



BURNSIDE

**2025 Biennial Groundwater Monitoring
Report - Greenbrook Well Field
(K1A, K2A, K4B, K4C, K5A, K8)**

The Region of Waterloo



BURNSIDE

**2025 Biennial Groundwater Monitoring
Report - Greenbrook Well Field
(K1A, K2A, K4B, K4C, K5A, K8)**

The Region of Waterloo

**R.J. Burnside & Associates Limited
292 Speedvale Avenue West Unit 20
Guelph ON N1H 1C4 CANADA**

**June 2026
HA0464020.2024**

Distribution List

No. of Hard Copies	PDF	Email	Organization Name
0	Yes	Yes	The Ministry of Environment, Conservation and Parks (MECP)
0	Yes	Yes	The Region of Waterloo

Record of Revisions

Revision	Date	Description
0	April 2026	Submission to Region of Waterloo
1	June 2026	Submission to the MECP

R.J. Burnside & Associates Limited

Report Prepared By:

Stephanie Charity, P.Geo.
Hydrogeologist
SC:js



Report Reviewed By:

Dave Hopkins, P.Geo.
Senior Hydrogeologist
DH:js



Table of Contents

1.0	Introduction.....	1
1.1	Scope of Work.....	1
2.0	Site Setting.....	2
2.1	Well Field Description.....	2
2.1.1	Pumping Wells.....	2
2.1.2	Monitoring Wells.....	3
2.2	Regional Geology.....	5
2.2.1	Surficial Geology and Conceptual Hydrostratigraphy.....	6
2.2.2	Bedrock Geology.....	7
2.3	Local Geology.....	8
3.0	2024 / 2025 Results.....	9
3.1	Precipitation.....	9
3.2	Monitoring Results.....	11
4.0	Impact Assessment.....	13
4.1	Well Interference.....	13
4.1	Aquifer Response to Pumping and Precipitation.....	14
5.0	Conclusions.....	15
6.0	References.....	16

Tables

Table 1: Production Well Construction Details.....	2
Table 2: Annual Water Taking 2024 / 2025.....	3
Table 3: Monitoring Well Construction Details.....	4
Table 4: Summary of Precipitation Data.....	10
Table 5: PTTWs in Vicinity of Greenbrook Well Field.....	14

Figures

Figure 1: Well Field Location Map
Figure 2: Kitchener Well Fields and Monitoring Network
Figure 3: Well Location Map
Figure 4: Surficial Geology
Figure 5: Location of the Waterloo Moraine
Figure 6: Greenbrook Well Field Cross Section A – A'
Figure 7: Greenbrook Well Field Cross Section B – B'

Appendices

Appendix A Permit To Take Water
Appendix B Well Records
Appendix C Monitoring Data (Pumped Volumes and Hydrographs)
Appendix D Precipitation Data
Appendix E Monitoring Program Overview

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 0071-BUKPU5) for the Greenbrook 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 conditions of the PTTW for 2024 and 2025. A copy of the current PTTW issued on October 20, 2020 is included in Appendix A.

The location of the Greenbrook Well Field is shown on Figure 1 and the production wells (K1A, K2A, K4B, K4C, K5A and K8) are shown on Figure 2 with the monitoring network shown on Figure 3. Well records for the production and monitoring wells are found in Appendix B.

1.1 Scope of Work

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

The Region has developed a monitoring program for the Greenbrook Well Field in accordance with PTTW 0071-BUKPU5, which consists of the following activities:

- Measuring the daily volume pumped from production wells K1A, K2A, K4B, K4C, K5A and K8 (Condition 4.1 of the PTTW);
- Measuring the water levels in monitoring wells K-GB-BH1-90-AB, K-GB-M4-94-AB, K-GB-GB1-96-ABC, K-GB-GB1-97-AB, K-GB-OW1-08-AB, K-GB-OW2-08-AB and K-GB-OW1-15-A (Condition 4.2 of the PTTW);
- Reviewing precipitation data from the nearest GRCA / Environment Canada weather station; and
- Completion of a biennial report (every 2 years) that presents data in compliance with condition 4.3 of the PTTW.

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

2.0 Site Setting

2.1 Well Field Description

The Greenbrook Well Field is located in the central portion of Kitchener just northwest of the intersection of Westmount Road and Conestoga Parkway (Highway 7 / 8). The supply wells are located along the natural corridor that borders Shoemaker Creek. The closest municipal well fields are the Mannheim East Well Field, located about 2.5 km to the southwest and the Parkway Well Field located about 3.2 km to the southeast (Figure 2). All the Greenbrook production wells are located within 100 m of Shoemaker Creek and its tributaries (Figure 3).

2.1.1 Pumping Wells

The Greenbrook Well Field consists of production wells K1A, K2A, K4B, K4C, K5A and K8. Well records for the production wells are found in Appendix B. In 2021, K4B was decommissioned and replaced with K4C. 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 / Screen Diameter (mm)	Screened Interval (mbgs)	Aquifer
K1A	2009	356 / 305	42.1 – 49.7	AFD1
K2A	2009	356 / 305	43.6 – 51.2	AFD1
K4B	1996	400 / 300	31.6 – 37.1	AFD1
K4C	2015	305 / 305	31.1 – 38.7	AFD1
K5A	1997	406 / 355	32.0 – 40.2	AFD1
K8	1987	300 / 300	42.4 – 46.9	AFD1

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

Table 2: Annual Water Taking 2024 / 2025

Well	PTTW	2024			2025		
	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)
K1A		2,202	3,163	803,810	2,110	3,597	770,153
K2A		1,606	2,162	586,043	674	1,968	246,030
K4B		0	0	0	0	0	0
K4C		1,976	5,170	721,334	791	3,111	288,755
K5A		867	2,705	316,394	446	1,353	162,861
K8		613	1,692	223,772	406	1,849	148,044
Total Combined	37,361	7,264	14,648	2,651,353	4,427	7,759	1,615,843

Condition 3.3 of the PTTW specifies that the combined water taking from the well field shall not exceed an annual daily average of 17,626 m³/day. As shown in Table 2, this requirement was met in both 2024 and 2025.

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

The pumping volumes are presented in Appendix C as total monthly volumes. Pumping volumes from the well field ranged from 97,761 m³/month to 283,992 m³/month in 2024, and from 79,501 m³/month to 218,509 m³/month in 2025. In total, 2,651,353 m³ was produced at this well field in 2024 and 1,615,843 m³ was produced in 2025. The 2024 volumes are within the range of pumping volumes for 2020, 2021 and 2022 and below the permitted volume of 13,636,692 m³ per year (Table C-1). Annual volumes in 2024 and 2025 are lower than historical volumes due to wells and water treatment plant going offline for repairs.

2.1.2 Monitoring Wells

As per the PTTW, water level monitoring is completed at the following monitoring wells: K-GB-BH1-90-A, K-GB-BH1-90-B, K-GB-M4-94-A, K-GB-M4-94-B, K-GB-GB1-96-A,

K-GB-GB1-96-B, K-GB-GB1-96-C, K-GB-GB1-97-A, K-GB-GB1-97-B, K-GB-OW1-08-A, K-GB-OW1-08-B, K-GB-OW2-08-A, K-GB-OW2-08-B and K-GB-OW1-15-A (Figure 3).

Construction and location details for the monitoring wells are described in Table 3 below. Well records for the monitoring wells are provided in Appendix B.

Table 3: Monitoring Well Construction Details

Monitoring Well ID	Year Built	Screened Depth (mbgs)	Screened Formation	Distance to Closest Pumping Well (Well)
K-GB-BH1-90-A	1990	19.8 – 23.3	ATB3	116 m (K5A)
K-GB-BH1-90-B		3.3 – 4.6	AFB2	
K-GB-GB1-96-A	1996	57.1 – 59.9	AFF1/ATG1	178 m (K1A) 197 m (K2A)
K-GB-GB1-96-B		51.2 – 54.4	AFD1	
K-GB-GB1-96-C		9.9 – 12.9	AFB2	
K-GB-GB1-97-A	1997	38.6 – 41.8	AFD1	10 m (K5A)
K-GB-GB1-97-B		1.1 – 4.3	AFB2	
K-GB-OW1-08-A	2008	44.2 – 47.3	AFD1	6 m (K1A)
K-GB-OW1-08-B		36.6 – 38.1	AFD1	
K-GB-OW2-08-A	2008	48.2 – 51.2	AFD1	6 m (K2A)
K-GB-OW2-08-B		37.5 – 39.0	AFD1	
K-GB-M4-94-A	1994	60.9 – 64.0	AFD1	1302 m (K2A)
K-GB-M4-94-B		50.3 – 53.6	ATC1/AFC1/ATC2	
K-GB-OW1-15-A	2015	32.6 – 35.87	AFD1	26 m (K4C)

2.2 Regional Geology

The following sections provide a brief overview of the regional geology and hydrogeology of the Greenbrook Well Field. The surficial geology based on regional OGS mapping is provided in Figure 4. The Greenbrook Well Field is located in the core of the Waterloo Moraine (Figure 5). Representative cross-sections showing the stratigraphy in the vicinity of the Greenbrook Well Field are included as Figures 6 and 7. The cross-section locations are provided on Figure 3.

The cross-sections are provided as a visual aid and do not necessarily contain all wells in the monitoring program for the Greenbrook Well Field. The recently completed Tier Three Assessment Update Project (Aqua Insight et al, 2023) has revised the previous (Matrix 2015) stratigraphic interpretation of the lithology around the Greenbrook Well Field. The lithological layers were updated in accordance with documentation provided in the Numerical Model Surface Transfer memorandum (Aqua Insight Inc, 2026).

Refinements (Aqua Insight et al, 2023) along cross-section A-A" (Figure 6) include the following:

- The ATB1 unit was subdivided into ATA1, AFA1, and ATB1. ATA1 and AFA1 represent surficial units, with ATA1 interpreted as Whittlesey Clay and AFA1 interpreted as Whittlesey sand deposits;
- There were minimal changes to the thickness of ATB1 and AFB1. However, the thickness of AFB1 decreased in the area between K-GB-GB1-96-ABC and Stirling Avenue;
- Between Homer Watson Parkway and Conestoga Parkway, AFA1 and AFB1 were largely replaced by ATB2. The thickness of ATB2 decreased near K2A but increased in the area between K-GB-GB1-96-ABC and K-GB-BMW121-92-ABCD;
- The thickness of AFB2 increased in the area south of McClennan Park (former Kitchener Landfill). In contrast, there were minimal to no changes in the area immediately surrounding the Greenbrook production wells, except for localized thickness increases near K-GB-GB1-96-ABC and decreases near K-GB-BMW121-ABCD;
- AFB3 is absent within the wellfield area; and
- ATB3 thickens toward the northeast, while ATC1 correspondingly thins in that direction.

Refinements along cross-section B to B' (Figure 7) include the following:

- An updated DEM provides improved delineation of the former Kitchener Landfill in the south/southeast compared to the DEM used in the previous study;
- The ATB1 unit has been subdivided into ATA1, AFA1, and ATB1. ATA1 and AFA1 represent surficial units, with ATA1 interpreted as Whittlesey Clay and AFA1 interpreted as Whittlesey sand deposits;

- In the southwest portion of the cross-section, ATB2 is interpreted to be present, resulting in a corresponding thinning of AFB1;
- The thickness of AFB2 increases in the area extending from Greenbrook Drive to well K-GB-GB1-97-AB;
- ATB3 is thin to absent immediately northwest of Wells K1A / K2A and near K-GB-OWM3-94 (not shown on the cross-section); and
- Hydrostratigraphic surfaces have been smoothed overall particularly near Wells K1A / K2A, and near K-GB-BMW201-92.

2.2.1 Surficial Geology and Conceptual Hydrostratigraphy

The surficial geology of the area has been mapped and described by the Ontario Geological Survey (2003) and updated in Bajc and Shirota (2007). The surficial geology in the area of the Greenbrook Well Field consists of ice contact sand and gravel, silty to sandy till sediments and silty to clayey till sediments (Figure 4).

The lithologic units typically present within the Waterloo Moraine are briefly described below, in order from youngest to oldest.

Aquitard ATB1

Aquitard ATB1 consists of low permeability, spatially discontinuous, surficial till units found predominantly along the flanks of the Waterloo Moraine. Along the western flank of the Moraine, Aquitard ATB1 corresponds to the Mornington, Stratford and Tavistock Tills; whereas along the eastern flank of the Moraine this unit corresponds to the Upper Maryhill and Port Stanley Tills (Bajc and Shirota, 2007).

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

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

Aquitard ATB3 – Lower Maryhill Till

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

Aquitard ATC1 / ATC2 – Catfish Creek Till

The Catfish Creek Till was deposited by a major glacial advance from the north to northeast that covered all of southern Ontario. It is a dense, stony, sandy silt to silty sand till with little clay content. The hydrogeologic properties of the Catfish Creek Till are variable, ranging from a good aquitard to a poor aquifer, depending on local lithology, degree of compaction, and the presence of overlying aquitard units. The Catfish Creek Till is typically thickest in the core area of the Waterloo Moraine, and thin or absent along the eastern flank.

Aquifer AFD1 – Pre-Catfish Creek Sand and Gravel

Pre-Catfish Creek Till aquifer corresponds to sands and gravels re-worked from Catfish Creek and Pre-Catfish Creek Till and represents the main supply aquifer in several production wells in the Cities of Kitchener and Waterloo, including the Greenbrook Well Field. This unit is spatially discontinuous throughout much of the core areas of the Waterloo Moraine and pinches out beneath Alder Creek.

Aquitard ATE1 – Canning Drift

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

Aquifer AFF1 – Pre-Canning Till

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

2.2.2 Bedrock Geology

The Paleozoic bedrock in the area consists of the Salina and Guelph Formations.

2.3 Local Geology

The Greenbrook Well Field was included as part of the Tier 3 Water Budget and Local Area Risk Assessment study which was undertaken by the Region. As a result, there was additional refinement of the hydrostratigraphic model proposed by the OGS. The following is a summary of the hydrostratigraphic interpretation of the well field presented in the Tier 3 Study (Stantec, 2012). Borehole logs of the Greenbrook Well Field are included in Appendix B.

Upper Waterloo Moraine (AFB2) – This unit was interpreted to be continuous in the Greenbrook area. The aquifer unit is identified as a surficial aquifer consisting of fine to coarse sand, with silty sand and sand and silt. AFB2 ranges in thickness from 5 m to 30 m, with an average thickness of about 10 m. The updates to the lithological layers (Aqua Insight Inc. et al, 2023) did not result in any significant changes to AFB2 in the area near the production wells. AFB3 which was previously interpreted to be present in the area is now considered to be absent (Aqua Insight Inc. et al, 2023).

Lower Maryhill Till (ATB3) – This unit is one of the most significant aquitard units in the Region, physically separating Aquifer AFB1 / AFB2 from Aquifer AFB3. ATB3 consists of the lower Maryhill Till and equivalents, and was interpreted to be generally continuous in the Greenfield Well Field area with a thickness ranging from 5 m to 25 m, and an average thickness of 8 m. The Tier 3 Update resulted in ATB3 being thickened approximately 3 m to 4 m east of the production wells towards Highland Road (Figure 6). There were several identified areas where ATB3 was found to be thin or absent with a pinch out identified at K-GB-BMW213-94A (Aqua Insight Inc. et al, 2023), possibly allowing for windows or leakage into the lower aquifer systems. ATB3 varies from clayey silt to silty clay till and was found at elevations between 295 masl to 320 masl.

Catfish Creek Till (ATC1 / AFC1 / ATC2) – This unit is interpreted to be continuous in the area of the Greenbrook Well Field; with thicknesses typically ranging from 5 m to 25 m. It is typically defined as a sandy silt till; however, in areas it is described as silt or clay and is commonly referred to as “Hard Pan” in MECP Water Well Records (WWR). When paired with ATB3 acts to provide an effective confining layer above the municipal supply aquifer AFD1. Near the Greenbrook production wells, ATC1 is observed to be vertically extensive, reaching thicknesses up to 25 m and averaging 10 m. ATC2 was identified within several boreholes surrounding the Greenbrook production wells. Where present this unit is typically thin, averaging only 3 m in thickness. It was identified based on the presence of AFC1, the aquifer unit that separates ATC1 from ATC2. When AFC1 was not present, the entire Catfish Creek Till unit was identified as ATC1. Combined, ATC1 and ATC2 are generally vertically extensive units, being at least 10 m thick.

Pre-Catfish Creek Sand and Gravel (AFD1) - This unit is the municipal supply aquifer for the Greenbrook Well Field. The production wells are completed in AFD1 at depths between 31.6 and 50 m below ground (291.2 to 278.4 masl). AFD1 consists of

Pre-Catfish sand and gravel material and is interpreted to be generally continuous in the Greenbrook Well Field area typically occurring at elevations of 275 masl to 295 masl. It is described as anything from a silty sand to a gravel; however, near the production wells the aquifer composition is predominantly gravel or gravelly sand. Continuous coring near Production Wells K1A and K2A indicate a general coarsening of aquifer material with depth, starting as a silty sand and transitioning to medium to coarse sand and gravel and gravel at depths where the production wells are screened. The vertical extent of this unit varies, ranging from 5 m to 25 m, with an average thickness of 15 m. Recent Tier 3 work (Aqua Insight Inc. et al, 2023) has resulted in the thickness of AFD1 being increased by about 2 m near Lakeside Park (Figure 6) and 3 to 5 m along Highway 7/8 (Figure 7).

Canning Drift (ATE1) – This unit is interpreted to be thin (average of 5 m) and continuous in the Greenbrook Well Field. ATE1 physically separates AFD1 from AFF1; however, it likely does not provide effective hydraulic separation between these two aquifer units, as wells screened within AFF1 tend to respond to pumping in AFD1. ATE1 was described as a dense clay or silty clay till unit in the area of the Greenbrook Well Field. It is generally found at elevations between 270 masl and 290 masl.

Pre-Catfish Creek Till (ATG1) – This unit is described as stony to silty sand till and is typically found between 255 masl to 275 masl. It is a thin unit, ranging in thickness from 1 m to 15 m, but typically averaging less than 5 m. This unit was identified in boreholes near the production wells. It is not considered to be a significant unit. When present, it was found to directly overlie bedrock and was identified as a stony to silty gravel.

Pre-Canning Till (AFF1) – this unit consists of a thin (<10 m thickness) sand and silt layer of coarse textured glaciofluvial / glaciolacustrine deposits. When present, AFF1 is typically found to exist between 270 masl and 290 masl. AFF1 was found to be discontinuous throughout the Greenbrook Well Field and was identified in less than half of the investigated borehole logs.

3.0 2024 / 2025 Results

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

3.1 Precipitation

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

Since variations in precipitation totals can occur throughout the Region due to localized events, monthly precipitation data from the University of Waterloo (U of W) and Environment Canada station located closest to the production wells are used. The closest weather station relative to the Greenbrook Well Field is the U of W station located 6.7 km from the well field. The closest Environment Canada station is Roseville located about 8.3 km 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 University of Waterloo station are shown on Figure D.1, Appendix D. At the U of W station, the long-term average was calculated from 1998 until the end of 2025. The Roseville station has “Climate Normals” calculated by Environment Canada for 1981 to 2010.

Annual 2024 / 2025 precipitation data for the U of W and Environment Canada meteorological stations closest to the Greenbrook Well Field are presented in Table 4 below. In 2024, Roseville was missing 5 days of data and 20 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)
University of Waterloo ⁽²⁾	763	-108	871 ^(B)	943	+72
Roseville Station ⁽¹⁾	856	-63	919 ^(A)	786	-133
Sources: Environment Canada (1), University of Waterloo (2) ^A 1981 to 2010 Normal ^B 1998-2025 data					

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 the U of W station was 763 mm, which is 108 mm below the long-term average, indicating 2024 was drier-than-average at the well field. A similar below long-term average trend is noted at the Roseville station. On March 1, 2024, the GRCA snow survey indicated a snowpack across the Region that was also low compared to normal. In 2025, the total precipitation at U of W was 943 mm, which is 72 mm above the long-term average. In 2025, the total precipitation at the Roseville station was 133 mm below the long-term average, indicating 2025 was a

drier-than-average year. However, Roseville was missing 20 days of data in 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

In accordance with Condition 4.2 of the PTTW, water levels were measured and recorded once per month at the monitoring wells listed in Table 3. 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.

K-GB-BH1-90-AB

Monitoring well nest K-GB-BH1-90-AB is located approximately 120 m northeast of K5A and about 260 m northwest of K4C. Screen A is located in the till aquitard (ATB1). Screen B is located in Aquifer 1 (AFB2). Water level monitoring at the A and B screens was completed using monthly manual measurements.

The 2024 and 2025 water levels in Screen A are within historical ranges. Water levels in Screen A are impacted by pumping with historical drawdowns of up to 4 m occurring. Water levels rise / fall about 2.1 m after June 2025 when pumping at K4C is decreased / increased. Water levels do not show any long-term impacts from pumping.

Water levels in the B screen are also within historical ranges in 2024 and 2025. In the B screen, changes in water levels are within a 2.0 m range showing a seasonal trend. A gradual increase in water levels of about 1 m is observed after May 2025 in response to decreased pumping at the well field. Water levels in the B screen are stable and do not show any long-term impact from pumping.

K-GB-M4-94-AB

Monitoring wells K-GB-M4-94-AB are located 1.3 km west of K2A and water levels are collected using monthly manually measurements in the A screen and electronically using an automatic water level recorder in the B screen. Screen A is located in AFD1 and Screen B is located in the Catfish Creek Till unit ATC1 / AFC1 / ATC2 about 10 m above the A screen.

The 2024 and 2025 water levels in Screens A and B are within historical ranges. Screen A water levels fluctuate within a 2 m range in response to pumping. From 2016 to the end of 2025 water levels range from 321.9 masl to 326 masl with no long-term decreasing trend observed. Screen B water level trends are similar to Screen A with fluctuations of up to 2 m in response to variations in pumping. Water levels range from

322.5 masl to 326.6 masl from 2016 to the end of 2025. Water levels in both screens decline about 3 m from February to May 2025 in response to increased pumping. Levels then rise about 2.3 m when pumping is reduced.

K-GB-GB1-96-ABC

Monitoring well nest K-GB-GB1-96-ABC is located about 180 m southeast of K1A and 200 m east of K2A and water levels are collected using monthly manual measurements. Screen A is located in the till aquitard ATE1 about 10 m below the production wells, Screen B is located in AFD1 at a similar interval to the production wells and Screen C is located in AFB2. Water levels in all three screens respond to pumping and the 2024 and 2025 water levels in Screens A, B and C are within historical ranges. Water levels vary by up to 6 m in the B screen and by up to 3 m in the A screen due to monthly changes in production volume at K2A. At the C screen water level responses are more subdued within 1 m variations. 2024 / 2025 water levels in all three screens are consistent with water levels seen during the past 10 years. Water levels in all screens decline from February to May 2025 in response to increased pumping. Levels then rise when pumping is reduced.

K-GB-GB1-97-AB

Monitoring well nest K-GB-GB1-97-AB is located 10 m east of K5A with Screen A located in AFD1 and Screen B located in AFB2. Water levels are monitored with monthly manual measurements. The 2024 and 2025 water levels in Screens A and B are within historical ranges.

At Screen A, water levels fluctuate up to 11 m in response to variations in pumping at K5A. In 2024, the water levels rose above the top of pipe when pumping at K5A ceased. Water levels in both screens declined about 6 m from February to May 2025 in response to increased pumping. Levels then rose about 7 m when pumping was reduced. Screen B does not respond to pumping. Seasonal variations in water levels are observed in Screen B with peak water levels occurring in the spring and lowest annual water levels occurring in late summer / fall.

K-GB-OW1-08-AB

Monitoring well nest K-GB-OW1-08-AB is located adjacent to K1A and monitors groundwater levels in AFD1. Water level monitoring at the A and B screens was completed using monthly manual measurements. Water levels in both screens have similar patterns with levels historically varying by up to 8 m in response to changes in pumping volumes. 2024 / 2025 water levels in both screens are consistent with water levels seen during the past 10 years. Water levels in both screens decline from February to May 2025 in response to increased pumping. Levels then rise for the rest of the year when pumping is reduced.

K-GB-OW2-08-AB

Monitoring well nest K-GB-OW2-08-AB is located adjacent to K2A and monitors levels in AFD1. Water level monitoring at the A and B screens was completed using monthly manual measurements. The 2024 and 2025 water levels in Screens A and B are within historical ranges. Water levels in the A and B screens follow a similar pattern to water levels in K-GB-OW1-08-AB, responding to changes in pumping at K1A, K2A and K4C. Levels from 2016 to the end of 2025 have varied between 312 masl and 324 masl. Water levels rise 4.5 m in May 2025 when K2A goes offline.

K-GB-OW1-15-A

Monitoring well K-GB-OW1-15-A, located adjacent to K4C is screened in AFD1 and water levels are collected with an electronic datalogger. During the monitoring period, water levels ranged from 308.5 masl to 322.6 masl with short term variations of up to 13 m in response to daily pumping at K4C. 2024 / 2025 water levels are within the historical range. Water levels quickly decline from February to May 2025 in response to increased pumping. Levels then rise rapidly and are then stable for the rest of the year when pumping is reduced.

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".

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 K1A, K2A, K4C, K5A and K8 received in 2024 and 2025.

Other groundwater takings registered in the MECP PTTW database near the well field are mapped on Figure 3 and summarized below in Table 5.

Table 5: PTTWs in Vicinity of Greenbrook Well Field

Permit Number	Permit Holder	Purpose	Max Liters per Day	Distance from Closest Supply Well	Expiry Date
5620-D6EKT6	Stonerise Construction Inc.	Dewatering	1,606,944	1.5 km (K4C)	07/14/2025
3304-D2TM69	City of Kitchener	Golf Course Irrigation	Pond – 1,300,000	2.0 km (K4C)	04/30/2034
1517-D8ZGUD	926 King Development Inc	Dewatering	Well 1 - 399,187 Well 2 - 1,056,118	>2 km	10/22/2025

All three of the PTTWs mapped on Figure 3 are at least 1.5 km away from the Greenbrook production wells. There is no evidence that the water takings associated with these other PTTWs have impacted water levels in the supply aquifer and / or the Greenbrook monitoring well locations.

4.1 Aquifer Response to Pumping and Precipitation

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

Monitoring wells screened in the supply aquifer (AFD1) as well as monitoring wells screened in formations immediately above (ATC1 / AFC1 / ATC2) and below the supply aquifer (ATE1, AFF1 / ATG1) show responses to pumping at the well field.

Significant groundwater taking has occurred in the Greenbrook Well Field area for over 80 years. Local homes and businesses were constructed within the area under the groundwater drawdown conditions that resulted from extended pumping for water

supply. Various monitoring wells have been monitored since at least 2000, and as a result, there is historical data that shows a significant rise in water levels in response to the well field shut down in August 2004. Water levels after May 2025 rapidly rise in response to the reduction in well field pumping. Overall water level trends do not show any significant impacts to the municipal aquifer because of municipal pumping at the Greenbrook Well Field.

Seasonal fluctuations in the AFB2 aquifer are observed at K-GB-GB1-97-B with the highest and lowest levels observed in spring and late summer / fall, respectively. The correlation of individual precipitation events with groundwater levels is difficult due to several reasons including but not limited to hydraulic conductivity, well depth, precipitation intensity and ground cover conditions.

5.0 Conclusions

Impacts from pumping the municipal wells at the Greenbrook Well Field (K1A, K2A, K4C, K5A, K8) 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 0071-BUKPU5;
- 2024 and 2025 pumping volumes were within the permitted range;
- There were no reported well interference complaints arising from water taking at the Greenbrook Well Field; and
- There are no long-term impacts to the municipal aquifer as a result of pumping at the Greenbrook Well Field.

6.0 References

Aqua Insight Inc., Technical Memorandum Numerical Model Surface Transfer, March 2026.

Aqua Insight Inc., et al. 2023. Hydrogeological Characterization and Conceptual Model Update Report, Region of Waterloo Tier Three Assessment Update Project, June 2023.

Aqua Insight Inc., Stantec Consulting Ltd, S.S. Papadopoulos and Associates Inc., 2024. Updates to the Moraine and Cambridge Model following Model Calibration Reporting, July 2024.

Bajc, A.F. and Shirota J., 2007. Three-dimensional mapping of surficial deposits in the Regional Municipality of Waterloo, southwestern Ontario; report in Ontario Geological Survey, Groundwater Resources Study 3, p. 42.

Matrix Solutions Inc., 2015. Technical Memorandum: Numerical Model Surfaces Data Transfer. Region of Waterloo, June 5, 2015.

R.J. Burnside & Associates Limited, 2020. Region of Waterloo 2018/2019 Biennial Groundwater Monitoring Report.

Stantec Consulting Ltd., 2012. Tier 3 Water Budget and Local Area Risk Assessment. Greenbrook Well Field Characterization Study.

