 34

Pumping rate - (litres/min): 4542

Duration of pumping: 2 hrs + ____ min

Final water level end of pumping: 9.11 metres

Recommended pump type: ☐ Shallow ☒ Deep

Recommended pump depth: 34 metres

Recommended pump rate: 3751 (litres/min)

If flowing give rate - (litres/min)

If pumping discontinued, give reason.

Draw Down Time min	Water Level Metres	Recovery Time min	Water Level Metres
Static Level	2.93		
1	8.02	1	6.87
2	8.10	2	
3	8.32	3	6.54
4	8.38	4	6.33
5	8.42	5	6.13
10	8.52	10	5.60
15	8.63	15	5.28
20	8.69	20	5.03
25	8.72	25	4.88
30	8.77	30	4.66
40	8.85	40	4.54
50	8.90	50	4.42
60	8.95	60	4.33

Plugging and Sealing Record

☒ Annular space ☐ Abandonment

Depth set at - Metres From	To	Material and type (bentonite slurry, neat cement slurry) etc.	Volume Placed (cubic metres)
0	6	CEMENT	0.46

Method of Construction

☐ Cable Tool ☒ Rotary (air) ☐ Diamond ☐ Digging
☒ Rotary (conventional) ☐ Air percussion ☐ Jetting ☐ Other
☐ Rotary (reverse) ☐ Boring ☐ Driving

Water Use

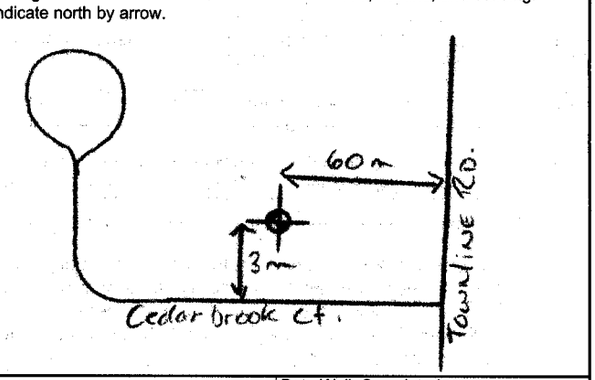
☐ Domestic ☐ Industrial ☐ Public Supply ☐ Other
☐ Stock ☐ Commercial ☐ Not used
☐ Irrigation ☒ Municipal ☐ Cooling & air conditioning

Final Status of Well

☒ Water Supply ☐ Recharge well ☐ Unfinished ☐ Abandoned, (Other)
☐ Observation well ☐ Abandoned, insufficient supply ☐ Dewatering
☐ Test Hole ☐ Abandoned, poor quality ☐ Replacement well

Location of Well

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



Audit No. Z 34701

Date Well Completed YYYY MM DD

Was the well owner's information package delivered? ☐ Yes ☐ No

Date Delivered YYYY MM DD

Well Contractor/Technician Information

Name of Well Contractor: Gerrits Well Drilling Inc

Well Contractor's Licence No. 3406

Business Address (street name, number, city etc.): RR 1 Cayuga Ontario

Name of Well Technician (last name, first name): GERRITS, STEVE

Well Technician's Licence No. T-2964

Signature of Technician/Contractor: X Gerrits Well Drilling Inc

Date Submitted YYYY MM DD

Ministry Use Only

Data Source

Contractor 3406

Date Received JAN 25 2007 YYYY MM DD

Date of Inspection YYYY MM DD

Remarks

Well Record Number

0506E (09/03) Contractor's Copy ☐ Ministry's Copy ☒ Well Owner's Copy ☐

Cette formule est disponible en français

C-CM-OW01-10-A

Ontario — Ministry of the Environment

Measurements recorded in: ☐ Metric ☐ Imperial

Well Tag No. A085843 **A 085843**

Well Record

Regulation 903 Ontario Water Resources Act

Page 1 of 1

Well Owner's Information

First Name	Last Name / Organization	E-mail Address	☐ Well Constructed by Well Owner
	REGIONAL MUNICIPALITY OF WATERLOO		

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
		ON		

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
CORNER OF FRANKLIN BLVD. AND LINDSEY RD.			

County/District/Municipality	City/Town/Village	Province	Postal Code
	CAMBRIDGE	Ontario	N1T1J4

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	17	556347	4805058		BEHIND PUMPHOUSE G6

Overburden and Bedrock Materials/Abandonment Sealing Record *(see instructions on the back of this form)*

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	To
GREY	FINE-MED SAND		IRON STAINING.	0'	15'
GREY	FINE SAND	RED CLAY, COARSE SAND	INTERBEDDED.	15'	20'
RED-GREY	MED SAND	FINE SAND, TRACE CLAY		20'	30'
RED-GREY	COARSE SAND	TRACE SILT, CLAY		30'	45'

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)
0'	29'8"	BENTONITE	
29'8"	42'1"	#00N SAND.	
42'1"	45'	BENTONITE.	

Method of Construction

☐ Cable Tool ☐ Diamond
☐ Rotary (Conventional) ☐ Jetting
☐ Rotary (Reverse) ☐ Driving
☒ Boring 6¼" H.S.A. ☐ Digging
☐ Air percussion
☐ Other, *specify*

Well Use

☐ Public ☐ Commercial ☐ Not used
☐ Domestic ☐ Municipal ☐ Dewatering
☐ Livestock ☐ Test Hole ☐ Monitoring
☐ Irrigation ☐ Cooling & Air Conditioning
☐ Industrial
☐ Other, *specify*

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To
2"	PVC	0.157"	32'1"	+3'

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To
2"	PVC	0.010	42'1"	32'1"

Status of Well

☐ Water Supply
☐ Replacement Well
☐ Test Hole
☐ Recharge Well
☐ Dewatering Well
☒ Observation and/or Monitoring Hole
☐ Alteration (Construction)
☐ Abandoned, Insufficient Supply
☐ Abandoned, Poor Water Quality
☐ Abandoned, other, *specify*
☐ Other, *specify*

Water Details

Water found at Depth (m/ft)	Kind of Water	
	☐ Gas	☐ Fresh ☐ Untested ☐ Other, *specify*
	☐ Gas	☐ Fresh ☐ Untested ☐ Other, *specify*
	☐ Gas	☐ Fresh ☐ Untested ☐ Other, *specify*

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
0'	45'	2.4"

Results of Well Yield Testing

After test of well yield, water was:
☐ Clear and sand free
☐ Other, *specify*

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping ____ hrs + ____ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate *(l/min / GPM)*

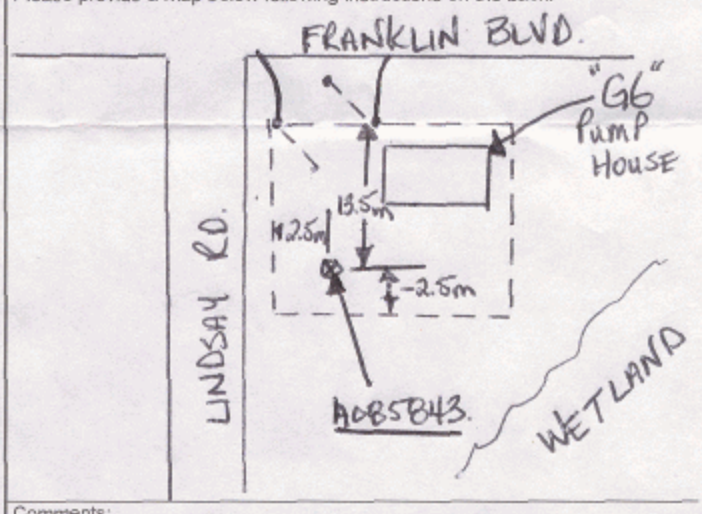
Well production *(l/min / GPM)*

Disinfected? ☐ Yes ☐ No

	Draw Down Time (min)	Water Level (m/ft)	Recovery Time (min)	Water Level (m/ft)
Static Level				
1			1	
2			2	
3			3	
4			4	
5			5	
10			10	
15			15	
20			20	
25			25	
30			30	
40			40	
50			50	
60			60	

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
ALL-TERRAIN DRILLING LTD.	7423

Business Address (Street Number/Name)	Municipality
#3-661 COLBY DR.	WATERLOO

Province	Postal Code	Business E-mail Address
ON	N2V1C2	allterrain@golden.net.

Bus. Telephone No. (inc. area code)	Name of Well Technician (Last Name, First Name)
5198868810	GRANT MIKE.

Well Technician's Licence No.	Signature of Technician and/or Contractor	Date Submitted
3554		2011 02 22

Well owner's information package delivered	Date Package Delivered	Date Work Completed
☐ Yes ☐ No	Y Y Y Y M M D D	Y Y Y Y M M D D

Ministry Use Only

Audit No. Z128438

Received MAR 31 2011

Ministry's Copy

PROJECT: 08-1112-0150

BOREHOLE LOG OF: C-CM-OW02AB-10

LOCATION: N 4804356.0 ;E 557206.0

DRILLING DATE: February 19, 2010

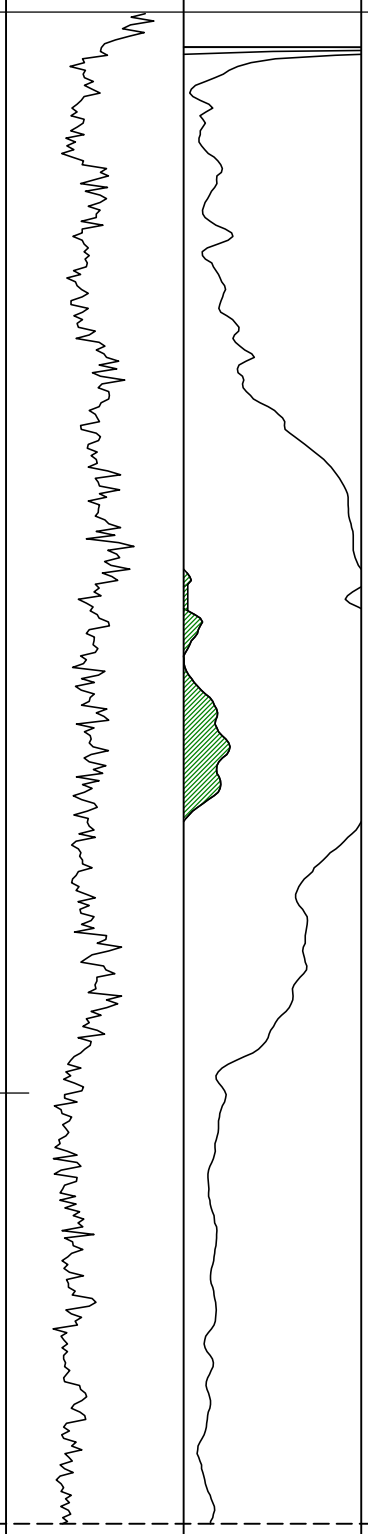
DRILL RIG: PQ Coring

DRILLING CONTRACTOR: All Terrain Drilling

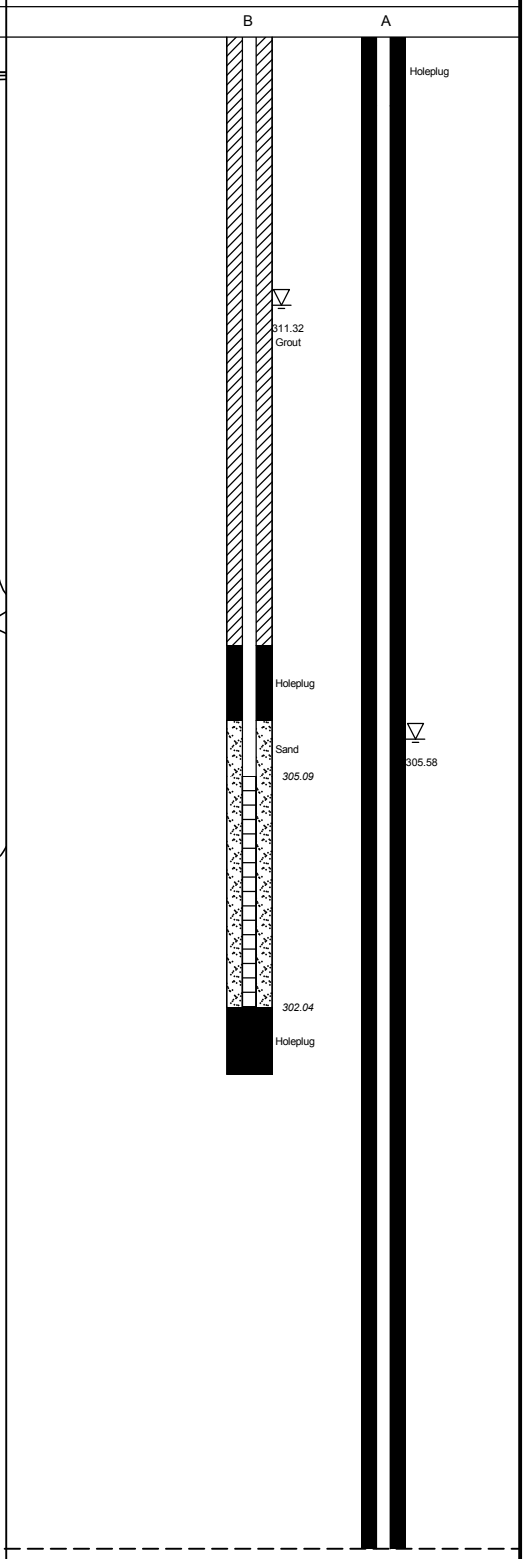
DATUM: NAD83

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	OGS CODE
	GROUND SURFACE	314.87	
0	Moist, dark brown, SILTY CLAY, some organics	0.15	ATB3
	Dark brown, SILT, some clay, trace fine grained sand	0.43 / 313.75	
	Light brown, sandy SILT to silty SAND, trace rounded gravel	1.22 / 313.19	
	Brown, GRAVEL, some silt	1.68	
2	Light brown, SILTY CLAY		
	Brown, COBBLES and coarse SAND	312.43	
	Dry, light brown, SILTY CLAY	2.44	
	Light brown, fine-grained SAND	2.74	
	Moist, medium brown, SILT, some sand, trace clay, trace rounded gravel Mediun-grained sand layers at 3.35-3.43 m and 3.66-3.73 m	2.90 / 310.63	
4	COBBLES	4.24	
	Moist, medium brown, fine-grained sandy SILT, trace clay	4.57 / 309.10	
6	Moist, reddish brown, fine-grained SAND, trace clay	5.77 / 308.16	
	Wet, dark brown, CLAYEY SAND to SANDY CLAY	6.71	
	Firm, dry, dark brown, CLAY and SILT	7.01 / 306.87	
8	Moist, brownish grey, CLAY	8.00 / 306.34	
	Moist to wet, brown, silty SAND, trace to little clay	8.53	
	Brown, CLAYEY SILT	8.84 / 305.47	
	Very stiff, moist, brown, SILT, some clay	9.40	
10	Wet, dark brown, silty SAND, trace clay, layered SA-1 (9.4-10.7 m)	304.96 9.91 / 304.51	
	Wet, reddish brown to brown, SILT, trace to some fine sand Wet to saturated, brown, silty SAND	10.36 / 302.68	
12	Wet, dark brown, fine-grained SAND, trace to little silt	12.19 / 302.14	
	Medium brown, SILT, trace to little fine-grained sand, trace to little clay	12.73 / 301.46	
	Firm, grey-brown, CLAY, some silt	13.41 / 300.57	
14	Compact, greenish brown, gravelly SILT, gravel 1-3 cm diameter	14.30	ATC1
	COBBLE, rounded, 9 cm diameter	299.71	
	Firm, brown, SILT, trace clay	15.16 / 297.19	
16	Firm, brown, CLAYEY SILT SA-2 (18.1-18.9 m)	17.68 / 295.46	
18	Firm, moist, brown, SILT	19.41	
20	*CONTINUED NEXT PAGE*		

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 100

Golder Associates

LOGGED: JH

CHECKED: CM

PROJECT: 08-1112-0150

BOREHOLE LOG OF: C-CM-OW02AB-10

LOCATION: N 4804356.0 ;E 557206.0

DRILLING DATE: February 19, 2010

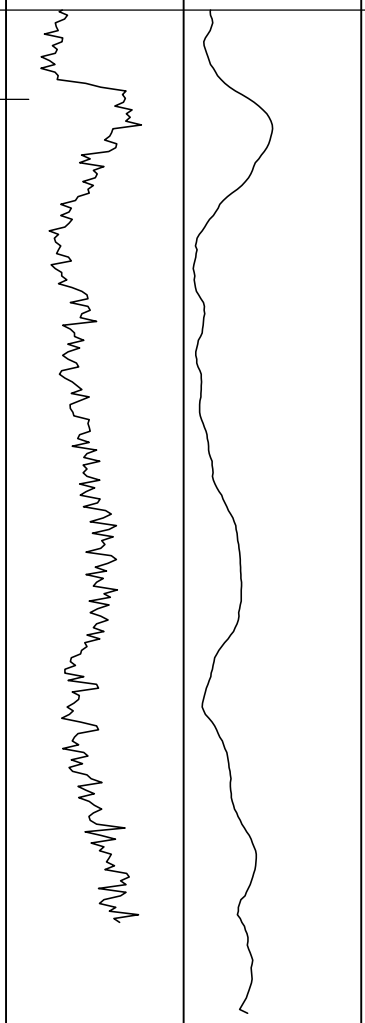
DRILL RIG: PQ Coring

DRILLING CONTRACTOR: All Terrain Drilling

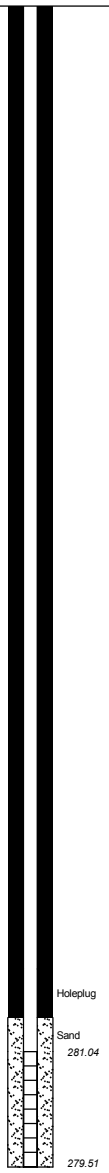
DATUM: NAD83

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	OGS CODE
	--- CONTINUED FROM PREVIOUS PAGE ---		
20	Firm, moist, brown, SILT - Becoming less firm at 20.27 m	293.84	ATC1
	Brown, fine to medium SAND	21.18	ATC2
	Stiff, brown, SILTY CLAY, some seams of silt, trace gravel	291.45	
22			
	Compact, wet, brown, silty SAND, some gravel	23.42 290.31	
24			
	Very stiff to hard, moist, brown, sandy SILT, some clay, some gravel, layered	24.56 289.32	
	Brown, fine to medium SAND		
26	Saturated, brown, silty SAND	25.81	
	Very stiff, moist, brown, sandy SILT, some clay, trace gravel	287.69	
	Very stiff to hard, moist, brown, CLAYEY SILT, some sand, trace to some gravel	27.18 286.70	
28			
	Firm to stiff, wet, brown, sandy SILT, trace to some clay, trace gravel	28.17 286.17	
	Very stiff to hard, moist, brown, CLAYEY SILT, trace sand, trace gravel	28.70 285.46	
	Loose to compact, brown, fine SAND, some silt, some clay	29.41 29.72	
30	Brown, fine to medium SAND, some silt, trace gravel	284.75 30.12	
	Very stiff to hard, moist, brown, SILTY CLAY, trace to some sand, trace to some gravel - Saturated from 30.43 m to 30.61 m SA-3 (31.1-32.0 m)		
32			
	Compact, brown, sandy SILT, some gravel, trace clay, trace cobbles	282.03 32.84 33.07	
	Hard, moist, brown, CLAYEY SILT, trace sand, trace gravel		
34		280.40	
	Compact, wet, brown, fine to medium SAND, some silt, some gravel	34.47 34.67	
	Compact, wet, brown, fine SAND, some silt, some gravel SA-4 (34.7-35.4 m)	279.69 35.18	
36	Saturated, brown to light brown, fractured DOLOSTONE with gravelly silt filling the fracture	278.75 36.12	
	Saturated , brown to light brown, fractured DOLOSTONE, some sand, some silt	277.23	
38	END OF BOREHOLE	37.64	
40			

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 100

Golder Associates

LOGGED: JH

CHECKED: CM

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMOW1-06

SHEET 1 OF 3

LOCATION: N 4805314.2 ;E 558725.6

DRILLING DATE: May 9 to May 15, 2006

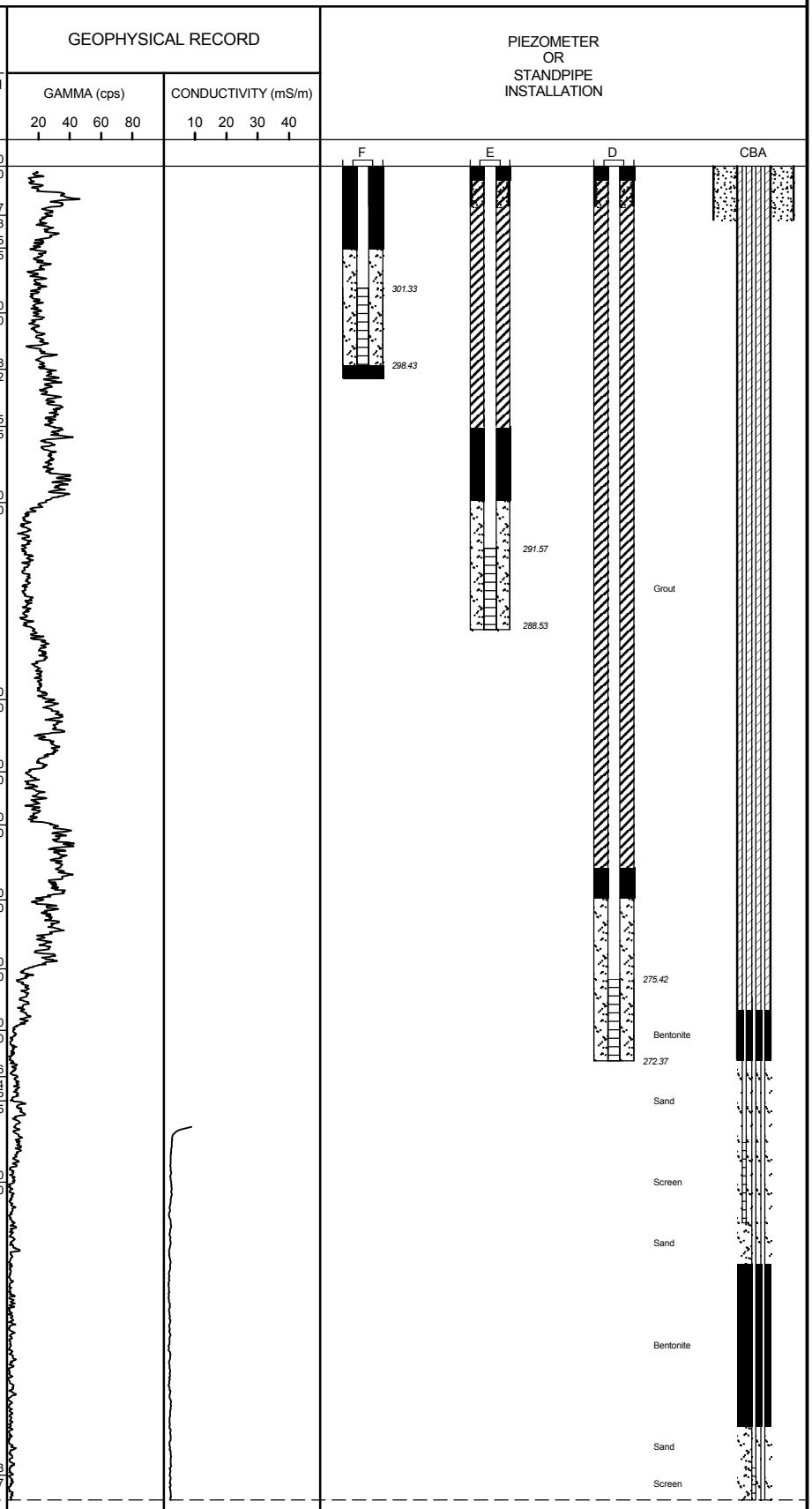
DATUM: Geodetic

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)
	GROUND SURFACE	305.90
0	TOPSOIL dark brown, wet, organics (rootlets and wood)	0.00 / 304.07
	Medium brown GRAVEL and SAND with some clay, hetero, angular to subangular gravel	1.83 / 302.85
	Medium brown SAND and GRAVEL with little silt, heterogeneous, wet, loose, angular to subrounded gravel	3.05 / 300.40
5	Greyish brown fine to coarse SAND, some gravel, fairly uniform, saturated, compact, subrounded to subangular gravel	5.50 / 298.28
	Greyish-brown clayey SAND and GRAVEL (TILL), heterogeneous, subrounded to subangular gravel	7.62 / 296.15
10	Medium brown CLAY, soft, uniform	9.75 / 293.30
	Greyish brown GRAVEL and SAND, heterogeneous, fairly clean, subangular to subrounded gravel	12.60 / 285.90
15		
20	Brown SILTY CLAY, trace gravel (TILL), heterogeneous, subrounded to subangular gravel	20.00 / 283.20
	Grey SAND and GRAVEL, with occasional boulder and cobbles, heterogeneous, dense, subangular to angular gravel	22.70 / 281.20
25	Brown grey CLAY, stiff, homogeneous	24.70 / 278.40
	SILTY CLAY, little gravel, little sand	27.50 / 275.80
30	Grey brown SAND and GRAVEL little cobbles, heterogeneous, subangular to sub rounded	30.10 / 273.50
	Buff brown DOLOMITE, thickly bedded, fractured, non-weathered uneven partings, few fossils (Guelph Fm)	32.40 / 271.76
		34.14 / 270.85
35	Grey DOLOMITE, fine grained, thickly bedded, fossiliferous, irregular parting (Guelph Fm)	35.05
	Buff brown DOLOMITE, fine grained, massive, moderately indurated, tabular chips (Guelph Fm)	267.80 / 38.10
	50 mm fracture at 35.7 m depth	
40	Various shades of buff grey DOLOMITE, weakly laminated, moderately indurated, platy chips (Guelph Fm)	
	Grayish brown from 42.7 to 44.2 m depth	
45	Weathered yellowish brown from 45.1 m to 45.4 m depth	
		256.83 / 49.07
50		

CONTINUED NEXT PAGE



DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMOW1-06

LOCATION: N 4805314.2 ;E 558725.6

DRILLING DATE: May 9 to May 15, 2006

DATUM: Geodetic

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	GEOPHYSICAL RECORD: GAMMA (cps) 20 40 60 80	GEOPHYSICAL RECORD: CONDUCTIVITY (mS/m) 10 20 30 40	PIEZOMETER OR STANDPIPE INSTALLATION (F E D CBA)
	--- CONTINUED FROM PREVIOUS PAGE ---					
50	DOLOMITE medium buff brown, thickly bedded, fine grained, moderately indurated, some small vugs throughout, weathered yellowish brown in areas (Guelph Fm)					Screen
55	Very vuggy from 54.9 m to 56.4 m depth Weakly indurated from 56.4 m to 59.4 m depth					
60	Becoming brownish - buff grey colour by 45.1 m and less vuggy		244.60 / 61.30			Sand
	Dark dull brown DOLOMITE with some black mineralization on fracture/bedding planes, moderately indurated, fine crystalline, blocky to platy chips with strong petroliferous odour (Eramosa Member) Fracture or void at 64.3 m depth					
65	Becoming dark blackish-brown with sparse clean white mineral from 65.5 m					Bentonite
70						
	Becoming lighter brown		231.80 / 74.10			
75	Bluish grey DOLOMITE, blocky white, crystalline, moderately indurated, weakly laminated, platy to blocky chips (Amabel Fm)		229.91 / 75.99			
	Light-grayish-white DOLOMITE, fine grained, fossiliferous, vuggy (small), porous rock weakly laminated, blocky irregular chips (Amabel Fm)					
80						Rock Fill
	Grey DOLOMITE, crystalline, well indurated, weakly laminated, irregular blocky to tabular chips, smooth parting, sparse micro vugs (Amabel Fm)		222.08 / 83.82			
85	Becoming fossiliferous and blocky grey colour by 88.3 m					
90						
95	Darker grey by 96.0 m					Bentonite
100						Sand
	CONTINUED NEXT PAGE					

DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMOW1-06

LOCATION: N 4805314.2 ;E 558725.6

DRILLING DATE: May 9 to May 15, 2006

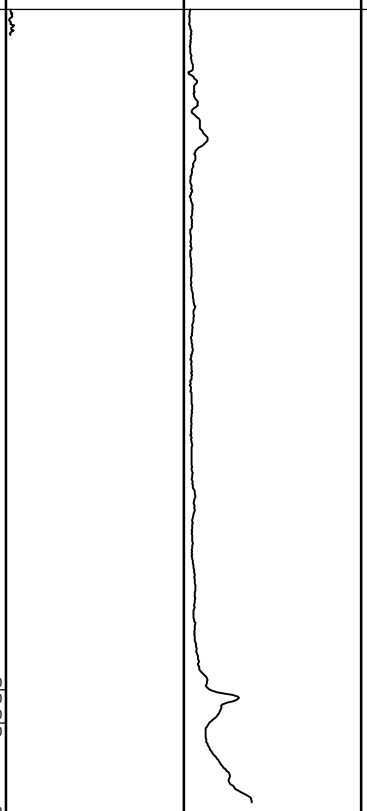
DATUM: Geodetic

DRILL RIG: Air Rotary

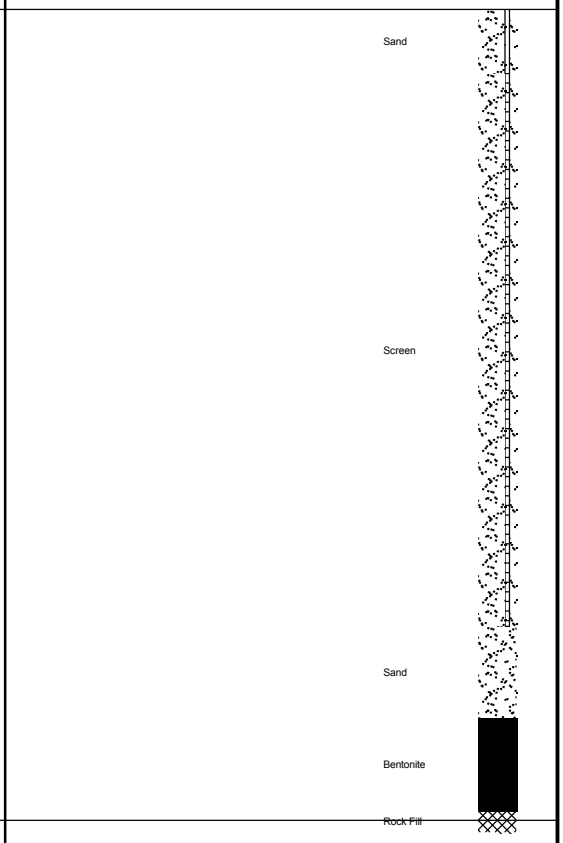
DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)
	--- CONTINUED FROM PREVIOUS PAGE ---		
100	Grey DOLOMITE, crystalline, well indurated, weakly laminated, irregular blocky to tabular chips, smooth parting, sparse micro vugs (Amabel Fm) Several large vugs/fractures from 102.1 m to 111.3 m depth		
105			
110	Light brown and grey, vuggy from 111.3 m to 115.8 m depth		
115			
120	Becoming darker grey at 118.9 m depth		
			183.40
	Grey SHALE (Rochester Fm)		122.50 182.30
	Grey DOLOMITE, occasional fine sulphides, weakly laminated, no odour		123.60
125	Dull greyish-brown at 124.9 m		
	Brown, mottled black with sulphides		179.10
	Green soft shale		126.80
	END OF BOREHOLE		
130			
135			
140			
145			
150			

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

Monitoring Well: C-CM-OW1-15

C-CM-OW1-15-(A-B-C)

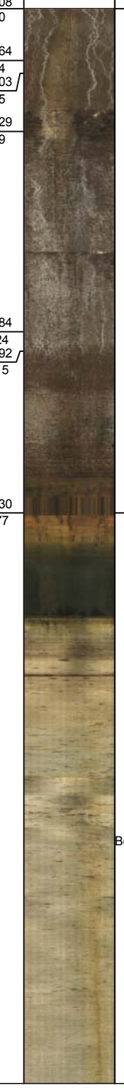
Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Cambridge, ON
Number: 160900798

Field Investigator: n/a
Contractor: Gerrits Well Drilling Inc.
Drilling method: Monitoring wells constructed within existing wells
Date started/completed: 02-Apr-2015 / 14-Apr-2015

SUBSURFACE PROFILE

Lithologic Description	Elevation (m AMSL) / Depth (m BGS)
Ground Surface	301.08 / 0.00
SAND contains silt, brown, soft	298.64 / 2.44
SAND contains gravel, brown, soft	298.03 / 3.05
CLAY contains silt, brown, soft	295.29 / 5.79
TILL contains stones, brown, hard grey at 9.45 m BGS	285.84 / 15.24
SAND grey, soft	284.92 / 16.15
CLAY contains stones, grey, soft contains sand and gravel at 22.56 m BGS	277.30 / 23.77
BEDROCK LIMESTONE brown water producing zone according to MOECC water well records at 32.31 m BGS light brown at 32.61 m BGS grey at 35.36 m BGS	302.21 (BGS)

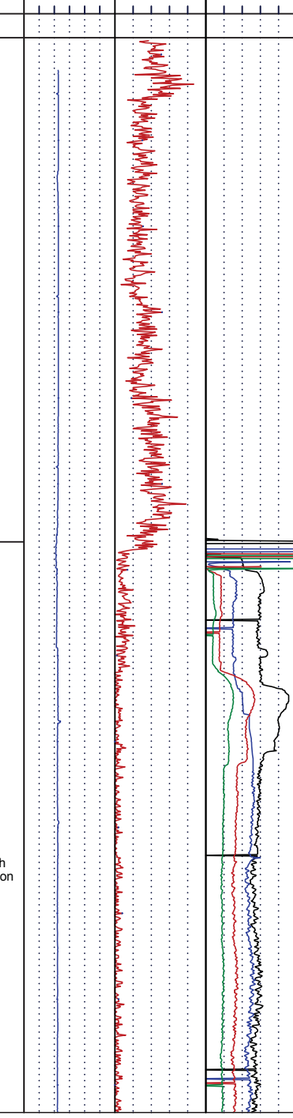
Optical Televiewer



HYDROGEOLOGY

Hydro Stratigraphic Unit	Description
Bedrock	Guelph Formation

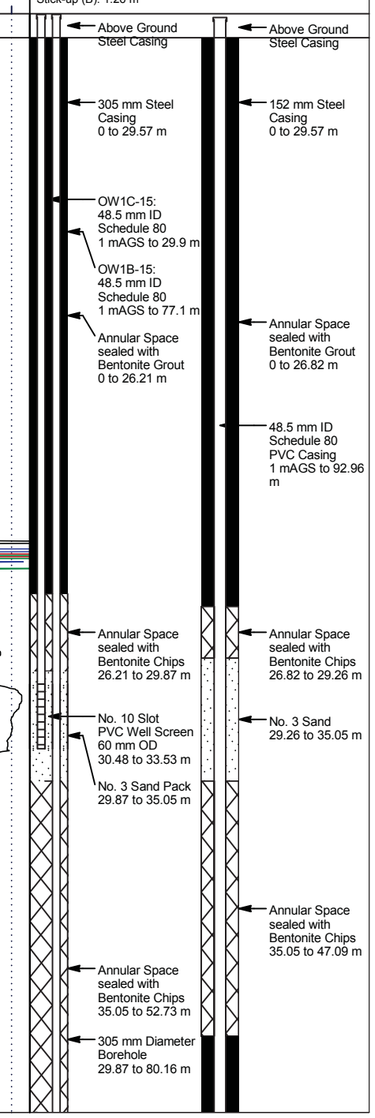
GEOPHYSIC DETAILS



WELL DETAILS

Name: C-CM-OW1C/B-15
GS Elev: 301.08 m AMSL
TOC Elev(C): 302.29 m AMSL
TOC Elev(B): 302.34 m AMSL
Easting: 557244
Northing: 4803751
Stick-up (C): 1.21 m
Stick-up (B): 1.26 m

Name: C-CM-OW1A-15
GS Elev: 301.53 m AMSL
TOC Elev: 302.51 m AMSL
Easting: 557251
Northing: 4803752
Stick-up: 0.98 m



Screen Interval: 30.48 - 33.53; 77.11 - 80.16; 92.96 - 96.01 m BGS
Sand Pack Interval: 96.02 - 99.97; 96.02 - 99.97 m BGS
Well Seal Interval: 0.00 - 29.87; 81.53 - 92.05 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing

n/a - not available/applicable

MW (screen A) re-constructed from existing C-CM-OW3-92
MW (screens B and C) re-constructed from existing C-CM-TW2-92
Geophysics data obtained by Lotowater (27-Mar-2015), from constructed C-CM-OW3-92
Lithologic description and water producing zones based on MOECC WWRs of C-CM-OW3-92 and C-CM-TW2-92
WT-EB-OW1A-15 WRAS No. 9207189
WT-EB-OW1B/C-15 WRAS No. 9207190

Stantec

Drawn By/Checked By: EH,NS/LV

STANTEC BOREHOLE AND WELL - MASTER 17X11 160900798_20150309_CD.GPJ STANTEC - DATA TEMPLATE.GDT 9/25/15 NSPINA

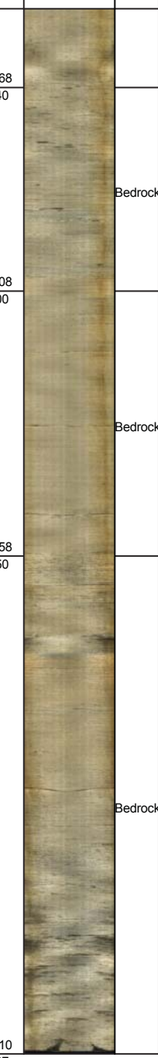
Monitoring Well: C-CM-OW1-15

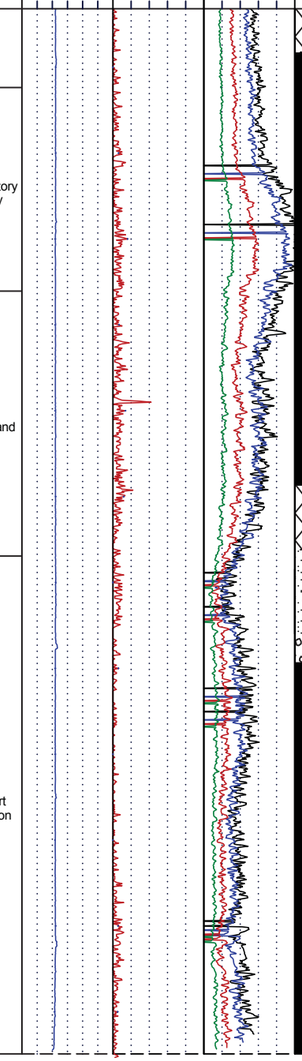
Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Cambridge, ON
Number: 160900798

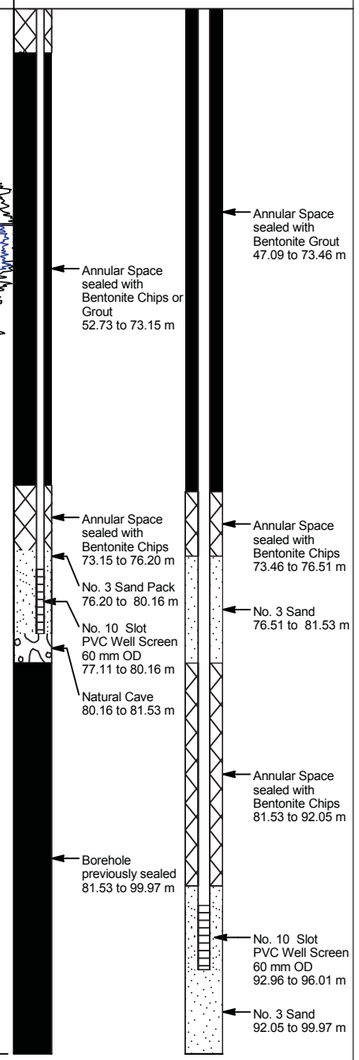
Field Investigator: n/a
Contractor: Gerrits Well Drilling Inc.
Drilling method: Monitoring wells constructed within existing wells
Date started/completed: 02-Apr-2015 / 14-Apr-2015

SUBSURFACE PROFILE | HYDROGEOLOGY | GEOPHYSIC DETAILS | WELL DETAILS

Depth (ft)	Depth (m)	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description
170	52	BEDROCK LIMESTONE brown			
175	54		246.68 54.40		
180	56			Bedrock	Reformatory Quarry
185		water producing zone according to MOECC water well records from 56.69 m BGS to 58.22 m BGS			
190	58				
195	60				
200	62				
205					
210	64	water producing zone according to MOECC water well records at 63.70 m BGS	237.08 64.00		
215	66			Bedrock	Goat Island
220					
225	68				
230	70				
235	72				
240					
245	74	water producing zone according to MOECC water well records from 73.76 m BGS to 74.98 m BGS			
250	76		224.58 76.50		
255	78	water producing zone according to MOECC water well records from 77.42 m BGS to 78.94 m BGS		Bedrock	Gasport Formation
260	80				
265		water producing zone according to MOECC water well records at 80.77 m BGS			
270	82				
275	84				
280	86				
285					
290	88	water producing zone according to MOECC water well records from 87.78 m BGS to 88.39 m BGS			
295	90				
300	92				
305		water producing zone according to MOECC water well records at 92.32 m BGS			
310	94	water producing zone according to MOECC water well records from 93.88 m BGS to 93.32 m BGS			
315	96				
320	98				
325		water producing zone according to MOECC water well records at 98.76 m BGS	201.10		
330	100	End of Borehole	99.97		
335	102				







Screen Interval: 30.48 - 33.53; 77.11 - 80.16; 92.96 - 96.01 m BGS
Sand Pack Interval: 96.02 - 99.97; 96.02 - 99.97 m BGS
Well Seal Interval: 0.00 - 29.87; 81.53 - 92.05 m BGS

Notes:
m AMSL - metres above mean sea level
m BGS - metres below ground surface
m BTOC - metres below top of casing

n/a - not available/applicable

MW (screen A) re-constructed from existing C-CM-OW3-92
MW (screens B and C) re-constructed from existing C-CM-TW2-92
Geophysics data obtained by Lotowater (27-Mar-2015), from constructed C-CM-OW3-92
Lithologic description and water producing zones based on MOECC WWRs of C-CM-OW3-92 and C-CM-TW2-92
WT-EB-OW1A-15 WRAS No. 9207189
WT-EB-OW1B/C-15 WRAS No. 9207190