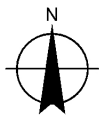
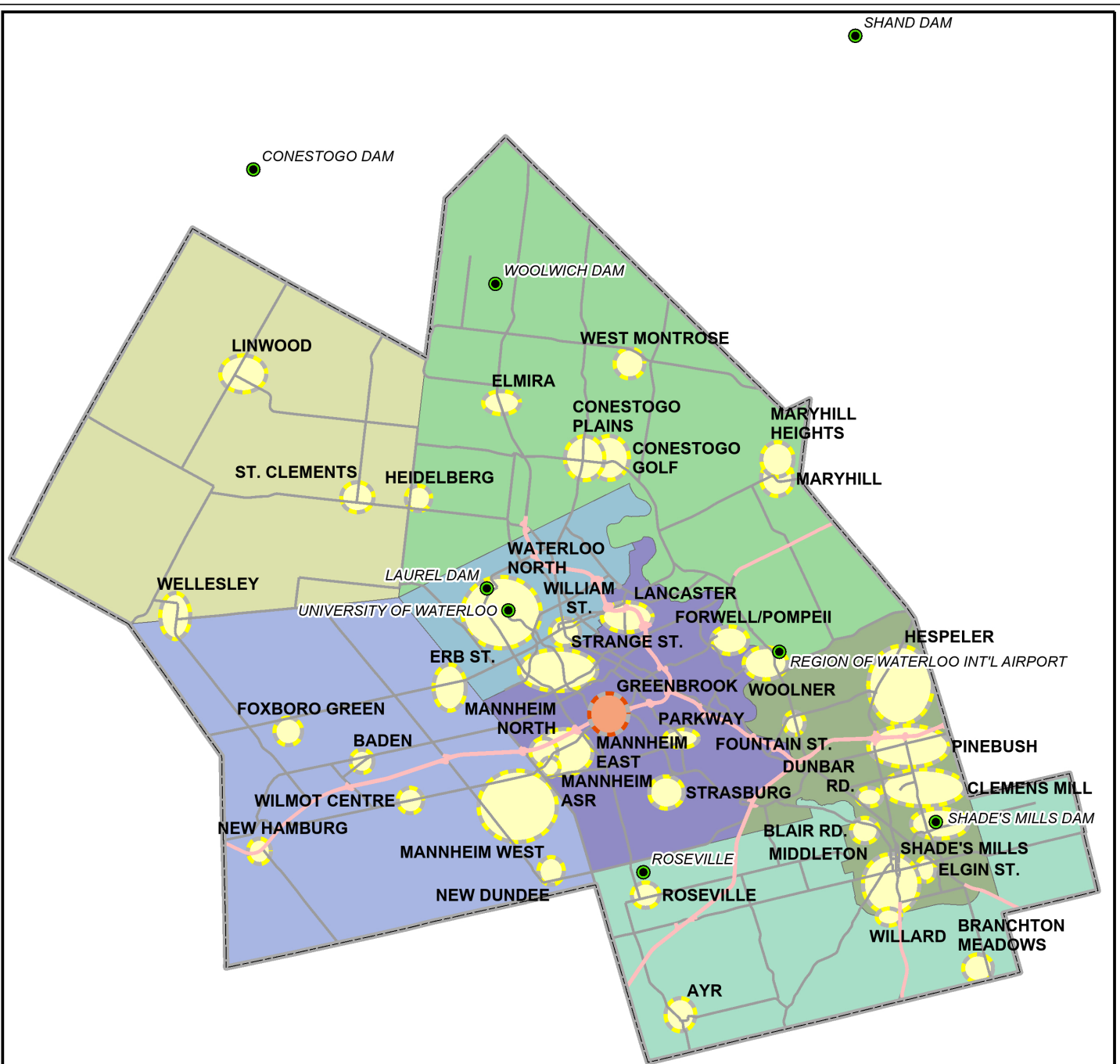


BURNSIDE

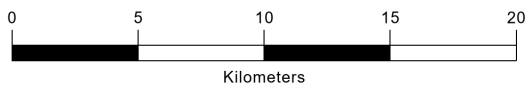
[THE DIFFERENCE IS OUR PEOPLE]



Figures



Data Source:
Region of Waterloo; Includes material © 2012 of the Queen's
Printer for Ontario. All rights reserved.



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



Map Title

2025 GROUNDWATER MONITORING REPORT - GREENBROOK WELL FIELD

WELL FIELD LOCATION MAP

Client

REGION OF WATERLOO

Drawn

HN

Scale

1:300,000

Checked

SQ

Date

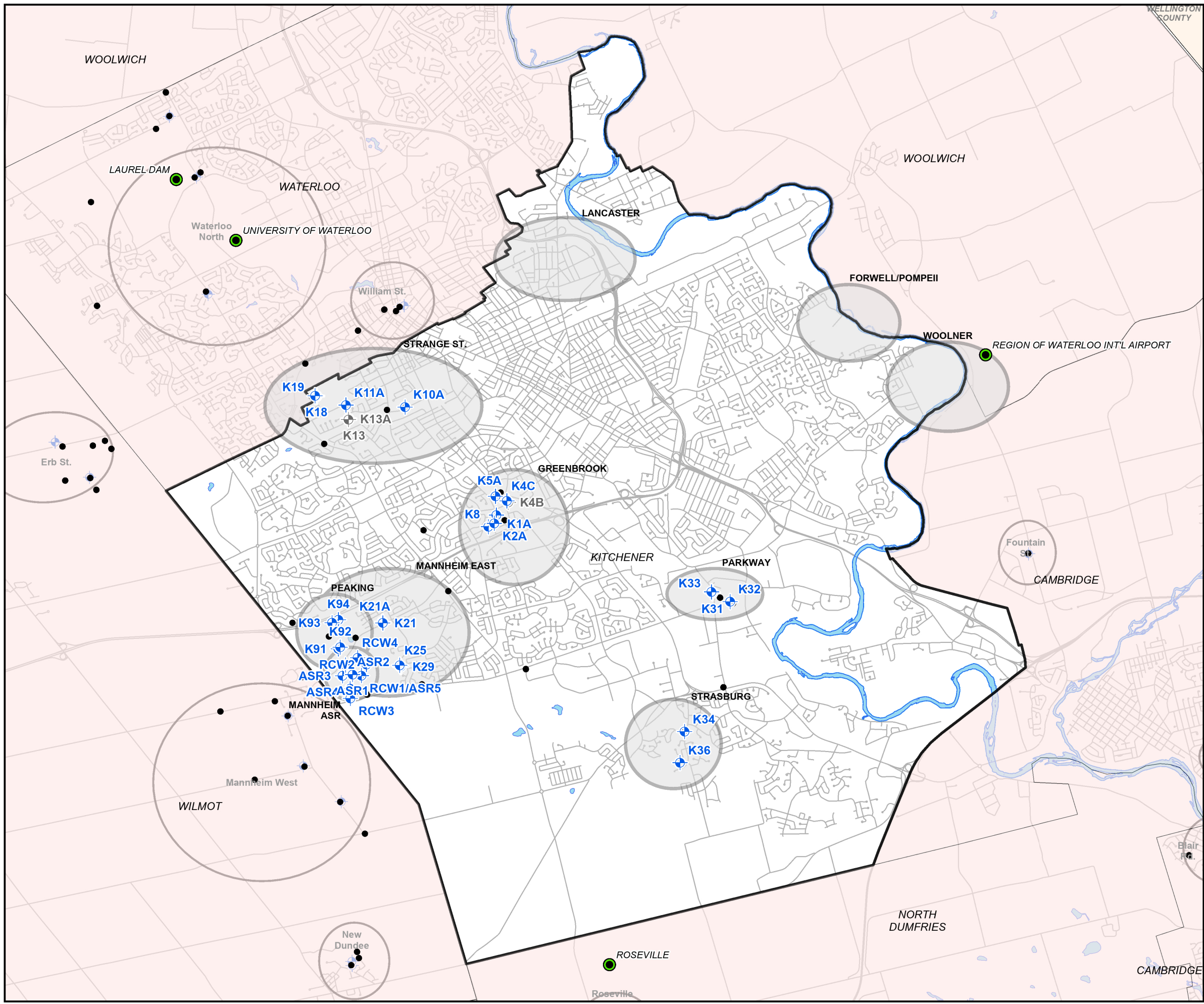
February 2026

Project No.

HA0464020

Figure No.

1



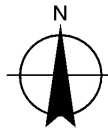
LEGEND

- Production Well Location
- Monitoring Well Location
- Decommissioned Production Well Location
- Kitchener Municipal Boundary
- Well Fields
- Meteorological Monitoring Locations

Sources:

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

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

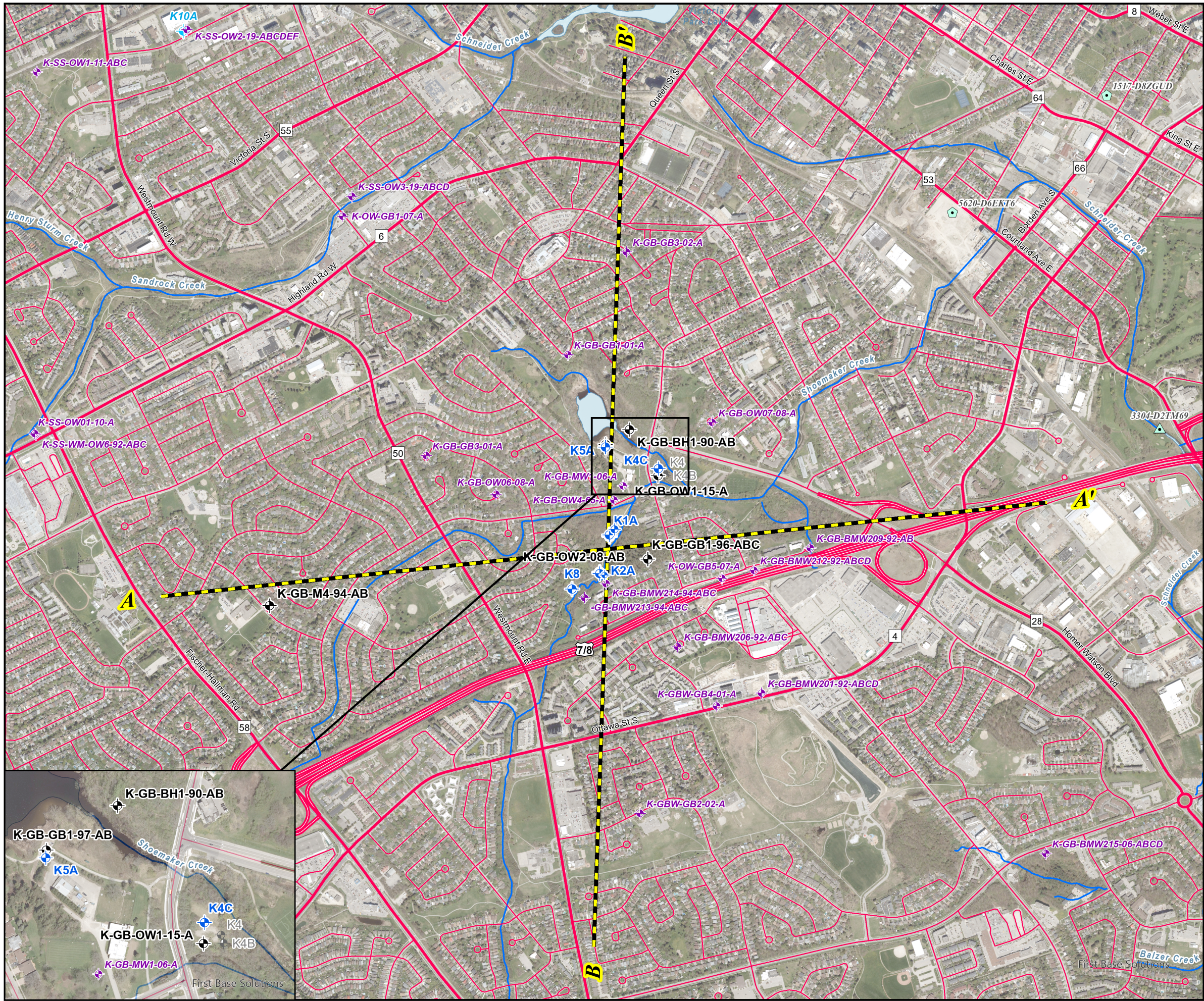


Client
REGION OF WATERLOO

Figure Title
**2025 GROUNDWATER MONITORING
REPORT - GREENBROOK WELL FIELD**
**KITCHENER WELL FIELDS AND
MONITORING NETWORK**

Drawn	Checked	Date	Figure No. 2
HN	SQ	March 2026	
Scale		Project No. HA0464020	

1:70,000

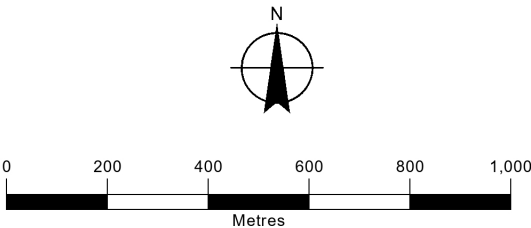


- Legend**
- PTTW Monitoring Well Location
 - Nearby Monitoring Well Location
 - Nearby Production Well Location
 - Decommissioned Production Well Location

- Additional MECP PTTW Locations**
- Groundwater
 - Surface Water
 - Cross Section Orientation
 - Provincial Highway
 - Municipal Roads
 - Local Roads
 - Stream: Permanent (OHN)
 - Waterbody: Permanent (OHN)

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



Client
REGION OF WATERLOO

Figure Title
**2025 GROUNDWATER MONITORING REPORT
GREENBROOK WELL PLAN AND CROSS SECTION LOCATIONS**

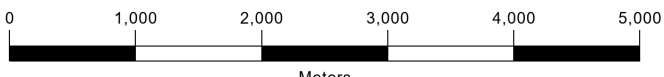
Drawn	Checked	Date	Figure No. 3
HN	SQ	March 2026	
Scale		Project No. HA0464020	

1:15,000



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

- | | | |
|---|---|--|
| <ul style="list-style-type: none"> RMOW Supply Well Watercourse Waterbody <p>Surficial Geology</p> <ul style="list-style-type: none"> 5b: Stone-poor, carbonate-derived silty to sandy till (ATA2/ATB1 - Aquitard) | <ul style="list-style-type: none"> 5d: Glaciolacustrine-derived silty to clayey till (ATB1 - Aquitard) 6: Ice-contact stratified deposits (AFB1 - Aquifer) 7a: Glaciofluvial deposits: Sandy deposits (AFA2 - Aquifer) | <ul style="list-style-type: none"> 7b: Glaciofluvial deposits: Gravelly deposits (AFA2 - Aquifer) 8a: Fine-textured glaciolacustrine deposits: Massive-well laminated (ATA1) 19: Modern alluvial deposits |
|---|---|--|



- 20: Organic deposits
- Sand and Gravel Pit
- Ice-Contact Slope
- Terrace
- Sample Location
- Hummocky Topography
- Unit Contact
- Boundary



Map Title
**2025 GROUNDWATER MONITORING
 REPORT - GREENBROOK WELL FIELD**

SURFICIAL GEOLOGY

Client

REGION OF WATERLOO

Drawn

HN

Scale

1:60,000

Checked

SQ

Date

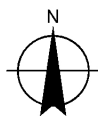
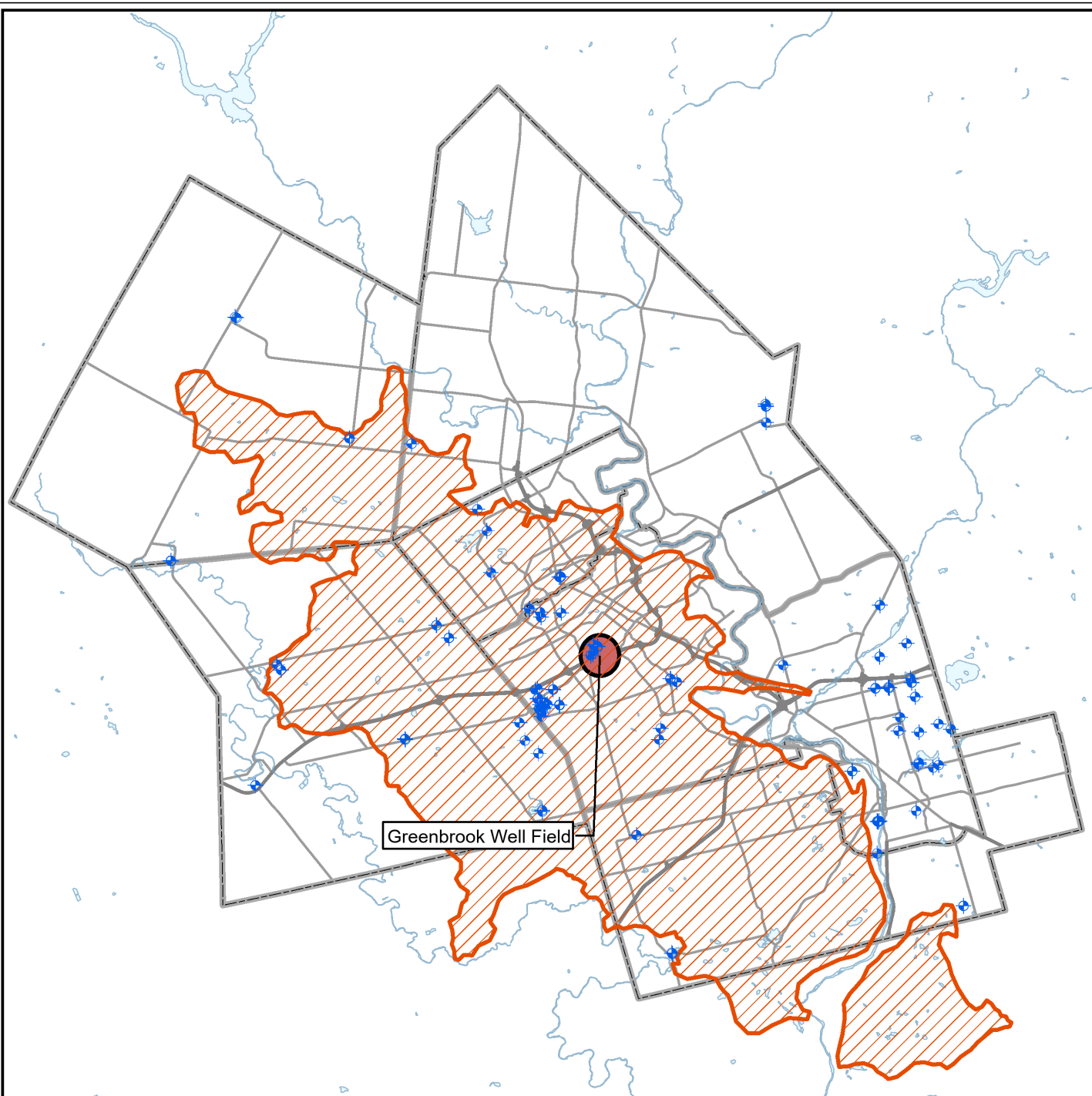
February 2026

Project No.

HA0464020

Figure No.

4



Data Source:
 1. Andy F. Bajc, Hazen A.J. Russell and David R. Sharpe (2014) A three-dimensional hydrostratigraphic model of the Waterloo Moraine area, Southern Ontario, Canada, Canadian Water Resources Journal / Revue canadienne des ressources hydriques, 39:2, 95-119
 2. Region of Waterloo; Includes material © 2019 of the Queen's Printer for Ontario. All rights reserved.



- RMOW Supply Well
- Waterloo Moraine (2014)
- Greenbrook Well Field
- Waterbody
- Regional Municipal Boundaries



Map Title

2025 GROUNDWATER MONITORING REPORT - GREENBROOK WELL FIELD

LOCATION OF THE WATERLOO MORaine

Client

REGION OF WATERLOO

Drawn

HN

Scale

1:300,000

Checked

SQ

Date

March 2026

Project No.

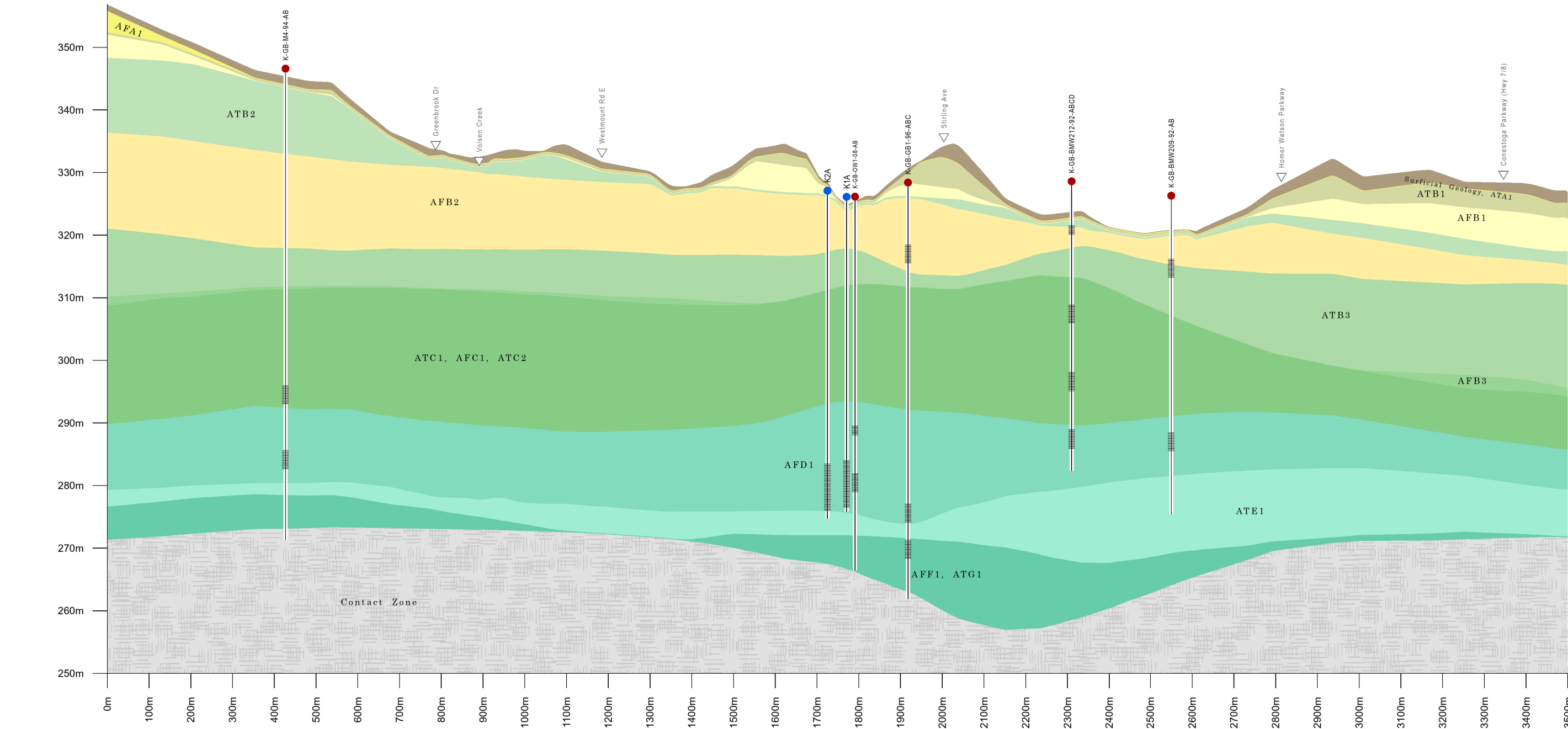
HA0464020

Figure No.

5

A

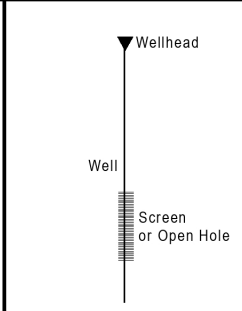
A'



Wells
● Production Well (Active) ● Monitoring Well

Moraine Model 2026

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

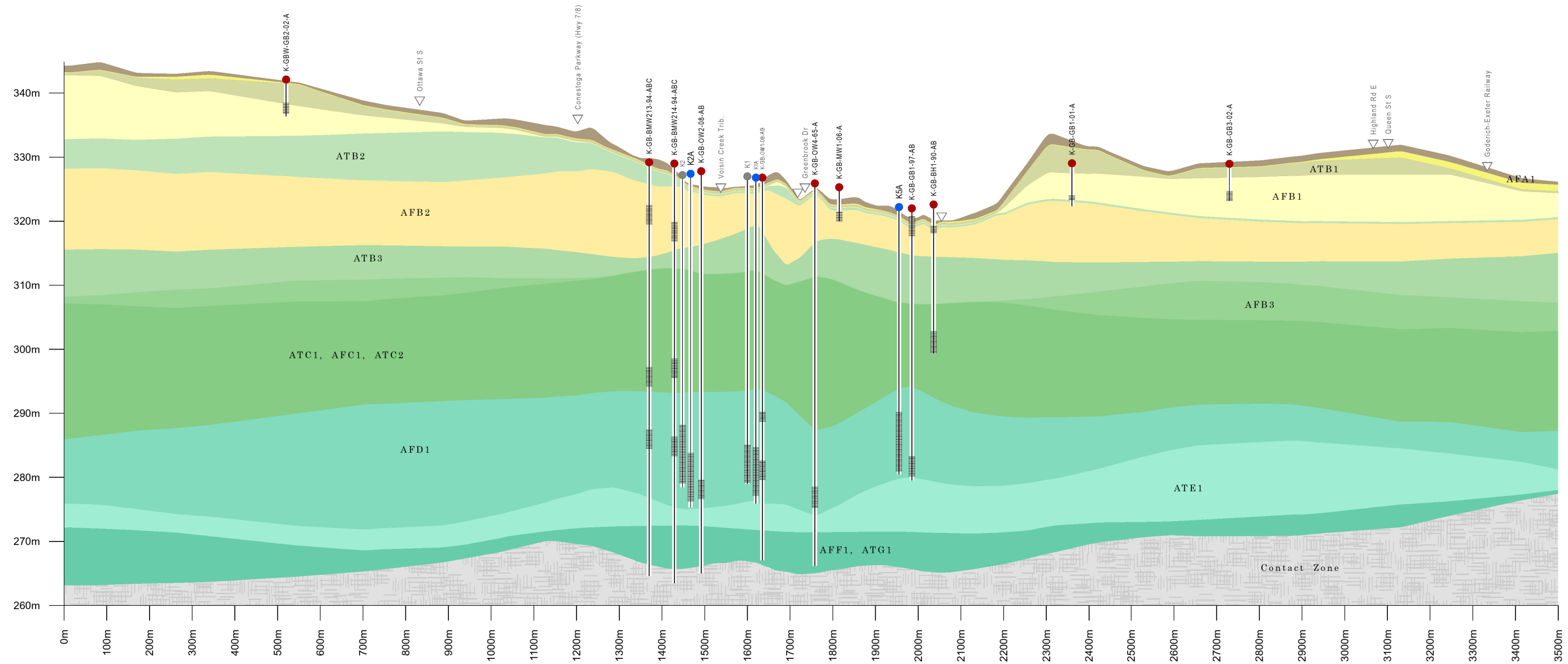


Client
REGION OF WATERLOO

Figure Title				Figure No. 6
GEOLOGIC CROSS SECTION REGION OF WATERLOO Greenbrook Cross Section A - A'				
Drawn	Checked	Date		
PS	DH	2026/06/01		
Horizontal Scale 1:10,000		Project No.		
Vertical Ex.:15x		HA046402		

B

B'

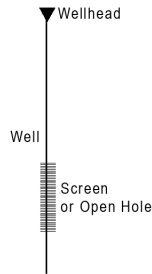


Wells

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

Moraine Model 2026

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



Client

REGION OF WATERLOO

Figure Title

**GEOLOGIC CROSS SECTION
REGION OF WATERLOO**

Greenbrook
Cross Section B - B'

Drawn	Checked	Date	Figure No.
PS	DH	2026/06/01	
Horizontal Scale 1:10,000		Project No.	
Vertical Ex.:15x		HA046402	7



BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

Permit To Take Water

PERMIT TO TAKE WATER

Ground Water
NUMBER 0071-BUKPU5

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

For the water taking from: Greenbrook Well Field (K1A, K2A, K4B, K4C, K5A, and K8)

Located at: Lot 19, Concession GERMAN COMPANY TRACT, Geographic Township of Waterloo
Kitchener, Regional Municipality of Waterloo

Lot 19, Concession GERMAN COMPANY TRACT, Geographic Township of Waterloo
Kitchener, 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. 0071-BUKPU5 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 **September 30, 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	K1A, K2A K4B K4C K5A K8	Well Drilled	Municipal	Water Supply	25,945	24	37,360,800	365	17 540584 4808459
						Total Taking:	37,360,800		

- 3.3 Notwithstanding the Maximum Taken per Day specified in Table A of Condition 3.2, the combined taking from wells K1A, K2A, K4B, K4C, K5A, and K8 shall not exceed an annual daily average of 17,625,600 L/day.

4. Monitoring

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

- K-GB-BH1-90-A
- K-GB-BH1-90-B
- K-GB-M4-94-A
- K-GB-M4-94-B
- K-GB-GB1-96-A
- K-GB-GB1-96-B
- K-GB-GB1-96-C
- K-GB-GB1-97-A
- K-GB-GB1-97-B
- K-GB-OW1-08-A
- K-GB-OW1-08-B
- K-GB-OW2-08-A

- K-GB-OW2-08-B
- K-GB-OW1-15-A

- 4.3 The Permit Holder shall prepare and submit a report every two years by June 30 commencing June 30, 2020, that presents the results of the wellfield water level monitoring for the two preceding calendar years, assesses changes in water levels in the supply aquifers in relation to precipitation and the water taking from the aquifers, and provides a summary of all interference complaints received by the Permit Holder related to this Permit and reported in the District Office in accordance with Condition 5.1 and the manner in which the Region has dealt with the complaint.