Stantec

Drawn By/Checked By: EH,NS/LV

STANTEC BOREHOLE AND WELL - MASTER 17X11 160900798_20150309_CD.GPJ STANTEC - DATA TEMPLATE.GDT 9/25/15 NSPINA

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMOW2-06

SHEET 1 OF 3

LOCATION: N 4804173.7 ;E 559589.2

DRILLING DATE: June 6 to June 13, 2006

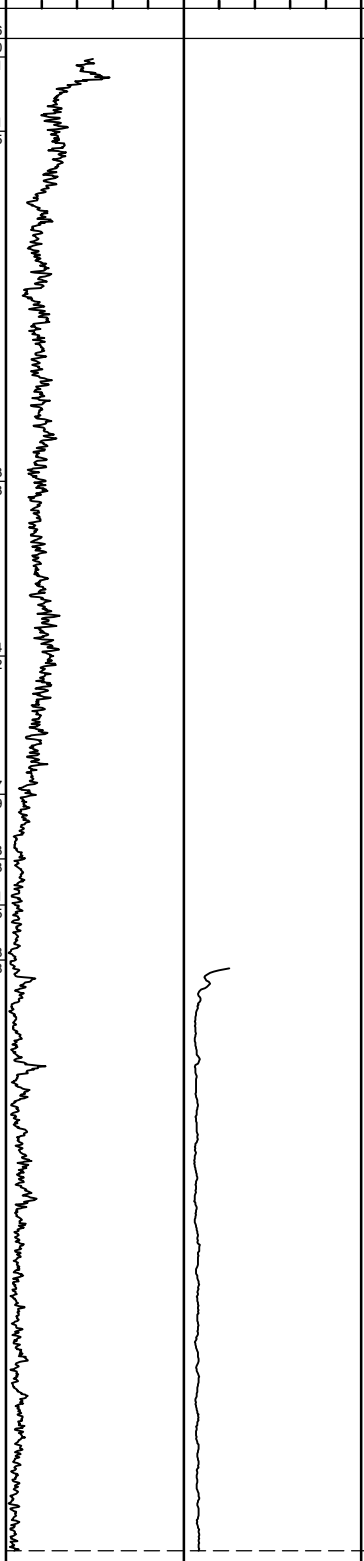
DATUM: Geodetic

DRILL RIG: Air Rotary

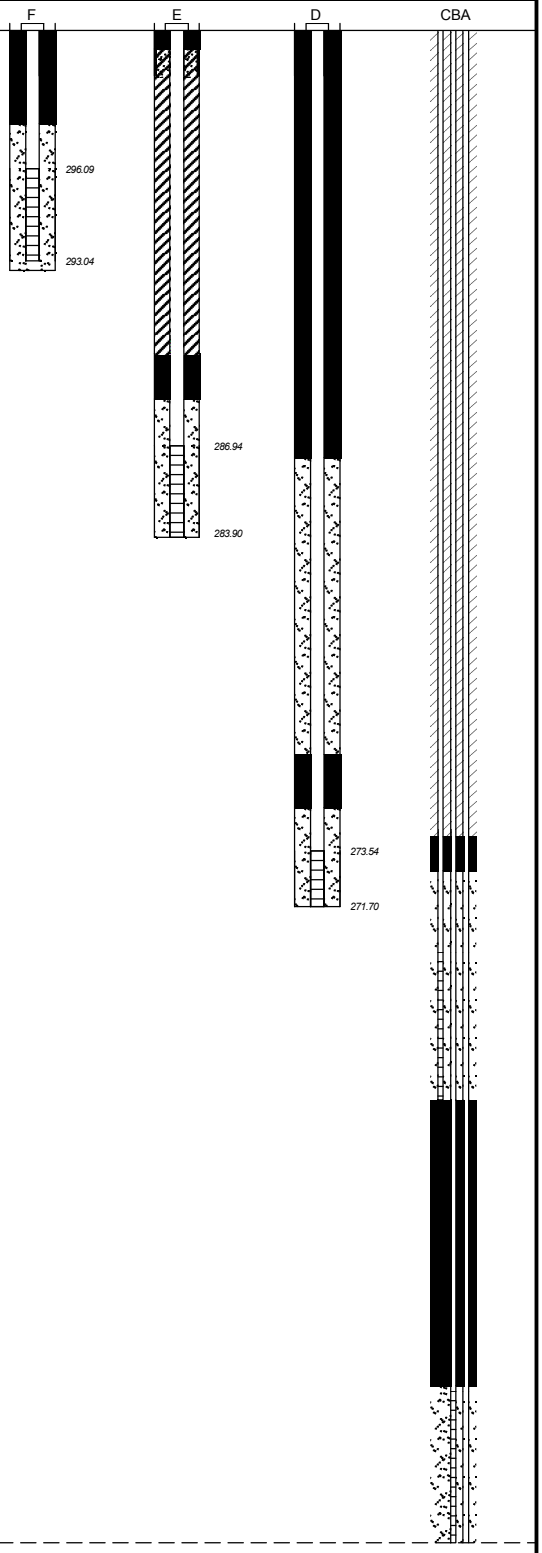
DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)
	GROUND SURFACE	300.66
0	(TOPSOIL) brown ORGANIC SILT, rootlets	0.00
	Brown CLAY, with SANDY GRAVEL (TILL)	0.61
		297.61
	Brown SILTY SAND and GRAVEL (TILL) and trace cobbles, heterogeneous, moist, compact, subrounded to subangular gravel	3.05
5		
10		
		286.03
15	Brown-grey SAND and GRAVEL, some cobbles, porous, fairly clean, angular to subrounded Fine to coarse gravel from 15. m to 15.5 m depth	14.63
20		280.24
	Medium brown, fine SAND, some coarse sand, uniform, homogeneous, loose	20.42
25	Fine to medium sand, trace cobbles and occasional boulder from 24.4 to 25.0 m depth	275.67 24.99
	Brown-grey fine SAND and GRAVEL, some silty clay, very dense, heterogeneous (TILL)	273.53
	Brown SILTY SAND and gravel grading to coarse gravel, heterogeneous	27.13 272.01
	Buff brown DOLOMITE, fractured, moderately weathered, massive, fine grained (Guelph Fm)	28.65 270.18
30	Brown/greyish brown DOLOMITE, crystalline, weakly laminated, trace micro vugs, moderately to well indurated, blocky to platy chips (Guelph Fm) Intermittent thin fractures from 32 m to 36.6 m depth	30.48
35		
40		
45		
50		

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



CONTINUED NEXT PAGE

DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMOW2-06

LOCATION: N 4804173.7 ;E 559589.2

DRILLING DATE: June 6 to June 13, 2006

DATUM: Geodetic

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	GEOPHYSICAL RECORD: GAMMA (cps) 20 40 60 80	GEOPHYSICAL RECORD: CONDUCTIVITY (mS/m) 10 20 30 40	PIEZOMETER OR STANDPIPE INSTALLATION F E D CBA
	--- CONTINUED FROM PREVIOUS PAGE ---					
50	Brown/greyish brown DOLOMITE, crystalline, weakly laminated, trace micro vugs, moderately to well indurated, blocky to platy chips (Guelph Fm)					
55	Fine grained, vuggy, porous rock from 57.9 m to 61.9 m depth					
60			239.56 / 61.10			
	Dark brown DOLOMITE trace clear calcite, crystalline, moderately indurated, blocky to platy chips with strong petroliferous odour (Eramosa Member)					
65	Thin grey clay seam at 66.8 m depth					
70			228.42 / 72.24			
	Blotchy grey DOLOMITE, fine crystalline, moderately indurated, weakly laminated, tabular to platy chips (Amabel Fm)					
75	Dull, light grey from 74.7 m to 93.0 m depth					
80	Micro-vugs starting at 79.2 m depth					
85						
90	Vuggy from 89.6 m to 88.4 m depth					
	Well indurated, some small vugs, trace fossils from 91.4 m to 105.2 m depth					
95						
100	*CONTINUED NEXT PAGE*					

DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMOW2-06

LOCATION: N 4804173.7 ;E 559589.2

DRILLING DATE: June 6 to June 13, 2006

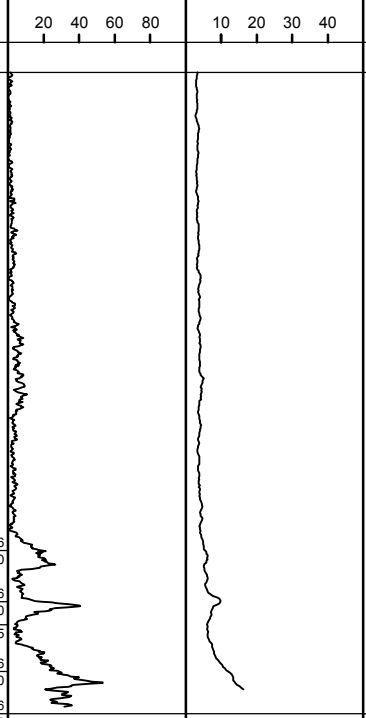
DATUM: Geodetic

DRILL RIG: Air Rotary

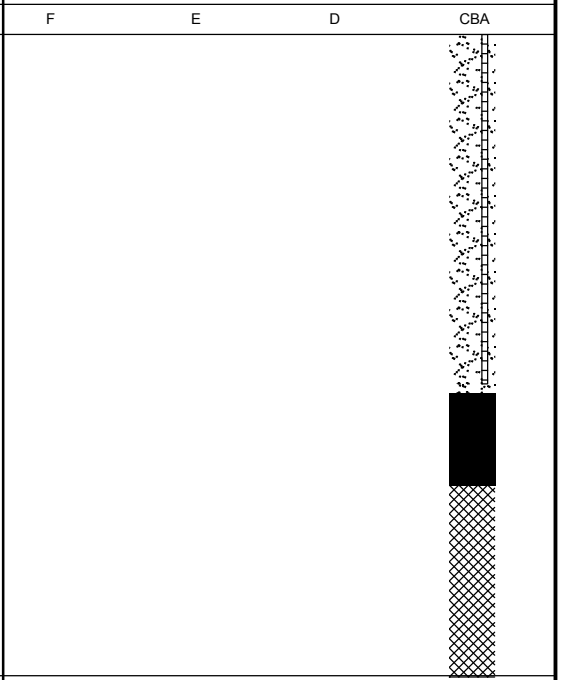
DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)
	--- CONTINUED FROM PREVIOUS PAGE ---		
100	Blotchy grey DOLOMITE, fine crystalline, moderately indurated, weakly laminated, tabular to platy chips (Amabel Fm)		
	Small fracture or vug at 103.3 m depth		
105	Becoming darker grey colour and weakly laminated		
	Trace fossils from 106.7 m to 111.3 m depth		
	Trace fine sulphides from 108.2 m to 109.7 m depth		
110			
115			184.86
	Dark grey DOLOMITE, disseminated fine sulphides, platy to flaggy chips, crystalline contains thin shale lined fractures		115.80
			183.16
	Grey SHALE (Rochester Fm)		117.50
	Dark grey DOLOMITE		118.25
			180.86
120	Dull brownish-gray DOLOMITE, interbedded green, soft shale, black mottling, disseminated sulphides, thinly laminated, platy chips		119.80
			179.46
	END OF BOREHOLE		121.20
125			
130			
135			
140			
145			
150			

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

C-CM-OW3-06-(A-B-C)

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMOW3-06

SHEET 1 OF 3

LOCATION: N 4804866.4 ;E 558916.3

DRILLING DATE: July 31 - August 3, 2006

DATUM: Geodetic

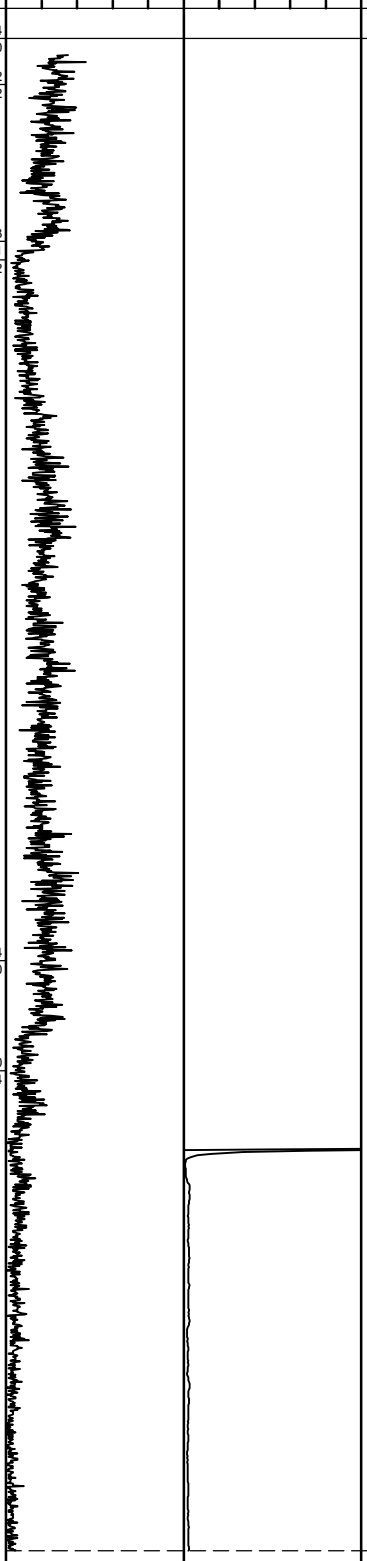
DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Gerrits Drilling Ltd.

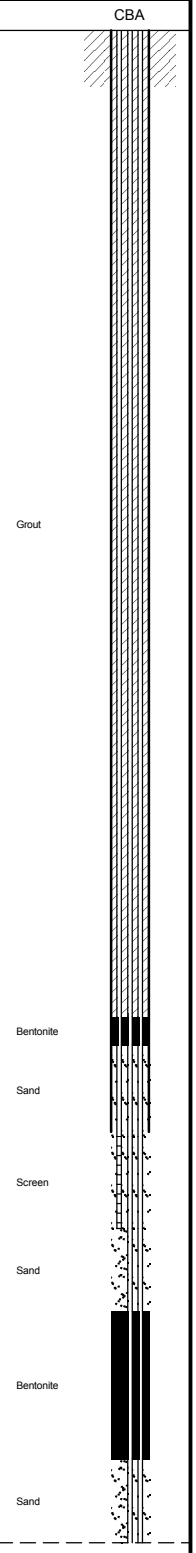
DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)
	GROUND SURFACE	302.44
0	Brown, moist, SILTY SAND	0.00
		300.92
	Brown, moist, medium to coarse SAND, some gravel	1.52
5		
		295.73
	Grey, moist gravelly CLAYEY SILT (TILL)	6.71
	Brown, saturated SAND and GRAVEL, (coarse)	7.32
10	Becoming fine to coarse sand from 10.7 m to 12.2 m depth	
15	Becoming medium sand from 15.5 m to 19.8 m depth	
20		
25		
30	Becoming sandy gravel from 29 m to 30.5 m depth	
		271.94
	Brown, saturated, fine to coarse SAND, some gravel	30.50
		268.30
35	Beige/brown DOLOSTONE (Guelph Fm)	34.14
40		
45		
50	*CONTINUED NEXT PAGE*	

SYMBOLIC LOG

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 250

Golder Associates

LOGGED: KS

CHECKED:

MIS-HYD 003 05-1112-010.GPJ GAL-MISS.GDT 4/23/07

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMOW3-06

LOCATION: N 4804866.4 ;E 558916.3

DRILLING DATE: July 31 - August 3, 2006

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DATUM: Geodetic

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	GEOPHYSICAL RECORD: GAMMA (cps) 20 40 60 80	GEOPHYSICAL RECORD: CONDUCTIVITY (mS/m) 10 20 30 40	PIEZOMETER OR STANDPIPE INSTALLATION
	--- CONTINUED FROM PREVIOUS PAGE ---					CBA
50	Beige/brown DOLOSTONE (Guelph Fm)					Screen
55			246.74			
	Brown/black DOLOSTONE (Eramosa Member)		55.70			Sand
60						
			238.34			
	Grey/white DOLOSTONE (Amabel Fm)		64.10			
65						Bentonite
70						
75						Sand
80						
85						
90						Screen
95						
100	*CONTINUED NEXT PAGE*					

DEPTH SCALE

1 : 250

Golder Associates

LOGGED: KS

CHECKED:

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMOW3-06

LOCATION: N 4804866.4 ;E 558916.3

DRILLING DATE: July 31 - August 3, 2006

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DATUM: Geodetic

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	GEOPHYSICAL RECORD: GAMMA (cps) 20 40 60 80	GEOPHYSICAL RECORD: CONDUCTIVITY (mS/m) 10 20 30 40	PIEZOMETER OR STANDPIPE INSTALLATION
	--- CONTINUED FROM PREVIOUS PAGE ---					CBA
100	Grey/white DOLOSTONE (Amabel Fm)					Screen
105						
110						Sand
						Bentonite
115			185.94			
	Grey SHALE (Rochester Fm)		116.50			
			184.74			
	DOLOSTONE		117.70			Rock Fill
120			180.84			
	Green/grey SHALE (Cabot Head Fm)		121.60			
			179.34			
	END OF BOREHOLE		123.10			
125						
130						
135						
140						
145						
150						

DEPTH SCALE

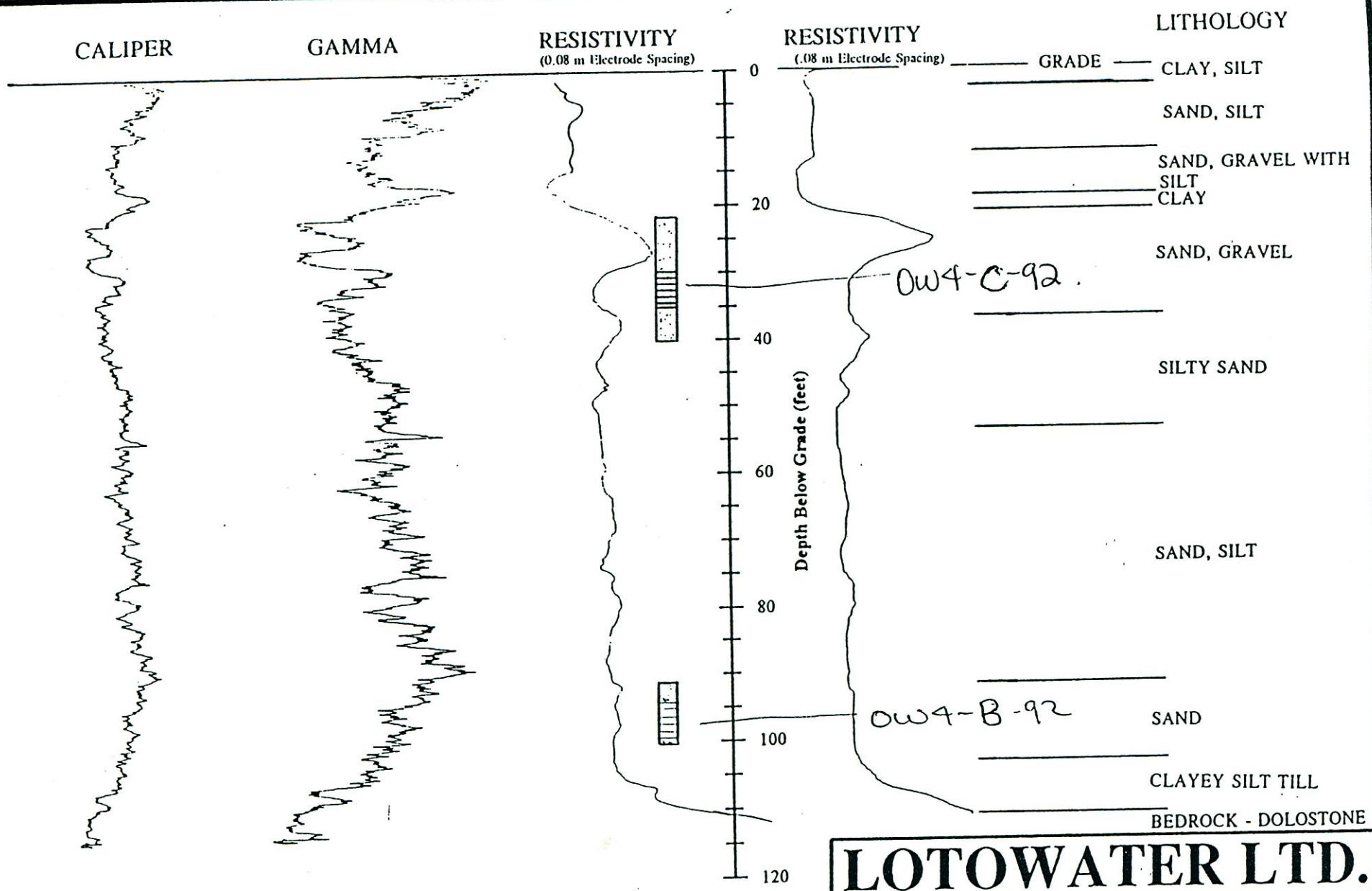
1 : 250

Golder Associates

LOGGED: KS

CHECKED:

C-CM-OW4-92-(A-B-C)



LEGEND

2m Silica Sand Pack

0.25mm Slot Monitor Well Screen

Well Screen Intervals Isolated and Sealed with Bentonite Gravel

LOTOWATER LTD.

REGIONAL MUNICIPALITY OF WATERLOO
Clemens Mill Aquifer Study
Cambridge, Ontario

OVERBURDEN LOGS AND WELL COMPLETION INTERVALS AT OW4/92

Project: 006-024 March 1993

LOTOWATER LTD. MONITORING WELL DRILLING & COMPLETION LOG

C-CM-OW6-94-(A-B-C-D)

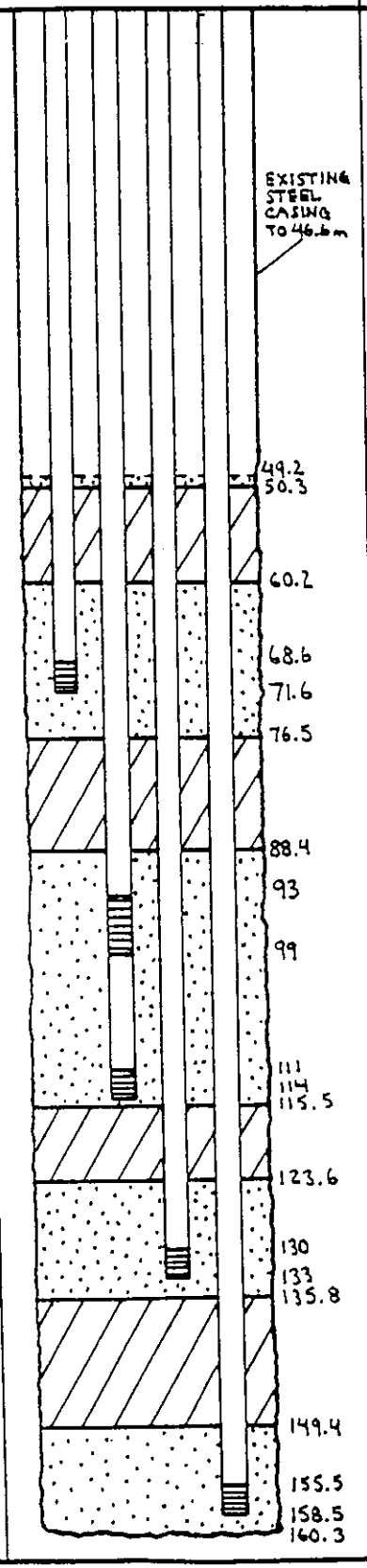
PROJECT: TURNBULL MONITOR WELL COMPLETION
CLIENT: REGION OF WATERLOO
LOCATION: TW2/91 SITE OW6-94
METHOD: EXISTING HOLE (AIR ROTARY)

COMPLETION DATE: 94.03.21
TOTAL DEPTH OF HOLE (m): 160.3
GRADE ELEVATION (m a.s.l.): 322.37
PROJECT NO: 006-039

GEOLOGIC PROFILE			MONITOR INSTALLATION	SAMPLE
DEPTH (m)	STRATIGRAPHY	ELEVATION (m a.s.l.)		
20	OVERBURDEN SEDIMENTS			
40		38.1		
60	DOLOSTONE BEDROCK			
80				
100				
120				
140				
160		155.4		
	SHALE BEDROCK	160.3		
	HOLE TERMINATED			

NOTES:

1) 206 mm hole drilled to 100 m in November 1991.
2) 150 mm hole drilled from 100 to 160.3 m in November 1993.
3) Monitor well pipe is 32 mm ID, Schedule 80, flush joint, PVC pipe.
4) Monitor well screens consist of 3 m sections of 0.25 mm slotted PVC pipe.
5) Sand packs consist of No.2 grade silica sand.
6) Seals consist of 95 mm bentonite gravel.



PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: PBOW1-06

SHEET 1 OF 3

LOCATION: N 4806058.2 ;E 559285.8

DRILLING DATE: June 21 to June 26, 2006

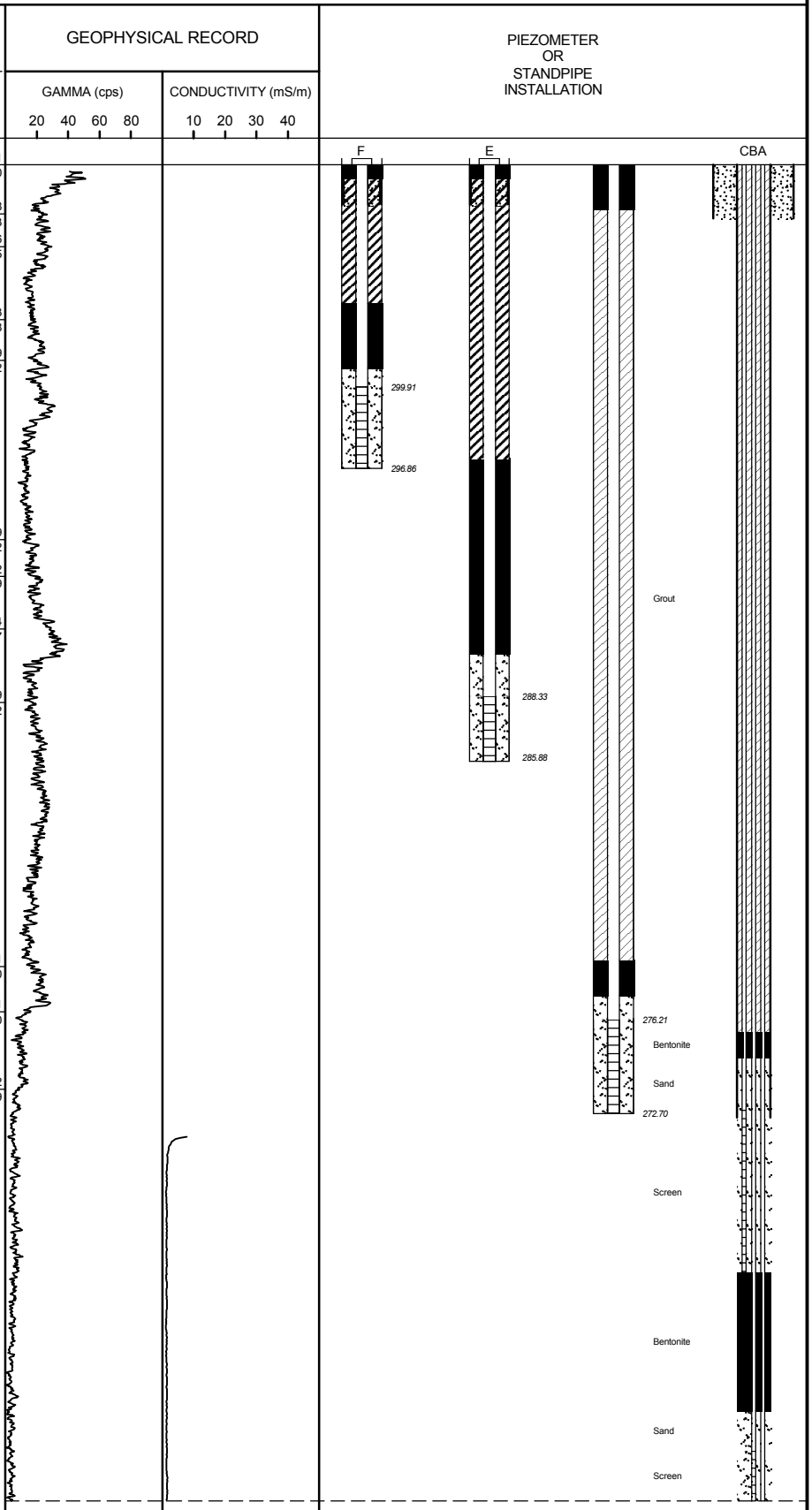
DATUM: Geodetic

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)
	GROUND SURFACE	308.21
0	Brown CLAY, lean, moist, uniform, contains rootlets	0.00
		306.38
	Medium brown SILTY CLAY, some sand, some gravel, fairly uniform, weathered	1.83
		305.16
	Brown, GRAVELLY SILT, trace clay, heterogeneous, wet, moderate weathered (TILL)	3.05
5		302.43
	Grey SILTY SAND and GRAVEL, heterogeneous (TILL)	5.78
	With clay from 7.0 m to 7.3 m depth	300.89
	Grey SAND and GRAVEL, little silt, heterogeneous, subangular to subrounded gravel	7.32
10	Predominantly coarse gravel from 11.3 m to 11.7 m depth	
		294.19
	Greyish-brown fine SAND, loose, clean, homogeneous	14.02
15		292.82
	Grey SILTY CLAY with coarse SAND, heterogeneous, compact (TILL)	15.39
		290.84
	Brown SAND and fine GRAVEL, heterogeneous, compact	17.37
20		288.09
	Brown fine SAND, loose, homogeneous, clean	20.12
25		
		278.21
30	Trace gravel at 30.0 m to 30.5 m depth	30.00
	Grey CLAY with SAND, heterogeneous, stiff (TILL)	276.51
	Brown GRAVEL and SAND, trace silt, heterogeneous, fairly clean, dense, angular to subrounded gravel	31.70
	With cobbles from 32.0 m to 23.6 m depth	273.62
35	Grayish brown DOLOMITE, fine grained, blocky to platy chips, irregular parting, uniform, medium indurated (Guelph Fm)	34.59
40		
45		
50	Becoming a dull, light brown, color at 48.8 m depth	

CONTINUED NEXT PAGE



DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: PBOW1-06

LOCATION: N 4806058.2 ;E 559285.8

DRILLING DATE: June 21 to June 26, 2006

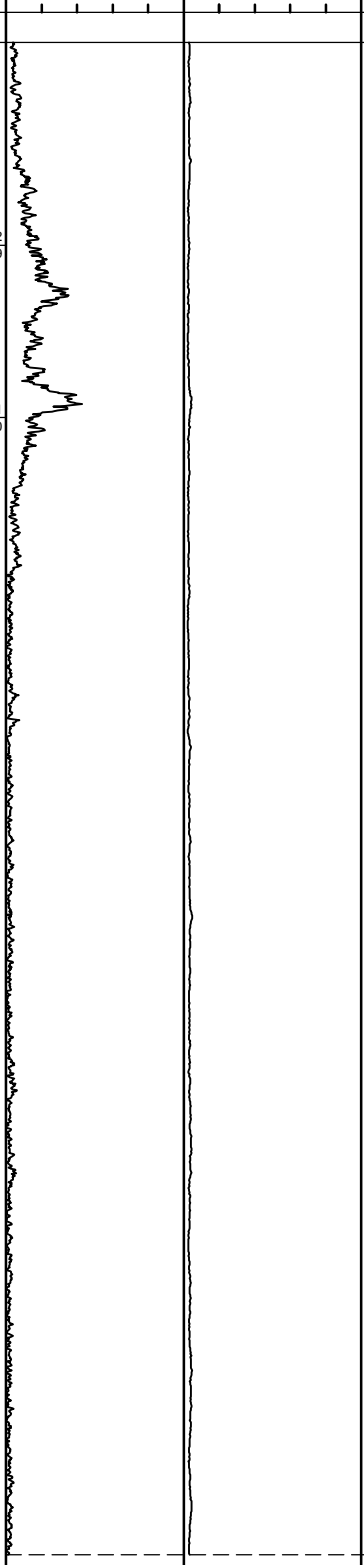
DATUM: Geodetic

DRILL RIG: Air Rotary

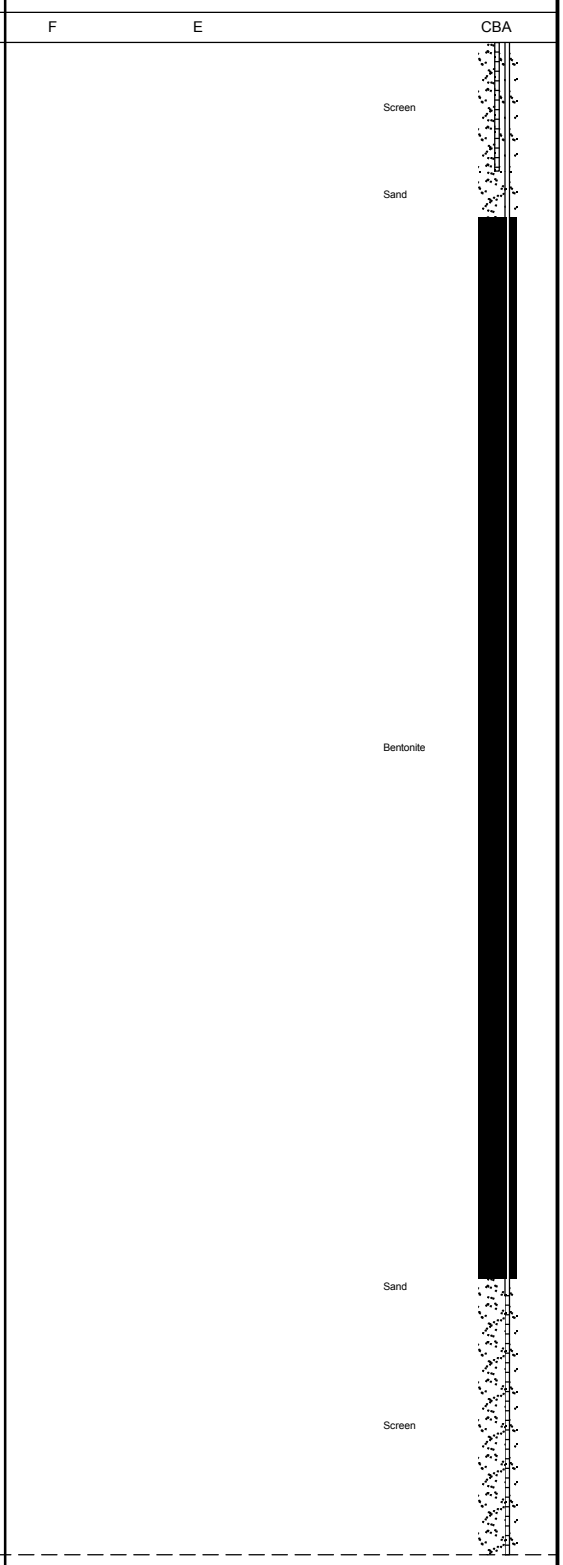
DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)
	--- CONTINUED FROM PREVIOUS PAGE ---		
50	Grayish brown DOLOMITE, fine grained, blocky to platy chips, irregular parting, uniform, medium indurated (Guelph Fm) Vuggy rock from 50.3 m to 53.3 m depth		
55	Darker, dull brown from 54.6 m to 56.7 m depth		
			251.52 / 56.69
	Dark brown DOLOMITE, crystalline, thickly bedded, platy to blocky chips, moderately indurated with strong petroliferous odour (Eramosa Member)		
60			
			245.81 / 62.40
	Dull, light brownish grey blotchy, crystalline, platy to blocky chips (Amabel Fm)		
65	Trace sulphides at 65.2 m depth		
	Relict peloids/fossils from 67.1 m to 71.6 m depth		
70			
	With micro-vugs from 73.2 m to 80.8 m depth		
75			
80			
	Small fracture at 83.8 m depth		
85	Fossiliferous (coral) porous rock from 85.3 m to 111.3 m depth		
	Crinoids, peloids and shell fossils from 88.4 m to 89.9 m depth		
90	Dull light grey from 89.9 m to 99.1 m depth		
95			
	Fracture or vug (30 cm thick) at 98.5 m depth		
100	*CONTINUED NEXT PAGE*		

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: PBOW1-06

LOCATION: N 4806058.2 ;E 559285.8

DRILLING DATE: June 21 to June 26, 2006

DRILL RIG: Air Rotary

DRILLING CONTRACTOR: Gerrits Drilling Ltd.

DATUM: Geodetic

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)
	--- CONTINUED FROM PREVIOUS PAGE ---		
100	Dull, light brownish grey blotchy, crystalline, platy to blocky chips (Amabel Fm) Very vuggy (porous) from 100.6 m to 111.3 m depth		
105			
110			196.91
	Grey DOLOMITE, crystalline, weakly laminated, moderately indurated, smooth parting, no odour (Amabel Fm)		111.30
115			
120			186.71
	Grey SHALE (Rochester Fm)		121.50
	Brown DOLOMITE with green shale stringers, mottled black, contains disseminated fine sulphides Sparse sulphides from 121.9 m to 123.4 m depth		122.00
125			182.61
	Grey SHALE, soft (Cabot Head Fm)		125.60 / 181.71
	END OF BOREHOLE		126.50
130			
135			
140			
145			
150			

GEOPHYSICAL RECORD

GAMMA (cps): 20 40 60 80

CONDUCTIVITY (mS/m): 10 20 30 40

PIEZOMETER OR STANDPIPE INSTALLATION

F E CBA

Screen

Sand

Bentonite

Rock Fill

DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

MIS-HYD 003 05-1112-010.GPJ GAL-MISS.GDT 4/23/07

C-CM-PLOW1-06-(A-B)

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: PLOW1-06

SHEET 1 OF 1

LOCATION: N 4806775.2 ;E 559402.9

DRILLING DATE: August 17 and 18, 2006

DATUM: Geodetic

DRILL RIG: Direct Push with Continuous Scope

DRILLING CONTRACTOR: Strata Soil Sampling Inc.

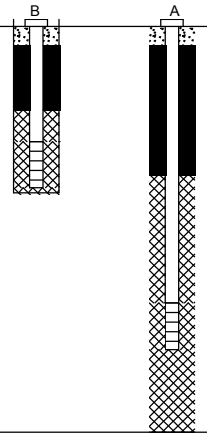
DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)
	GROUND SURFACE		307.30
	GRAVELLY silt, (FILL)		0.00
	Coarse gravelly SAND		0.76 / 305.47
	Fine SAND, some gravel		1.83
	Coarse SAND and GRAVEL		2.43 / 303.95
	Medium-grained SAND and GRAVEL, some silt		3.35 / 303.04
	Fine SAND and GRAVEL, little silt		4.26 / 4.72
	Medium grained GRAVELLY SAND		5.48
	Fine SANDY SILT, some clay		6.10
	Fine grained SAND, some silt		6.70
	CLAY		299.08
	SAND, some fine gravel, trace silt		8.22
	GRAVEL and coarse grained SAND		8.99
	Fine grained SAND		9.75
	Coarse SAND and GRAVEL		10.36 / 295.10
	Coarse SAND		12.20 / 293.88
	END OF BOREHOLE		13.42

GEOPHYSICAL RECORD

GAMMA (cps): 20 40 60 80

CONDUCTIVITY (mS/m): 10 20 30 40

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE METRES: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

DEPTH SCALE

1 : 250

Golder Associates

LOGGED: JLH

CHECKED: AI

MIS-HYD 003 05-1112-010.GPJ GAL-MISS.GDT 4/23/07

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMTW3-05

LOCATION: N 4805132.0 ;E 557560.0

DRILLING DATE: November 9 and 11, 2005

DATUM: Geodetic

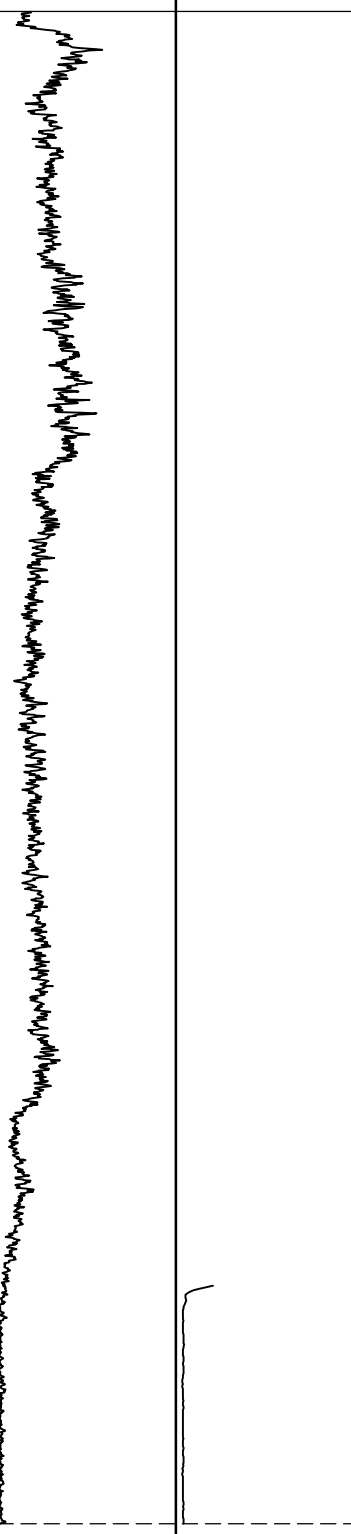
DRILL RIG: Mud Rotary

DRILLING CONTRACTOR: Davidson Well Drilling

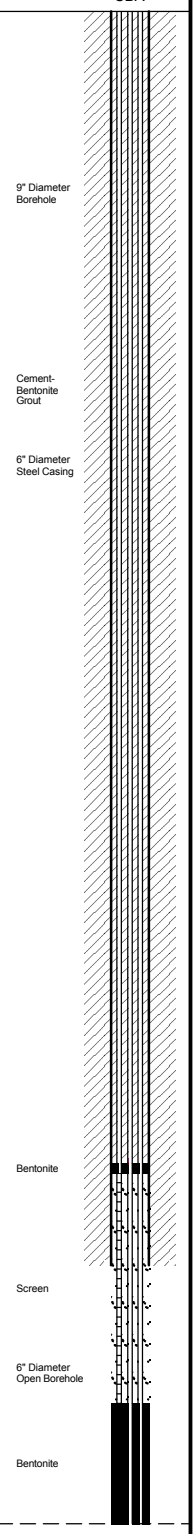
DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)
	GROUND SURFACE	
0	Dark brown to light brown CLAYEY fine SAND, homogeneous, soft, moist	0.00
	Brown SAND and GRAVEL, heterogeneous, loose, subrounded to subangular	1.83
	Brown, SILTY fine SAND, trace organics (wood-tree trunks), moist, loose	3.05
5	Brown GRAVEL, some fine sand, heterogeneous, wet, subrounded to subangular	6.10
	Brown CLAY, homogeneous, soft, no odour	8.50
10		
15	Brown CLAY, trace fine sand, trace gravel, homogeneous, moist, soft	15.00
20	Brown, SAND, GRAVEL and CLAY, heterogeneous (TILL)	19.81
	Brown CLAY, trace fine sand, gravel, homogeneous, moist, soft	20.42
25		
	COBBLES and GRAVEL, trace clay, dense massive	27.43
30	Light brown SILTY fine SAND, Compact, homogeneous, massive	30.48
35	SAND and GRAVEL, heterogeneous, loose	34.44
	Light brown DOLOMITE, fractured, poorly indurated, trace dark brown weathering, blocky rock chips, uneven parting, massive texture, crystalline, contains some grey dolomite after 38.1 m depth (Guelph Fm)	36.50
40	Light brown and brown DOLOMITE, contains intermittent laminations of weathered (orange-brown) siltstone/mudstone, trace vugs, moderately indurated, fine crystalline tabular to blocky chips (Guelph Fm)	41.15
45	Light brown DOLOMITE, fine crystalline, well indurated, fine crystalline flaggy chips with fractures, trace weathering, uneven parting (Guelph Fm)	44.20
		47.24
50		

SYMBOLIC LOG

GEOPHYSICAL RECORD



PIEZOMETER OR STANDPIPE INSTALLATION



CONTINUED NEXT PAGE

DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMTW3-05

LOCATION: N 4805132.0 ;E 557560.0

DRILLING DATE: November 9 and 11, 2005

DATUM: Geodetic

DRILL RIG: Mud Rotary

DRILLING CONTRACTOR: Davidson Well Drilling

DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	GEOPHYSICAL RECORD: GAMMA (cps) 20 40 60 80	GEOPHYSICAL RECORD: CONDUCTIVITY (mS/m) 10 20 30 40	PIEZOMETER OR STANDPIPE INSTALLATION
	--- CONTINUED FROM PREVIOUS PAGE ---					CBA
50	Light grey DOLOMITE, well indurated, crystalline, platy chips, thinly to medium layered, faintly weathered, contains trace small vugs (Guelph Fm)					
	Light brownish-grey DOLOMITE, crystalline, thinly to medium bedded, platy to blocky chips, irregular parting (Guelph Fm)		53.34			
55						Bentonite
	Grey DOLOMITE slight bluish hue, well indurated, thinly to medium layered, flaggy chips, crystalline, smooth to uneven parting (Guelph Fm)		58.83			
60						
						Sand
65						
	Less indurated, coarser grained, some vugs starting at 67.1 m depth					Screen
70						
	Coarse crystalline, fossiliferous, vuggy from 71.6 m to 76.2 m depth Fractured rock at 71.9 m					Sand
75						
	Light greyish-brown DOLOMITE, coarse crystalline, moderately indurated tabular chips, smooth - uneven parting, trace secondary sulphide mineralization		77.72			
80						
	Dark grey DOLOMITE, fine crystalline, well indurated with relict spheres, blocky to platy chips, smooth parting Some small (< 1 mm) vugs from 82.3 m to 85.3 m depth		80.77			
85						
						Bentonite
	Brown DOLOMITE, moderately indurated, coarse grained, tabular to platy chips, smooth parting		86.87			
90	Fractured rock at 89.9 m to 91.4 m depth					
	Fractured rock with strong sulphur odour from 92.7 m to 93.0 m depth		92.96			
95	Light grey DOLOMITE, vuggy, porous, moderately indurated, coarse crystalline, tabular to blocky chips (Amabel Fm)					
			99.06			
100	*CONTINUED NEXT PAGE*					

DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

PROJECT: 05-1112-010(1000)

BOREHOLE LOG OF: CMTW3-05

LOCATION: N 4805132.0 ;E 557560.0

DRILLING DATE: November 9 and 11, 2005

DATUM: Geodetic

DRILL RIG: Mud Rotary

DRILLING CONTRACTOR: Davidson Well Drilling

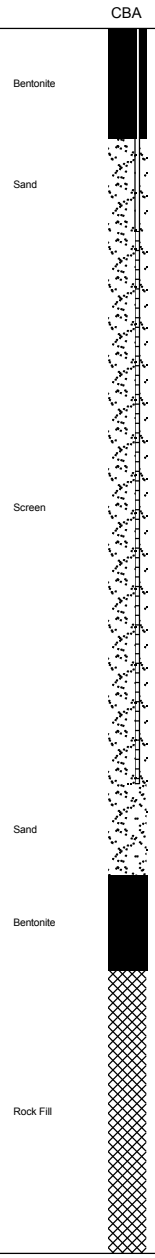
DEPTH SCALE METRES	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)
	--- CONTINUED FROM PREVIOUS PAGE ---		
100	Grey DOLOMITE, moderately indurated, fine crystalline, blocky to platy chips, smooth to irregular parting (Amabel Fm) Vuggy from 99.1 m to 100.6 m depth Fractured zone from 101.5 m to 101.8 m depth		
105	Greyish-brown colour from 105.2 m to 108.2 m depth		
110	Trace small (< 2 mm) vugs from 109.7 m to 112.8 m depth Dark brown, soft layer from 110.3 m 110.5 m depth		
	Grayish brown DOLOMITE, moderately indurated, fine crystalline, platy to tabular chips, smooth parting, relict fossils (Amabel Fm)		112.80
115	Light grey DOLOMITE, moderately to well indurated, predominantly fine crystalline with thin coarse grained beds (Amabel Fm)		115.80
120			
125	Dark grey DOLOMITE, moderately indurated, fine crystalline, thinly to medium bedded, platy chips, smooth to uneven parting (Amabel Fm)		125.00
	Light grey DOLOMITE, moderately indurated, fine grained, tabular to platy chips (Amabel Fm)		128.00
130			
	Grey SHALE (Rochester Fm)		134.00
135	Brown DOLOMITE, well indurated, fine crystalline, tabular chips, smooth parting, trace sulphides, trace black mottling		135.00
	Gray SHALE, poorly indurated, fine grained (Cabot Head Fm)		138.40
140	END OF BOREHOLE		140.50
145			
150			