5. Impacts of the Water Taking

5.1 Notification

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

5.2 For Groundwater Takings

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

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

6. Director May Amend Permit

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

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

1. Condition 1 is included to ensure that the conditions in this Permit are complied with and can be enforced.
2. Condition 2 is included to clarify the legal interpretation of aspects of this Permit.
3. Conditions 3 through 6 are included to protect the quality of the natural environment so as to safeguard the ecosystem and human health and foster efficient use and conservation of waters. These conditions allow for the beneficial use of waters while ensuring the fair sharing, conservation and sustainable use of the waters of Ontario. The conditions also specify the water takings that are authorized by this Permit and the scope of this Permit.

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

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

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

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

This notice must be served upon:

*The Secretary
Environmental Review Tribunal
655 Bay Street, 15th Floor
Toronto ON
M5G 1E5
Fax: (416) 326-5370
Email: ERTTribunalsecretary@ontario.ca*

AND

*The Director, Section 34.1,
Ministry of the Environment, Conservation
and Parks
Floor 1, 135 St Clair Ave W
Toronto, ON
M4V 1P5*

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

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

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

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

This Permit cancels and replaces Permit Number 7562-AUWPKG, issued on 2018/01/11.

Dated at Toronto this 20th day of October, 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 0071-BUKPU5, dated October 20, 2020.

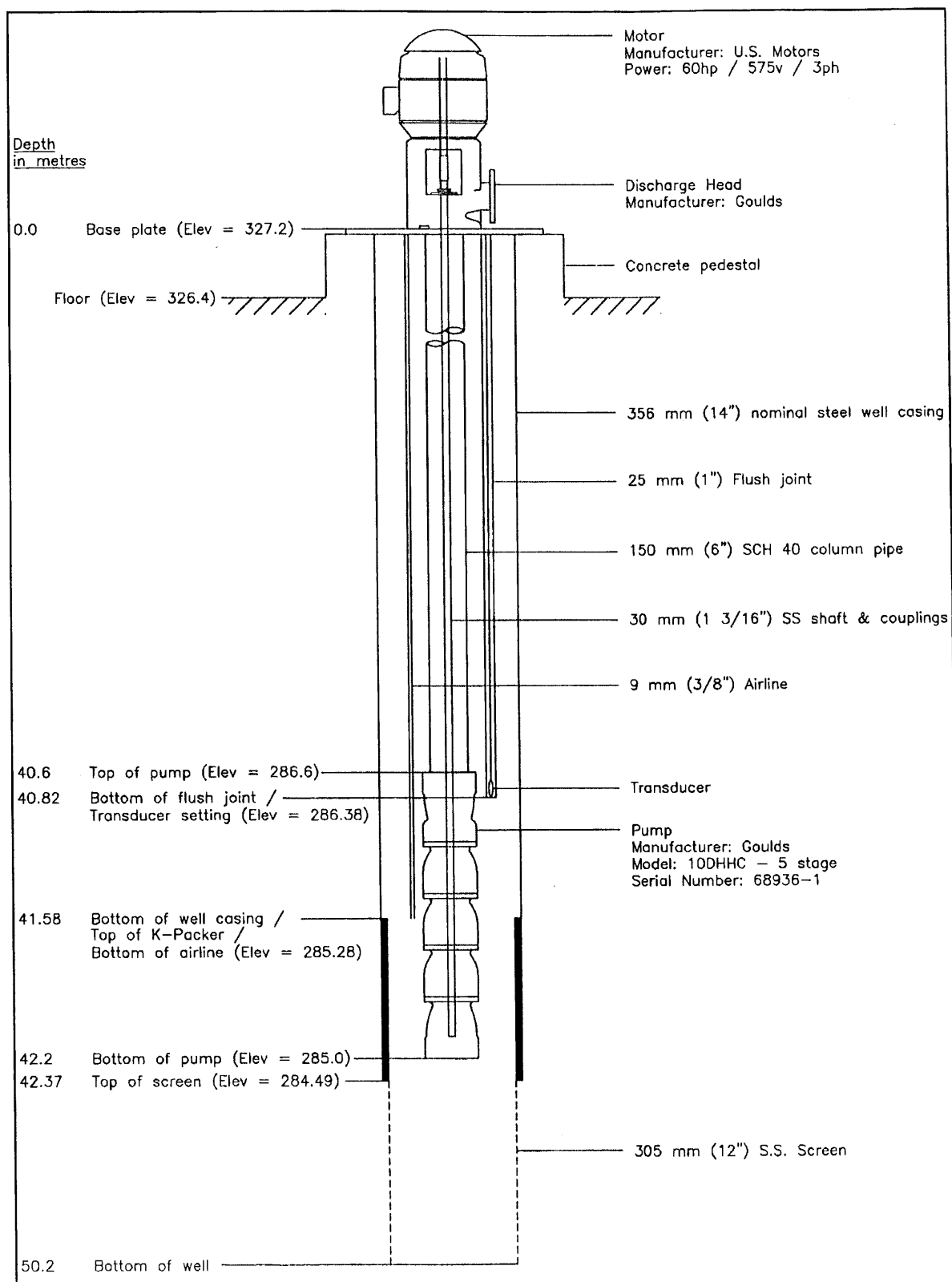


BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

Well Records



NOTES



CLIENT

Regional Municipality of Waterloo

TITLE

Well K1A
Pump Installation Details

PROJECT No. 006-238

G:\Lotwater Projects\006 Region of Waterloo\238 K1A & K2A Pumphouse\Wellshaft Pump Install.dwg

DESIGN

DRAWN

CHECKED

BN

2013/03/14

REVISION No. 2013/03/14

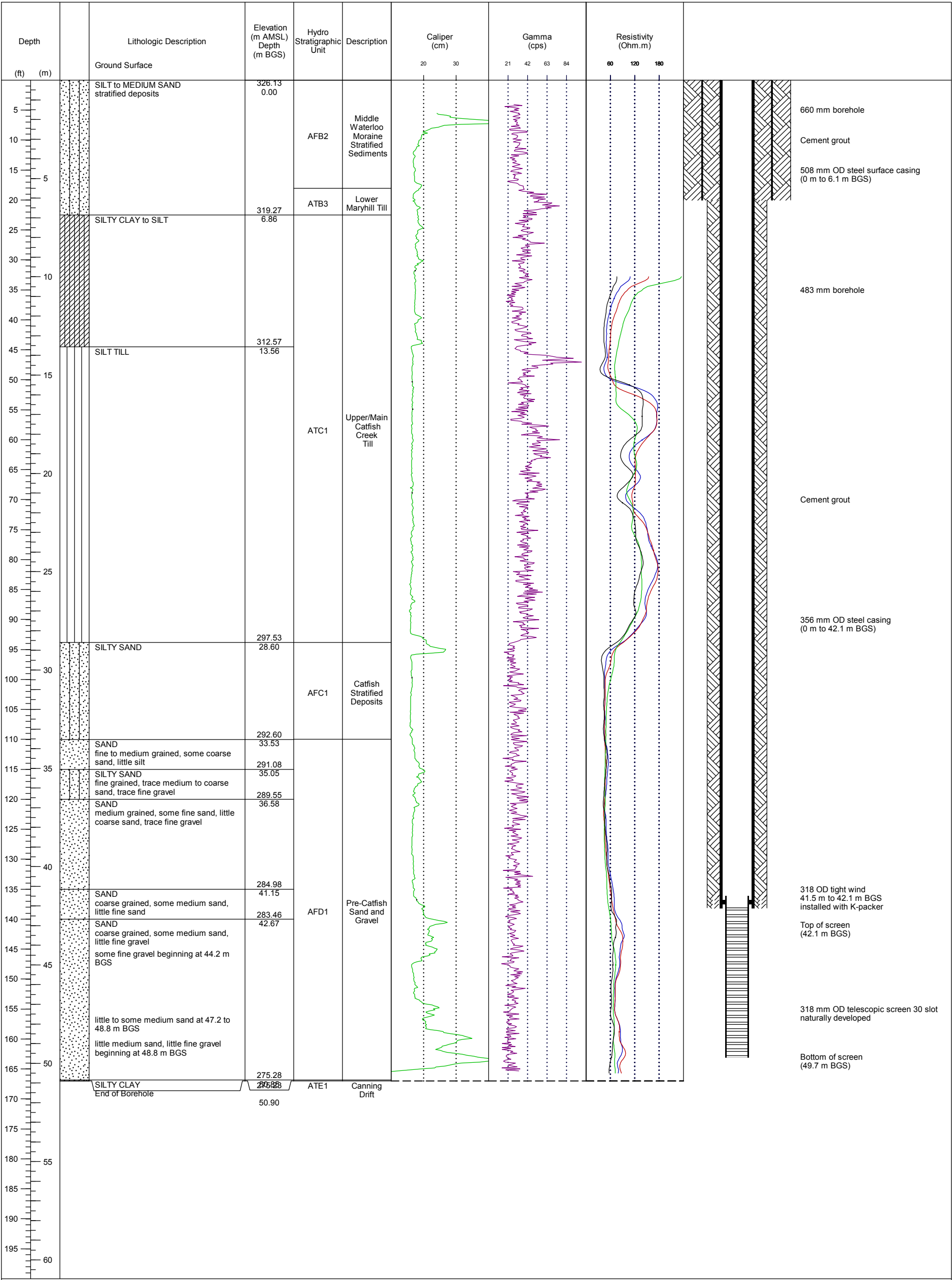
SCALE N.T.S.

FIGURE
1

Production Well: K1A

Project: K1 and K2 Replacement
Client: Region of Waterloo
Location: Greenbrook Well Field
Number: 1609-00487
Field investigator: K.McLagan/L.Veale
Contractor: Davidson Drilling Ltd.

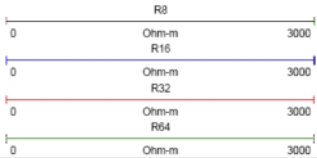
Drilling method: Truck Mount Mud Rotary
Date started/completed: Feb-26-2009 / Apr-3-2009
Ground surface elevation: 326.13 m AMSL
Top of casing elevation: 326.86 m AMSL
Easting: 540584
Northing: 4808458

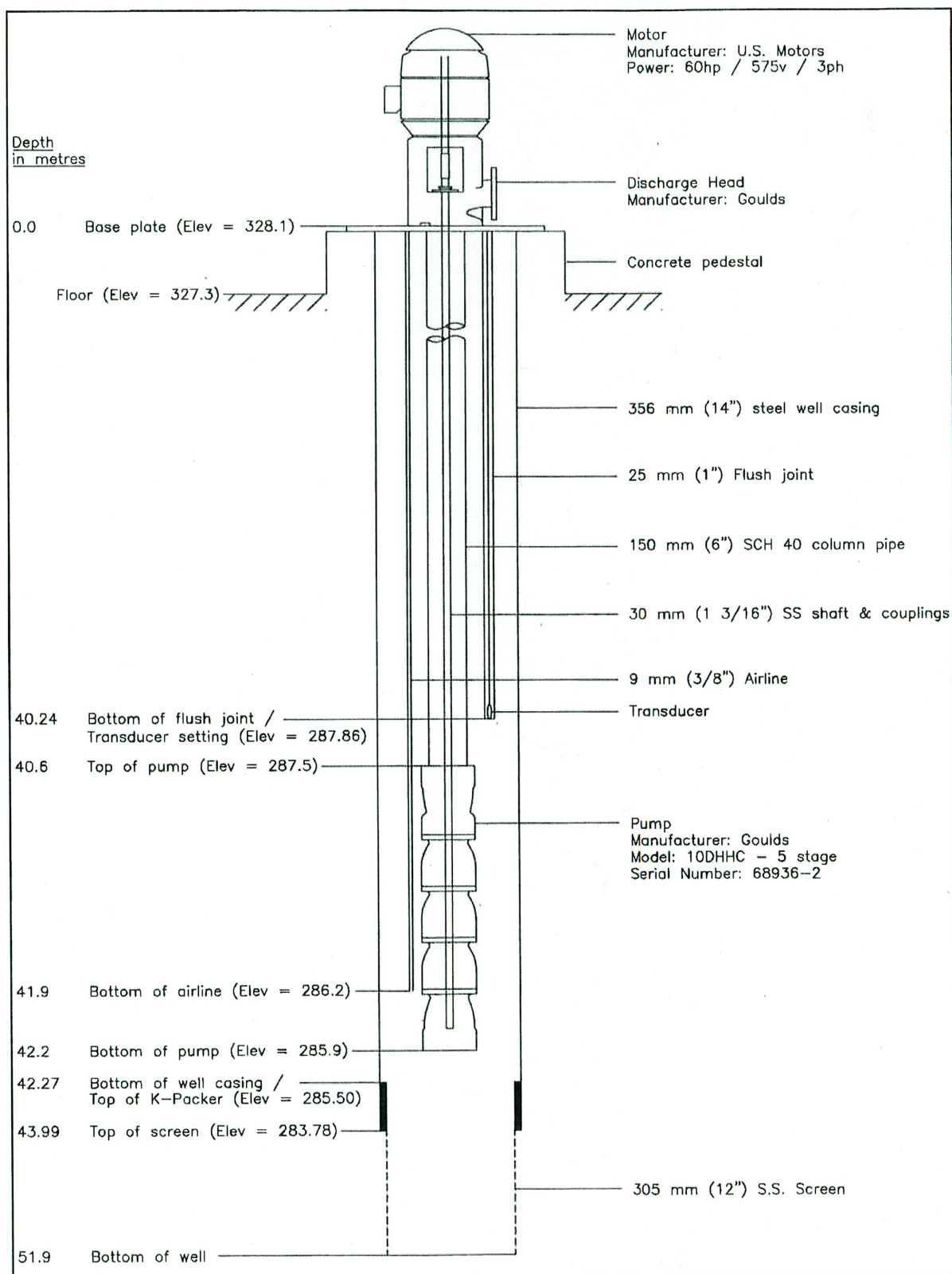


NOTES:

mAMSL - metres above mean sea level
mBGS - metres below ground surface

Stratigraphy from 0 m to 33.5 m BGS based on adjacent monitoring well K-GB-OW 1-08. Detailed stratigraphy presented on K-GB-OW 1-08 log. Identified Hydrostratigraphic unit based on geophysics above 33.53 m, and lithological description & geophysics below 33.53 m.





NOTES



CLIENT

Regional Municipality of Waterloo

TITLE

Well K2A
Pump Installation Details

PROJECT No. 004-238

G:\Lotowater Projects\004 Region of Waterloo\235 K1A & K2A Pumphouse\Whreshoff Pump Install.dwg

DESIGN

DRAWN

CHECKED

BH

2013/03/14

REVISION No. 2013/03/14

SCALE N.T.S.

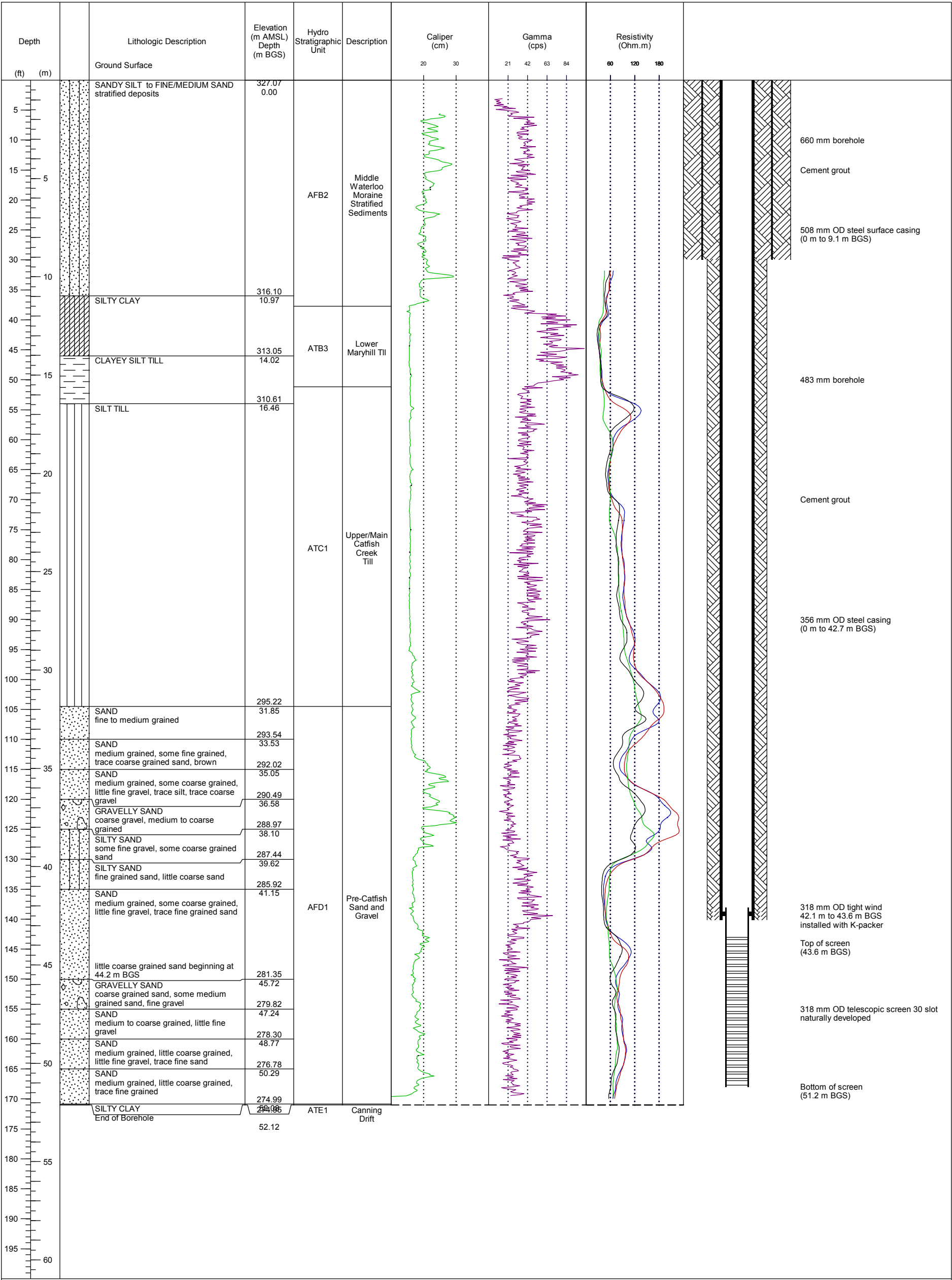
FIGURE

1

Production Well: K2A

Project: K1 and K2 Replacement
Client: Region of Waterloo
Location: Greenbrook Well Field
Number: 1609-00487
Field investigator: K.McLagan/L.Veale
Contractor: Davidson Drilling Ltd.

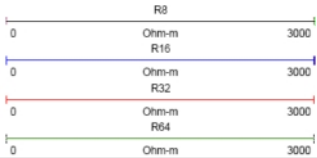
Drilling method: Truck Mount Mud Rotary
Date started/completed: Apr-6-2009 / May-6-2009
Ground surface elevation: 327.07 m AMSL
Top of casing elevation: 327.77 m AMSL
Easting: 540545
Northing: 4808307

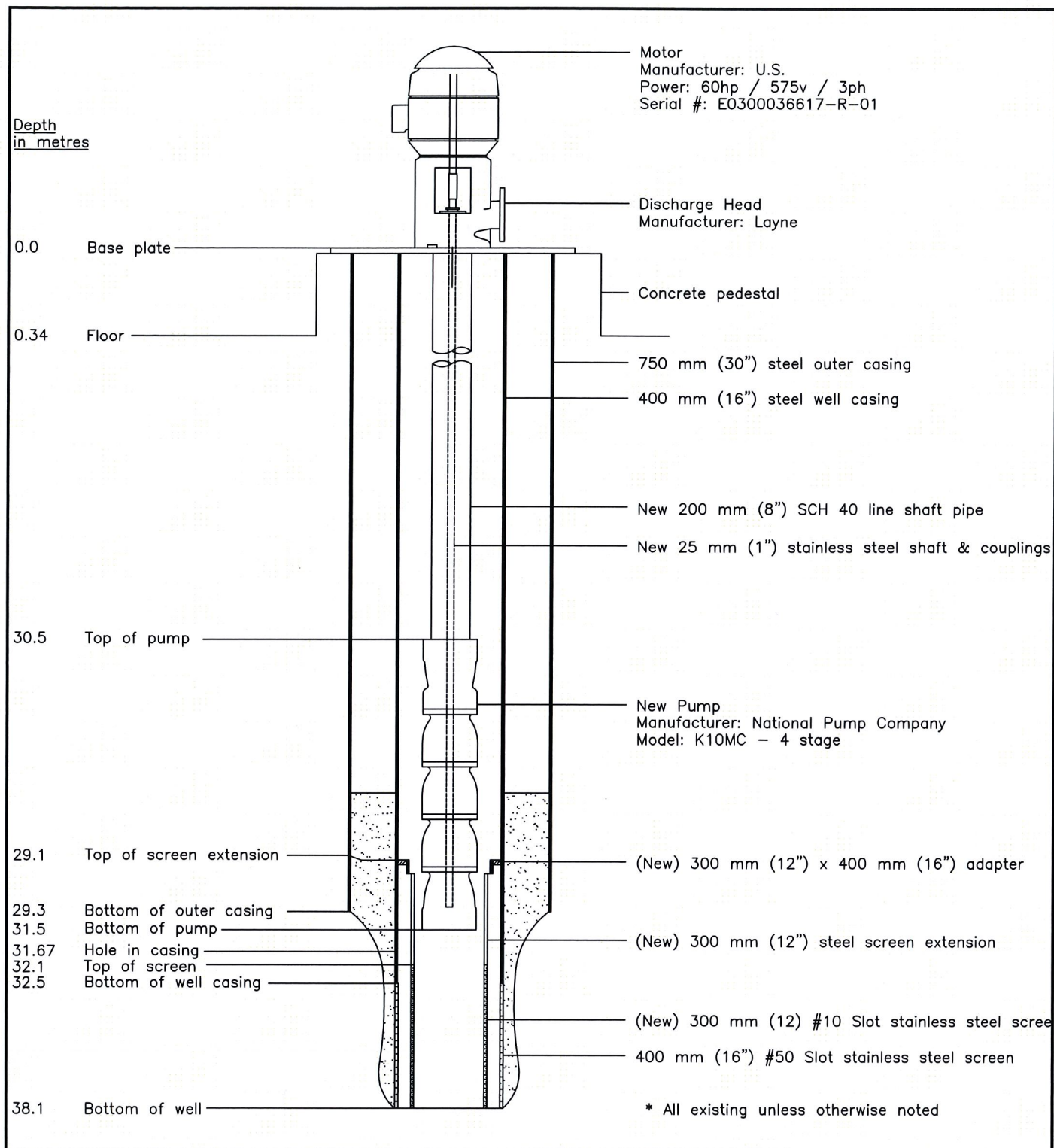


NOTES:

mAMSL - metres above mean sea level
mBGS - metres below ground surface

Stratigraphy from 0 m to 33.5 m BGS based on adjacent monitoring well K-GB-OW2-08. Detailed stratigraphy presented on K-GB-OW2-08 log. Identified Hydrostratigraphic unit based on geophysics above 33.5 m, and lithological description & geophysics below 33.5 m.





 **Lotowater**
TECHNICAL SERVICES INC.

CLIENT

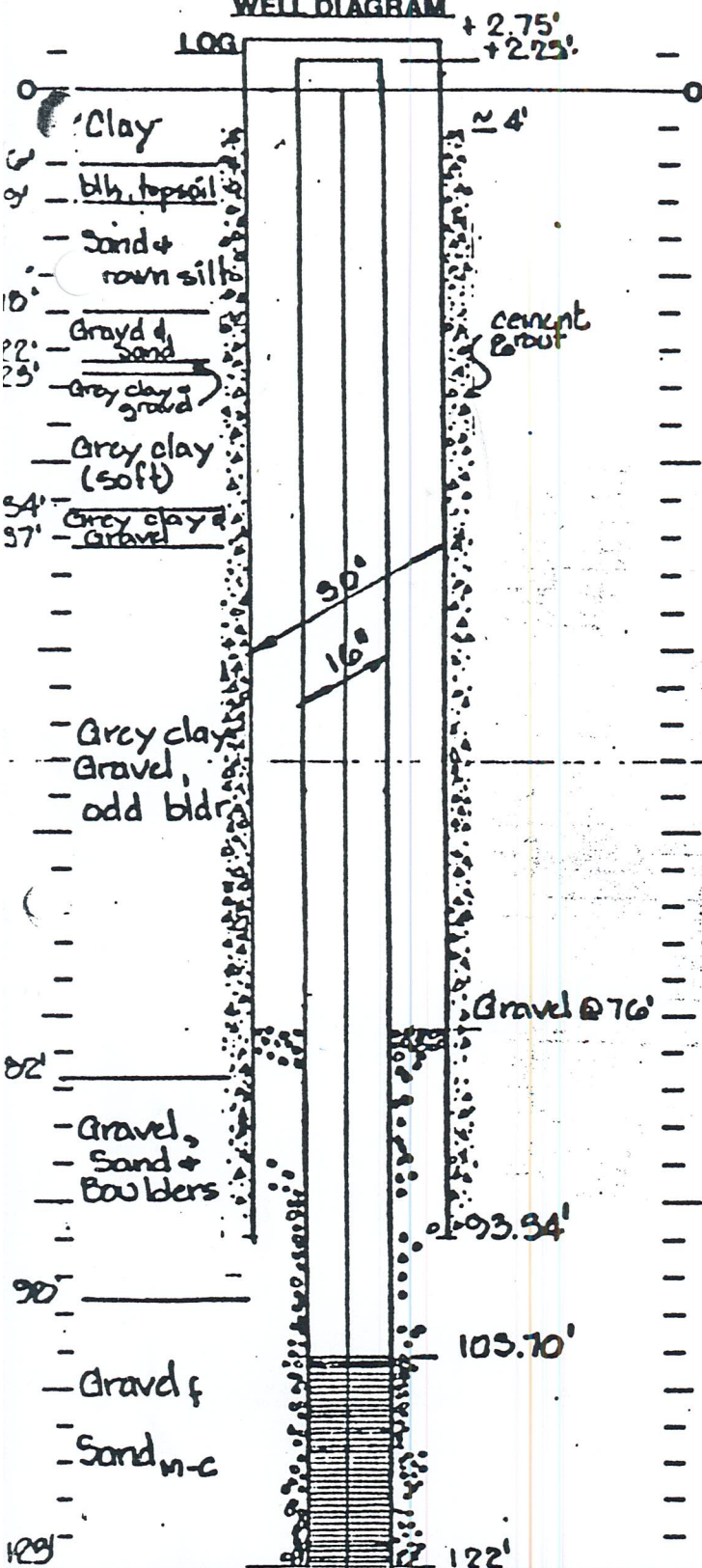
Regional Municipality of Waterloo

TITLE

Well K4B Pump &
Screen Installation Drawing

PROJECT No. 006—317			G:\Lotowater Projects\006 Region of Waterloo\317..\K4B Pump Install.dwg		FIGURE 1
DESIGN			REVISION No. 2015—04—02	SCALE N.T.S.	
DRAWN	EH	2014/12/10			
CHECKED	BP				

WELL DIAGRAM



WELL MATERIAL

Outer Casing: 30 " dia. 375 " Wall Thk. Matl.: steel
 Cemented from 0 " to 93.34 "
 Inner Casing: 16 " dia. 375 " Wall Thk. Matl.: steel
 Screen: Make dm 16 " dia., Opening & Matl.: 50 steel
 Plug: Type plug Matl. steel Other: _____
 Gravel: Type silica Size 1/2 x 10 Quantity 10 ton

WELL TEST DATA

Preliminary Test Date: April 14/86 by P. Magee
 Static Level: _____ " below M.P. _____
 Pumping Rate IGM: _____
 Pumping Duration: _____ hrs. _____ min.
 Pumping Level at Test End: _____ "
 Performance Plots: dd-t Dwg. _____
 dd-r Dwg. A86119
 step test B86117
A86118

Final Test: Date _____ by _____
 Rated Well Capacity IGM _____
 Pumping Rate IGM _____ Static level _____ "
 Pumping level _____ " at _____ hrs. _____ min.
 Pump pressure: _____ psi; Main pressure _____ psi
 Shut off: AGH _____ psi; W.L. _____ "
 Clear Well Depth from B.P. _____ " Air Line _____ "

PUMP & MOTOR DATA

Pump Make Layne Rating 1100 IGM @ 128 ' TH
 Head: Type TF 101B S.N. 72852
 Column: 95 ' x 10 " x 1 3/16 " : Shaft Matl.: st. steel
 Bowl: 12 RHPEN Stage 2 : Curve: _____
 Suction: 8 " dia 10 " : Long
 Special: Zinc Sleeves Yes - 10 : Taped Oil Line _____
 Other: _____
 Motor Make: U.S. Frame: 404 UPHSN: 1184207
60 HP, 3 ph, 60 hz, 1800 rpm
 Bearing No. Upper 7320 M
 Lower 6218 JC

Special Equipment

COPY

WELL REVISIONS AND REHABILITATION

DATE	WORK DONE	BY

International Water Supply Limited

SASKATOON - BARRIE - MONTREAL

CLIENT: REGION of WATERLOOWELL NO: K4BDRILLED BY: T. KyleDATE 4/86DRAWN: J. Wall

INSTALLED BY:

DATE:

DATE: April, 1986

Driller Log

Well Design

Depth from Grade
mTop of Casing (Stick-up)
0.5 mbglDepth
mbglRefer to Log of TW1-05 for detail
of upper soilsSWL
07-Jan-2016

520 mm (20") dia. Borehole

Cement Grout 0 - 23.5 m

Silty Clay Trace Gravel

305 mm (12") dia Steel
Schedule 40 Wall Casing

High Solids Bentonite Grout

Coarse Gravel

23.5 —

Bentonite Seal

26.9 —

Natural Pack with some Sand

31.1 — (102')

SCREEN
Nominal 305 mm (12") dia. Stainless Steel
Pipe Size 70 Slot HiQ Wire Wound

38.7 — (127')

39.0 — End of Borehole

Log from Pilot Hole TW2-05

Silty Clay Till

Gravel

Organics / Clay / Silt

Gravel

Bedrock at 54.2 mbgl

*Note:

All depths are metres below ground level unless otherwise stated.