GEOPHYSICAL RECORD

GAMMA (cps): 20 40 60 80

CONDUCTIVITY (mS/m): 10 20 30 40

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE

1 : 250

Golder Associates

LOGGED: AI

CHECKED:

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

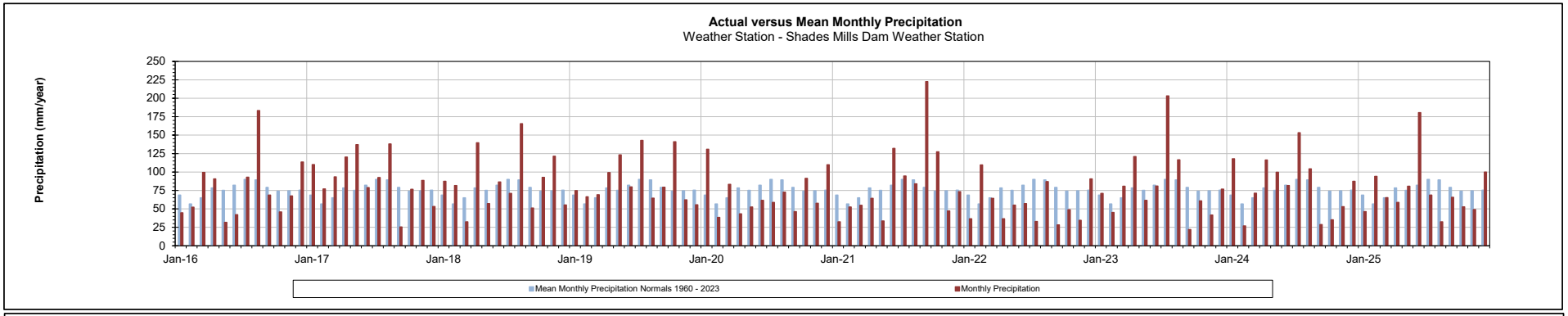
Monitoring Data
(Pumped Volumes and Hydrographs)

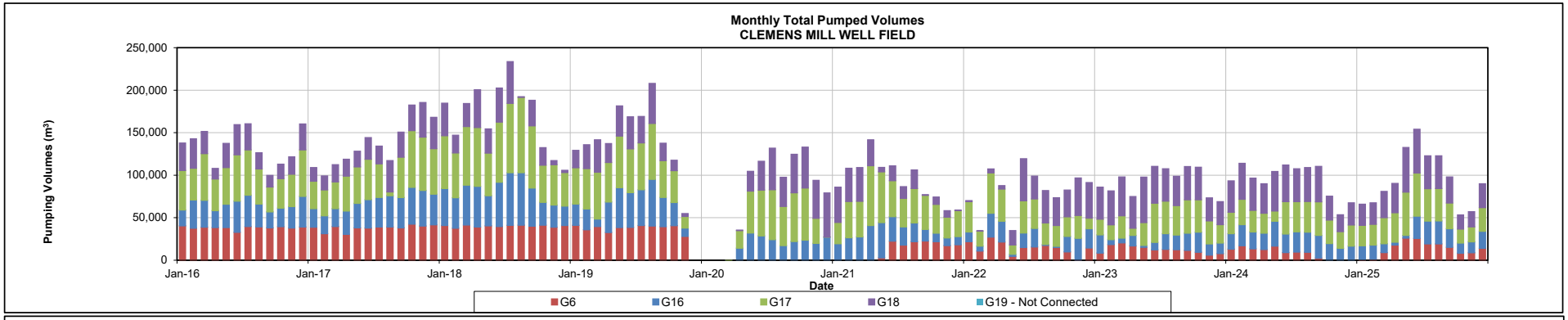
TABLE C-1
WELL FIELD WATER PRODUCTION SUMMARY
REGION OF WATERLOO - 2025 GROUNDWATER MONITORING REPORT

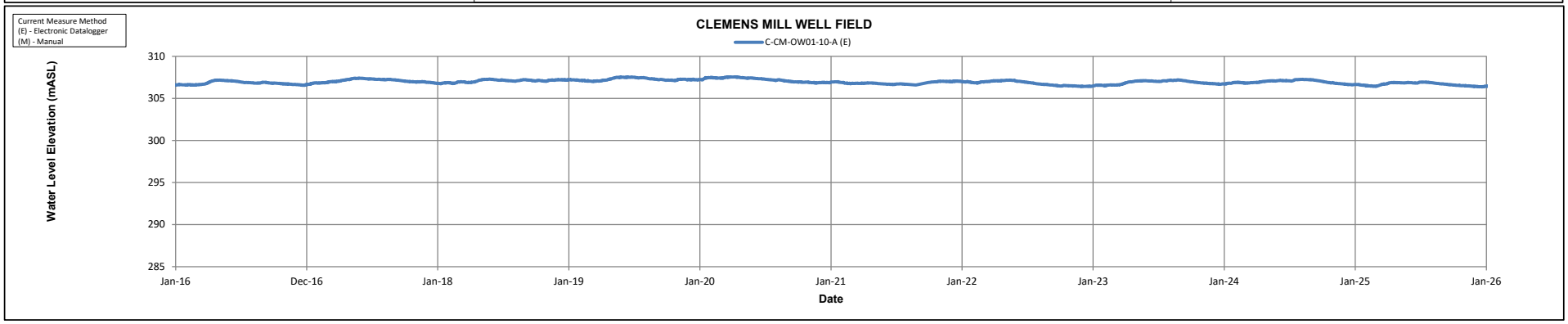
Well Field	Major or Minor Supply	Production Well Name	Status	Permit to Take Water Details			2021 Production Summary			2022 Production Summary			2023 Production Summary			2024 Production Summary			2025 Production Summary		
				MOE Permit Number	Permitted Capacity (total m^3/year)*	Permitted Rate (L/s)*	Total Production Well Volume (total m3/year)	Average Daily Rate (m3/day)	Average Rate (L/s)	Total Production Well Volume (total m3/year)	Average Daily Rate (m3/day)	Average Rate (L/s)	Total Production Well Volume (total m3/year)	Average Daily Rate (m3/day)	Average Rate (L/s)	Total Production Well Volume (total m3/year)	Average Daily Rate (m3/day)	Average Rate (L/s)	Total Production Well Volume (total m3/year)	Average Daily Rate (m3/day)	Average Rate (L/s)
Clemens Mill	Major	G6	Supply				144,945	397	5	173,305	0	0	151,668	416	5	103,082	282	3	164,940	452	5
		G16	Supply				269,765	739	9	180,131	494	6	161,387	442	5	258,296	708	8	197,331	541	6
		G17	Supply	5552-BUJN94	4,756,680	150.8	485,273	1330	15	334,300	916	11	342,428	938	11	336,629	922	11	383,459	1051	12
		G18	Supply				226,811	621	7	291,963	800	9	461,183	1264	15	435,740	1194	14	389,805	1068	12
		G19	Not Commissioned																		
				Well Field Total	***4,756,680***	***150.8***	***1,126,794***	***3,087***	***35.7***	***979,699***	***2,684***	***31.1***	***1,116,666***	***3,059***	***35.4***	***1,133,747***	***3,106***	***36.0***	***1,135,535***	***3,111***	***36.0***

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

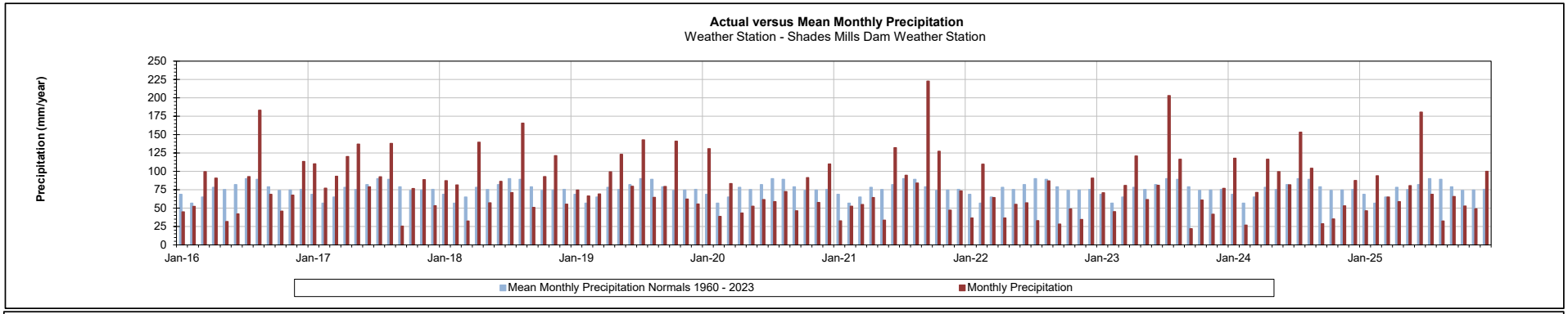
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
CLEMENS MILL

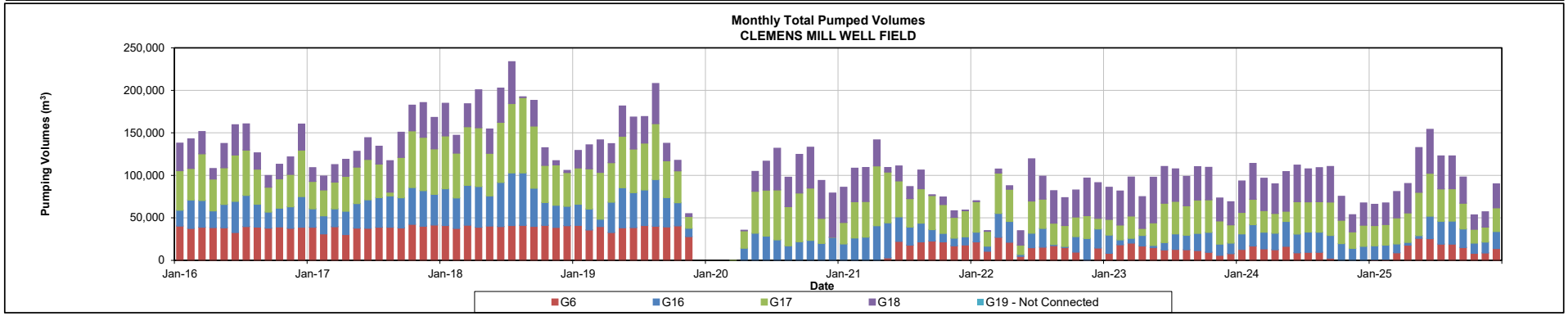


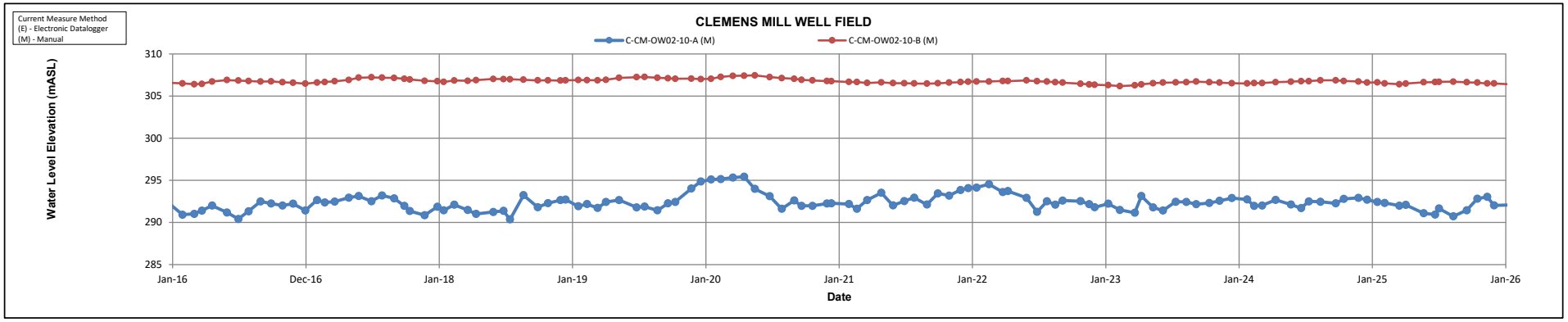




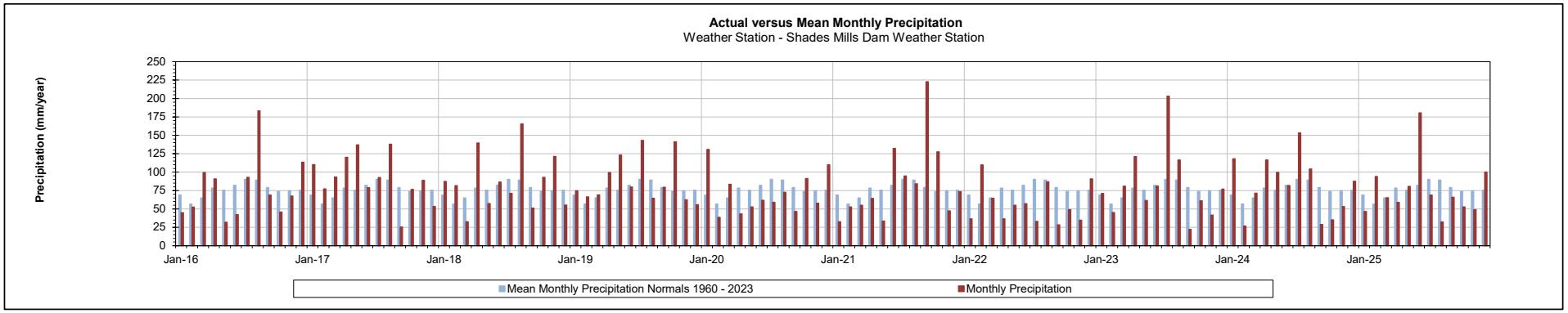
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
CLEMENS MILL

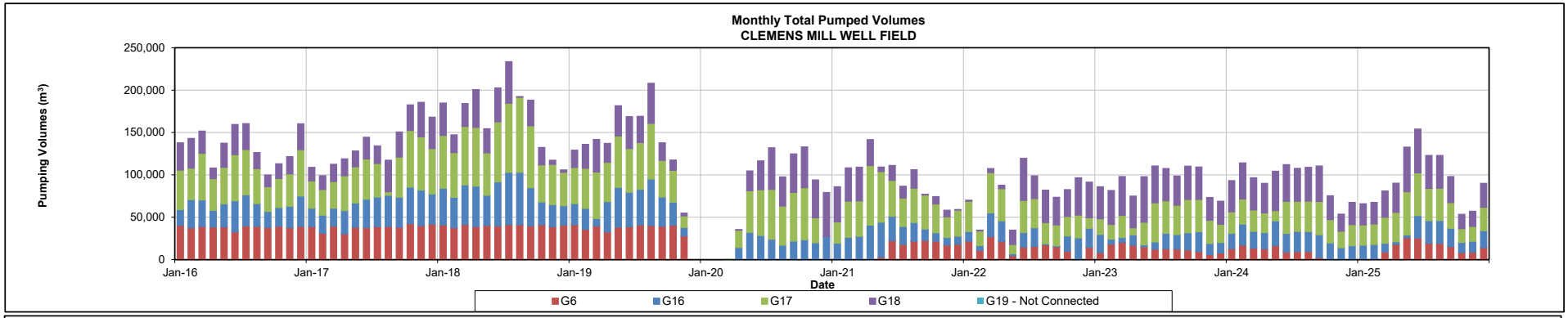


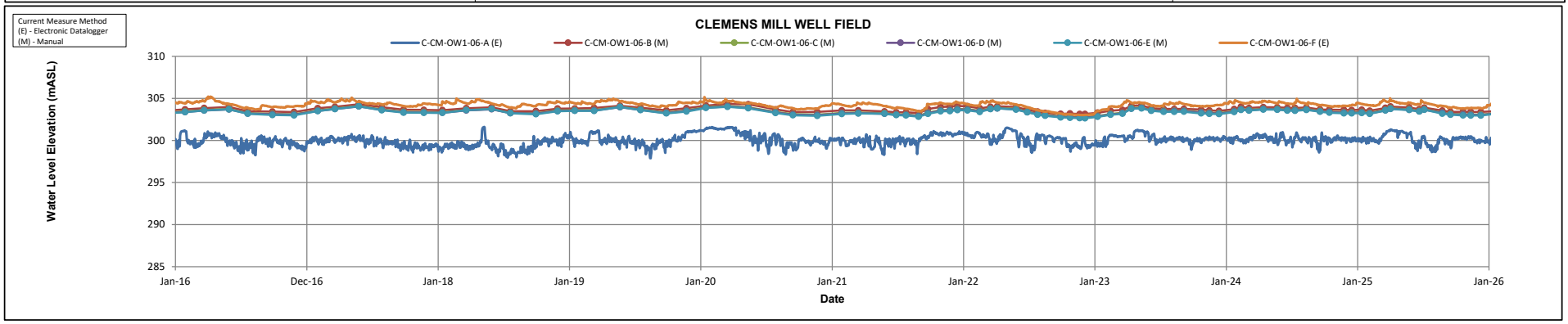




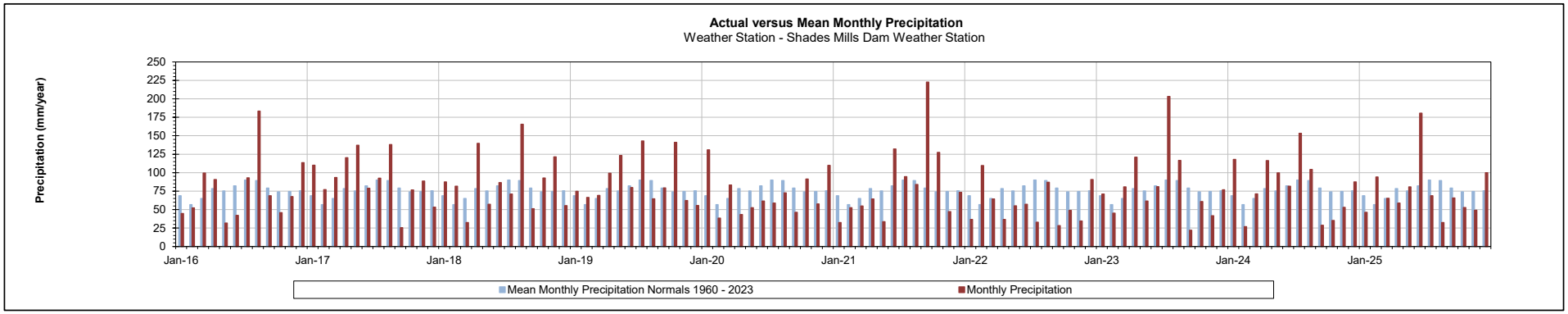
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
CLEMENS MILL

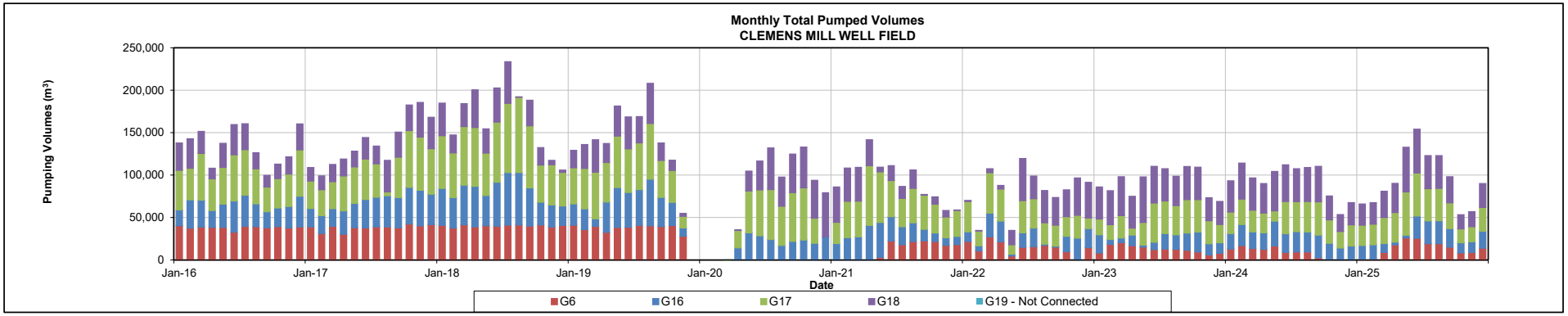


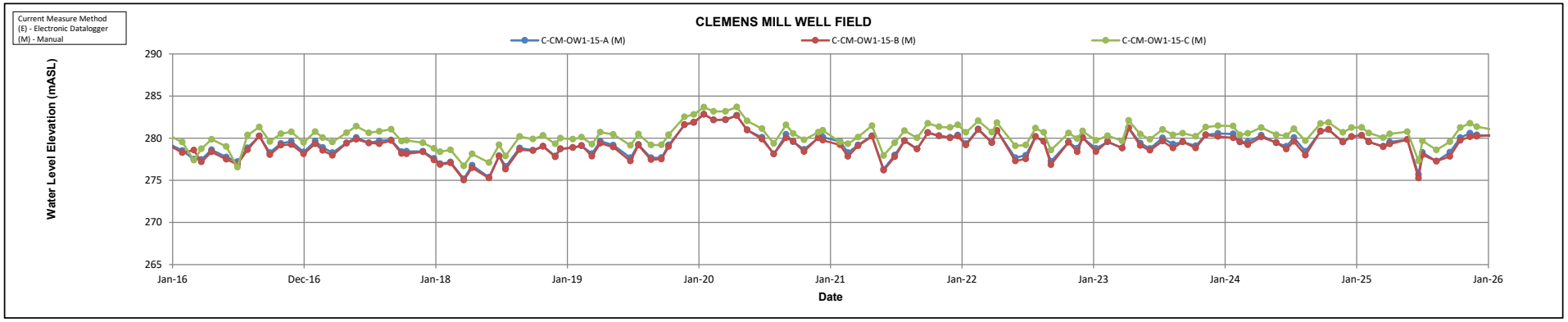




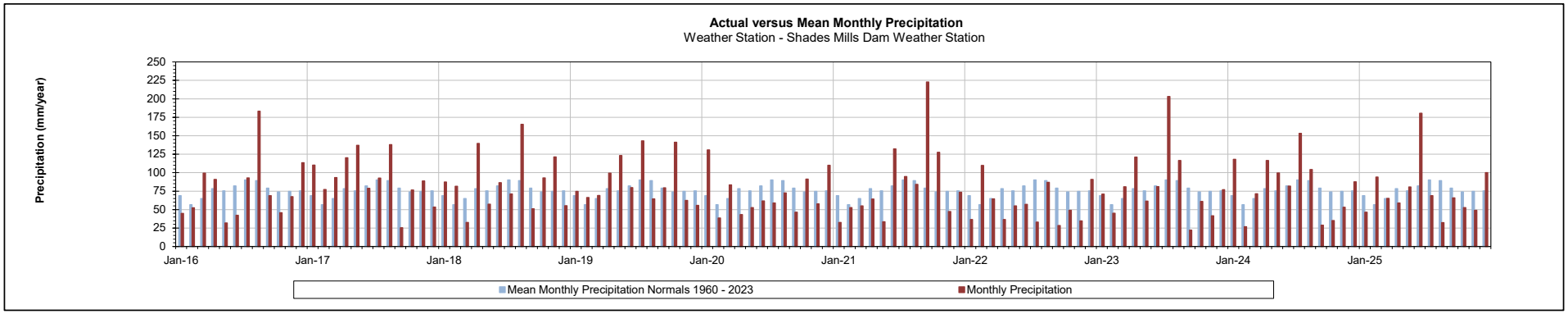
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
CLEMENS MILL

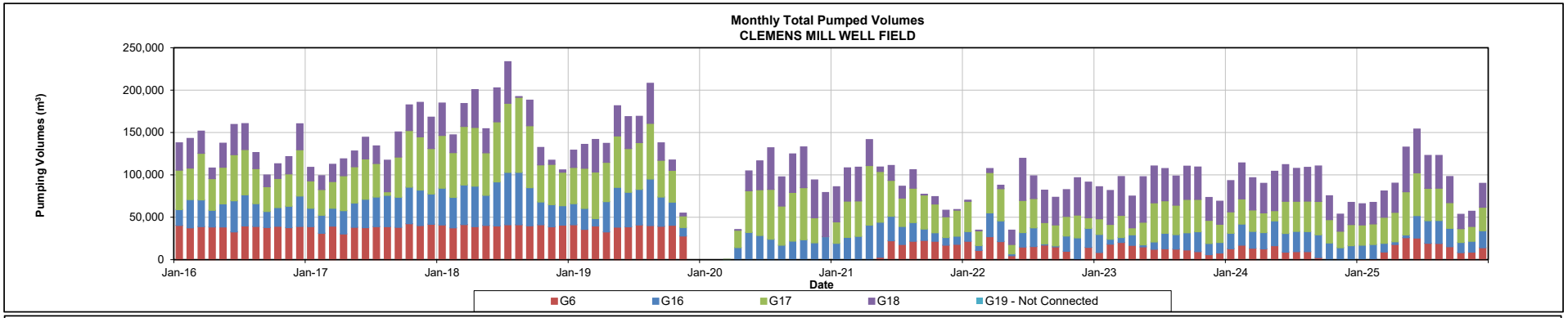


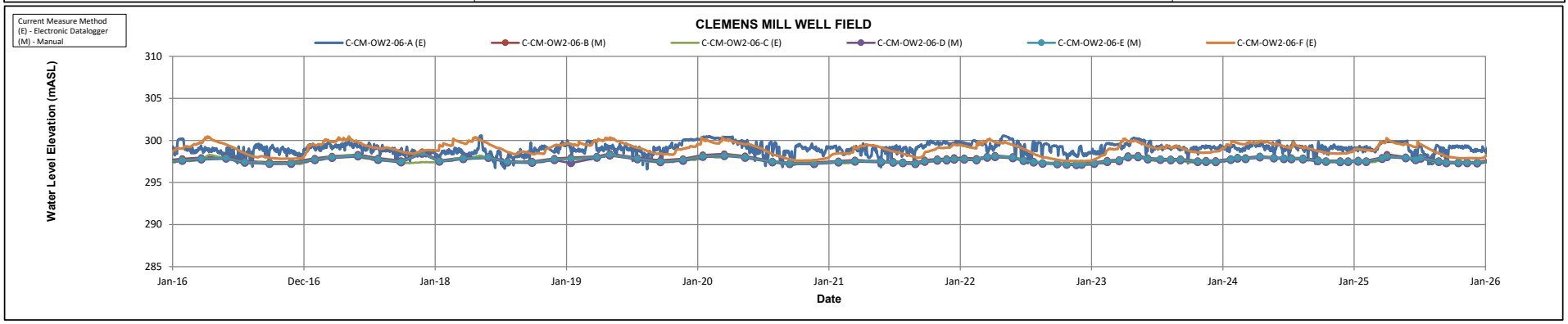




REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
CLEMENS MILL







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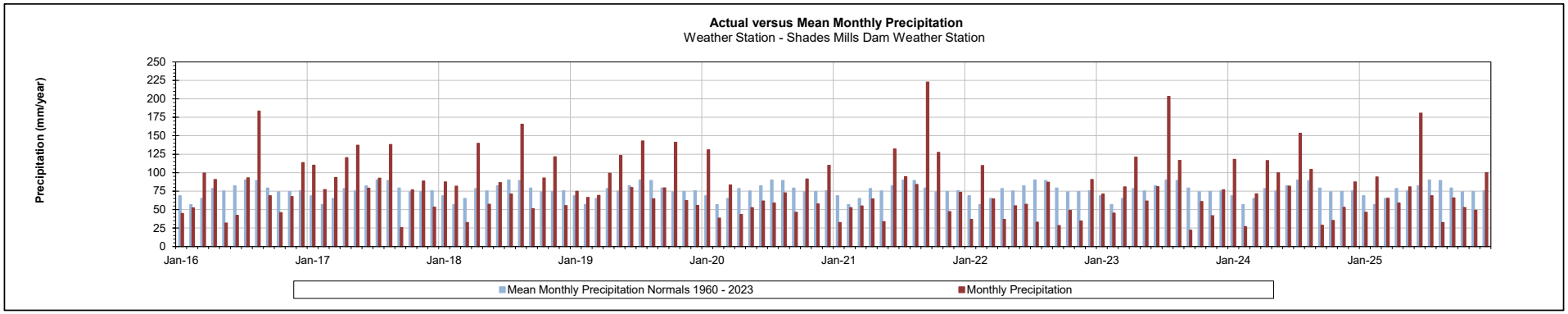

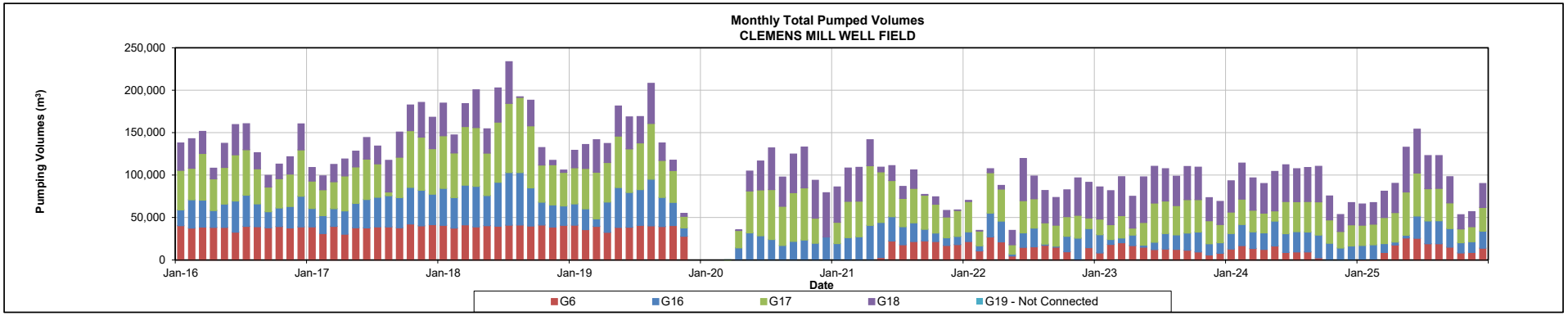

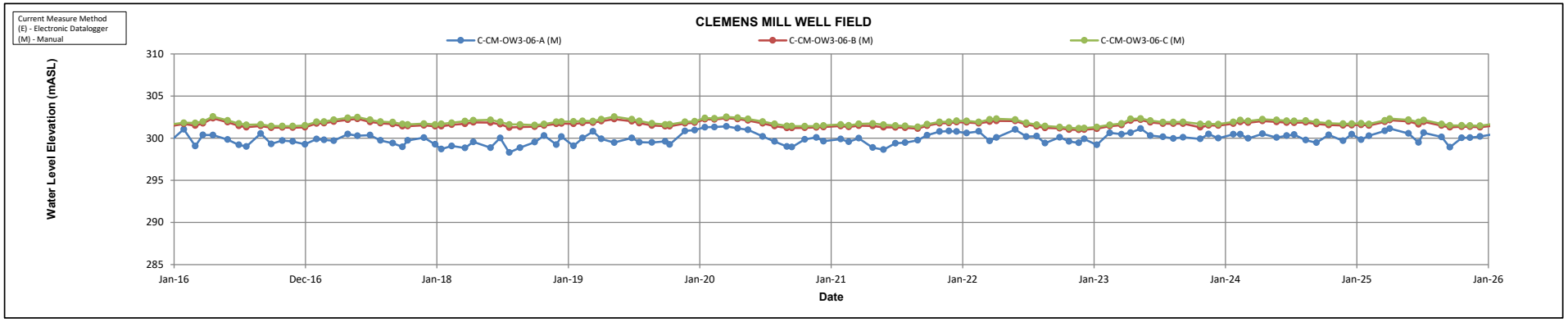

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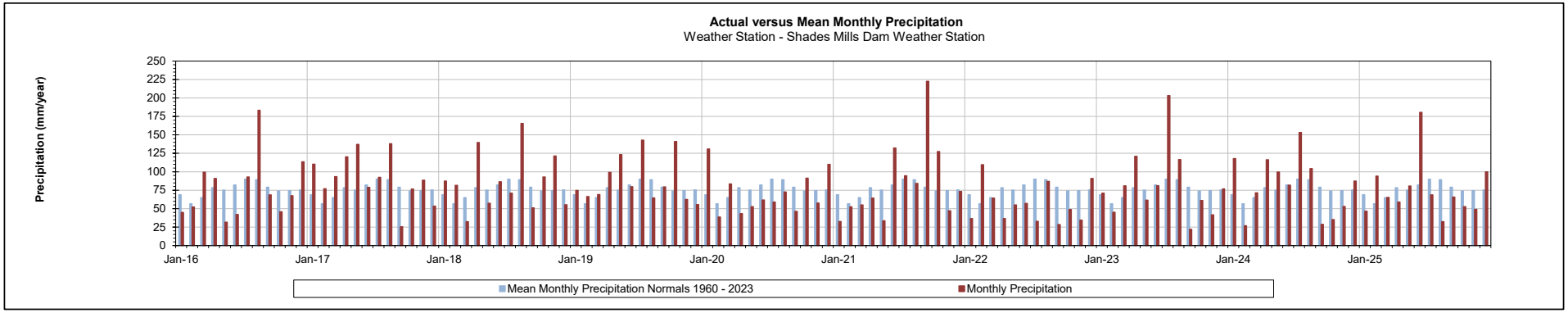

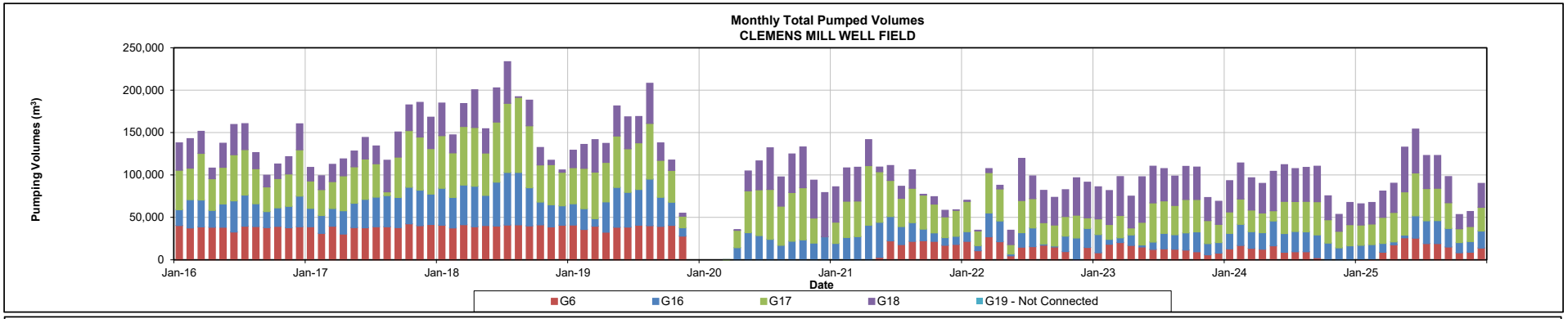

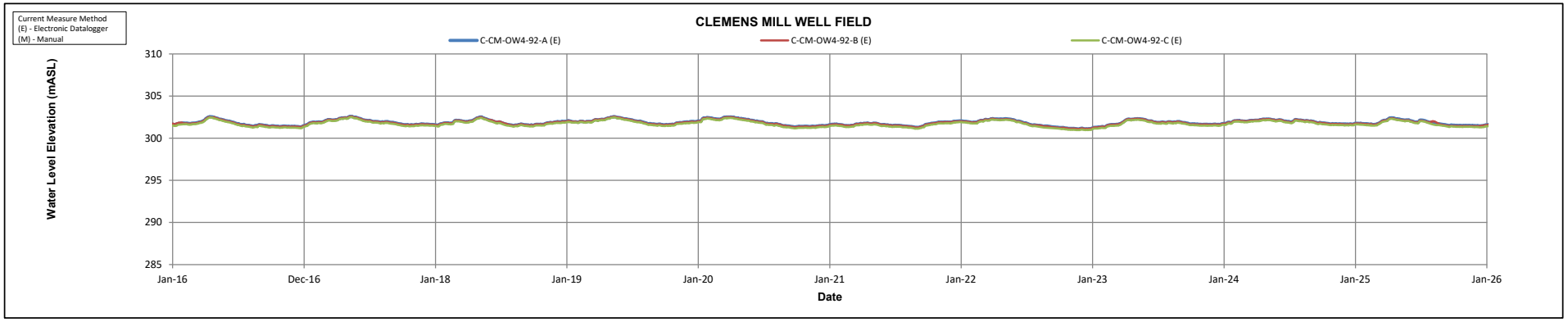

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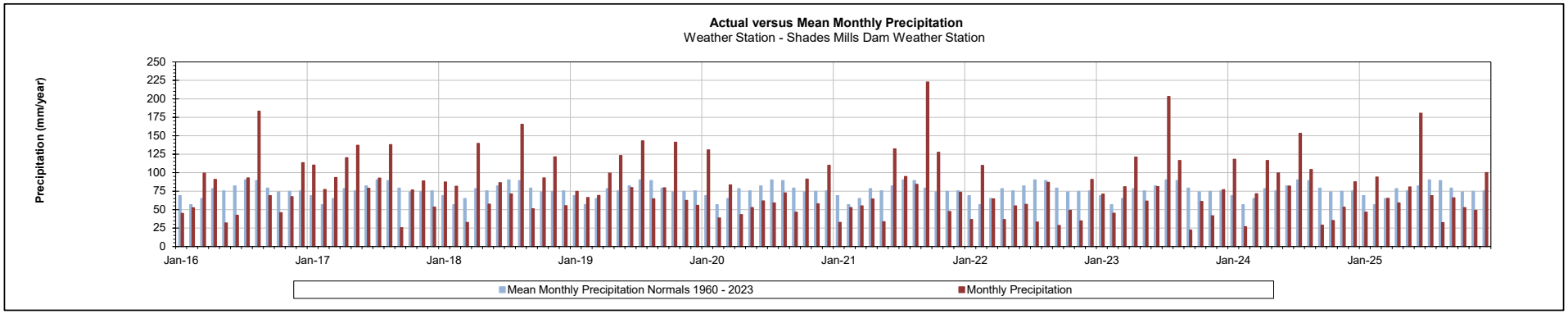

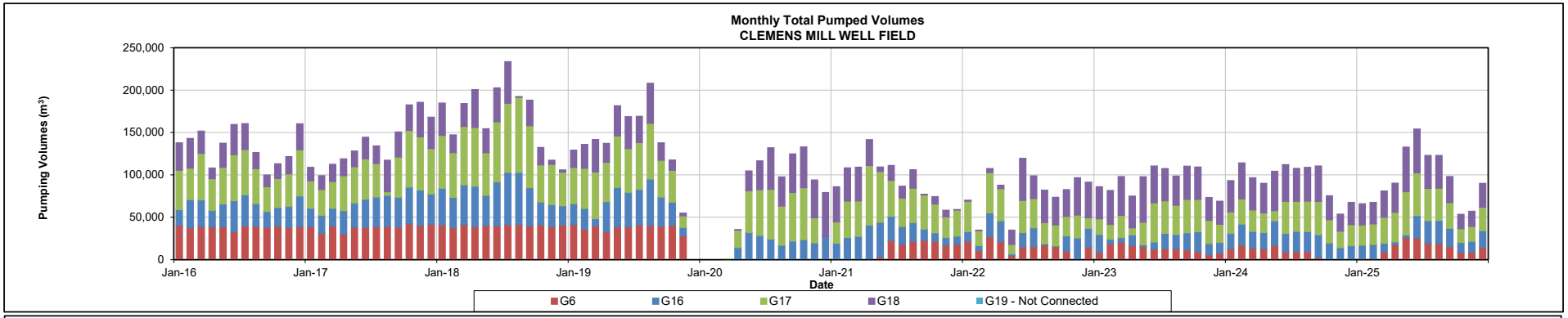

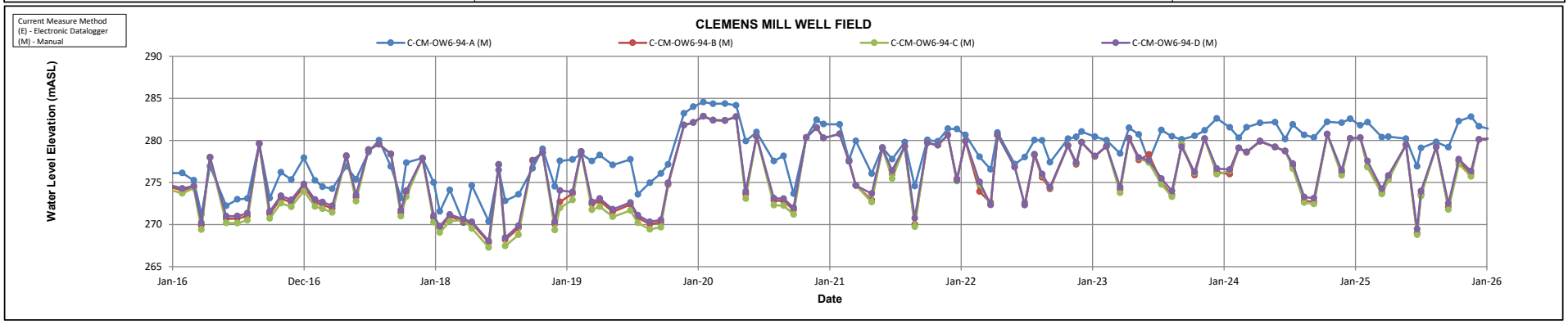

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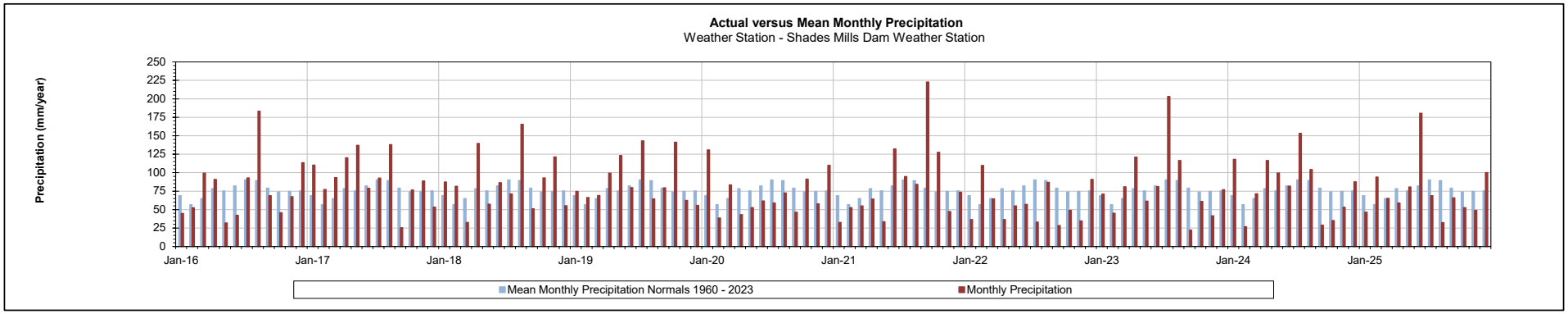