Well Drilled 09-Sep-2015 by Gerrits Drilling (License 7564)

CLIENT
REGION OF WATERLOOPROJECT
GREENBROOK WELL FIELD
2015 CONSTRUCTION AND TESTING AT SITE K4C55
CONSULTANT

YYYY-MM-DD 2016-07-18

PREPARED JPR

DESIGN

REVIEW JLH

APPROVED GWS

TITLE

WELL K4C
CONSTRUCTION AS-BUILTPROJECT No.
1520338

Phase

Rev.

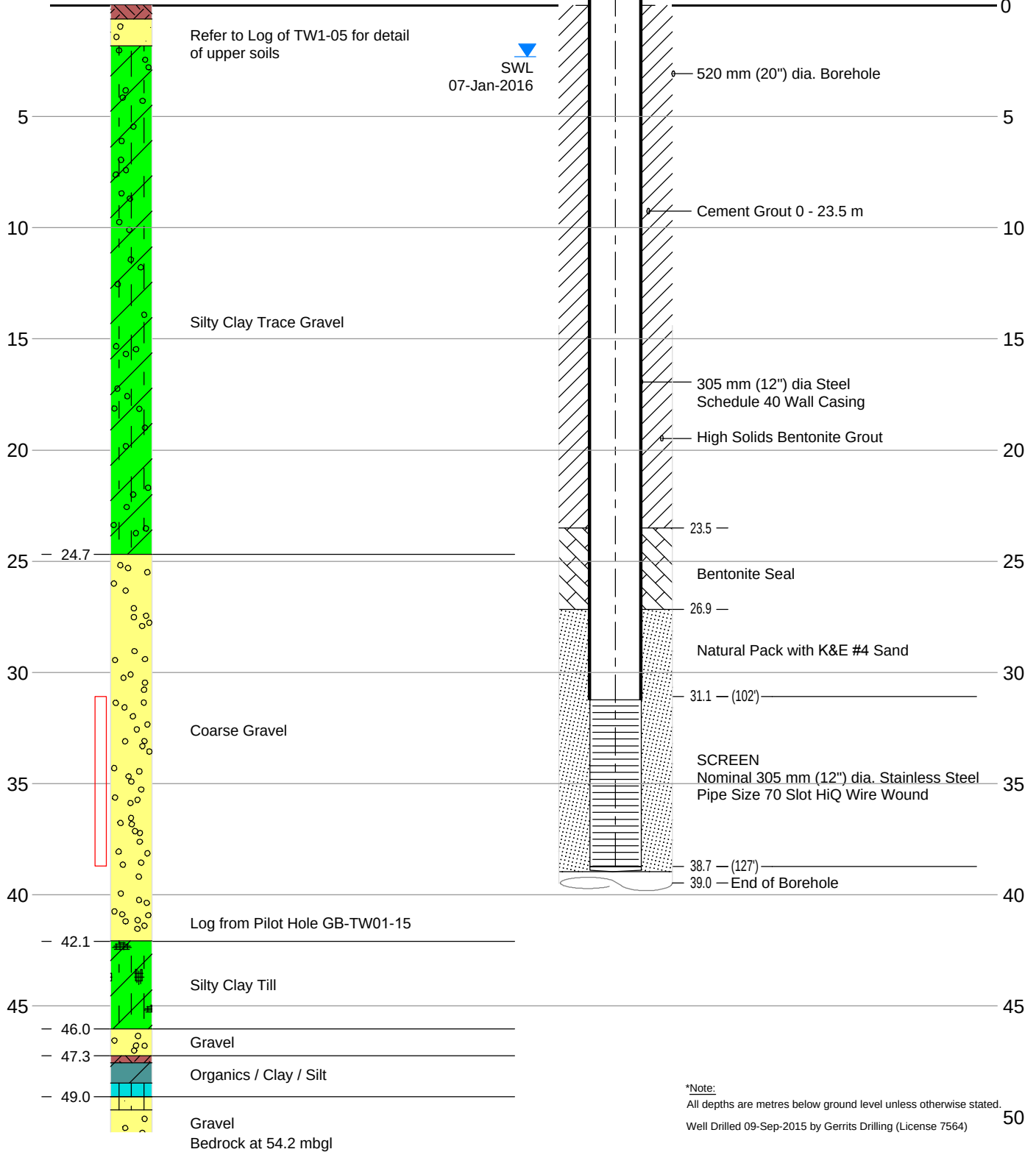
Figure

8



Driller Log

Well Design

Depth from Grade
mTop of Casing (Stick-up)
0.5 mbglDepth
mbglCLIENT
REGION OF WATERLOOPROJECT
GREENBROOK WELL FIELD
2015 CONSTRUCTION AND TESTING AT SITE K4C

CONSULTANT

YYYY-MM-DD 2016-07-18

PREPARED JPR

DESIGN

REVIEW JLH

APPROVED GWS



TITLE

WELL K4C
CONSTRUCTION AS-BUILTPROJECT No.
1520338

Phase

Rev.

Figure

8

PROJECT: 1520338
 LOCATION: N 4808720.50; E 540775.00

RECORD OF BOREHOLE: K-GB-TW01-15

BORING DATE: May 5, 2015

SHEET 1 OF 5
 DATUM: UTM NAD 83

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE		SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION				
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m												
								SHEAR STRENGTH Cu, kPa		nat V.	+ rem V.	Q - U -	● ○			WATER CONTENT PERCENT			
								20	40	60	80	10 ⁻⁶	10 ⁻⁵			10 ⁻⁴	10 ⁻³	Wp	W
0		GROUND SURFACE		321.86															
	PQ Wireline Coring	ORGANICS		0.00															
		(SW) SAND, fine grained		0.10															
				321.50															
		(SP) SAND, some fine gravel, trace organics		0.36															
				321.10															
1		(ML) CLAYEY SILT, some coarse sand and gravel; light brown to orange; moist, firm		0.76															
				320.33															
		(ML) ORGANIC CLAYEY SILT; dark red to black; moist		1.53															
				320.03															
2		(PT) PEAT; dark red to black, strong odour; moist, non-cohesive		1.83															
				319.42															
		(OH) Clayey ORGANIC SILT, peaty layers throughout; light grey to brown; moist, soft		2.44															
3					1	DC													
		(CH) CLAY, very soft, fossils throughout, trace silt; dark grey; moist to wet		318.53															
				3.33															
4					2	DC													
				317.28															
		(GM) SILTY GRAVEL; soft, wet		4.58															
5		(CH) CLAY, trace coarse sand, trace fine gravel; light brown, (TILL); cohesive, moist, firm		4.73															
6																			
7					3	DC													
8																			
		(CL) SILTY CLAY, trace medium to coarse sand, trace fine gravel; grey to brown, (TILL); moist to wet, soft to firm		314.23															
				7.63															
9					4	DC													
10																			
		CONTINUED NEXT PAGE																	

DEPTH SCALE
 1 : 50



LOGGED: HJ
 CHECKED: GWS

GTA-BHS 001 S:\CLIENTS\REGION OF WATERLOO\GREENBROOK\02_DATA\GINTV1520338.GPJ GAL-MIS.GDT 12/19/16

PROJECT: 1520338
LOCATION: N 4808720.50; E 540775.00

RECORD OF BOREHOLE: K-GB-TW01-15

BORING DATE: May 5, 2015

SHEET 2 OF 5
DATUM: UTM NAD 83

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION		
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	20 40 60 80				10 ⁻⁵ 10 ⁻⁵ 10 ⁻⁴ 10 ⁻³							
								SHEAR STRENGTH Cu, kPa		nat V. + Q - rem V. ⊕ U - ○		WATER CONTENT PERCENT							
												Wp ———— W ———— WI							
								20	40	60	80			10	20	30	40		
10	PQ Wireline Coring	--- CONTINUED FROM PREVIOUS PAGE ---																	
		(CL) SILTY CLAY, trace medium to coarse sand, trace fine gravel; grey to brown, (TILL); moist to wet, soft to firm																	
				4	DC														
15		(SM) SILTY SAND, well graded; brown; cohesive, wet		307.07 14.79	7	DC													
		(SM) SILTY SAND, moist		306.76 15.10															
		Interbedded (CL) SILTY CLAY and (SM) SILTY SAND		15.25															
16		(CL) SILTY CLAY; moist, firm		305.87 15.99	8	DC													
17		(SM) SILTY SAND, well graded, moist to wet interbeds; brown; cohesive		305.03 16.83	9	DC													
18																			

DEPTH SCALE
1 : 50



LOGGED: HJ
CHECKED: GWS

PROJECT: 1520338
LOCATION: N 4808720.50; E 540775.00

RECORD OF BOREHOLE: K-GB-TW01-15

BORING DATE: May 5, 2015

SHEET 3 OF 5
DATUM: UTM NAD 83

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m										
								SHEAR STRENGTH Cu, kPa				WATER CONTENT PERCENT					
								20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³		
								nat V. + Q - ● rem V. ⊕ U - ○				Wp — W — Wi					
								20	40	60	80	10	20	30	40		
20	PQ Wireline Coring	--- CONTINUED FROM PREVIOUS PAGE ---															
		(CL) SILTY CLAY, trace coarse sand; (TILL); cohesive, moist, firm															
10				DC													
21																	
22		(SM) Gravelly SILTY SAND (CL) SILTY CLAY, layers of (CH) CLAY throughout; dark brown to purple; cohesive, moist, firm to stiff		299.90 21.98													
23																	
11				DC													
24																	
25		(SM) SILTY SAND, trace coarse sand (GP) GRAVEL, fine to coarse gravel, trace cobbles, no matrix recovery		297.46 24.40 24.55	12	DC											
26		(GP) GRAVEL and SAND, fine to coarse gravel, medium to coarse grained sand matrix, trace cobbles, some silt; wet		295.93 25.93													
27				13	DC												
28																	
29		(SW) SAND, medium to coarse grained; wet (GP) GRAVEL to (GP) GRAVEL and SAND, gravel, fine to coarse grained, trace cobbles, sand matrix, coarse grained, some silt; wet		293.78 28.08 293.55 28.31	14	DC											
30						15	DC										
			CONTINUED NEXT PAGE														

DEPTH SCALE

1 : 50



LOGGED: HJ

CHECKED: GWS

PROJECT: 1520338
 LOCATION: N 4808720.50; E 540775.00

RECORD OF BOREHOLE: K-GB-TW01-15

BORING DATE: May 5, 2015

SHEET 4 OF 5
 DATUM: UTM NAD 83

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES		DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION	
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s					
								SHEAR STRENGTH Cu, kPa		nat V. + Q - rem V. ⊕ U - ○		WATER CONTENT PERCENT					
								20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴			10 ⁻³
30	PQ Wireline Coring	--- CONTINUED FROM PREVIOUS PAGE ---															
		(GW) GRAVEL and SAND, gravel, fine to coarse grained, sand, coarse grained, trace cobbles; wet		291.36	15	DC											
				30.50													
31					16	DC											
32																	
33																	
		(GP) GRAVEL, fine to coarse grained, trace cobbles, trace sand matrix; wet		288.31													
				33.55													
34				18	DC												
35		(GP) GRAVEL and SAND, fine to coarse sand, trace to some silt		286.78													
	35.08																
				19	DC												
36																	
				20	DC												
37																	
				21	DC												
38																	
39																	
40																	
		CONTINUED NEXT PAGE															

DEPTH SCALE
 1 : 50



LOGGED: HJ
 CHECKED: GWS

GTA-BHS 001 S:\CLIENTS\REGION OF WATERLOO\GREENBROOK\02_DATA\GINTV1520338.GPJ GAL-MIS.GDT 12/19/16

PROJECT: 1520338
 LOCATION: N 4808720.50; E 540775.00

RECORD OF BOREHOLE: K-GB-TW01-15

BORING DATE: May 5, 2015

SHEET 5 OF 5
 DATUM: UTM NAD 83

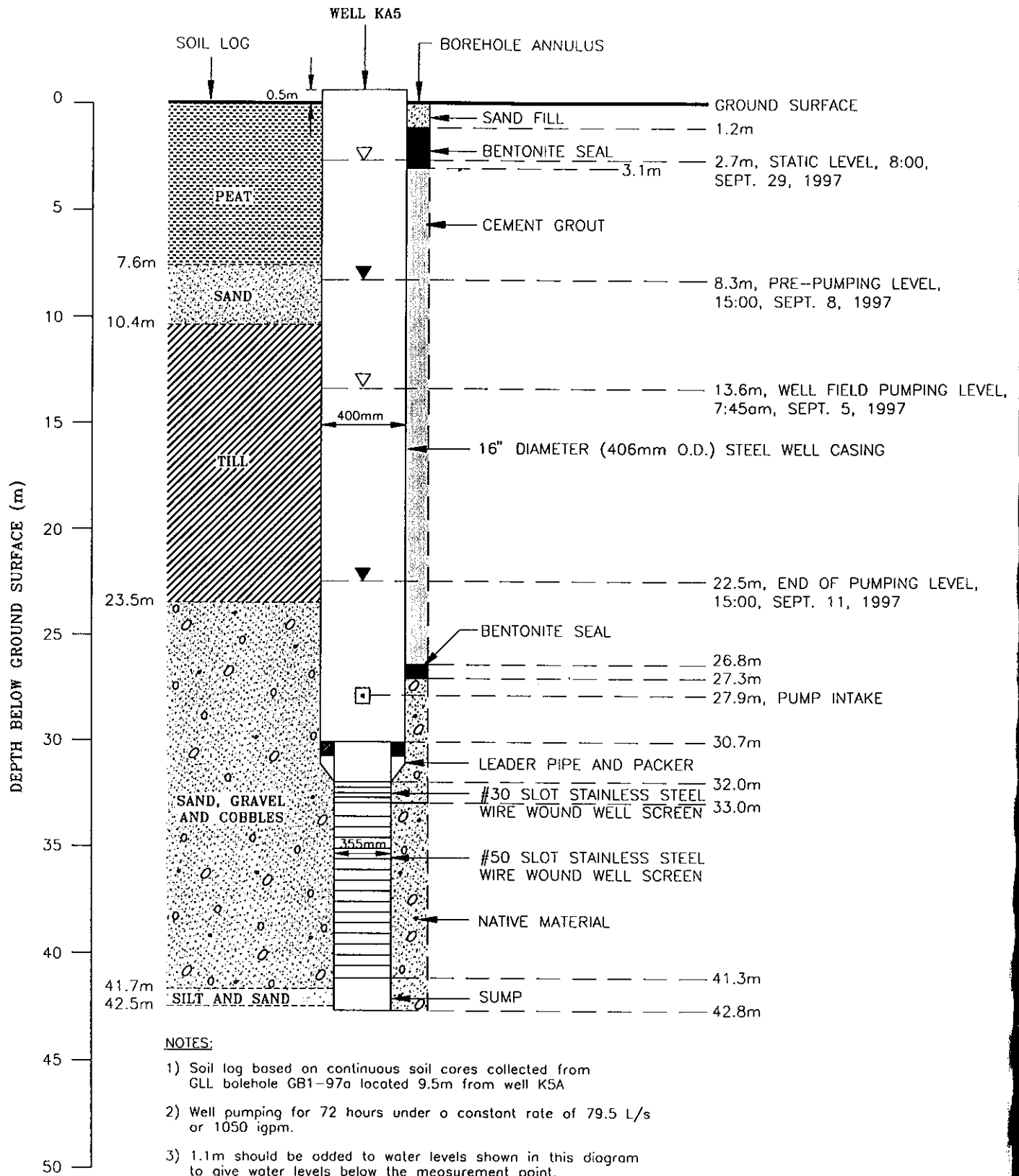
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m				HYDRAULIC CONDUCTIVITY, k, cm/s				ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	RESISTANCE, BLOWS/0.3m				k, cm/s					
								SHEAR STRENGTH Cu, kPa		nat V. + Q - rem V. ⊕ U - ●		WATER CONTENT PERCENT					
								20	40	60	80	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³		
40		--- CONTINUED FROM PREVIOUS PAGE ---															
		(GP) GRAVEL and SAND, fine to coarse sand, trace to some silt															
					24	DC											
41					25	DC											
42					26	DC											
					27	DC											
43		(CH) CLAY and SAND		278.85 43.01	28	DC											
		END OF BOREHOLE		278.55 43.31													
44																	
45																	
46																	
47																	
48																	
49																	
50																	

DEPTH SCALE
 1 : 50



LOGGED: HJ
 CHECKED: GWS

GTA-BHS 001 S:\CLIENTS\REGION OF WATERLOO\GREENBROOK\02_DATA\GINTV1520338.GPJ GAL-MIS.GDT 12/19/16



NOT TO SCALE

Site Name:

File Name: 97159FG1.DWG

Gartner
Lee

Regional Municipality of Waterloo

K5A SOIL LOG, WELL CONSTRUCTION,
PUMP SETTING AND WATER LEVELS

Project No.

97-159

Date Issued:

NOVEMBER 1997

Figure 3



Print only in spaces provided.
Mark correct box with a checkmark, where applicable.

The Ontario Water Resources Act WATER WELL RECORD

K5A
6508181

County or District Region of Waterloo	Township/Borough/City/Town/Village 150 Frederick St. Kitchener	Con block tract survey, etc. Lot
Owner's surname Reg. Munc of Waterloo	First name 150 Frederick St. Kitchener	Date completed 27 Sept 97

LOG OF OVERBURDEN AND BEDROCK MATERIALS (see Instructions)				
General colour	Most common material	Other materials	General description	Depth - feet
				From To
Black	Fill			0 2
Black	Muck			2 7
Black	clay	sandy		7 48
grey	clay			48 55
grey	clay	some gravel & clay streaks		55 75
	gravel	grey clay		75 78
	Gravel s.m	sand		78 82
grey	clay	gravel		82 85
	Sand	gravel, grey clay		85 89
	Sand	gravel		89 92
	Sand f.c			92 103
	Gravel s.m	Sand f.m		103 137
	sand s.m			137 -

WATER RECORD	
Water found at - feet	Kind of water
	☐ Fresh ☐ Sulphur ☐ Salty ☐ Minerals ☐ Gas
	☐ Fresh ☐ Sulphur ☐ Salty ☐ Minerals ☐ Gas
	☐ Fresh ☐ Sulphur ☐ Salty ☐ Minerals ☐ Gas
	☐ Fresh ☐ Sulphur ☐ Salty ☐ Minerals ☐ Gas

CASING & OPEN HOLE RECORD			
Inside diam inches	Material	Well thickness inches	Depth - feet
			From To
16"	☒ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	.375	+1.5' 105
16	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic	.375	135 140
	☐ Steel ☐ Galvanized ☐ Concrete ☐ Open hole ☐ Plastic		

SCREEN	Sizes of opening (Slot No.)	Length
	30 slot	3
	50 slot	27
	st. steel telescope	105

PLUGGING & SEALING RECORD	
Depth set at - feet	Material and type (Cement grout, bentonite, etc.)
From To	
90 88	bentonite seal
10 4	bentonite seal
88 10	cement grout

PUMPING TEST	
Pumping test method ☒ Pump ☐ Bailor	Pumping rate 1850 GPM
Static level 30'	Water level end of pumping 77'
Water level during pumping	Duration of pumping 72 Hours 72 Mins
15 minutes 52'	30 minutes 55'
45 minutes 58'	60 minutes 60'
If flowing give rate GPM	Pump intake set at feet
Recommended pump type ☐ Shallow ☒ Deep	Recommended pump rating feet
	Recommended pump rate GPM

FINAL STATUS OF WELL	
☒ Water supply ☐ Observation well ☐ Test hole ☐ Recharge well	☐ Abandoned, insufficient supply ☐ Abandoned, poor quality ☐ Abandoned (Other) ☐ Dewatering
☐ Unfinished ☐ Replacement well	
WATER USE	
☐ Domestic ☐ Stock ☐ Irrigation ☐ Industrial	☐ Commercial ☐ Municipal ☐ Public supply ☐ Cooling & air conditioning
☐ Not used ☐ Other	
METHOD OF CONSTRUCTION	
☒ Cable tool ☐ Rotary (conventional) ☐ Rotary (reverse) ☐ Rotary (air)	☐ Air percussion ☐ Boring ☐ Diamond ☐ Jetting
☐ Driving ☐ Digging ☐ Other	

LOCATION OF WELL	
In diagram below show distances of well from road and for line. Indicate north by arrow.	
	156575

Name of Well Contractor International Water Supply	Well Contractor's Licence No. 2801
Address P.O. Box 310 Barrie	
Name of Well Technician W. Nobes	Well Technician's Licence No. T-0115
Signature of Well Contractor [Signature]	Submission date 24 11 97

MINISTRY USE ONLY	

1 - CONTRACTOR'S COPY

metres LOG

0
0.61 FILL
2.13 Black MUCK

Black sandy CLAY

14.63
16.76 Grey CLAY

Grey CLAY, some
gravel and clay
streaks

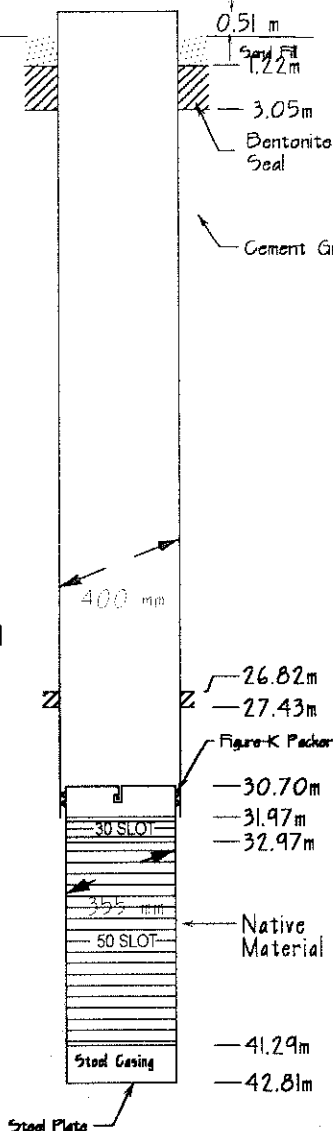
22.86
23.79 GRAVEL and grey clay
24.99 Fine, Med GRAVEL and sand
25.91 Grey CLAY and gravel
27.13 G. SAND, gravel, grey clay
28.04 SAND, coarse gravel

Fine to coarse SAND

31.39

Coarse GRAVEL,
fine to med. sand

41.76 SAND, silt



WELL MATERIAL

Outer Casing: 400 mm dia. 9.5 mm Wall Thk. Mat'l Steel
Cemented from 3.05 m to 26.82 m
Inner Casing: _____ mm dia. _____ mm Wall Thk. Mat'l _____
Screen: Make: Johnson 355 mm dia. Opening & Mat'l: 30 & 50 55
Plug: Type: Plate Mat'l CS Other Pump - 1.52 m
Gravel: Type: _____ Size: _____ Quantity: _____

AQUIFER TEST DATA

Date: Sept 8/97 By: W. Nobes
Static Level 9.45 m below M.P. 1.07 m A.G.L.
Pumping Rate L/s : 79.5
Pumping Duration: 72 hrs. 0 min.
Pumping Level at Test End: 23.62 m
Performance Plots: dd-t Dwg. by others
dd-r Dwg. by others
Step Test L97201

EQUIPPED WELL DATA

Date: _____ By: _____
Rated Well Capacity L/s _____
Pumping Rate L/s _____ Static Level _____ m
Pumping Level _____ m at _____ hrs. _____ min.
Pump Pressure: _____ kPa Main Pressure _____ kPa
Shut Off: AGH _____ kPa W.L. _____ m
Clear Well Depth from B.P. _____ m Air Line _____ m

PUMP & MOTOR DATA

Pump Make: _____ Rating: _____ L/s @ _____ m T.H.
Head: Type: _____ S.N. _____
Columa: _____ m X _____ mm X _____ mm X _____ mm Shaft Mat'l _____
Bowl: _____ Stage: _____ Curve: _____
Suction: _____ mm dia. _____ m Long
Special: Zinc Sleeves _____ Taped Oil Line _____
Other _____
Motor Make: _____ Frame: _____ S.N. _____
_____ kW _____ phase _____ hz _____ rpm _____ Volts
Bearing No. Upper _____
Lower _____

Special Equipment

WELL REVISIONS AND REHABILITATION

DATE	WORK DONE	BY

International Water Supply Ltd.