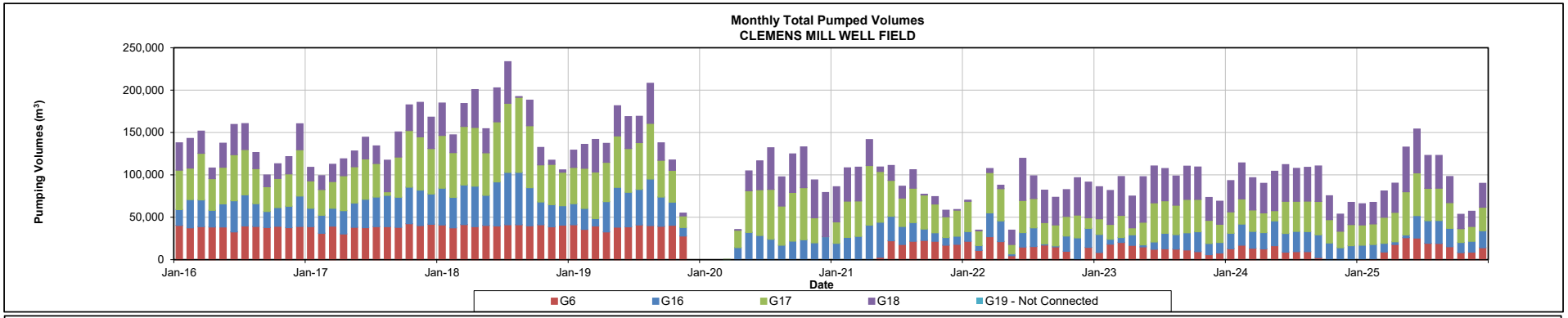

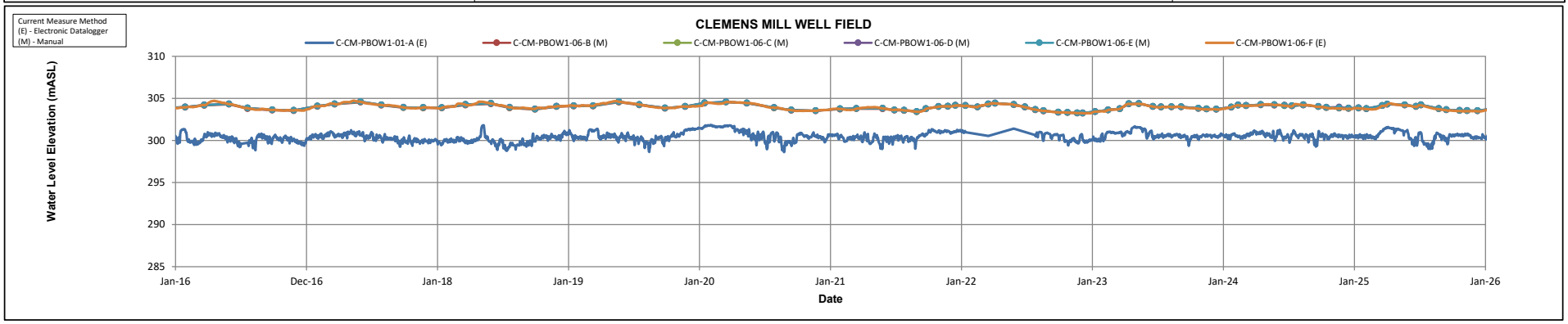

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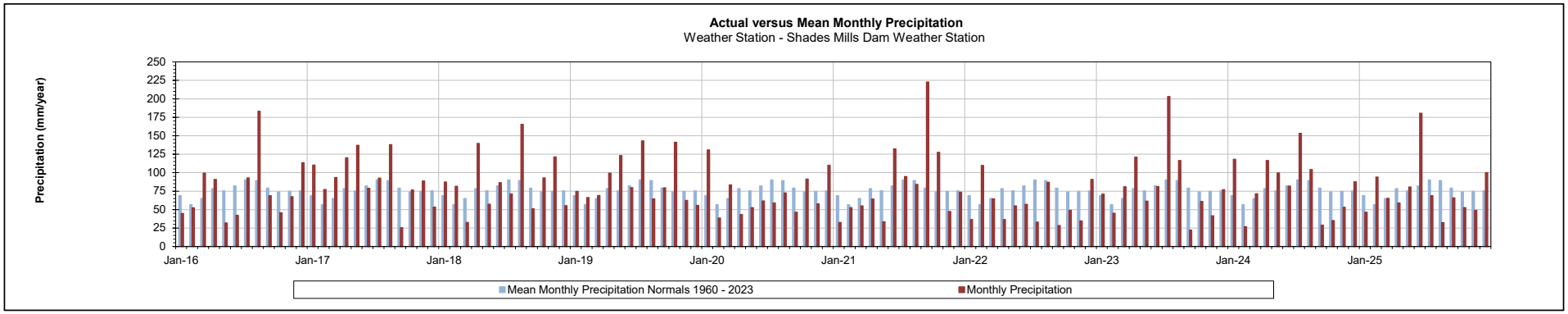

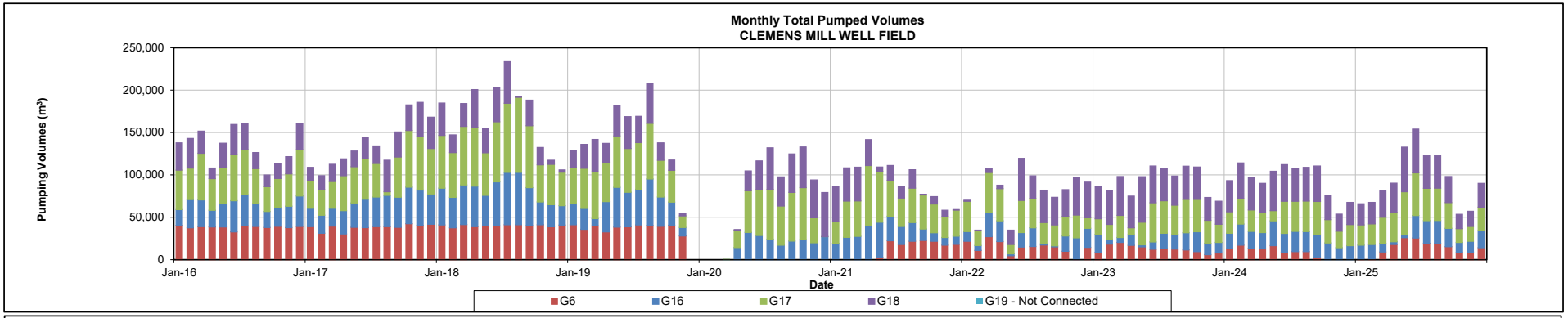

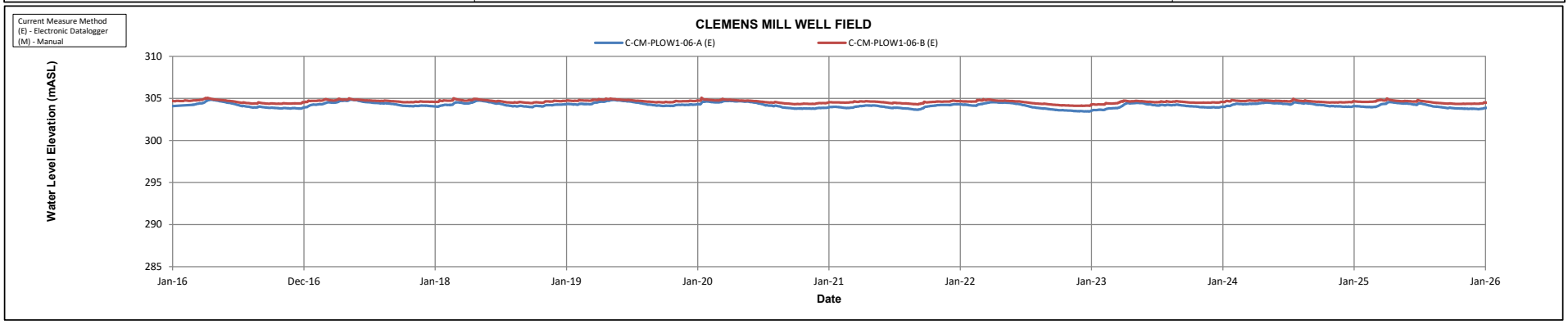

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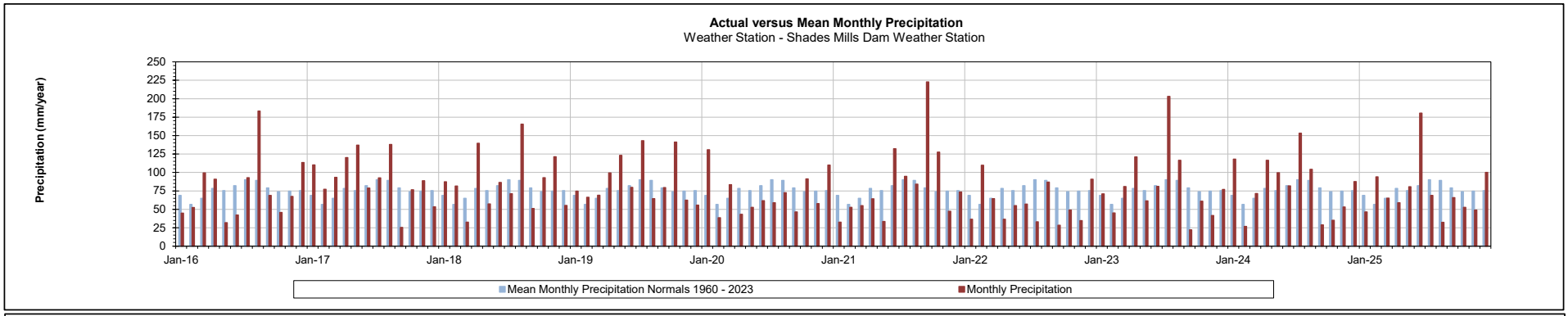

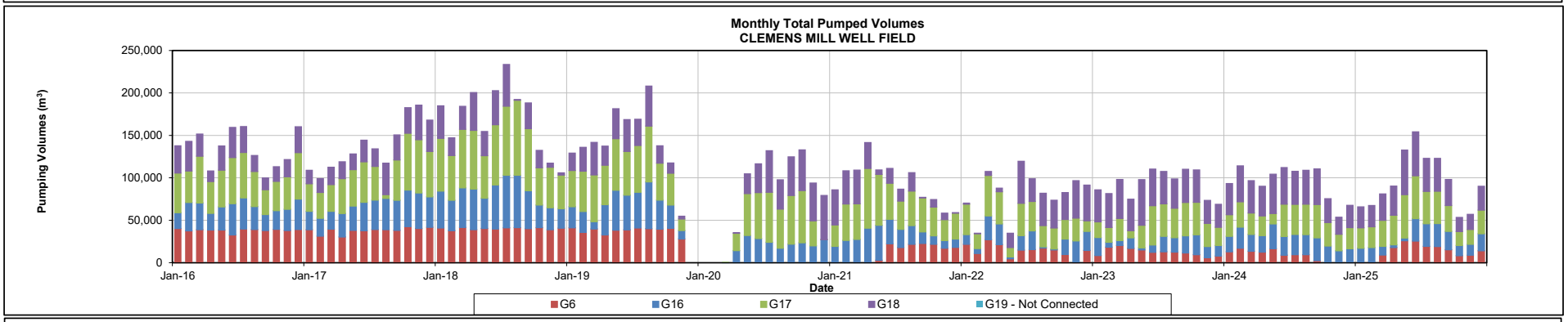

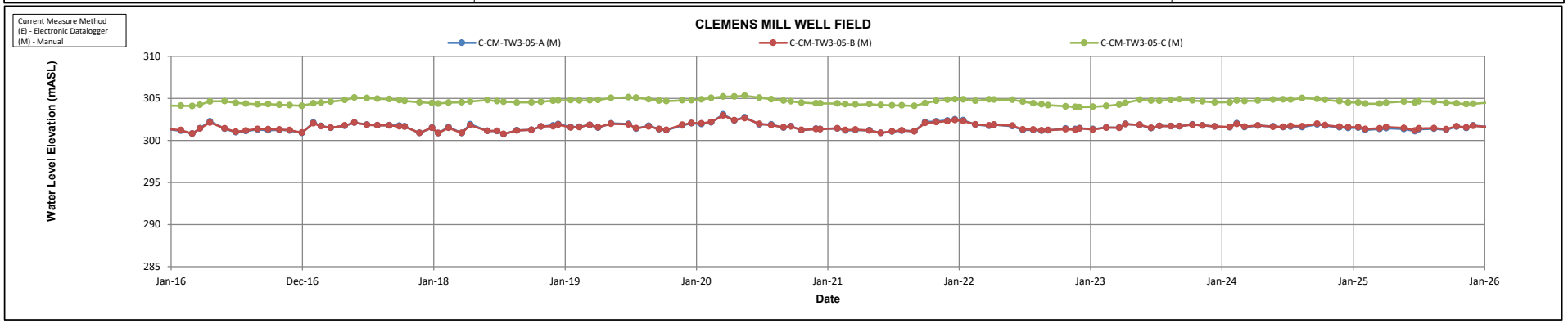

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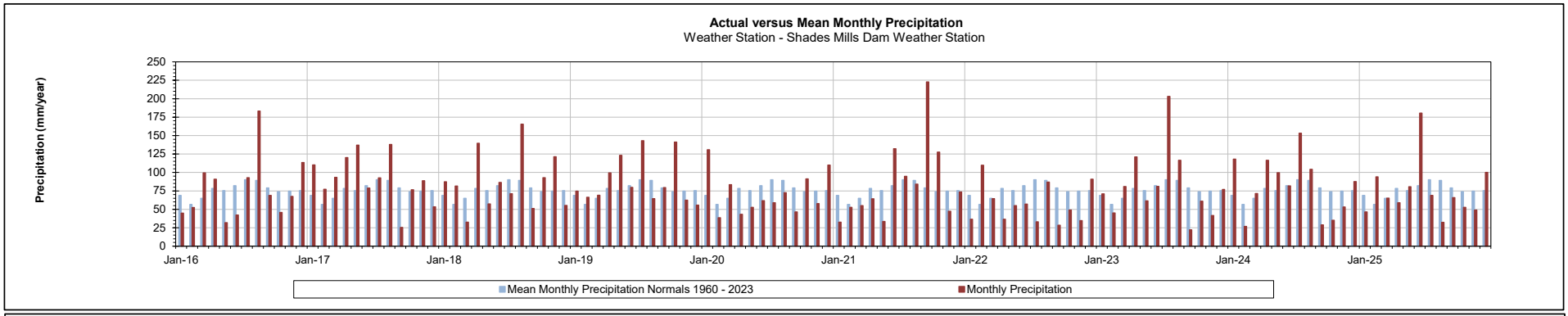

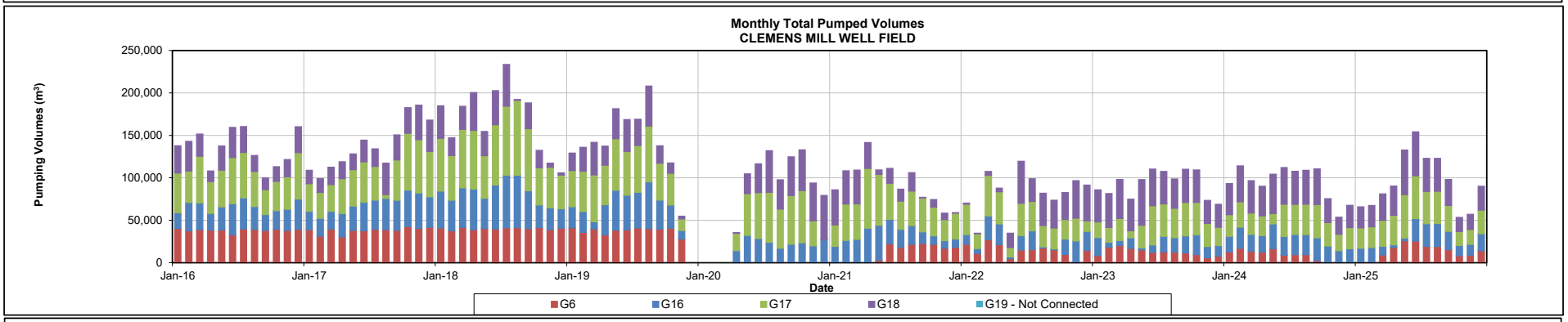

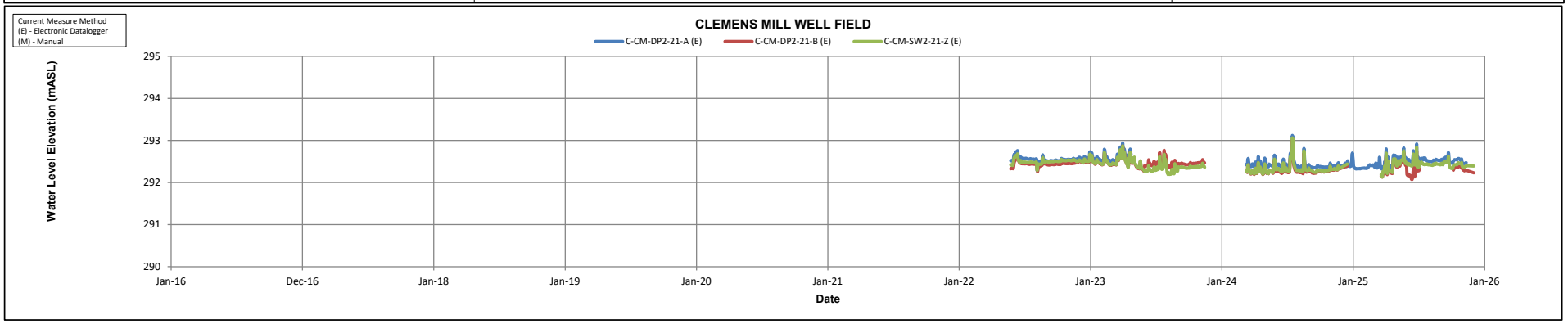

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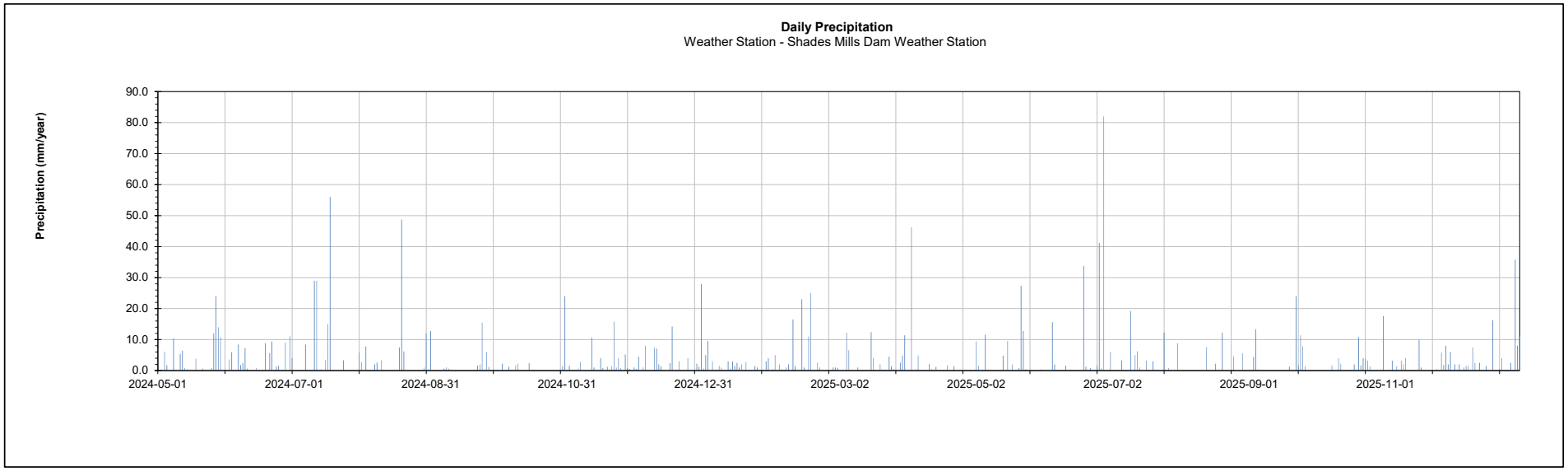

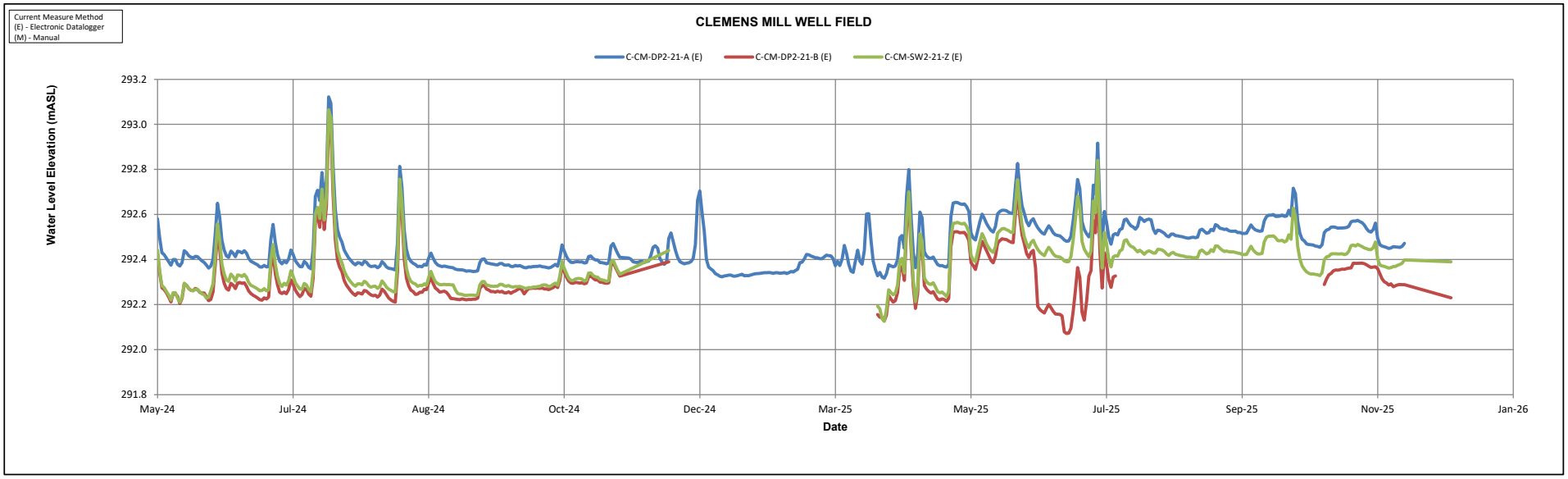

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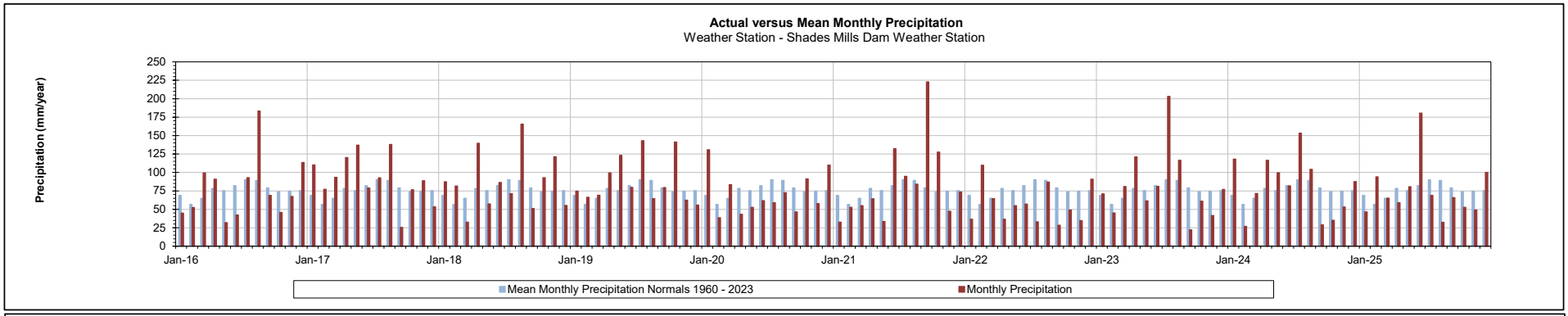