MONTREAL - BARRIE - SASKATOON

CLIENT: REGIONAL MUNICIPALITY OF WATERLOO

WELL No: K5-A

DRILLED BY: W NOBES

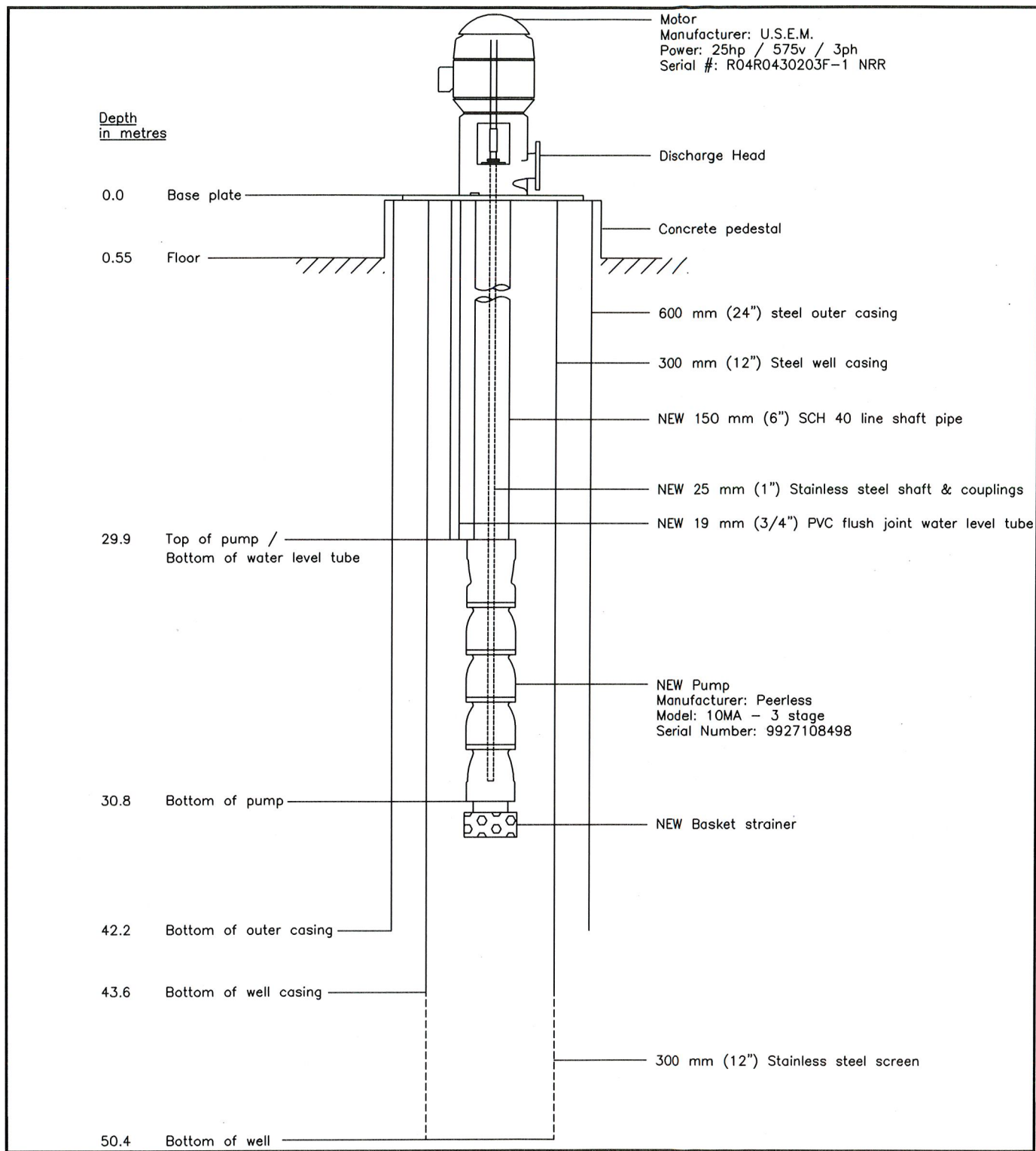
DATE: SEP/97

DRAWN: T Brown

INSTALLED BY:

DATE:

DATE: Oct 21/97



CLIENT

Regional Municipality of Waterloo

TITLE

Well K8
Pump Installation Drawing

PROJECT No. 006-349

G:\Lotowater Projects\006 Region of Waterloo\349 Well K8\Pump Install.dwg

DESIGN		
DRAWN	EH	2016/05/09
CHECKED		

REVISION No. 2016-05-09

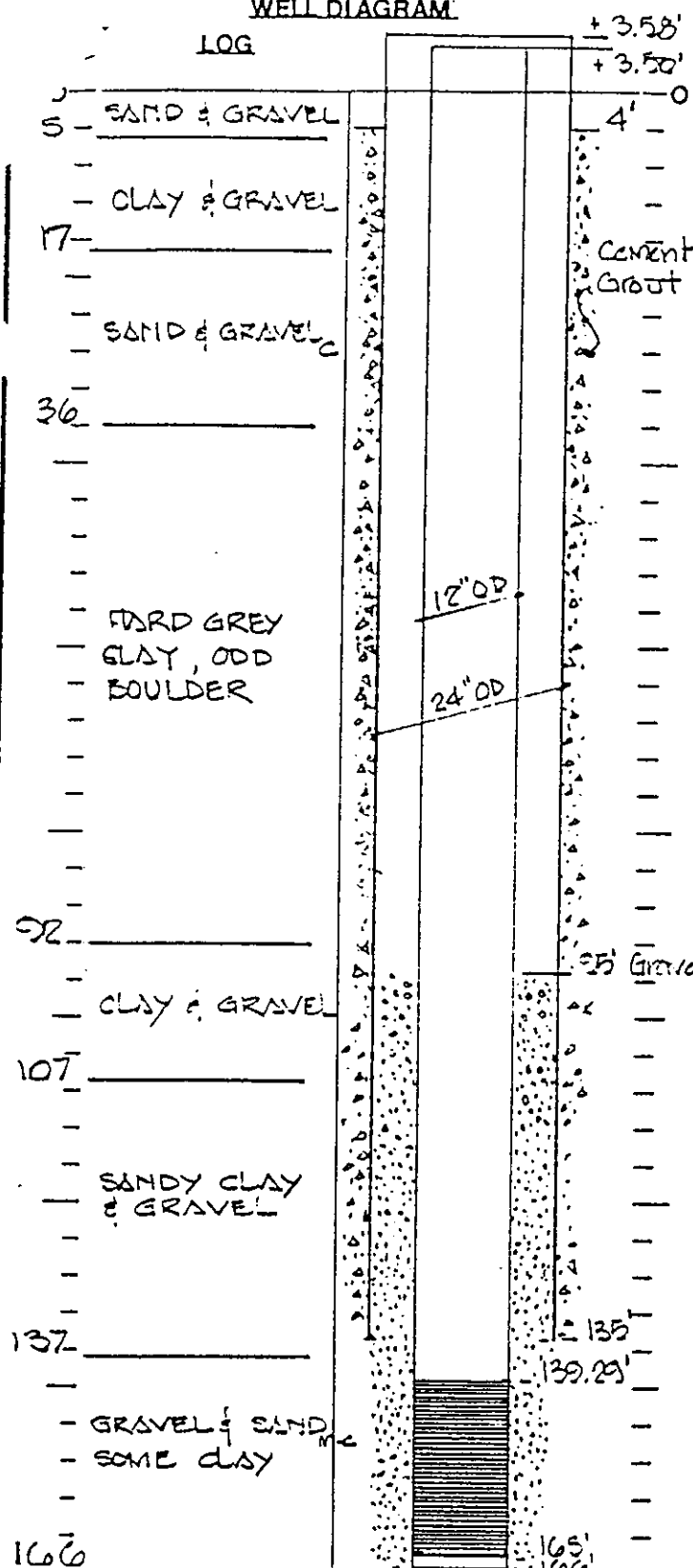
SCALE N.T.S.

FIGURE

3

WELL DIAGRAM

LOG



WELL MATERIAL

Outer Casing: 24" dia., 375" Wall Thk. Matl.: steel
 Cemented from 175" to 4"
 Inner Casing: 12" dia., 375" Wall Thk. Matl.: steel
 Screen: Make: Johnson 12" dia., Opening & Matl.: 20 mesh ss.
 Plug: Type: date Matl.: st. st. Other: _____
 Gravel: Type: silica Size: 0.8 mm Quantity: 14 ton

WELL TEST DATA

Preliminary Test Date: June 9 by JA
 Static Level: 166.4 " below M.P. +4.0
 Pumping Rate IGM: 500
 Pumping Duration: 6 hrs. — min.
 Pumping Level at Test End: 92.48
 Performance Plots: dd-t Dwg. A 87130
 dd-r Dwg. A 87129
 Step Test B 87127
A 87128 - A 87129
 Final Test: Date: _____ by _____
 Rated Well Capacity IGM: _____
 Pumping Rate IGM: _____ Static level: _____
 Pumping level: _____ at _____ hrs. _____ min.
 Pump pressure: _____ psi: Main pressure: _____ psi
 Shut off: AGH: _____ psi: W.L.: _____
 Clear Well Depth from B.P.: _____ Air Line: _____

PUMP & MOTOR DATA

Pump Make: _____ Rating: _____ IGM @ _____ TH
 Head: Type: _____ S.N.: _____
 Column: _____ X _____ X _____: Shaft Mtl.: _____
 Bowl: _____ Stage: _____ Curve: _____
 Suction: _____ dia.: _____ Long
 Special: Zinc Sleeves: _____ Taped Oil Line: _____
 Other: _____
 Motor Make: _____ Frame: _____ SN: _____
 _____ HP, _____ ph, _____ hz, _____ rpm, _____ Volts
 Bearing No. Upper: _____
 Lower: _____

Special Equipment

WELL REVISIONS AND REHABILITATION

DATE	WORK DONE	BY

International Water Supply Limited

SASKATOON - BARRIE - MONTREAL

CLIENT: REGION of WATERLOOWELL NO: K8DRILLED BY: R. Maice DATE: 6/87DRAWN: J. Wall

INSTALLED BY: _____

DATE: _____

DATE: June 9 87



1000834

The Ontario Water Resources Act

WATER WELL RECORD

K8

1. PRINT ONLY IN SPACES PROVIDED

2. CHECK ☒ CORRECT BOX WHERE APPLICABLE

2. CHECK ☒ CORRECT BOX WHERE APPLICABLE			
COUNTY OR DISTRICT	TOWNSHIP, BOROUGH, CITY, TOWN, VILLAGE	CON., BLOCK, TRACT, SURVEY, ETC.	LOT
WATERLOO	KITCHENER		
OWNER (SURNAME FIRST)	ADDRESS	DATE COMPLETED	
Region of Waterloo	Marsland Center Waterloo	DAY 28 MO 5 YR 87	
540437.02	4808249.37	328.6	

LOG OF OVERBURDEN AND BEDROCK MATERIALS (SEE INSTRUCTIONS)

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GENERAL DESCRIPTION	DEPTH - FEET	
				FROM	TO
	Sand & Gravel			0	5
	clay	gravel		5	17
	Sand & Gravel			17	36
Grey	clay	odd bldr.	hard	36	92
	clay	gravel		92	107
	clay	sandy, gravel		107	137
	Gravel	Sand some clay		137	166
	clay	gravel		166	170

WATER RECORD	
WATER FOUND AT - FELY	KIND OF WATER
137	☒ FRESH ☐ SULPHUR
	☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR
	☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR
	☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR
	☐ SALTY ☐ MINERAL
	☐ FRESH ☐ SULPHUR
	☐ SALTY ☐ MINERAL

CASING & OPEN HOLE RECORD				
INSIDE DIAM INCHES	MATERIAL	WALL THICKNESS INCHES	DEPTH - FEET	
			FROM	TO
24"	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	1375	+3.58	135
12"	☒ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE	.375	+3.50	130
	☐ STEEL ☐ GALVANIZED ☐ CONCRETE ☐ OPEN HOLE			

SCREEN	SIZE(S) OF OPENING (SLOT NO.)	DIAMETER	LENGTH
	20 slot	12 INCHES	25 FEET
	MATERIAL AND TYPE	WIRE WRAPPED WITH TO TOP OF SCREEN	
	stainless steel	130 FEET	

PLUGGING & SEALING RECORD			
DEPTH SET AT - FEET		MATERIAL AND TYPE (CEMENT GROUT LEAD PACKER, ETC.)	
FROM	TO		
135	4	Cement Grout	

PUMPING TEST METHOD ☒ PUMP ☐ BAILER		PUMPING RATE 500 GPM		DURATION OF PUMPING 6 HOURS _____ MINS	
STATIC LEVEL	WATER LEVEL END OF PUMPING	WATER LEVELS DURING ☒ PUMPING ☐ RECOVERY			
WP + 4.0' 66.42 FEET	92.48 FEET	15 MINUTES 88.63 FEET	30 MINUTES 89.59 FEET	45 MINUTES _____ FEET	60 MINUTES 90.38 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 130 FEET		RECOMMENDED PUMPING RATE 500 GPM	

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

LOCATION OF WELL

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

North

K8

West MOONT

425'

13'

10/26

662'

K8

K2

750'

CONESTOGA PKWY

Hwy 7 Bypass

DRILLERS REMARKS:

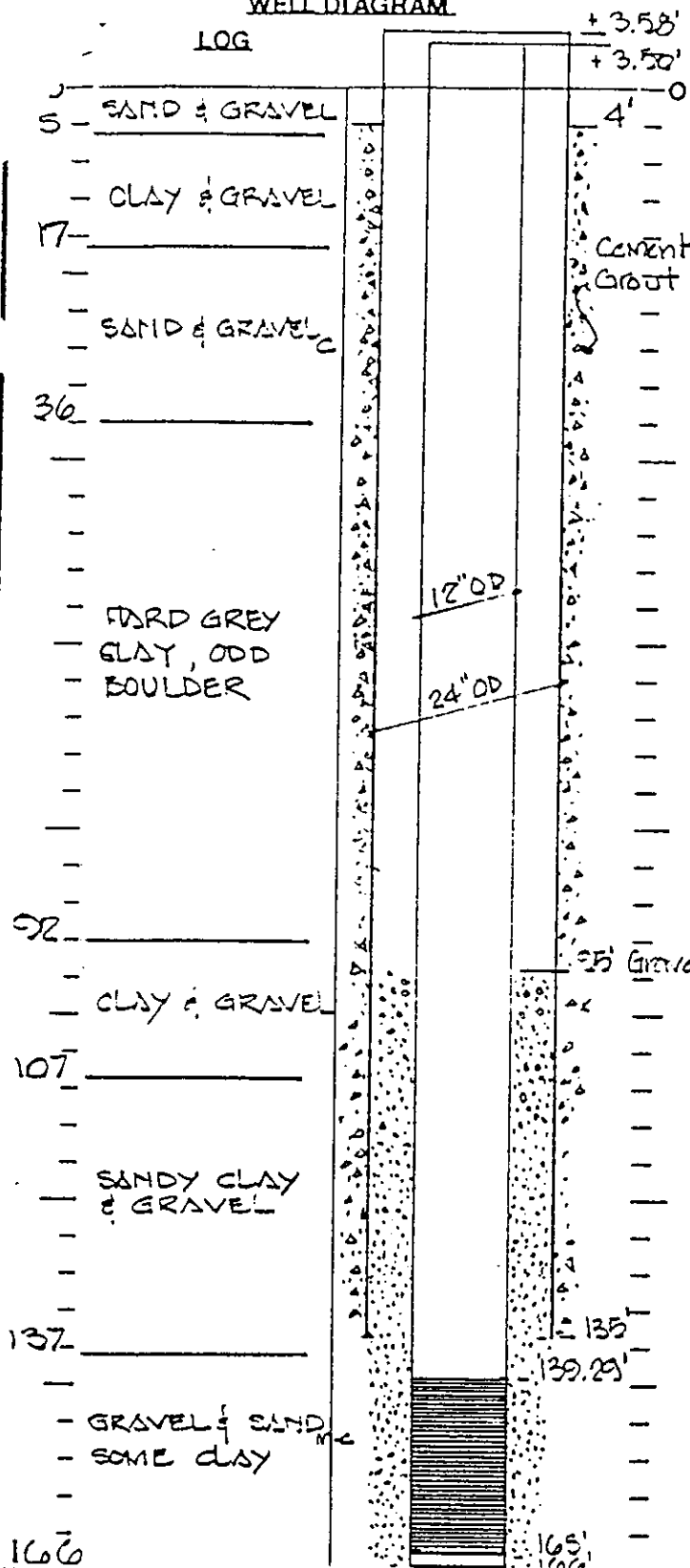
05849

CONTRACTOR	NAME OF WELL CONTRACTOR		LICENCE NUMBER
	International Water Supply		2801
	ADDRESS		
	PO Box 310 Darrin		
CONTRACTOR	NAME OF DRILLER OR BORER		LICENCE NUMBER
	B. Mace		T0117
	SIGNATURE OF CONTRACTOR		SUBMISSION DATE
			DAY 9 MO 6 YR 97

OFFICE USE ONLY				

WELL DIAGRAM

LOG



WELL MATERIAL

Outer Casing: 24 " dia., 375 " Wall Thk. Matl.: steel
 Cemented from 175 " to 4 " "
 Inner Casing: 12 " dia., 375 " Wall Thk. Matl.: steel
 Screen: Make Johnson 12 " dia., Opening & Matl.: 20 slot ss.
 Plug: Type date Matl. st. st. Other: _____
 Gravel: Type silica Size 0.8 mm Quantity 14 ton

WELL TEST DATA

Preliminary Test Date: June 9 by JA
 Static Level: 166.4 " below M.P. +4.0
 Pumping Rate IGM: 500
 Pumping Duration: 6 hrs. — min.
 Pumping Level at Test End: 92.48 "
 Performance Plots: dd-t Dwg. A 87130
 dd-r Dwg. A 87129
 Step Test B 87127
A 87128 - A 87129
 Final Test: Date: _____ by _____
 Rated Well Capacity IGM _____
 Pumping Rate IGM _____ Static level _____ "
 Pumping level _____ " at _____ hrs. _____ min.
 Pump pressure: _____ psi: Main pressure _____ psi
 Shut off: AGH _____ psi: W.L. _____ "
 Clear Well Depth from B.P. _____ " Air Line _____ "

PUMP & MOTOR DATA

Pump Make _____ Rating _____ IGM @ _____ ' TH
 Head: Type _____ S.N. _____
 Column: _____ ' X _____ " X _____ " : Shaft Mtl: _____
 Bowl: _____ Stage _____ Curve: _____
 Suction: _____ " dia. _____ " Long
 Special: Zinc Sleeves _____ Taped Oil Line _____
 Other _____
 Motor Make _____ Frame: _____ SN: _____
 _____ HP, _____ ph, _____ hz, _____ rpm, _____ Volts
 Bearing No. Upper _____
 Lower _____

Special Equipment

WELL REVISIONS AND REHABILITATION

DATE	WORK DONE	BY

International Water Supply Limited

SASKATOON - BARRIE - MONTREAL

CLIENT: REGION of WATERLOOWELL NO: K8DRILLED BY: R. Maice DATE: 6/87DRAWN: J. Wall

INSTALLED BY: _____

DATE: _____

DATE: June '87



TROW, DAMES & MOORE

Client: CITY OF KITCHENER Project No.: 19155-001
 Project: STIRLING AVENUE & HOMER WATSON BLVD
 Location: STIRLING AVENUE & HOMER WATSON BLVD
 Driller: ATCOST DRILLING COMPANY Date Drilled: 90/04/23
 Drilling Supervised By: C. NIX, D. MARKS
 Drilling Method: HOLLOW STEM AUGERS

BOREHOLE NO. 1

Elevation: PKSA = 321.8 MASH

- Datum: MUNICIPAL WELL K-5 (ass 100.000m)

- Ground surface: 100.32 m 322.12 MASH

- Measuring Pt.: 100.57 m 322.37

Monitoring Well Data - Pipe: SCHEDULE 80 PVC

- Screen: 1.5 m, 10 SLOT

Other Monitors: GAS MONITOR, LOW DENSITY POLYETHYLENE TUBING

Sample Type

SS - Split Spoon Sample
 WA - Wash Sample
 AU - Auger Sample
 CN - Continuous Sample
 RX - Rock Core

Well screen
 (water level elev. m,
 year/month/day)

Gas monitor screen
 (vapour reading,
 year/month/day)

Elev. (m) Depth (m)	Soil Description	Strat Plot	Depth Scale (ft.) (m)	Monitoring Details		Sample			Ti Value
				Casing		Number	Interval	Type	
	SAND FILL - Fine to medium grained, wet, brown		1	Concrete		1	2.5-4.0	ss	2
99.32	SILTY SAND ORGANICS- Black, rootlets, wet		5	Cuttings		2	5.0-6.5	ss	3
98.82	SANDY SILT - Greyish white - soft, wet - many small rootlets - shells throughout		2			3	7.5-9.0	ss	2
			3	Bentonite		4	10.0-11.5	ss	2
			4	Silica sand					
			5	Screen					
			15	Bentonite		5	15.0-16.5	ss	8
95.12	SAND - Fine to medium grained, wet, greyish black		20	Cuttings		6	20.0-21.5	ss	17
94.22	SILTY CLAY - Greyish black, rootlets, wet		7			7	25.0-26.5	ss	22
92.52	SAND - Medium to coarse grained - grey, dry - occasional small stone		8			8	30.0-31.5	ss	22
			9	Gas probe					
90.22	SAND WITH A TRACE OF SILT - greyish brown - sand is very finely grained - unsaturated		10			9	35.0-36.5	ss	26
			11			10	40.0-41.5	ss	32
			12			11	45.0-46.5	ss	28
			13			12	50.0-51.5	ss	33
			14			13	55.0-56.5	ss	32
84.42	SAND - greyish brown - contains thin layers of moisture, but is generally dry. - sand is medium grained and well sorted. - becomes saturated at 19.5 m.b.g.l.		15			14	60.0-61.5	ss	32
			16			15	65.0-66.5	ss	25
			17			16	70.0-75.5	ss	32
			18			17	75.0-76.5	ss	61
			19						
			20	Silica sand					
			21						
			22	Screen					
78.92	SILT TILL - greyish brown, hard, saturated - contains traces of clay and fine sand - occasional small stone		23						
77.02	HOLE TERMINATED AT 23.3 m (76.5ft).		24						
			25						

Prepared By: Dave Marks

Checked By: C.N.

Sheet 1 Of 1 Date Prepared: 90/05/01

Note: This borehole log was prepared for environmental assessment purposes. This borehole log does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation assistance from Trow, Dames & Moore personnel before use by others.

9200701 (1000932)

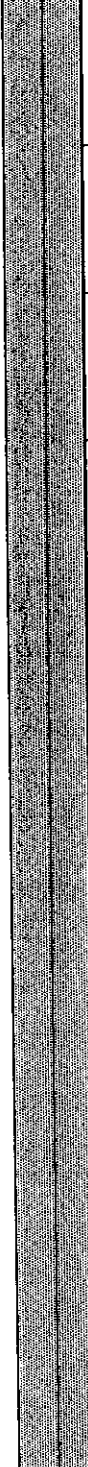
BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1A-96 1 of 7
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo	DATE: 23 January 1997 GEOLOGIST PW ELEVATION ~332 m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE					N VALUE				WATER CONTENT (%)					
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD								
											15	30	45	60	10	20	30	40
		TOPSOIL Dark brown sandy silt topsoil with tree roots and rootlets, moist.		1		CS			100									
0.5		Black organic layer between about 0.38 m to 0.51 m, moist to damp.																
0.8																		
1.1	1	SANDY SILT TILL Mottled brown sandy silt with occasional subrounded cobbles, trace rootlets, patchy limonite staining, dry.		2		CS			87									
1.5																		
1.8		SAND AND GRAVEL Brown fine to coarse sand with fine to coarse subangular to subrounded gravel, dry.																
2		SAND Brown silty fine sand with rare subrounded cobble.																
		Layers of brown clayey silt with some fine gravel interbedded with the silty fine sand from about 1.5 m to 1.8 m.		3		CS			90									
3		Becoming fine sand below about 1.8 m Occasional medium sand layers less than 1 cm thick between about 3.1 m to 3.4 m.																
4.2	4	Clayey silt layers within the silty sand with occasional medium sand layers from about 3.4 m to 4.2 m. Medium sand layers were wet to saturated.		4		CS			60									
4.9		Sand layers between 1 to 5 cm thick.																
5		SAND AND GRAVEL Fine to coarse sand with some gravel layers, patchy limonite staining within the coarser layers, limonite stained sand and gravel layer between about 4.22 m and 4.24 m, dry.		5		CS			85									
5.7		Grey fine sand layer between about 4.7 m and 4.8 m.																
6		SILTY SAND TILL Brown-grey silty sand till with subangular gravel.																
		SANDY SILT TO SILTY SAND Brown sandy silt, dry.																
7		Fine sand layers, about 5 cm thick between about 5.9 m and 6.4 m.		6		PQ			50									
		Becoming thinly laminated fine sand between about 6.4 m and 7.1 m, dry.																
8		Brown silt layer between about 7.1 m and 7.3 m, DTPL.																
		Brown fine silty sand, vaguely laminated, some medium sand below about 7.3 m.		7		PQ			85									
9		Brown silt layer between about 8.9 m and 9.0 m. Grading to sandy silt.																

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1A-96 2 of 7
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 23 January 1997 GEOLOGIST PW ELEVATION ~ 332 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE					N VALUE				WATER CONTENT (%)					
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD								
											15	30	45	60	10	20	30	40
		Becoming fine sand with trace silt below about 9.9 m.		8		PQ			88									
11																		
12		Brown silt with trace fine sand between about 11.5 m and 11.8 m, saturated.		9		PQ			92									
12.4		Becoming reddish-brown silt below about 11.8 m, vaguely laminated, dry.																
		Becoming brown silt below about 11.9 m, moist to wet.																
13		Brown fine sand with trace silt, increasing silt with depth.		10		PQ			92									
		SANDY SILT																
		Brown sandy silt, saturated.																
14		Reddish-brown silt layer between about 13.31 m and 13.34 m, laminated, dry.																
		Brown fine sand with silt between about 13.6 m and 14.6 m.																
14.5																		
14.6		Brown silt between about 14.55 m and 14.63 m, thinly laminated, moist.		11		PQ			83									
14.9																		
15		Reddish-brown clayey silt between about 14.63 m and 14.95 m, thinly laminated, dry.																
		Brown medium sand with some fine sand and silt between about 14.95 m and 15.88 m, saturated.																
15.9																		
16		SILT AND CLAY		12		PQ			100									
		Reddish-brown silt and clay, thinly laminated, hard, DTPL.																
16.7		Increasing gravel content below about 16.6 m.																
17		SANDY SILT TILL																
		Grey-brown sandy silt till with subrounded to subangular gravel, DTPL, some sandier sections.																
				13		PQ			60									
18																		
19				14		PQ			30									
		Siltier section between about 19.4 m and 23.7 m.																

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1A-96 3 of 7
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo	DATE: 23 January 1997 GEOLOGIST PW ELEVATION ~332 m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						N VALUE				WATER CONTENT (%)				
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD								
											15	30	45	60	10	20	30	40
21		Decreasing gravel content between about 23.7 m and 25.3 m.		15	PQ			70										
22																		
23																		
24																		
25																		
26																		
27				17	PQ			55										
28				18	PQ			98										
29				19	PQ			100										
				20	PQ			85										

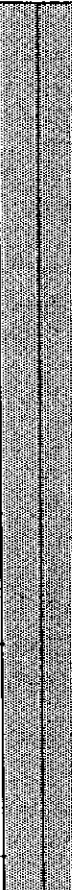
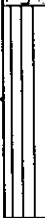
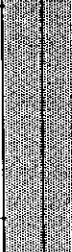
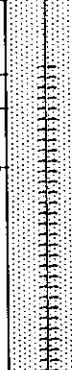
BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1A-96 4 of 7
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 23 January 1997 GEOLOGIST PW ELEVATION ~ 332 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE					N VALUE				WATER CONTENT (%)					
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD								
											15	30	45	60	10	20	30	40
31.0 31.1	31	Silty sand layer between about 30.35 m and 30.38 m, moist. Silt layer between about 30.48 m and 30.56 m, moist. Silt layer between about 30.73 m and 30.81 m. Silt layer between about 31.04 m and 31.06 m.		21		PQ			88									
				22		PQ			90									
32																		
33				23		PQ			88									
34																		
				24		PQ			97									
35																		
		Sandier between about 35.5 m and 36.0 m.																
36				25		PQ			82									
36.8		Sand and gravel layer between about 36.19 m and 36.22 m, some limonite staining within this layer.																
37		<u>SAND</u> Brown fine to medium sand, saturated.		26		PQ			78									
38																		
38.3		<u>SILT</u> Grey-brown silt, vaguely laminated, saturated.																
39.2	39	Grading into fine sand below about 39 m.		27		PQ			82									
		<u>SAND</u> Grey-brown fine sand with trace silt, saturated.																

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1A-96 5 of 7
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 23 January 1997 GEOLOGIST PW ELEVATION ~332 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						N VALUE				WATER CONTENT (%)				
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD								
											15	30	45	60	10	20	30	40
41		Becoming fine to medium sand below about 40.5 m, moist.		28		PQ			60									
42				29		PQ			75									
43																		
44		Becoming wet to saturated below about 43.6 m.		30		PQ			80									
45				31		PQ			92									
46																		
47.0		Becoming coarser with depth.		32		PQ			93									
47		<u>SILT AND SAND LAYERS</u> Grey silt, vaguely laminated, moist to wet. Grey fine to medium sand between about 49.2 m and 49.5 m, vaguely laminated, some slightly coarser layers, wet. Grey silt layer between about 49.30 m and 49.31 m.																
48		Grey laminated silt and fine to medium sand below about 49.7 m, laminations about 1 cm thick.		33		PQ			82									
49																		
49.8		<u>SAND AND GRAVEL</u>		34		PQ			12									

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1A-96 6 of 7
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 23 January 1997 GEOLOGIST PW ELEVATION ~332 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE					N VALUE				WATER CONTENT (%)						
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD									
											15	30	45	60	10	20	30	40	
51		Grey sand and gravel with cobbles, saturated.		35	PQ			70											
52																			
53					36	PQ			7										
54																			
54.4		<u>SILT</u> Dark grey silt, thinly laminated with clay layers, DTPL.		37	PQ			88											
55		Grey silty sand till layer between about 55.2 m and 55.4 m.																	
55.8		Grey silty sand till layer between about 55.5 m and 55.6 m.																	
56		<u>SAND</u> Grey silty fine sand with occasional irregular black layers, moist.			38	PQ			98										
56.6		<u>ORGANIC</u> Black silty sand with some clay, hard, dry, woody fibrous pieces between about 56.89 m and 57.0 m.																	
57.1		Rock-like between about 57.0 m and 57.1 m.																	
57.3		<u>SILT AND CLAY</u> Grey-brown silt and clay, DTPL.			39	PQ			62										
57.7		<u>SAND</u> Grey-brown silty fine sand, moist. Becoming sandier with depth with some silty sections.																	
58		<u>SAND AND GRAVEL</u> Grey fine to medium sand and gravel with some subrounded cobbles, saturated. Increasing cobbles with depth.																	
59					40	PQ			87										

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1A-96 7 of 7
Greenbrook Capture Zone Green brook Well Field, Kitchener		DATE: 23 January 1997
FOR: Regional Municipality of Waterloo		GEOLOGIST PW ELEVATION ~332 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE					N VALUE				WATER CONTENT (%)					
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD								
											15	30	45	60	10	20	30	40
60.8		Grey-brown silt layer between about 60.75 m to 60.81 m, saturated.		41		PQ			93									
61		<u>SANDY SILT TILL</u> Reddish-brown sandy silt with fine to medium gravel and occasional subrounded cobble, dry.																
62		Silt layer between about 61.02 m and 61.04 m. Silt layer between about 61.09 m and 61.1 m.		42		PQ			100									
63																		
64		Dark reddish-brown silt and clay layer between about 63.7 m and 63.8 m, rare fine gravel. Sand and gravel layer/lense between about 64.0 m and 64.03 m.		43		PQ			95									
65		Increasing grey limestone cobble and rock pieces below about 65 m.		44		PQ			97									
65.4		<u>LIMESTONE BEDROCK</u> Grey fine grained to aphanitic limestone bedrock. Thin bedded.																
66		Silt and clay seam between about 66.22 m and 66.23 m.																
66.5		Borehole terminated at 66.5 m in limestone bedrock.																

9200701

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1B-96 1 of 1
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo	DATE: 29 January 1997 GEOLOGIST SS ELEVATION m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						N VALUE				WATER CONTENT (%)			
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD	15	30	45	60	10	20	30
		TOPSOIL Dark brown sandy silt topsoil with tree roots and rootlets, moist.															
0.5																	
0.8		Black organic layer between about 0.38 m to 0.51 m, moist to damp.															
1.1	1	SANDY SILT TILL Mottled brown sandy silt with occasional subrounded cobbles, trace rootlets, patchy limonite staining, dry.															
1.5																	
1.8		SAND AND GRAVEL Brown fine to coarse sand with fine to coarse subangular to subrounded gravel, dry.															
2		SAND Brown silty fine sand with rare subrounded cobble.															
3		Layers of brown clayey silt with some fine gravel interbedded with the silty fine sand from about 1.5 m to 1.8 m.															
4		Becoming fine sand below about 1.8 m Occasional medium sand layers less than 1 cm thick between about 3.1 m to 3.4 m.															
4.2		Clayey silt layers within the silty sand with occasional medium sand layers from about 3.4 m to 4.2 m. Medium sand layers were wet to saturated.															
4.9		Sand layers between 1 to 5 cm thick.															
5		SAND AND GRAVEL Fine to coarse sand with some gravel layers, patchy limonite staining within the coarser layers, limonite stained sand and gravel layer between about 4.22 m and 4.24 m, dry.															
5.7		Grey fine sand layer between about 4.7 m and 4.8 m.															
6		SILTY SAND TILL Brown-grey silty sand till with subangular gravel.															
7		SANDY SILT TO SILTY SAND Brown sandy silt, dry.															
8		Fine sand layers, about 5 cm thick between about 5.9 m and 6.4 m. Becoming thinly laminated fine sand between about 6.4 m and 7.1 m, dry.															
9		Brown silt layer between about 7.1 m and 7.3 m, DTPL. Brown fine silty sand, vaguely laminated, some medium sand below about 7.3 m.															
		Brown silt layer between about 8.9 m and 9.0 m. Grading to sandy silt.															

Printed: 9 MAR 98

BOREHOLE LOG

PROJECT: 96-326

BOREHOLE: GB1B-96 2 of 6

Greenbrook Capture Zone
Green brook Well Field, Kitchener
FOR: Regional Municipality of Waterloo

DATE: 29 January 1997

GEOLOGIST SS

ELEVATION m ASL

FOR: Regional Municipality of Waterloo																		
DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						N VALUE				WATER CONTENT (%)				
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD	15	30	45	60	10	20	30	40
11		Becoming fine sand with trace silt below about 9.9 m.																
12		Brown silt with trace fine sand between about 11.5 m and 11.8 m, saturated.																
12.4		Becoming reddish-brown silt below about 11.8 m, vaguely laminated, dry.																
13		Becoming brown silt below about 11.9 m, moist to wet.																
		Brown fine sand with trace silt, increasing silt with depth.																
		SANDY SILT																
		Brown sandy silt, saturated.																
		Reddish-brown silt layer between about 13.31 m and 13.34 m, laminated, dry.																
14		Brown fine sand with silt between about 13.6 m and 14.6 m.																
14.5																		
14.6		Brown silt between about 14.55 m and 14.63 m, thinly laminated, moist.																
14.9																		
15		Reddish-brown clayey silt between about 14.63 m and 14.95 m, thinly laminated, dry.																
		Brown medium sand with some fine sand and silt between about 14.95 m and 15.88 m, saturated.																
15.9																		
16		SILT AND CLAY																
		Reddish-brown silt and clay, thinly laminated, hard, DTPL.																
16.7		Increasing gravel content below about 16.6 m.																
		SANDY SILT TILL																
17		Grey-brown sandy silt till with subrounded to subangular gravel, DTPL, some sandier sections.																
18																		
19																		
		Siltier section between about 19.4 m and 23.7 m.																

BOREHOLE LOG

PROJECT: 96-326

BOREHOLE: GB1B-96 3 of 6

Greenbrook Capture Zone

Green brook Well Field, Kitchener

FOR: Regional Municipality of Waterloo

DATE: 29 January 1997

GEOLOGIST SS

ELEVATION m ASL

FOR: Regional Municipality of Waterloo																		
DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						N VALUE				WATER CONTENT (%)				
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD	15	30	45	60	10	20	30	40
21																		
22																		
23																		
24		Decreasing gravel content between about 23.7 m and 25.3 m.																
25																		
26																		
27																		
28																		
29																		

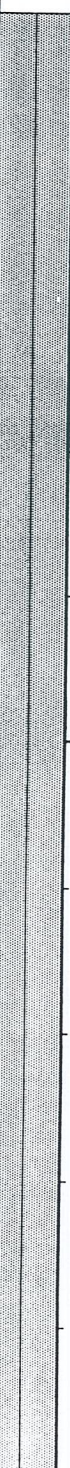
Gartner Lee Lim

Printed: 9 MAR 98

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1B-96 4 of 6
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 29 January 1997 GEOLOGIST SS ELEVATION m ASL

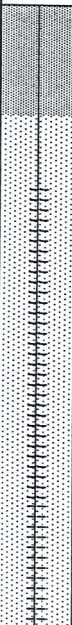
FOR: Regional Municipality of Waterloo																		
DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						N VALUE				WATER CONTENT (%)				
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD								
											15	30	45	60	10	20	30	40
31.0 31.1	31	Silty sand layer between about 30.35 m and 30.38 m, moist. Silt layer between about 30.48 m and 30.56 m, moist. Silt layer between about 30.73 m and 30.81 m. Silt layer between about 31.04 m and 31.06 m.																
	32																	
	33																	
	34																	
	35																	
	36	Sandier between about 35.5 m and 36.0 m.																
36.8		Sand and gravel layer between about 36.19 m and 36.22 m, some limonite staining within this layer.																
37		<u>SAND</u> Brown fine to medium sand, saturated.																
38																		
38.3		<u>SILT</u> Grey-brown silt, vaguely laminated, saturated.																
39.2	39	Grading into fine sand below about 39 m.																
		<u>SAND</u> Grey-brown fine sand with trace silt, saturated.																

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1B-96 5
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 29 January 1997 GEOLOGIST SS ELEVATION m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						N VALUE				WAT CONT (%)							
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD	15	30	45	60	10	20	30				
41		Becoming fine to medium sand below about 40.5 m, moist.																			
42																					
43																					
44				Becoming wet to saturated below about 43.6 m.																	
45																					
46																					
47.0		Becoming coarser with depth.																			
47		<u>SILT AND SAND LAYERS</u> Grey silt, vaguely laminated, moist to wet. Grey fine to medium sand between about 49.2 m and 49.5 m, vaguely laminated, some slightly coarser layers, wet. Grey silt layer between about 49.30 m and 49.31 m.																			
48																					
49				Grey laminated silt and fine to medium sand below about 49.7 m, laminations about 1 cm thick.																	
49.8			<u>SAND AND GRAVEL</u>																		

Printed: 9 MAR 98

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1B-96 6 of
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo	DATE: 29 January 1997 GEOLOGIST SS ELEVATION m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE							N VALUE				WATER CONTE (%)			
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD	15	30	45	60	10	20	30	
51		Grey sand and gravel with cobbles, saturated.																
52																		
53																		
54																		
54.4																		
55.0		<u>SILT</u> Dark grey silt, thinly laminated with clay layers, DTPL.																
55		Borehole terminated at 55.0 m in silt.																

332
51

281

9200701

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1C-96 1 of 1
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo	DATE: 29 January 1997 GEOLOGIST SS ELEVATION m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE							N VALUE				WATI CONTE (%)		
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD	15	30	45	60	10	20	30
		TOPSOIL Dark brown sandy silt topsoil with tree roots and rootlets, moist.															
0.5																	
0.8		Black organic layer between about 0.38 m to 0.51 m, moist to damp.															
1.1	1	SANDY SILT TILL Mottled brown sandy silt with occasional subrounded cobbles, trace rootlets, patchy limonite staining, dry.															
1.5																	
1.8		SAND AND GRAVEL Brown fine to coarse sand with fine to coarse subangular to subrounded gravel, dry.															
2																	
		SAND Brown silty fine sand with rare subrounded cobble. Layers of brown clayey silt with some fine gravel interbedded with the silty fine sand from about 1.5 m to 1.8 m. Becoming fine sand below about 1.8 m Occasional medium sand layers less than 1 cm thick between about 3.1 m to 3.4 m.															
3																	
4.2	4	Clayey silt layers within the silty sand with occasional medium sand layers from about 3.4 m to 4.2 m. Medium sand layers were wet to saturated. Sand layers between 1 to 5 cm thick.															
4.9																	
5		SAND AND GRAVEL Fine to coarse sand with some gravel layers, patchy limonite staining within the coarser layers, limonite stained sand and gravel layer between about 4.22 m and 4.24 m, dry. Grey fine sand layer between about 4.7 m and 4.8 m.															
5.7																	
6		SILTY SAND TILL Brown-grey silty sand till with subangular gravel. SANDY SILT TO SILTY SAND Brown sandy silt, dry. Fine sand layers, about 5 cm thick between about 5.9 m and 6.4 m. Becoming thinly laminated fine sand between about 6.4 m and 7.1 m, dry. Brown silt layer between about 7.1 m and 7.3 m, DTPL. Brown fine silty sand, vaguely laminated, some medium sand below about 7.3 m.															
7																	
8																	
9		Brown silt layer between about 8.9 m and 9.0 m. Grading to sandy silt.															

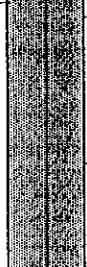
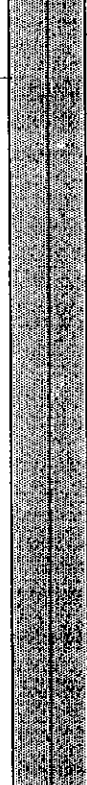
BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: GB1C-96 2 of
Greenbrook Capture Zone Green brook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 29 January 1997 GEOLOGIST SS ELEVATION m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE							N VALUE				WATER CONTENT (%)		
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC	% RQD							
											15	30	45	60	10	20	30
11		Becoming fine sand with trace silt below about 9.9 m.															
12		Brown silt with trace fine sand between about 11.5 m and 11.8 m, saturated.															
12.4		Becoming reddish-brown silt below about 11.8 m, vaguely laminated, dry.															
13		Becoming brown silt below about 11.9 m, moist to wet.															
		Brown fine sand with trace silt, increasing silt with depth.															
		SANDY SILT															
13.7		Brown sandy silt, saturated.															
		Reddish-brown silt layer between about 13.31 m and 13.34 m, laminated, dry.															
		Brown fine sand with silt between about 13.6 m and 14.6 m.															
		Borehole terminated at 13.7 m in sandy silt.															

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: K5A-I 1 of 5
Greenbrook Capture Zone Delineation Project Greenbrook Well Field, Kitchener FOR: Regional Municipality of Waterloo	DATE: 11 March 1997 GEOLOGIST PW/SS ELEVATION m ASL	

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						COMMENTS	
				NUMBER	INTERVAL	TYPE	N	VALUE	% WATER		% REC
0.2		<u>FILL</u> Light brown fine sand.									
1		<u>ORGANICS</u> Black muck with sand and subrounded gravel, moist. No gravel below about 1.2 m.									
2											
3.0											
3		Brown sandy silt with rootlets throughout, moist. Becoming grey fine to medium sand with some coarse sand, rare cobble, wet.		1		CS				63	
4.0				2		CS				43	
4		Grey fine to medium sand with some coarse sand interlayered with brown peaty rootlets and black muck.									
5		Sandier with depth.									
5.3				3		CS				20	
5.4		Light grey-brown marl. Dark grey to brown peat and organics, wet.									
6											
6.7				4		CS				50	
6.9		Olive green to grey marl interlayered with brown peat, organics and rootlets, moist.									
7.2		Dark brown muck, moist.									
7.6		<u>SILTY CLAY</u> Grey-brown silty clay with trace very fine gravel, WTPL.									
8		<u>SAND</u> Grey fine sand with some medium sand, wet. Thin brown silt layer at about 8.6 m, about 1 cm thick.		5		CS				50	
9				6		CS				68	

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: K5A-I 2 of 5
Greenbrook Capture Zone Delineation Project Greenbrook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 11 March 1997 GEOLOGIST PW/SS ELEVATION m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE					COMMENTS						
				NUMBER	INTERVAL TYPE	N VALUE	% WATER	% REC		% RQD					
10.4		SANDY SILT TO SILTY SAND TILL Grey sandy silt to silty sand with some gravel, moist.		7	CS			58							
11															
11.9		SILT TILL Grey sandy silt to silt with some fine gravel, DTPL. Less gravel with depth.		8	CS			58							
13															
14.3		CLAYEY SILT TO SILT TILL Reddish-brown silt to clayey silt with some sub-angular to rounded gravel, trace sand, APL.		9	CS			45							
15															
16		Some medium sand nodules below about 15.8 m.								10	CS			67	
17										11	CS			98	
18		Grey fine sand layer at about 18 m grading to medium sand at about 18.3 m, saturated, loose.													
19	Till becoming greyer in color below about 18.9 m.	12	CS			100									

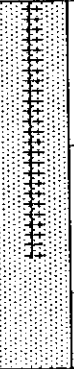
BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: K5A-I 3 of 5
Greenbrook Capture Zone Delineation Project Greenbrook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 11 March 1997 GEOLOGIST PW/SS ELEVATION m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						COMMENTS		
				NUMBER	INTERVAL	TYPE	N	VALUE	% WATER		% REC	% RQD
20.8				13		CS				100		
21.2	21	Some grey silt layers between about 20.8 m and 21.2 m, about 1 cm thick, some sand, wet.										
21.9		Silty sand between about 21.2 m and 21.9 m, well sorted, dense to compact.										
22	22	Coarse sand lenses at about 21.4 m and 21.6 m.										
		Coarse sand seam at about 21.9.		14		CS				88		
		Coarse sand seam at about 22.2 m.										
23		Coarse sand seam at about 22.8 m.										
23.5		Coarse sand seam at about 23.1 m.										
		SAND		15		CS				60		
24	24	Grey fine to medium sand, trace clay, saturated, loose.										
24.2		Becoming coarse sand below about 24 m.										
		SAND, GRAVEL AND COBBLES										
25		Medium gravel and cobbles with some coarse sand, angular to rounded limes tone, dolostone, granite and gneiss cobbles, saturated.		16		CS				0		
26												
27				17		CS				0		
28												
28				18		CS				0		
29												
29.6				19		CS				90		
29.9		Brown fine to coarse sand between about 29.6 m and 29.9 m.										

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: K5A-1 4 of 5
Greenbrook Capture Zone Delineation Project Greenbrook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 11 March 1997 GEOLOGIST PW/SS ELEVATION m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE					COMMENTS	
				NUMBER	INTERVAL	TYPE	N	VALUE		% WATER
30.2		Grey medium to fine sand between about 29.9 m and 30.2 m, trace fine gravel.								
30.5		Coarse sand and gravel, trace silt.								
31		Medium to coarse sand between about 30.5 m and 31.4 m, some gravel, trace silt, poorly sorted, loose.		20		CS			62	
31.4		Coarse sand, coarse gravel and cobbles, finer materials probably washed, red iron staining on some cobble surfaces.								
32		Less sand below about 32.6 m, grading to coarse gravel and cobbles.		21		CS			80	
33										
34		Sandy gravel to gravel with some to trace sand below about 34.1 m, coarse sand and medium to coarse gravel, poorly sorted.		22		CS			100	
35										
36		Some large cobbles below about 35.7 m.		23		CS			27	
37										
38				24		CS			100	
39					25		CS			67
		Some fine sand and clay below about 39.6 m.								

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: K5A-I 5 of 5
Greenbrook Capture Zone Delineation Project Greenbrook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 11 March 1997 GEOLOGIST PW/SS ELEVATION m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						COMMENTS		
				NUMBER	INTERVAL	TYPE	N	VALUE	% WATER		% REC	% RQD
41				26		CS				53		
41.7												
42		<u>SILT AND SAND</u> Brown-grey silt and sand with trace fine gravel, coarse sand, no cobbles		27		CS				100		
42.5		Borehole terminated at 42.5 m in silt and sand.										

BOREHOLE LOG	PROJECT: 96-326	BOREHOLE: K5A-II 1 of 1
Greenbrook Capture Zone Delineation Project Greenbrook Well Field, Kitchener FOR: Regional Municipality of Waterloo		DATE: 12 March 1997 GEOLOGIST SS ELEVATION m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						COMMENTS	
				NUMBER	INTERVAL	TYPE	N	VALUE	% WATER		% REC
0.2		FILL Light brown fine sand.									
1		ORGANICS Black muck with sand and subrounded gravel, moist. No gravel below about 1.2 m.									
2											
3.0											
3		Brown sandy silt with rootlets throughout, moist. Becoming grey fine to medium sand with some coarse sand, rare cobble, wet.									
4.0											
4.3		Grey fine to medium sand with some coarse sand interlayered with brown peaty rootlets and black muck. Borehole terminated at 4.3 m in sand.									

CH2M HILL ENGINEERING LTD.

PROJECT NUMBER: ONT29803.A0

WELL NUMBER: M4
Page 1 of 4

K-GB-M4-94-(A-B)

MONITORING WELL DRILLING & CONSTRUCTION LOG

CLIENT NAME: RMOW

LOCATION: BIRCHCLIFFE AVE.

DATE DRILLED: 14/01/94

LOGGER: PRL

DRILL COMPANY: ALL TERRAIN DRILLING LTD.

DRILLING METHOD: CONTINUOUS CORE

ELEVATIONS: -SURFACE ELEV.: 347 m.a.s.l.

(METERS) -TOP OF DEEP RISER: NA

-TOP SHALLOW RISER: NA

-TOTAL DEPTH: 75.29

EASTING: 539250

NORTHING: 4807900

DEPTH BELOW SURFACE (METERS)	SOIL SAMPLE			SOIL DESCRIPTION NAME, COLOUR, SOIL STRUCTURE PARTIAL SIZE DISTRIBUTION, MOISTURE CONTENT, PLASTICITY, DENSITY.	WELL CONSTRUCTION CASING, SCREEN INTERVAL, SAND PACK, SEAL, ETC.
	INTER- VAL (METERS)	TYPE AND NUMBER	RE- COVERY (M)		
		CONTINUOUS CS			
0		CS1	0.87	SANDY SILT (0 - 0.91 m) -tan/brown sandy silt, occasional pebbles	 Well Seal (0 - 48.5 m) bentonite slurry injected into place
		CS2	1.50	CLAYEY SILT (0.91 - 2.27 m) -brown clayey silt, minor sand becoming sandier with depth -2.27 - 2.44 m wet fine sand	
		CS3	0.89	PEBBLY CLAYEY SILT (2.44 - 5.18 m) -brown/tan pebbly clayey silt, minor sand seams -some dilatant tan silt zones 3.96 - 5.18 m	
5		CS4	1.12		
		CS5	0.87	CLAY (5.18 - 14.93 m) -soft grey clay stiffening towards lower contact, minor sand -small sand seams 11.28 - 12.80 m -grey sandy silt 14.32 - 14.42 m	
		CS6	0.40		
		CS7	0.46		
10		CS8	1.0		
		CS9	0.92		
		CS10	0.98		
15		CS11	1.45	SILTY SAND (14.93 - 19.81 m) -dark grey/brown silty medium to fine sand, occasional coarse sand -saturated, some dilatant zones	
		CS12	1.52		
		CS13	1.3		
20		CS14	1.27		

MONITORING WELL DRILLING & CONSTRUCTION LOG

CLIENT NAME: RMOW
LOCATION: BIRCHCLIFFE AVE.
DATE DRILLED: 14/01/94
LOGGER: PRL
DRILL COMPANY: ALL TERRAIN DRILLING LTD.

DRILLING METHOD: CONTINUOUS CORE
ELEVATIONS: -SURFACE ELEV.: 347 m.a.s.l.
(METERS) -TOP OF DEEP RISER: NA
-TOP SHALLOW RISER: NA
-TOTAL DEPTH: 75.29
EASTING: 539250
NORTHING: 4807900

DEPTH BELOW SURFACE (METERS)	SOIL SAMPLE			SOIL DESCRIPTION		WELL CONSTRUCTION	
	INTER- VAL (METERS)	TYPE AND NUMBER	RE- COVERY (M)	NAME, COLOUR, SOIL STRUCTURE PARTIAL SIZE DISTRIBUTION, MOISTURE CONTENT, PLASTICITY, DENSITY.		CASING, SCREEN INTERVAL, SAND PACK, SEAL, ETC.	
		CONTINUOUS CS					
20							
		CS15	0.43	SAND AND GRAVEL/COBBLESb (19.81 - 21.95 m) -coarse sand, gravel sub to well rounded, cobble rounded, 6-8 cm			
		CS16	0.30	SILTY SAND AND GRAVEL (21.95 - 31.7 m) -grey silty coarse sand and gravel - poorly sorted, gravel is medium to coarse grained - gravel coarsens with depth, increase in % of cobbles with depth			
		CS17	0				
25		CS18	0.30				
		CS19	0.10				
		CS20	0.15	CLAYEY SILT (31.7 - 34.14 m) -dark brown clayey silt, stiff to hard -occasional coarse sand			
30		CS21	0				
		CS22	0.90	CLAY (34.14 - 35.66 m) -dark brown clay, hard, minor coarse sand to fine gravel			
		CS23	1.5				
35		CS24	1.5	SILTY CLAY (35.66 - 36.36 m) -dark brown silty clay, hard, slight increase in % of sand and gravel			
		CS25	1.5				
		CS26	1.38	SANDY SILT (36.36 - 40.23 m) -dark brown fine grained sandy silt, saturated, loose to compact -change to grey sandy silt at 37.19 m, pebbles up to 4 cm - sandy zones, dilatant zones			
		CS27	0.57				
40							

MONITORING WELL DRILLING & CONSTRUCTION LOG

CLIENT NAME: RMOW
LOCATION: BIRCHCLIFFE AVE.

DATE DRILLED: 14/01/94

LOGGER: PRL

DRILL COMPANY: ALL TERRAIN DRILLING LTD.

DRILLING METHOD: CONTINUOUS CORE
ELEVATIONS: -SURFACE ELEV.: 347 m.a.s.l.
(METERS) -TOP OF DEEP RISER: NA
-TOP SHALLOW RISER: NA
-TOTAL DEPTH: 75.29

EASTING: 539250
NORTHING: 4807900

DEPTH BELOW SURFACE (METERS)	SOIL SAMPLE			SOIL DESCRIPTION		WELL CONSTRUCTION	
	INTER- VAL (METERS)	TYPE AND NUMBER	RE- COVERY (M)	NAME, COLOUR, SOIL STRUCTURE PARTICULAR SIZE DISTRIBUTION, MOISTURE CONTENT, PLASTICITY, DENSITY.		CASING, SCREEN INTERVAL, SAND PACK, SEAL, ETC.	
		CONTINUOUS CS					
40		CS28	1.05	SAND (40.23 - 41.75 m) -clean medium to coarse sand, minor fine sand			
		CS29	1.53	PEBBLY SILT (41.75 - 50.90 m) -grey pebbly silt, minor sand, occasional limestone cobbles near upper contact (41.75 - 43.28 m) and lower contact (46.32 - 47.85 m).			
		CS30	1.53				
45		CS31	0.74				
		CS32	1.53				
		CS33	1.5	-stiff tan pebbly silt, increasing clay %, changing to green colour near lower contact.			
50		CS34	1.32				
		CS35	0.85	SAND (50.90 - 53.17 m) - clean green/tan medium sand, dense, uniform texture, fining to very fine sand at 53.17 m.			
		CS36	1.53				
		CS37	1.6	SILTY SAND (53.17 - 56.5 m) -green becoming tan silty fine to medium sand, stiff, fining to very fine sand and silt, occasional limestone cobbles. Colour changes to tan at 55.5 m			
55		CS38	1.53				
		CS39	1.4	SAND (56.5 - 58.54 m) -medium to coarse sand, clean, uniform. Small zones of fine to medium sand.			
		CS40	1.5				
60							

Well Seal
(48.5 -
49.90 m)
bentonite
holeplug

Filter Pack
(49.90 -
55.20 m)
#1 silica
sand

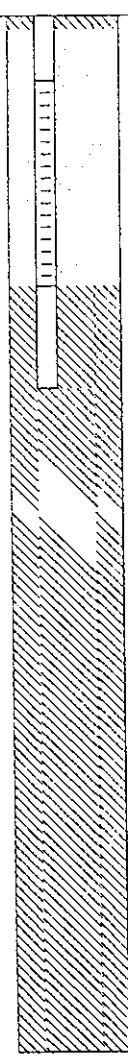
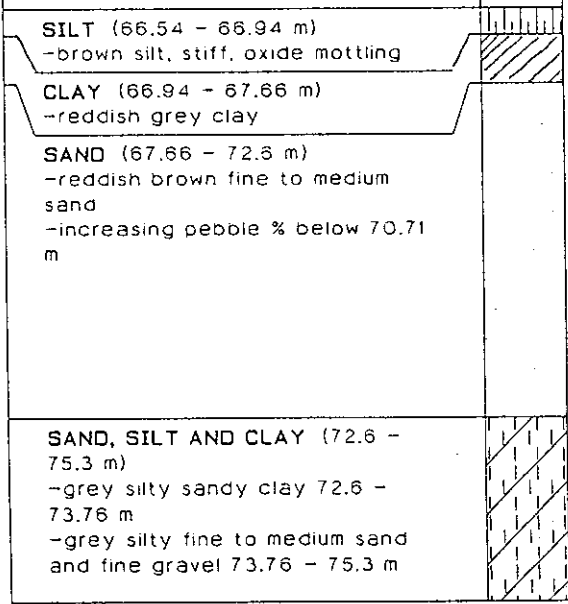
Well Screen
(50.60 -
53.60 m)
-stainless
steel #10
slot

Well Seal
(53.60 -
60.20 m)
bentonite
holeplug

MONITORING WELL DRILLING & CONSTRUCTION LOG

CLIENT NAME: RMOW
LOCATION: BIRCHCLIFFE AVE.
DATE DRILLED: 14/01/94
LOGGER: PRL
DRILL COMPANY: ALL TERRAIN DRILLING LTD.