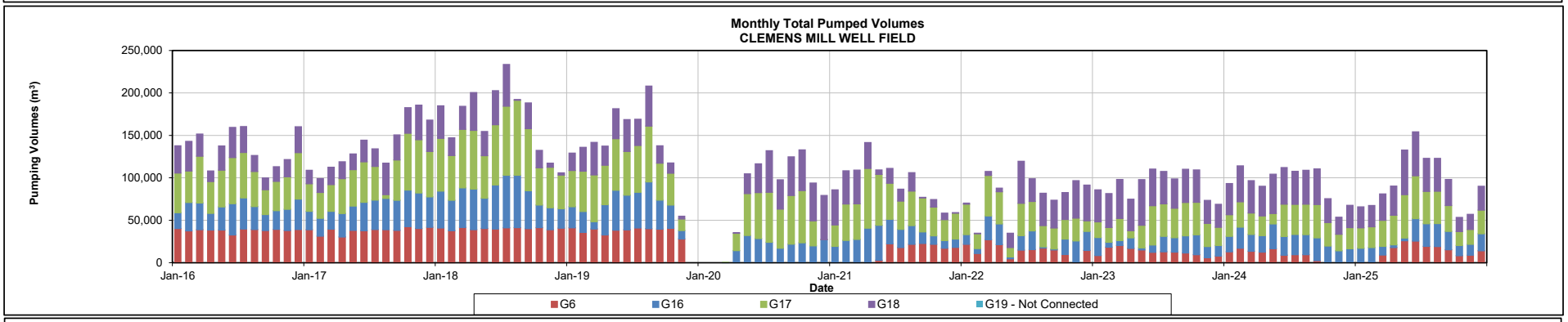

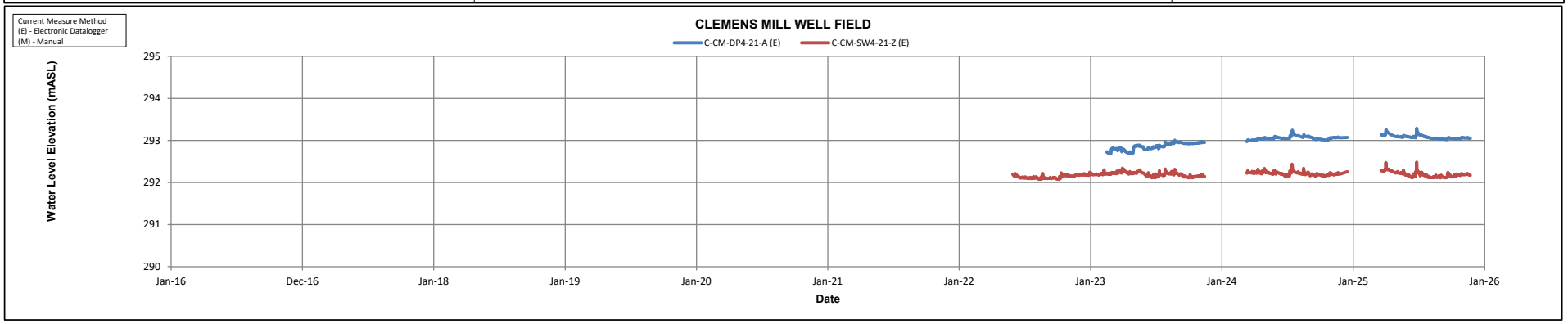

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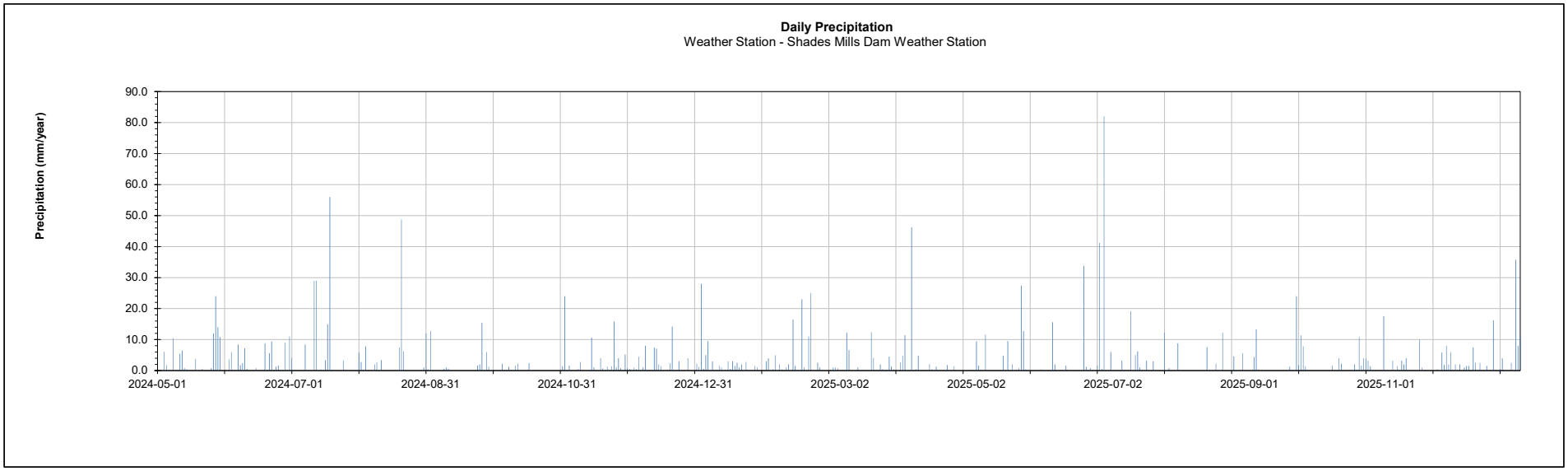

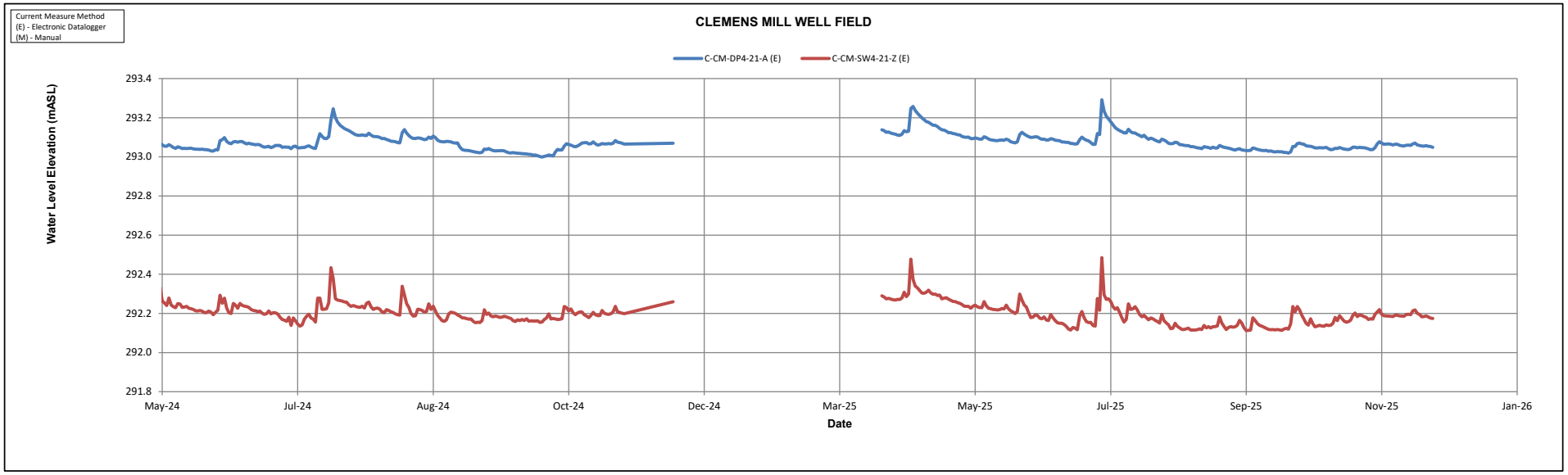

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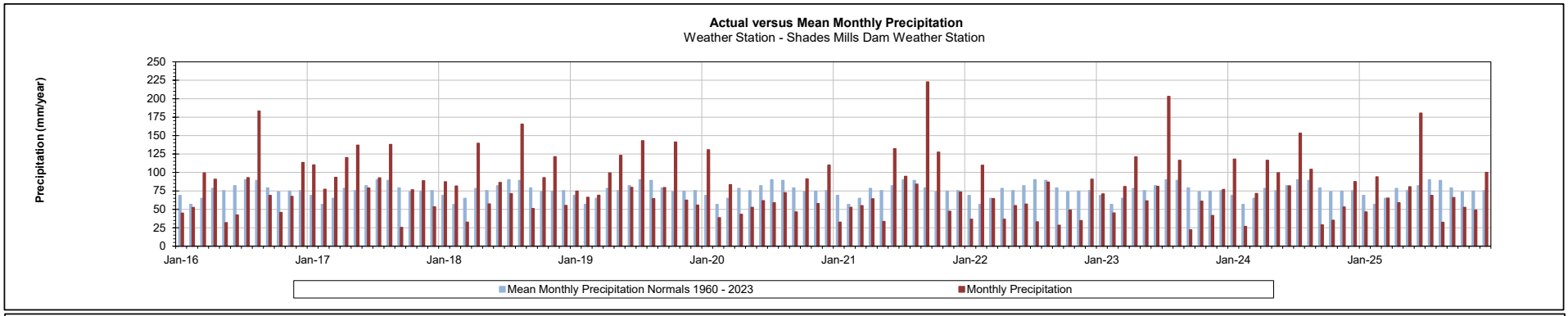

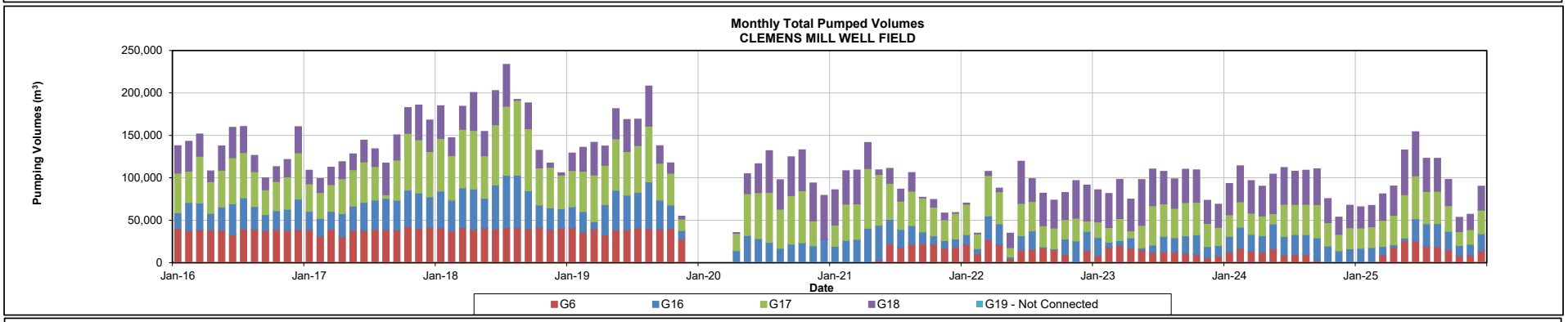

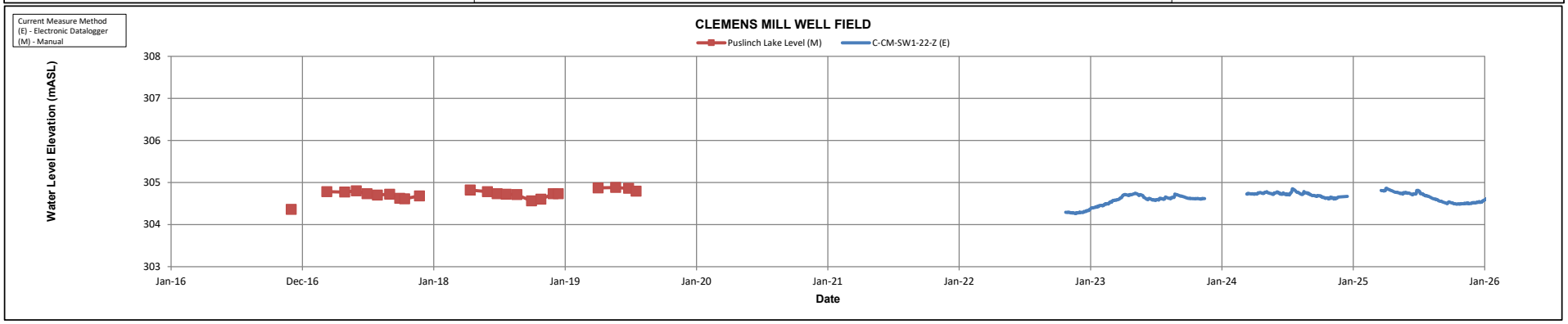

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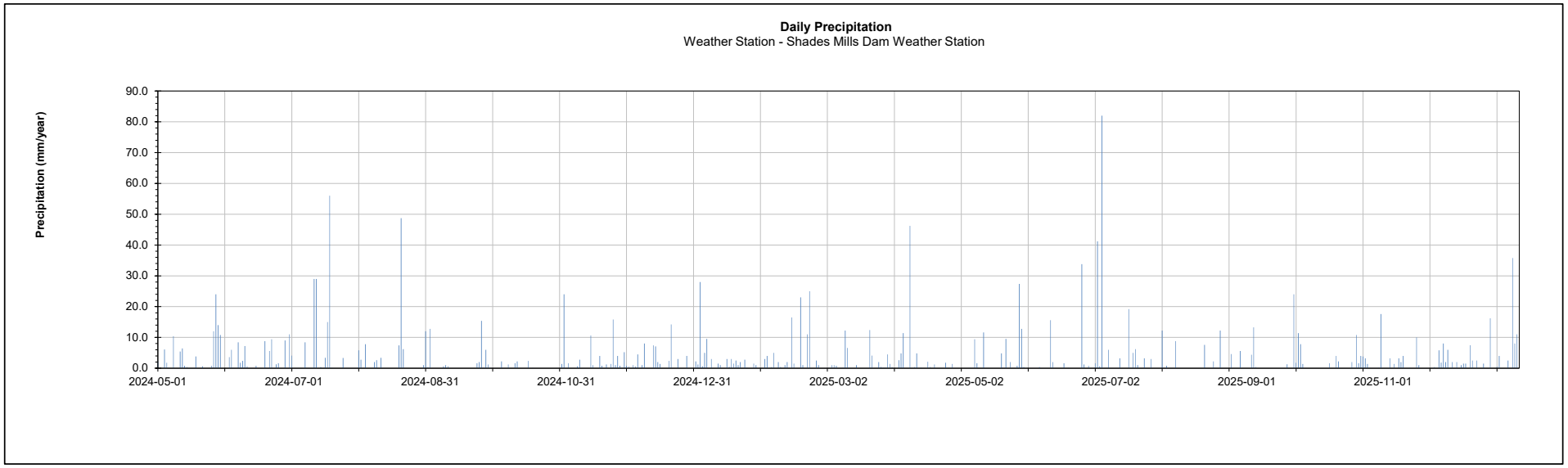

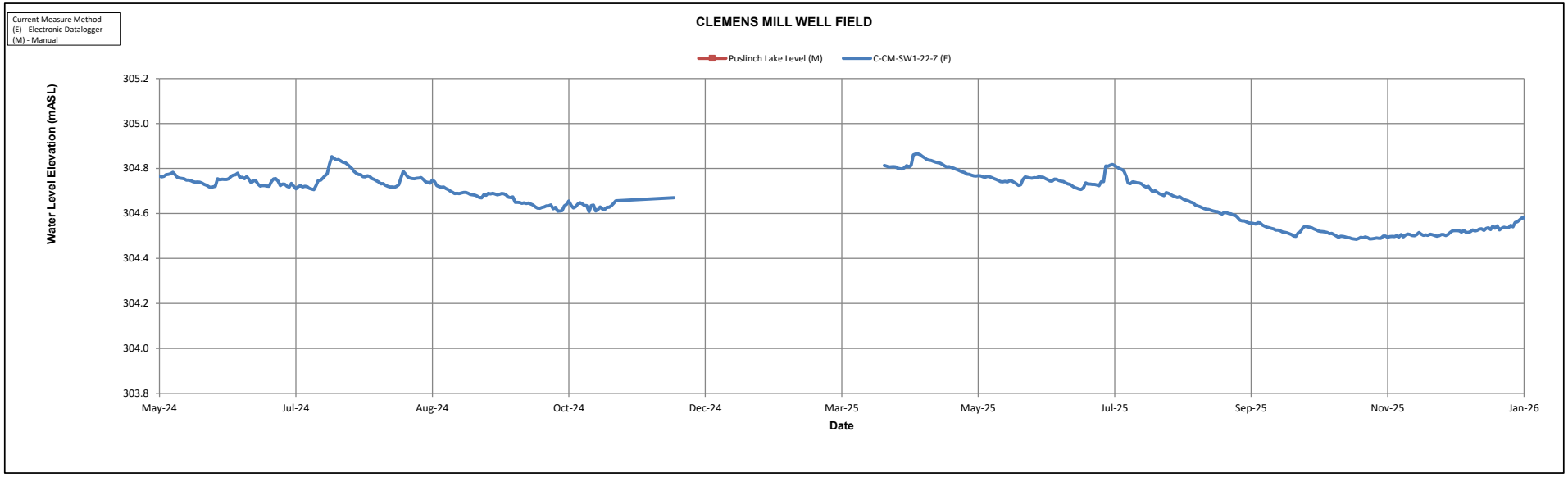

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Appendix D

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**

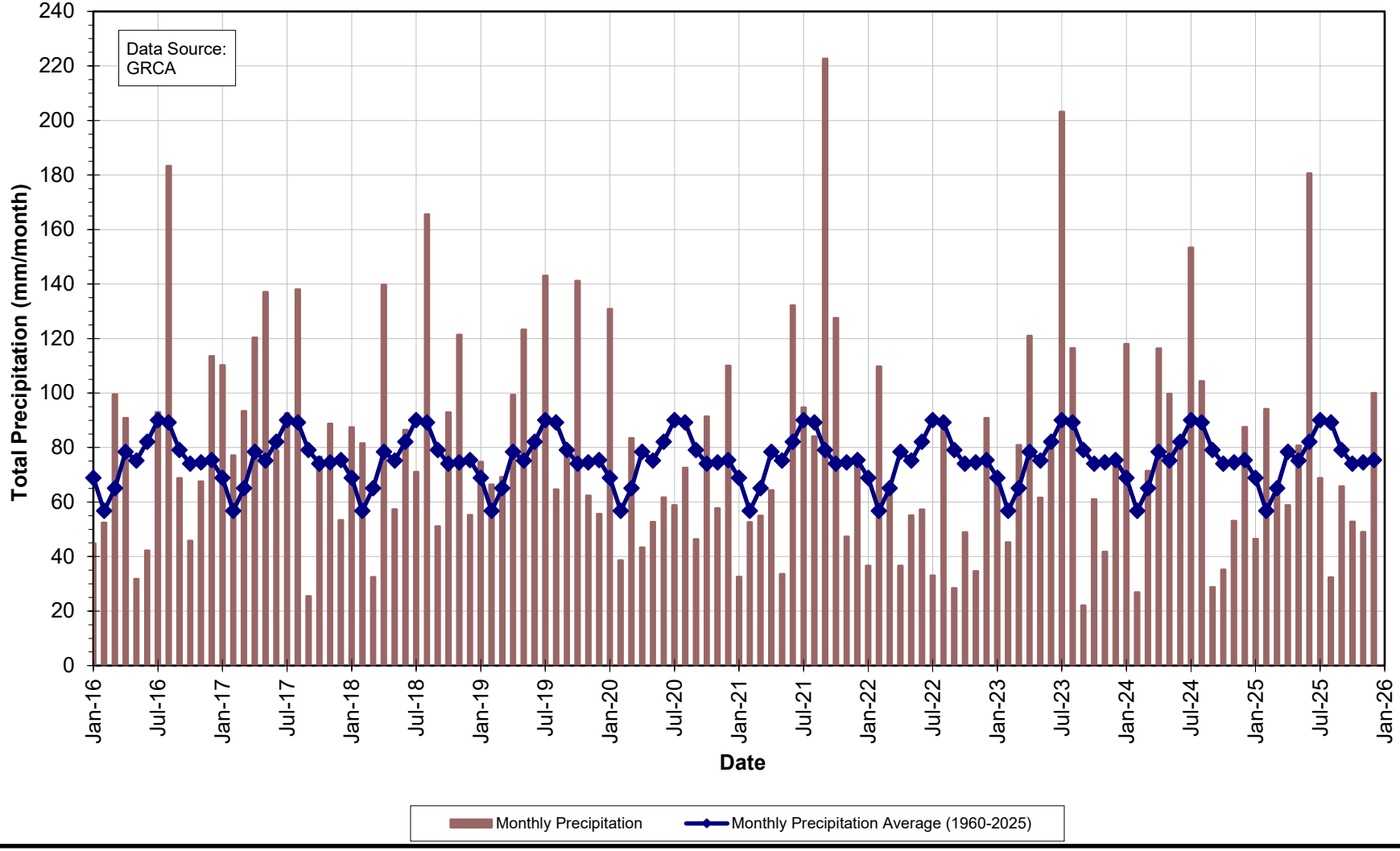
Year	Laurel Dam Established 1960		
	Annual Precipitation (mm)	Average Precipitation 1960-2025 (mm)	Difference (mm)
2016	985	938	**47**
2017	1062	938	**124**
2018	1071	938	**133**
2019	940	938	**2**
2020	938	938	**0**
2021	1027	938	**89**
2022	689	938	**-249**
2023	921	938	**-17**
2024	907	938	**-31**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

Figure D.1
Shade's Mills Dam
Monthly Precipitation



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Prepared By: S.Q.
Printed On: 2/13/2026
File: Appendix D Precipitation Data/Monthly Shades Mills

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

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

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

- 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.

R.J. Burnside & Associates Limited