DRILLING METHOD: CONTINUOUS CORE
ELEVATIONS: -SURFACE ELEV.: 347 m.a.s.l.
(METERS) -TOP OF DEEP RISER: NA
-TOP SHALLOW RISER: NA
-TOTAL DEPTH: 75.29
EASTING: 539250
NORTHING: 4807900

DEPTH BELOW SURFACE (METERS)	SOIL SAMPLE			SOIL DESCRIPTION		WELL CONSTRUCTION	
	INTER- VAL (METERS)	TYPE AND NUMBER	RE- COVERY (M)	NAME, COLOUR, SOIL STRUCTURE PARTIAL SIZE DISTRIBUTION, MOISTURE CONTENT, PLASTICITY, DENSITY.		CASING, SCREEN INTERVAL, SAND PACK, SEAL, ETC.	
		CONTINUOUS CS					
60		CS41	0.95	-reddish brown fine to medium sand, clean			Filter Pack (60.20 - 64.00 m) #1 silica sand Well Screen (60.96 - 64.00 m) stainless steel # 10 slot Well Seal (64.00 - 75.29 m) bentonite holeplug
		CS42	0.80				
		CS43	0.7				
65		CS44	1.3	-brown fine sand, clean			
		CS45	1.5	SILT (66.54 - 66.94 m) -brown silt, stiff, oxide mottling			
		CS46	1.5	CLAY (66.94 - 67.66 m) -reddish grey clay			
		CS47	0.8	SAND (67.66 - 72.6 m) -reddish brown fine to medium sand -increasing pebble % below 70.71 m			
70		CS48	1.25				
		CS49	1.35	SAND, SILT AND CLAY (72.6 - 75.3 m) -grey silty sandy clay 72.6 - 73.76 m			
		CS50	1.24	-grey silty fine to medium sand and fine gravel 73.76 - 75.3 m			
75							
80							

Monitoring Well: K-GB-OW1-08

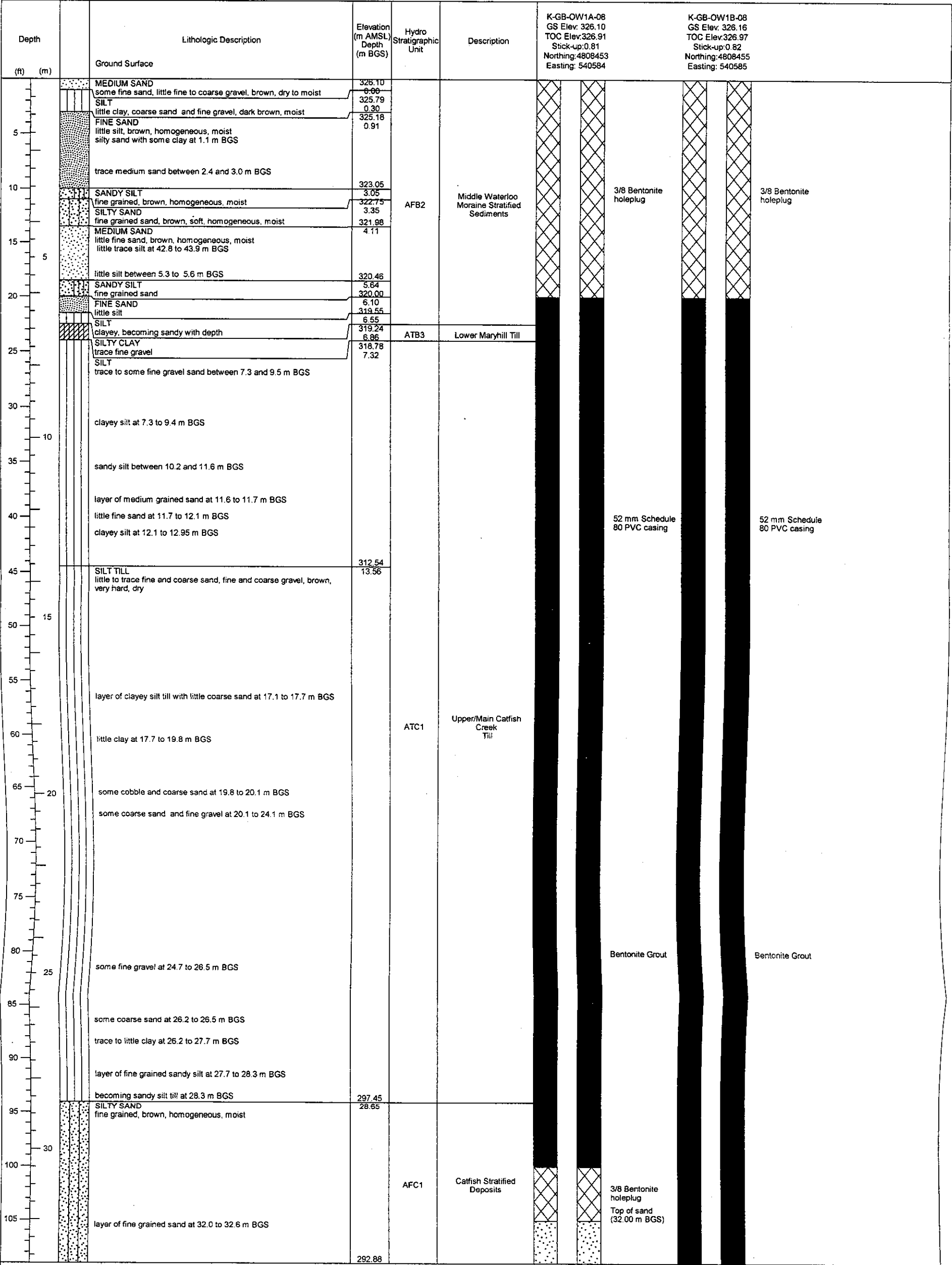
K-GB-OW1-08-(A-B)

Project: K1 and K2 Replacement
Client: Region of Waterloo
Location: Greenbrook Well Field - adjacent to K1
Number: 1609-00487
Field investigator: K.McLagan/L.Veale
Contractor: Boart Longyear

Drilling method: Pro sonic SR127 track mount
Date started/completed: Dec-8-2008 / Dec-12-2008
Ground surface elevation: 326.10 m AMSL

9203595

9203585

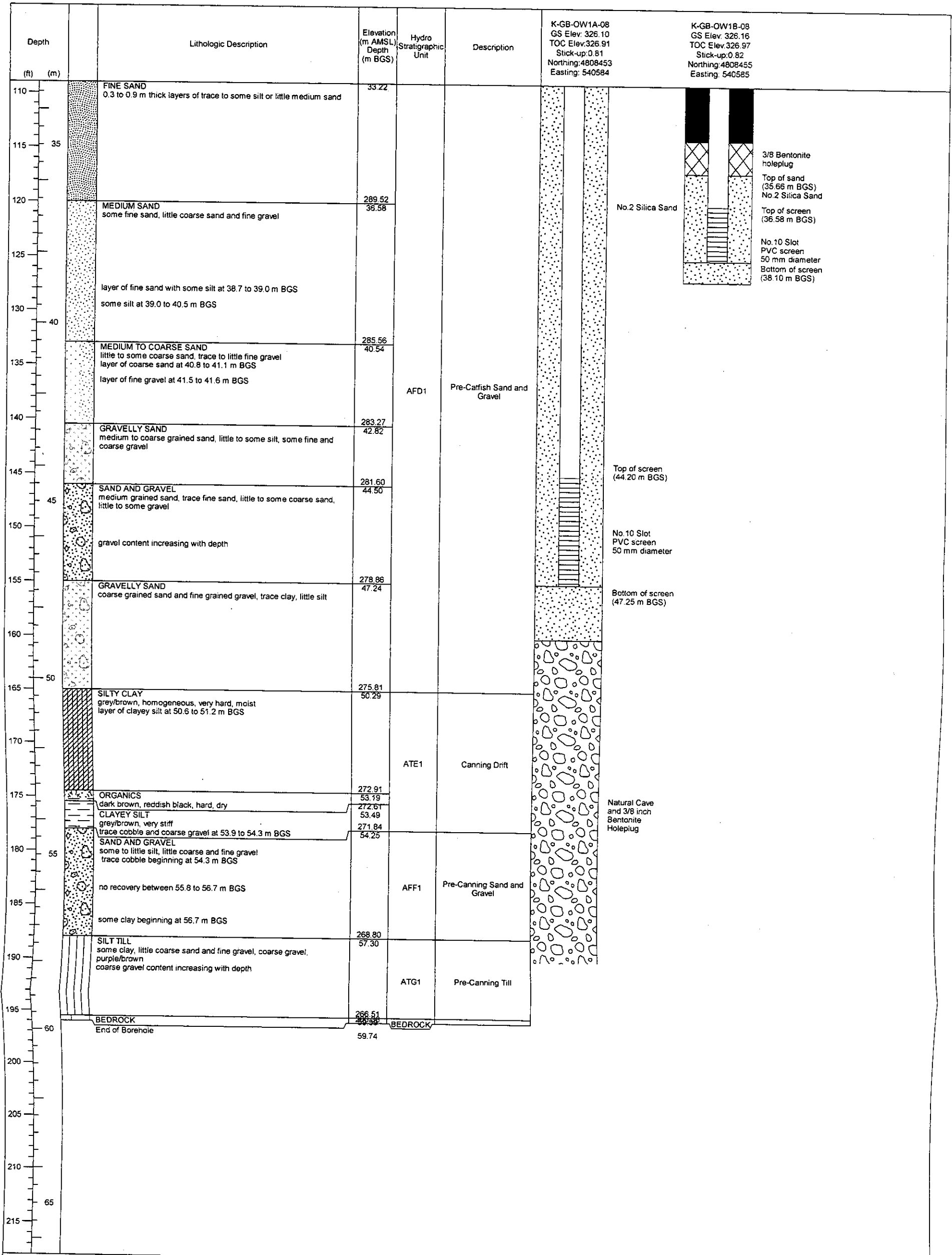


NOTES:
TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
mAMSL - metres above mean sea level
mBGS - metres below ground surface

Monitoring Well: K-GB-OW1-08

Project: K1 and K2 Replacement
Client: Region of Waterloo
Location: Greenbrook Well Field - adjacent to K1
Number: 1609-00487
Field investigator: K.McLagan/L.Veale
Contractor: Boart Longyear

Drilling method: Pro sonic SR127 track mount
Date started/completed: Dec-8-2008 / Dec-12-2008
Ground surface elevation: 326.10 m AMSL



NOTES:

TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
mASL - metres above mean sea level
mBGS - metres below ground surface



Monitoring Well: K-GB-OW2-08

K-GB-OW2-08-(A-B-C)

Project: K1 and K2 Replacement
Client: Region of Waterloo
Location: Greenbrook Well Field - adjacent to K2
Number: 1609-00487
Field investigator: K.McLagan/L.Veale
Contractor: Boart Longyear

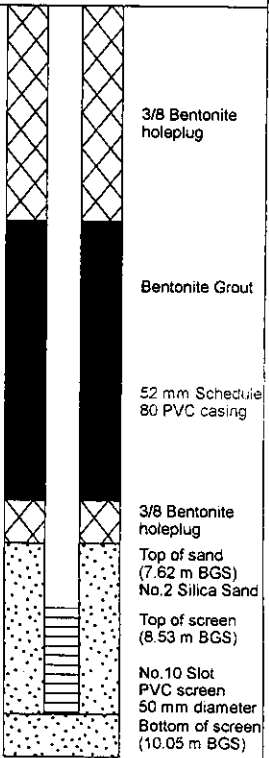
Drilling method: Pro sonic SR127 track mount
Date started/completed: Dec-4-2008 / Dec-17-2008
Ground surface elevation: 327.13 m AMSL

9203596

9203582

9205730

Depth (ft) (m)	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	K-GB-OW2A-08 GS Elev: 327.13 TOC Elev: 327.90 Stick-up: 0.78 Northing: 4808313 Easting: 540546	K-GB-OW2B-08 GS Elev: 327.20 TOC Elev: 328.04 Stick-up: 0.83 Northing: 4808310 Easting: 540544	K-GB-OW2C-08 GS Elev: 327.19 TOC Elev: 328.07 Stick-up: 0.87 Northing: 4808312 Easting: 540545
	Ground Surface						
	SILTY SAND fine grained sand, some fine gravel, brown, dry to moist	327.13 0.00					
5	FINE SAND some silt and medium grained sand, brown, dry	326.21 0.91					
	FINE SAND some silt, brown, dry	325.30 1.83					
10	increasing silt content at 3.1 m BGS						
15	some medium sand at 4.3 m BGS						
5	SILTY CLAY AND SAND layered deposits 5 to 10 cm thick of silty clay, medium and coarse sand, silt	322.25 4.88	AFB2	Middle Waterloo Moraine Stratified Sediments			
20	FINE SAND trace medium sand, light greyish brown	321.03 6.10					
25	layer of clayey silt at 7.0 to 7.1 m BGS some medium sand at 7.1 to 7.3 m BGS becoming coarser with depth						
30	increasing to fine and medium grained at 8.2 m BGS increasing to medium sand, little fine gravel, trace fine sand at 8.5m BGS						
10	SANDY SILT coarse grained, little fine gravel	317.99 9.14					
	MEDIUM TO COARSE SAND	317.53 9.60					
35	MEDIUM SAND little fine sand, trace fine gravel	317.22 9.91					
	cobble at 11.0 m BGS						
40	SILTY CLAY grey brown, stiff, moist	316.16 10.97					
45	trace coarse sand beginning at 14.0 m BGS		ATB3	Lower Maryhill Till			
15	CLAYEY SILT TILL some coarse sand and fine gravel, very stiff	313.11 14.02					
55	CLAYEY SILT stiff	310.97 16.15					
	SILT trace fine sand	310.67 16.46					
60	SILT TILL coarse gravel (rounded particles), very stiff	310.06 17.07					
	SILT grey brown, stiff	308.54 18.59					
20	SILT TILL fine to coarse gravel, very hard	307.13 19.99					
75	becoming very stiff at 23.2 m BGS						
80			ATC1	Upper/Main Catfish Creek Till			
85	SILT stiff	301.22 25.91					
90	SILT TILL little clay, little gravel, stiff	300.31 26.82					
30	SAND TILL fine grained sand, some silt, little coarse sand and fine gravel, yellowish brown	298.78 28.35					
100	silty sand till with little coarse sand and gravel at 29.3 to 29.9 m BGS increasing gravel and cobble content with depth						
105	FINE TO MEDIUM SAND some silt, little gravel	295.28 31.85	AFC1	Catfish Stratified Deposits			
		294.97 32.16					



NOTES:

TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
mAMSL - metres above mean sea level
mBGS - metres below ground surface

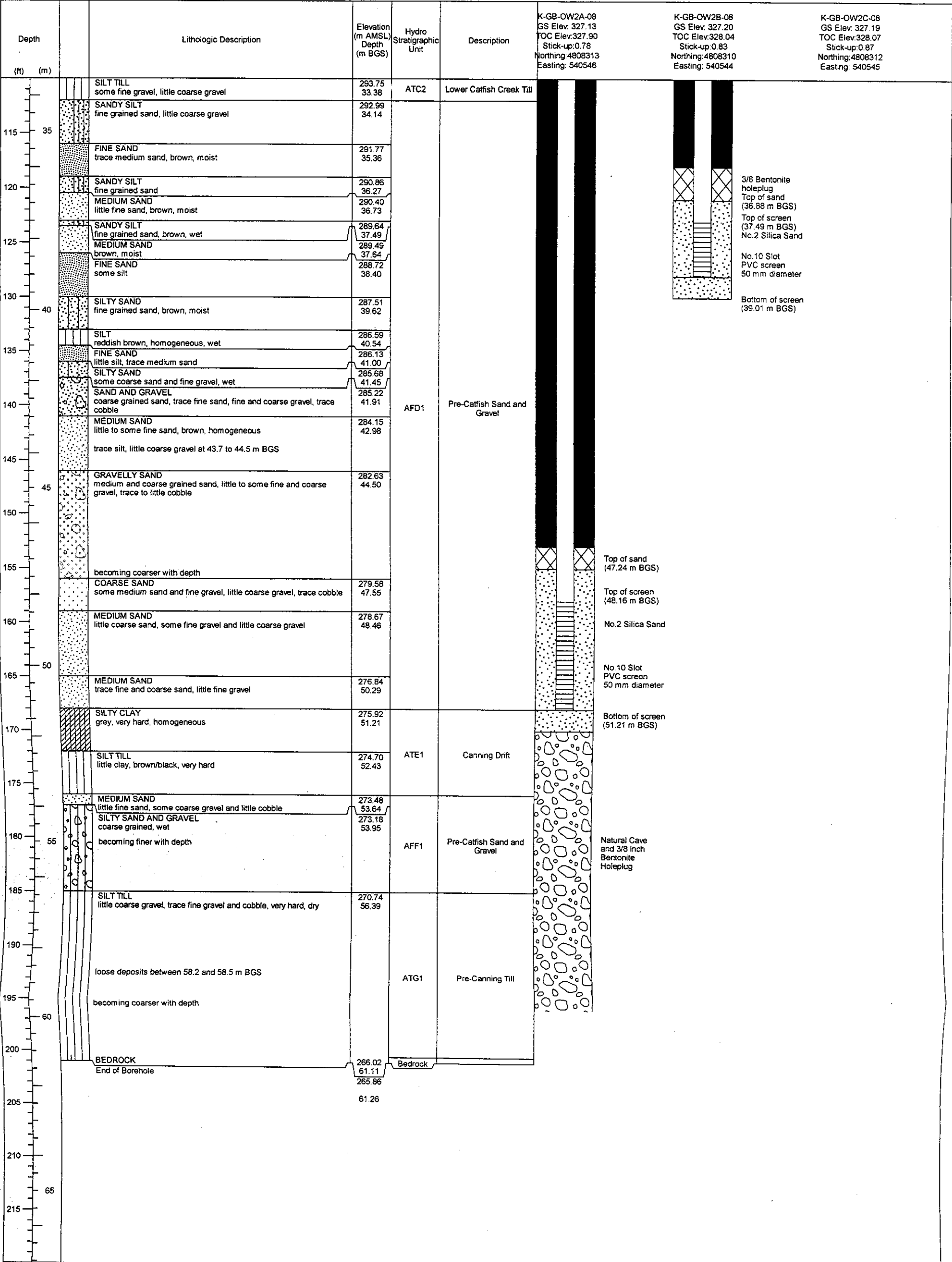


Sheet 1 of 2

Monitoring Well: K-GB-OW2-08

Project: K1 and K2 Replacement
Client: Region of Waterloo
Location: Greenbrook Well Field - adjacent to K2
Number: 1609-00487
Field investigator: K.McLagan/L.Veale
Contractor: Boart Longyear

Drilling method: Pro sonic SR127 track mount
Date started/completed: Dec-4-2008 / Dec-17-2008
Ground surface elevation: 327.13 m AMSL



NOTES:
TCR - Total Core Recovery
SCR - Solid Core Recovery
RQD - Rock Quality Designation
mAMSL - metres above mean sea level
mBGS - metres below ground surface

Monitoring Well: K-GB-OW1-15

Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Cambridge, ON
Number: 160900798
Field investigator: C.Davis
Contractor: Gerrits Well Drilling Inc.

Drilling method: Air Rotary
Date started/completed: 04-Mar-2015
Ground surface elevation: 321.86 m AMSL
Top of casing elevation: 322.81 m AMSL
Easting: 540776
Northing: 4808689

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		INSTALLATION DETAILS	
Depth	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Diagram	Description
(ft)	(m)								
		Ground Surface	321.86						
		SAND AND GRAVEL dark grey, coarse sand, fine gravel, trace silt, moist, subangular - angular	0.00						
5	2								← Above ground stick up 0.95 m
10				Possible AFB2	Possible Middle Moraine Stratified Sediments				← 48.5 mm ID Schedule 80 PVC casing 1 m AGS - 32.6 m BGS
15	4					1	GB		← 254 mm Borehole 0 - 6.1 m BGS
20	6								← 155.5 mm ID steel casing 1 m AGS to 20 m BGS
		SANDY CLAY light grey brown, fine to coarse sand, some silt, trace fine gravel	315.76						
			6.10						
25									
30	8			Possible ATB3 or ATC1	Possible Lower Maryhill till or Upper/ Main Catfish Creek Till	2	GB		
10		sand content increasing at 8.5 m BGS							

Screen Interval: 32.61 - 35.66 m BGS
 Sand Pack Interval: 31.39 - 38.10 m BGS
 Well Seal Interval: 0.00 - 31.39 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 GB - grab sample
 n/a - not available

WRAS No. 9207187



Monitoring Well: K-GB-OW1-15

Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Cambridge, ON
Number: 160900798
Field investigator: C.Davis
Contractor: Gerrits Well Drilling Inc.

Drilling method: Air Rotary
Date started/completed: 04-Mar-2015
Ground surface elevation: 321.86 m AMSL
Top of casing elevation: 322.81 m AMSL
Easting: 540776
Northing: 4808689

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		INSTALLATION DETAILS	
Depth (ft) (m)	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Diagram	Description
35		SANDY CLAY light grey brown, fine to coarse sand, some silt, trace fine gravel	310.28						
40		CLAYEY SILT grey brown, little fine to coarse sand, trace gravel, moist gravel content increasing at 12.8 m - 13.7 m BGS	11.58						
45									
50						3	GB		
55									
60						4	GB		
65				Possible ATC1	Possible Upper/Main Catfish Creek Till				
20									

← Bentonite grout
0 - 24.38 m

← 160.8 mm Borehole
6.1 - 38.1 m BGS

Screen Interval: 32.61 - 35.66 m BGS
 Sand Pack Interval: 31.39 - 38.10 m BGS
 Well Seal Interval: 0.00 - 31.39 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 GB - grab sample
 n/a - not available

WRAS No. 9207187



Drawn By/Checked By: CD/LV

Sheet 2 of 4

Monitoring Well: K-GB-OW1-15

Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Cambridge, ON
Number: 160900798
Field investigator: C.Davis
Contractor: Gerrits Well Drilling Inc.

Drilling method: Air Rotary
Date started/completed: 04-Mar-2015
Ground surface elevation: 321.86 m AMSL
Top of casing elevation: 322.81 m AMSL
Easting: 540776
Northing: 4808689

SUBSURFACE PROFILE				HYDROGEOLOGY		SAMPLE DETAILS		INSTALLATION DETAILS	
Depth	Graphic Log	Lithologic Description	Elevation (m AMSL) Depth (m BGS)	Hydro Stratigraphic Unit	Description	Sample Number	Sample Type	Diagram	Description
(ft) (m)									
70		CLAYEY SILT grey brown, little fine to coarse sand, trace gravel, moist							
22									
75						5	GB		
24									
80									
			296.25						
85		SAND AND GRAVEL fine to coarse sand, fine to coarse gravel, little cobbles, trace silt, wet	25.60						
26									
90						6	GB		
28									
95									
30									

Bentonite Holeplug
24.38 - 31.4 m BGS

Screen Interval: 32.61 - 35.66 m BGS
 Sand Pack Interval: 31.39 - 38.10 m BGS
 Well Seal Interval: 0.00 - 31.39 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 GB - grab sample
 n/a - not available

WRAS No. 9207187



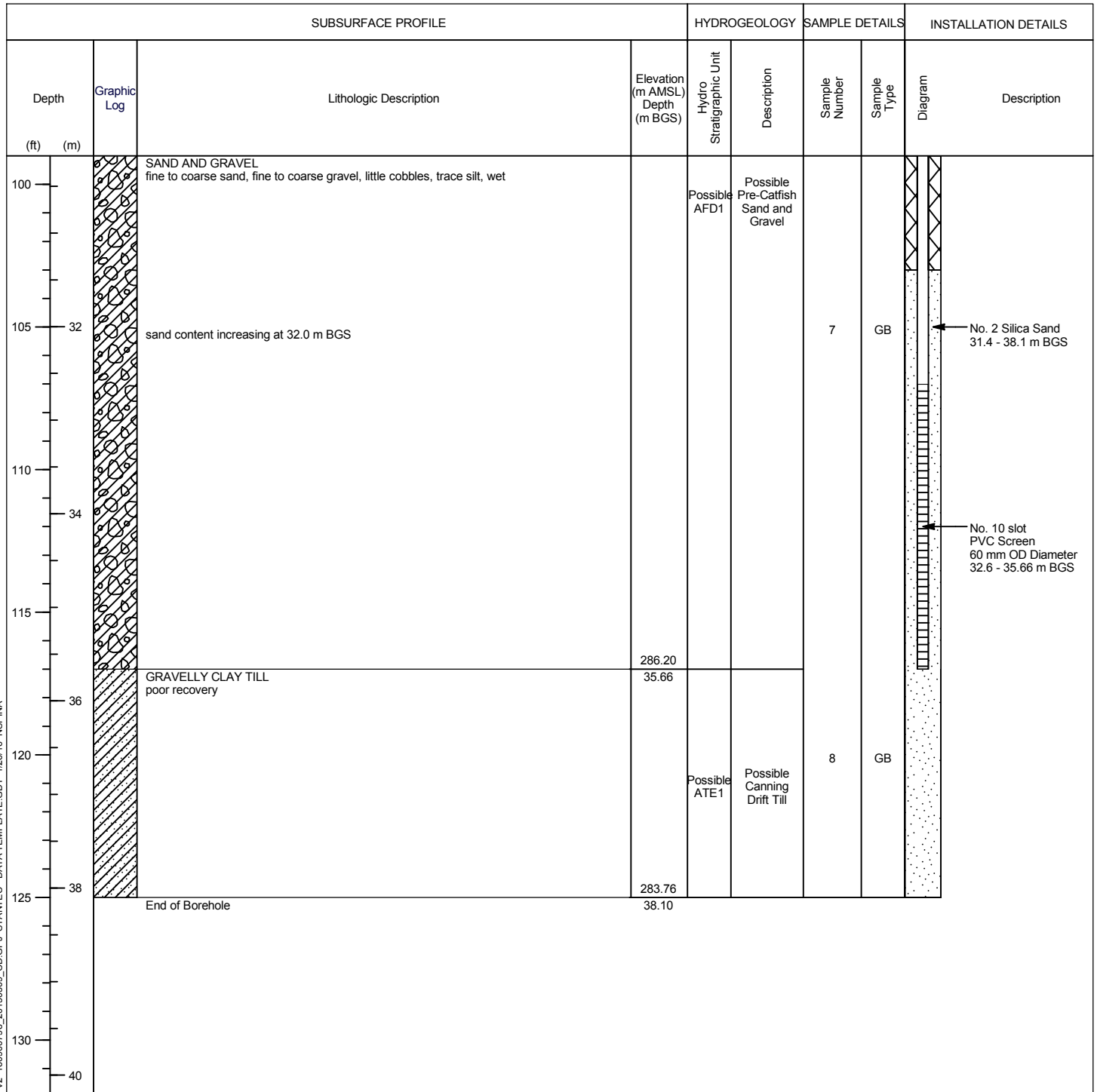
Drawn By/Checked By: CD/LV

Sheet 3 of 4

Monitoring Well: K-GB-OW1-15

Project: RMOW Well Replacement
Client: Regional Municipality of Waterloo
Location: Cambridge, ON
Number: 160900798
Field investigator: C.Davis
Contractor: Gerrits Well Drilling Inc.

Drilling method: Air Rotary
Date started/completed: 04-Mar-2015
Ground surface elevation: 321.86 m AMSL
Top of casing elevation: 322.81 m AMSL
Easting: 540776
Northing: 4808689



Screen Interval: 32.61 - 35.66 m BGS
 Sand Pack Interval: 31.39 - 38.10 m BGS
 Well Seal Interval: 0.00 - 31.39 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 GB - grab sample
 n/a - not available

WRAS No. 9207187



Drawn By/Checked By: CD/LV

Sheet 4 of 4



BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

Monitoring Data (Pumped Volumes and Hydrographs)



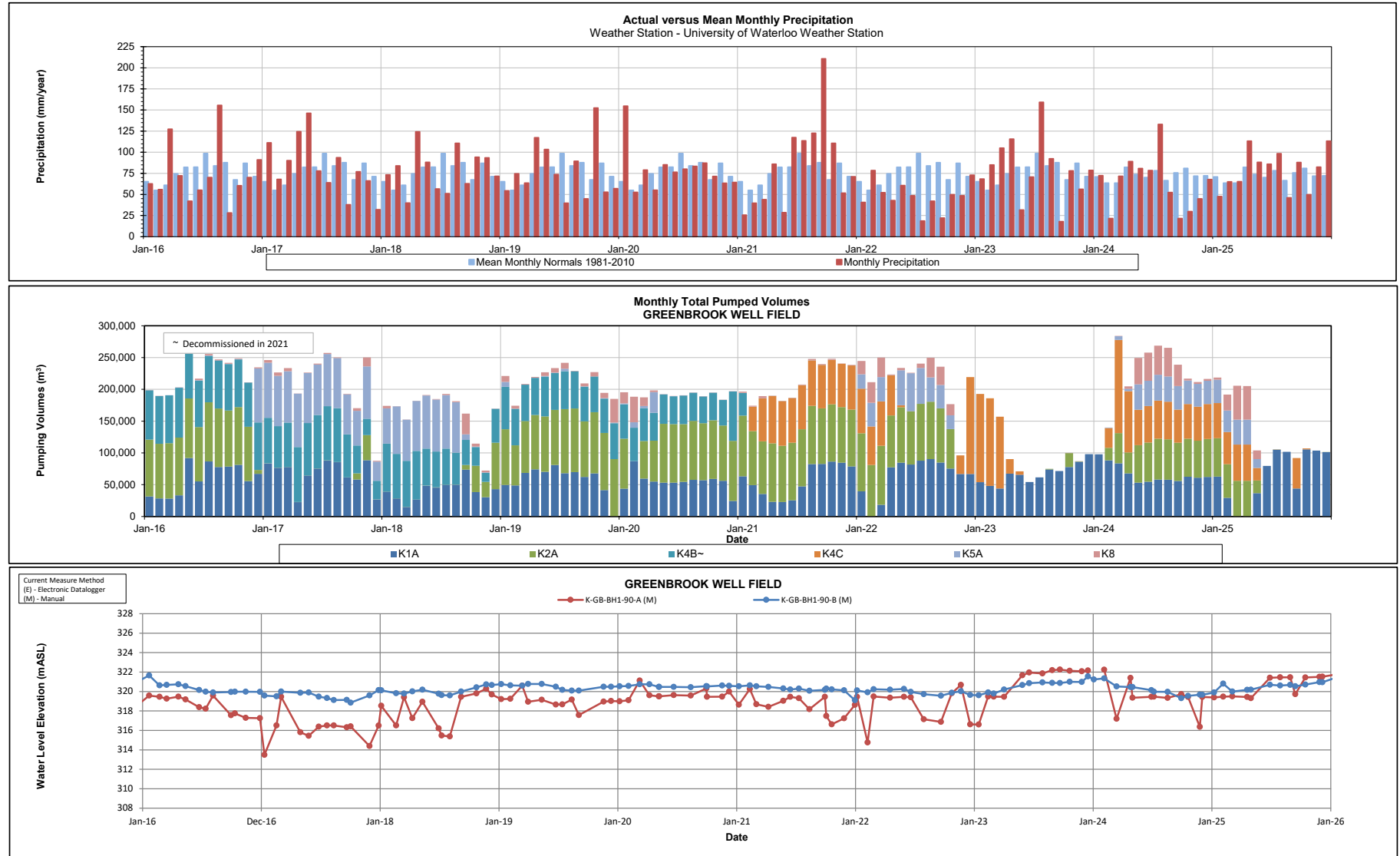
TABLE C-1
WELL FIELD WATER PRODUCTION SUMMARY
REGION OF WATERLOO - 2025 GROUNDWATER MONITORING REPORT



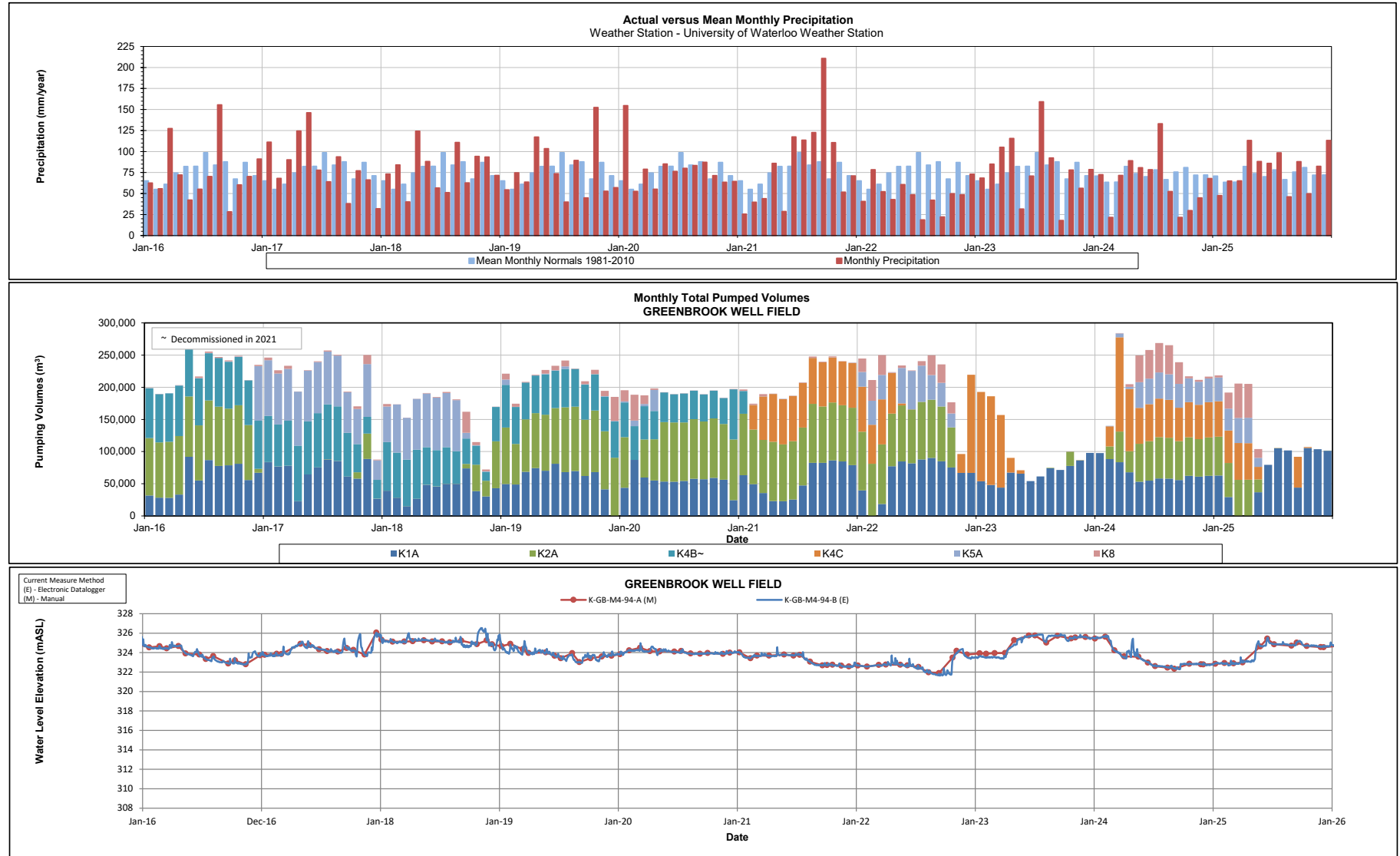
Well Field	Major or Minor Supply	Production Well Name	Permit to Take Water Details			2021 Production Summary			2022 Production Summary			2023 Production Summary			2024 Production Summary			2025 Production Summary		
			MOE Permit Number	Permitted Capacity (total m ³ /year)*	Permitted Rate (L/s)*	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)	Total Production Well Volume (total m ³ /year)	Average Daily Rate (m ³ /day)	Average Rate (L/s)
Greenbrook	Major	K1A	0071-BUKPU5	0071-BUKPU5		682,025	1,869	21.6	774,638	2,122	24.6	802,632	2,199	25.5	803,810	2,202	25.5	770,153	2,110	24.4
		K2A	0071-BUKPU5			1,070,079	2,932	33.9	844,409	2,313	26.8	22,977	63	0.7	586,043	1,606	18.6	246,030	674	7.8
		K4B	0071-BUKPU5			35,496	97	1.1	0	0	0.0	0	0	0.0	0	0	0	0	0	0
		K4C	0071-BUKPU5			737,013	2,019	23.4	448,347	1,228	14.2	417,418	1,144	13.2	721,334	1,976	22.9	288,755	791	9.2
		K5A	0071-BUKPU5			2,744	8	0.1	366,485	1,004	11.6	390	1	0.0	316,394	867	10.0	162,861	446	5.2
		K8	0071-BUKPU5			13,364	37	0.4	173,228	475	5.5	0	0	0.0	223,772	613	7.1	148,044	406	4.7
			Well Field Total	13,636,692	432.4	2,540,721	6,961	80.6	2,607,107	7,143	82.7	1,243,417	3,407	39.4	2,651,353	7,264	84.1	1,615,843	4,427	51.2
			* Maximum taken per day from all wells shall not exceed annual daily average of 37,360,800 L/day																	

Notes:
- = no applicable data
n/a = data not available
* = rates calculated based on the average annual taking limitation

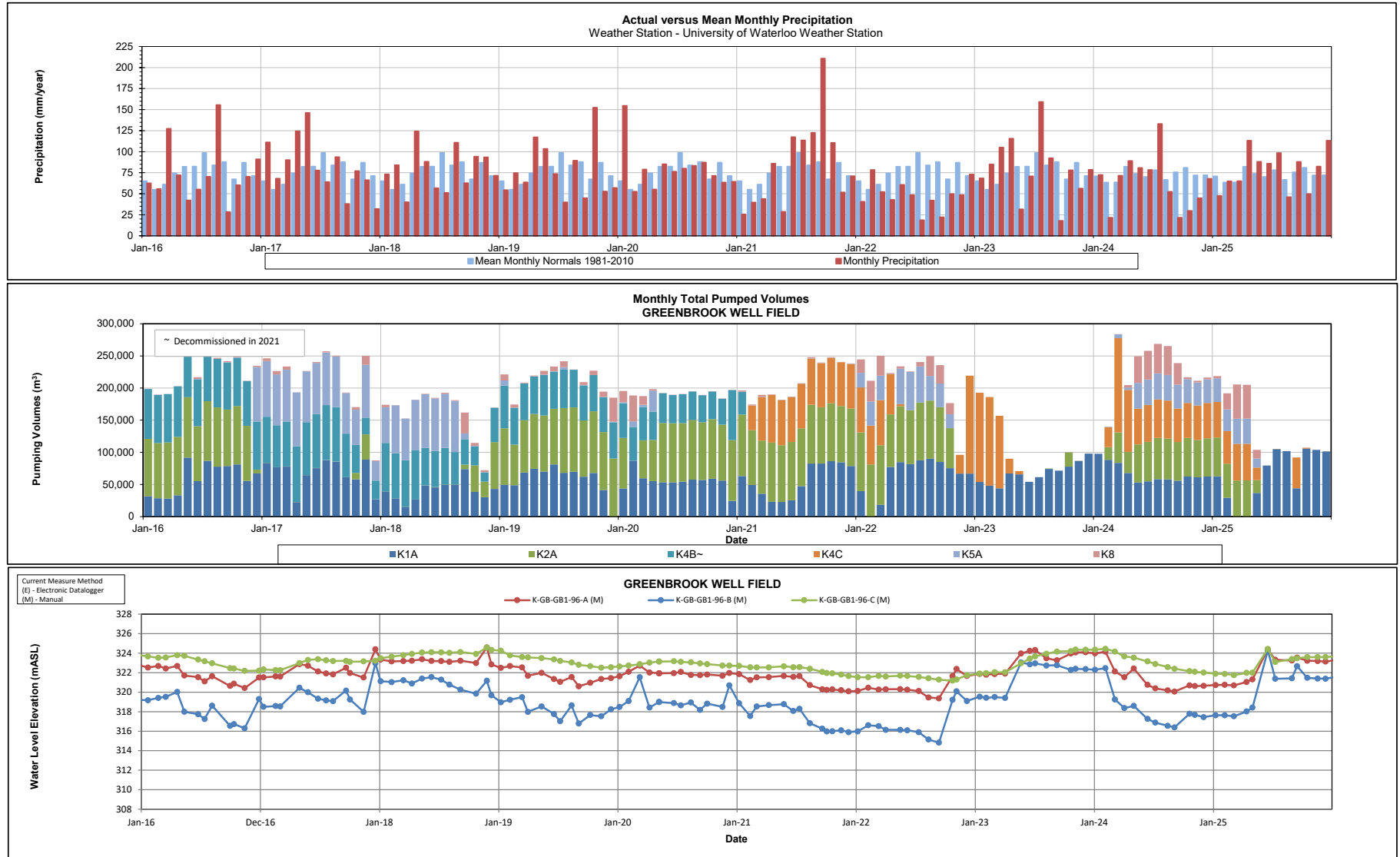
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
GREENBROOK



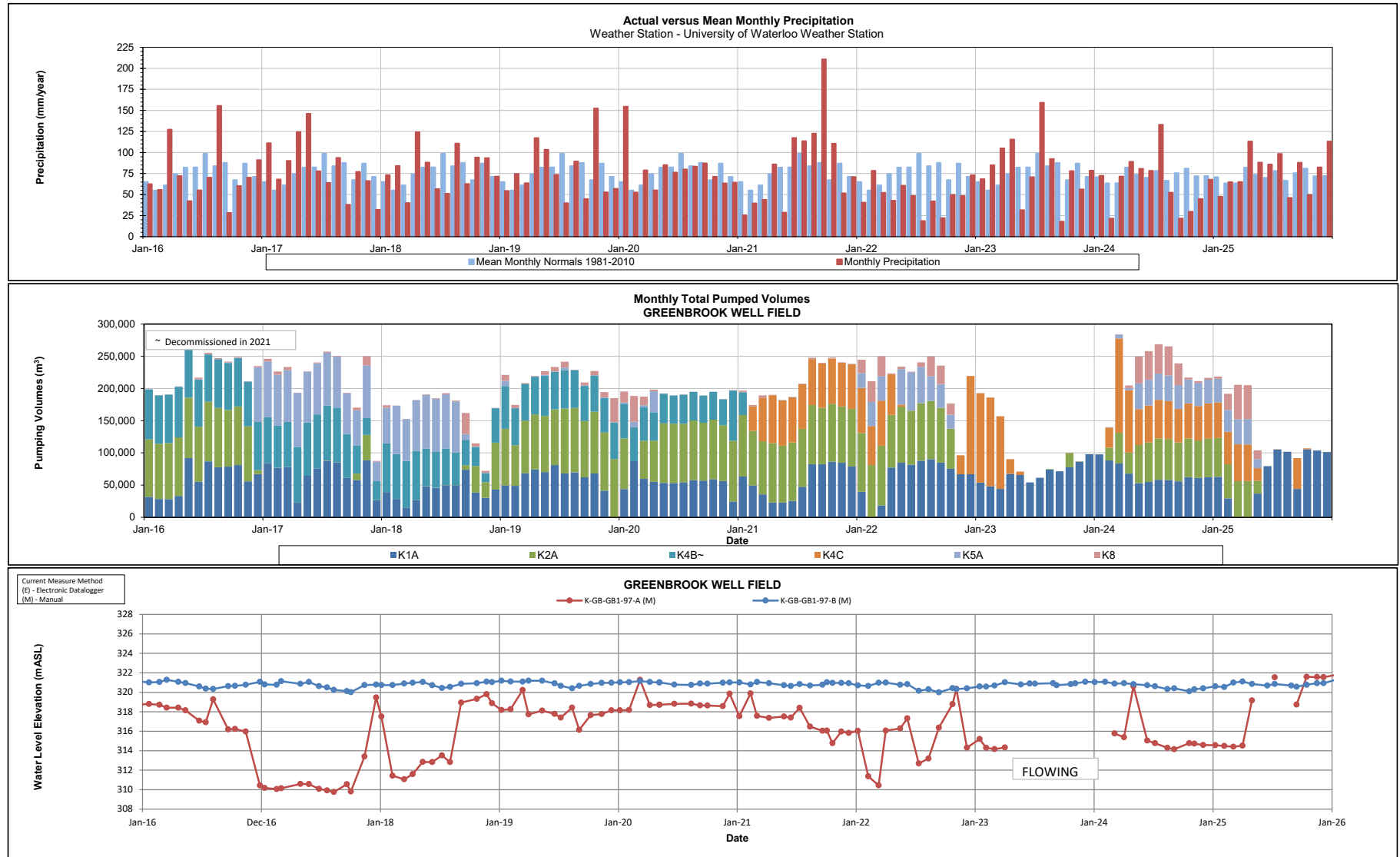
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
GREENBROOK



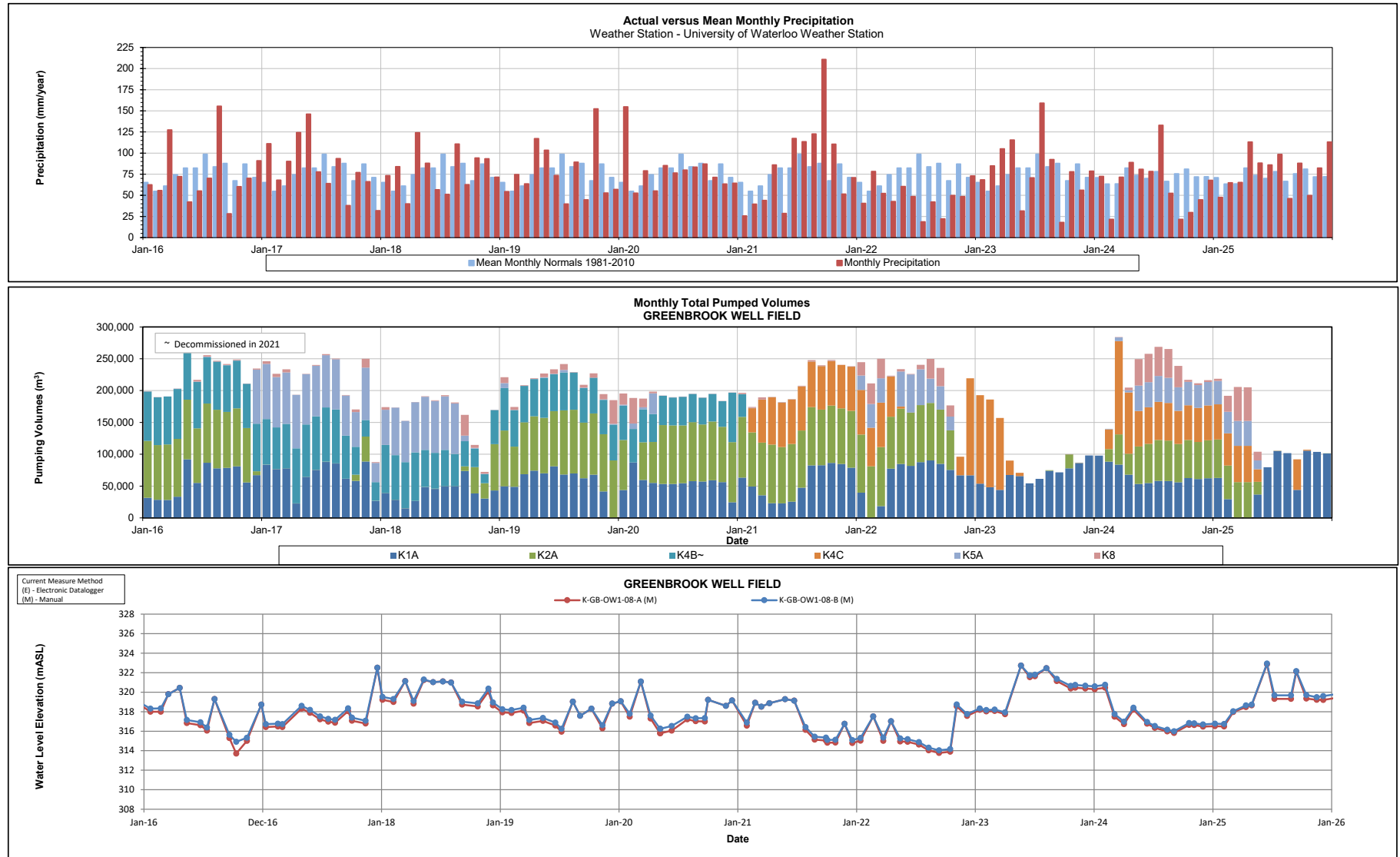
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
GREENBROOK



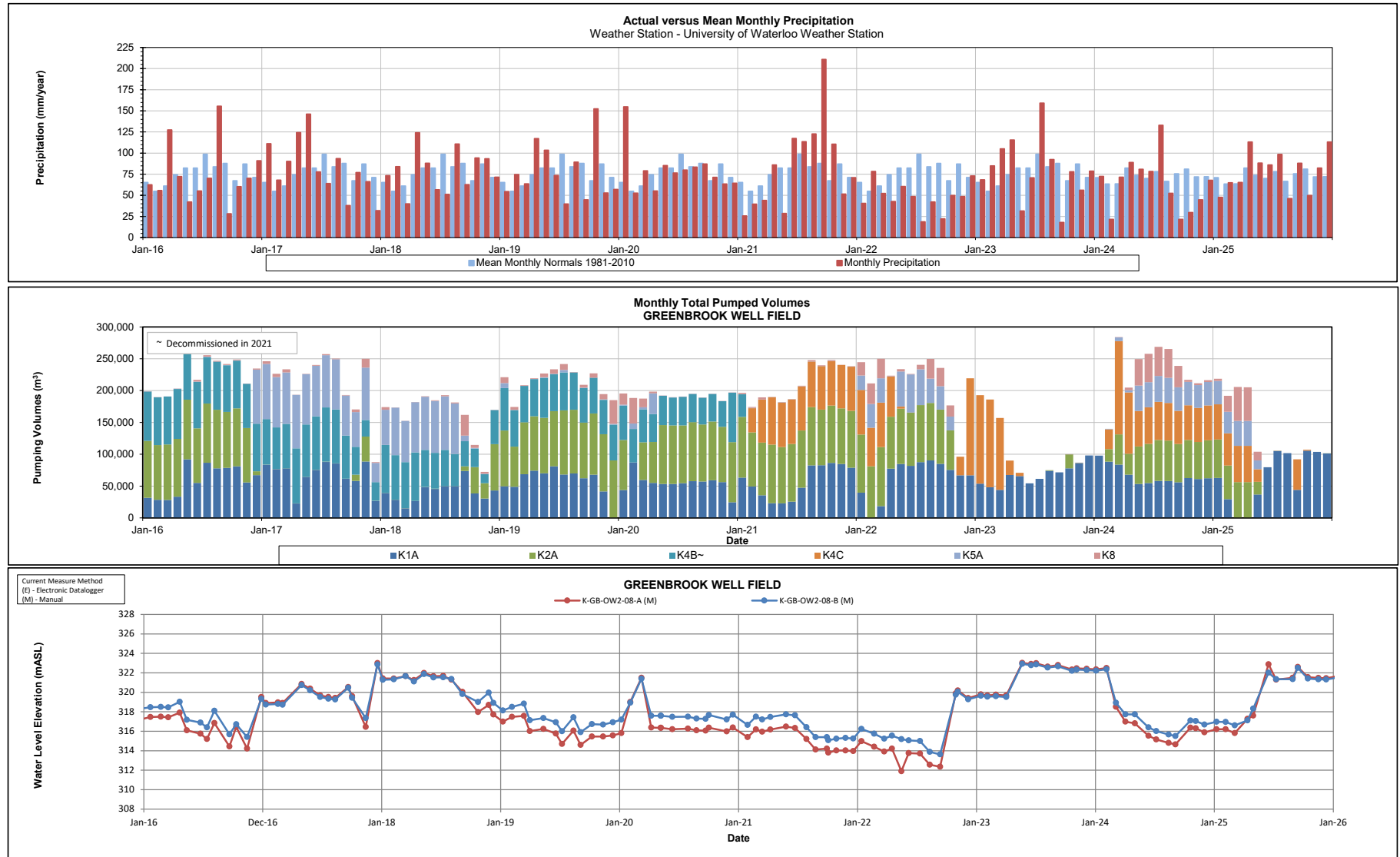
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
GREENBROOK



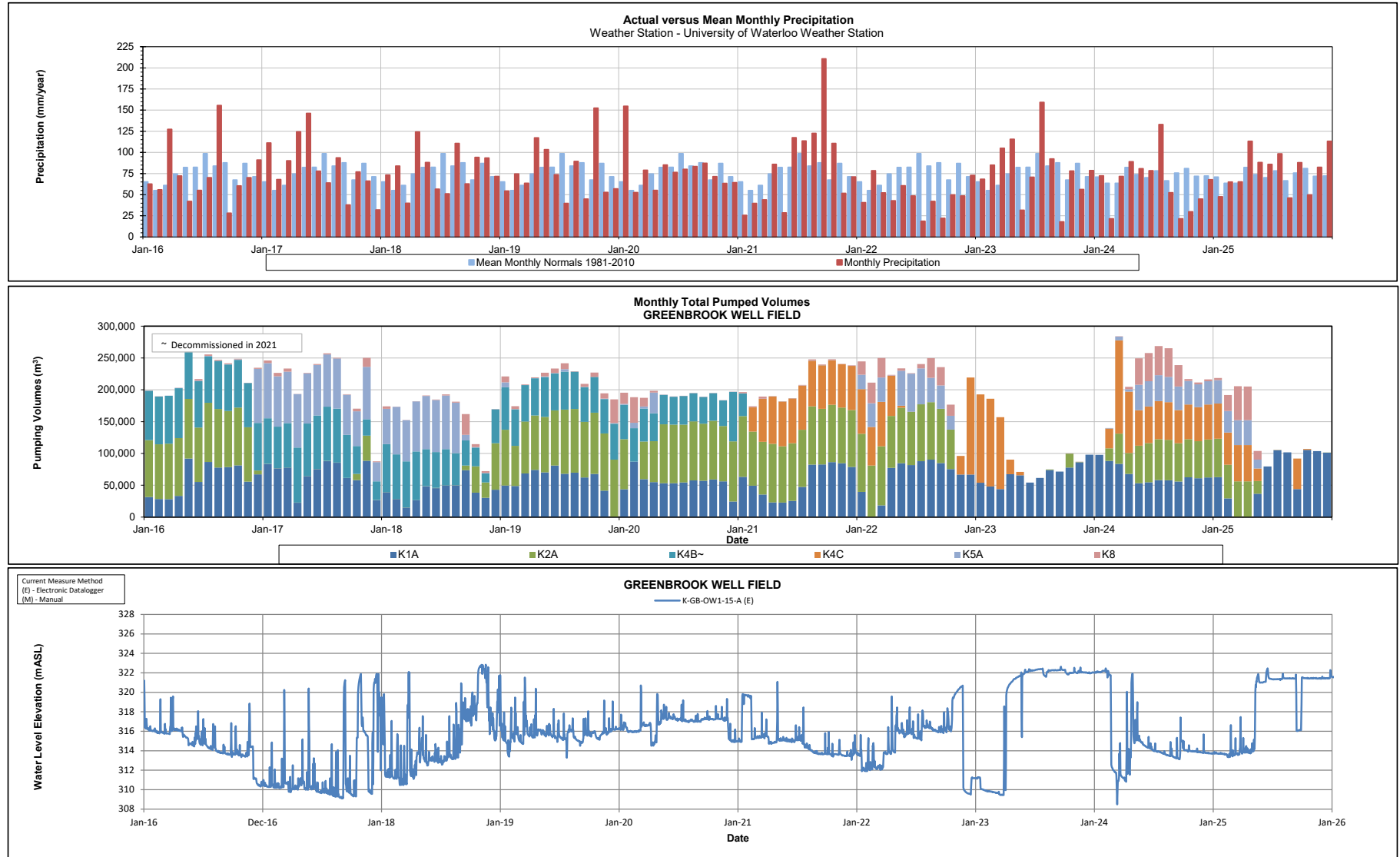
REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
GREENBROOK



REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
GREENBROOK



REGION OF WATERLOO
2025 GROUNDWATER MONITORING REPORT -
GREENBROOK





BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix D

Precipitation Data

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

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

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

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

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

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

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

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

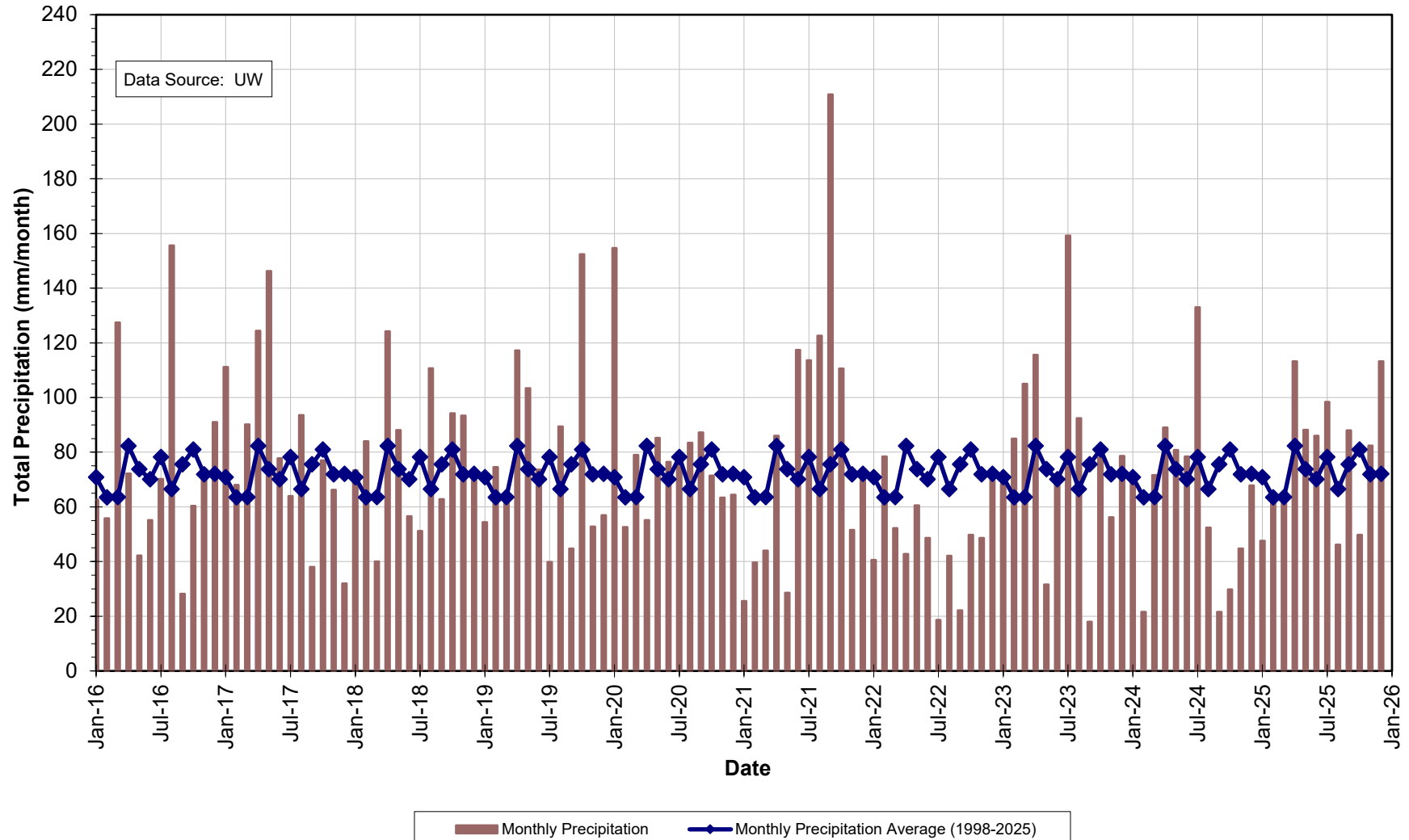
Year	Roseville Weather Station Established 1972		
	Annual Precipitation (mm)	30-yr NORMAL Precipitation 1981-2010 (mm)	Difference (mm)
2016	899	919	-20
2017	882	919	-37
2018	905	919	-14
2019	957	919	38
2020	817	919	-102
2021	832	919	-87
2022	637	919	-282
2023	945	919	26
2024	856	919	-63
2025	786	919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

NOTES:

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

Region of Waterloo – 2025 Groundwater Monitoring Report

Figure D.1
University of Waterloo Weather Station
Monthly Precipitation





BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix E

Monitoring Program Overview

GROUNDWATER LEVEL MONITORING PROGRAM PROCEDURES

E.1 Overview

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

E.1.1 Production Well Pumping and Water Levels

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

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

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

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

E.1.2 Monitoring Wells and Surface Water levels

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

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

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

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

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

E.1.3 Climatological Data

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

E.2 Groundwater Level Collection Protocols

E.2.1 Groundwater Level Monitoring Network Summary Well Checklist

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

E.2.2 Well Inspection

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

E.2.3 Monitoring Well Manual Water Level Measurement Procedure

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

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

E.2.4 Downloading of Water Levels from Electronic Dataloggers Procedure

For Non-Vented (Absolute) Datalogger Models:

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

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

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

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

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

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

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

