Clair-Maltby

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Clair-Maltby Comprehensive Environmental Impact Study, Year 1 Monitoring Report

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CITY OF Guelph
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EXECUTIVE SUMMARY

To understand and assess the area's unique natural heritage character a three (3) year monitoring program (2016-2018) was developed as part of the Comprehensive Environmental Impact Study (CEIS). The monitoring program is being conducted to supplement the available data from existing studies and reports and instrumentation.

The surface water monitoring program was initiated in mid-July 2016 and ended in late November 2016. The monitoring included a rainfall gauge at the Guelph Building Supply on the roof of the Guelph Home Building Supply, located at 500 Maltby Road East (ref. Figure 7). Continuous surface water levels Stations 9A – Kilkenny Place and 9B – Serena Lane) were tested in July of 2016 to monitor the discharge from the Hanlon Creek Subwatershed, draining to the north, with no flow recorded. Continuous surface water levels in Halls Pond (Station 7) and in the Puslinch Channel (Station 14) have been recorded (ref. Figure 7). The Halls Pond water levels receded in September resulting in no water levels being recorded. The Puslinch Channel is groundwater fed, as such it had continual flow throughout the 2016 monitoring year.

The continuous surface water level loggers have been used to record water quality (temperature) for Halls Pond and the Puslinch Channel, although due to water levels in Halls Pond receding, temperatures were not recorded for the fall months. The Puslinch Channel water temperature was always below 25^{o}C, which is within the coldwater fishery temperature range. Grab water quality sampling for one (1) dry event and three (3) wet evens was also conducted at Station 7 (Hanlon Creek) and Station 14. PWQO Guidelines were exceeded for Total Phosphorous, Ammonia and Iron at both stations, while Station 14 also had exceedances for Zinc.

A comprehensive groundwater monitoring program was initiated in 2016, including:

- Downhole Geophysical Logging
- Drive Point Mini Piezometer Installations
- Groundwater Level Monitoring
- Groundwater Quality Sampling
- Borehole Drilling and Monitoring Well Installations
- Guelph Permeameter Testing
- Surface Water Spot Flow Measurements
- Pond Bathymetry Surveys
- Seeps and Springs Observations
- Single Well Hydraulic Response Testing

In total, 17 boreholes at 9 locations were advanced and all boreholes were completed as monitoring wells. A total of 18 drive point mini piezometers were installed at 14 locations identified as areas of potential groundwater – surface water interaction (Figure 3). Groundwater quality sampling has been conducted at all monitoring wells.

The Year 1, 2016 field assessments have provided insight into the study area characterization and have provided the understanding required for any of the proposed monitoring modifications for Year 2, 2017 for the various disciplines. The Year 2 (2017) program will include revised surface water monitoring locations and the bulk of the natural heritage monitoring.

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1.0 INTRODUCTION

The City of Guelph is undertaking the Clair-Maltby Master Environmental Servicing Plan (MESP) and Clair-Maltby Secondary Plan (CMSP) Study to plan on a comprehensive basis the last unplanned greenfield area in the City - the Clair-Maltby Secondary Planning Area. The MESP is intended to satisfy and fulfill the requirements of the Environmental Assessment Act and the Planning Act. A key part of the Clair-Maltby MESP and Secondary Plan process is the Comprehensive Environmental Impact Study (CEIS) and MESP technical studies being conducted by Amec Foster Wheeler with support from Matrix and Beacon.

Protection of the Paris Moraine, its associated functions, and the unique area natural heritage character, presents unique challenges and opportunities. To understand and assess the area's unique natural heritage character a three (3) year monitoring program (2016-2018) was developed as part of the CIES. The monitoring program is being conducted to supplement the available data from existing studies and reports and instrumentation.

As part of the monitoring program a range of field assessments commenced as of June 2016 in accordance with the "preliminary" CEIS Work Plan. Preliminary field assessments and monitoring have been undertaken over the summer and fall of 2016 in order to inform the selection and refinement of monitoring locations, and to start data collection for ground and surface water as soon as possible so that three year of water-based monitoring data could be assessed. The 2016 field assessments are described in conjunction with the proposed monitoring for 2017 and 2018 for the various disciplines. As discussed with City staff in the context of the updates to the CEIS Work Plan, minor refinements to the field assessments initiated in 2016 will be made in 2017.

2.0 DEFINING THE STUDY AREAS

Three scales of study area (ref. Figure 1) have been identified for the CEIS, as per the following:

i. The Secondary Plan Area (SPA): The SPA is the area within which land use change will occur in accordance with an approved Secondary Plan. The SPA includes the lands south of Clair Road East, north of Maltby Road East, west of Victoria Road South, and approximately 1 km east of the Hanlon Expressway in the City of Guelph.
ii. The Primary Study Area (PSA): The PSA includes the SPA plus a 500 m zone beyond this boundary, allowing for assessment of ecological features and animal movements to and from the SPA.
iii. The Secondary Study Area (SSA): The SSA includes the PSA plus the receiving systems beyond the Clair-Maltby SPA. This area has been defined based on the area's hydrology and hydrogeology, as well as natural heritage features and functions in the adjacent lands, to ensure that landscape scale connectivity is considered from both a terrestrial and aquatic perspective. The SSA is based on appropriate groundwater and surface water model boundaries, which inherently consider subwatershed boundaries (Mill Creek, Hanlon Creek, Torrance Creek, Irish Creek and Lower Speed River), as well as groundwater flow divides.

Notably, in the fall of 2016 the SPA (and consequently the PSA) were expanded slightly from the SPA in the original Terms of Reference to include the two large ponds / wetlands and associated lands located just south of Clair Road and west of Gordon Street.

3.0 PROPERTY ACCESS

The landowner contact process was initiated in May 2016 with a landowner's information session (held Thursday May 26, 2016) and a subsequent mailout of requests for permission for property access to each of the landowners in the Secondary Plan Area. Permission forms provided options with respect to both the type(s) of filed work that may be permitted, as well as the type(s) of follow-up contact required by the landowner.

To date, different types of access have been provided by a limited number of landowners, as shown in Figure 2. Most of the access that has been provided is for undertaking groundwater monitoring. A few landowners have granted access for surface water and ecological monitoring.

The level of access provided for undertaking surface water and groundwater monitoring (ref. Figures 3, 4 and 7) is considered adequate in terms of both the numbers of stations and their representation across the PSA, to obtain a good understanding of the surface and groundwater dynamics at a level that is appropriate to support an MESP and Secondary Plan.

More limited access has, to date, been provided for various types of ecological monitoring. To compensate for this limited access: (a) more effort is being placed desktop analyses and on integration of data from site-specific studies in the PSA completed over the past decade (ref. Figure 8), as well as other available background, and (b) monitoring stations have been shifted as needed to suitable locations on public lands (including roadside stations) or lands where access has been granted (see Figures 8 and 9). Given the scale of the SPA, and the fact that a Natural Heritage System for the PSA has already been identified based on field work done as part of the City's Natural Heritage Strategy, this approach is considered adequate to inform an MESP and Secondary Plan.

4.0 MONITORING SUMMARY (Include maps)

4.1 Surface Water / Rainfall

The Clair Maltby Secondary Plan Area lies within the headwaters of the Hanlon, Torrance and Mill Creeks. This unique setting, along with the permeable nature of area soils and subsoils, and the predominant hummocky landscape has given rise to a distinct lack of open flowing watercourses. While some depressional features exist, including those associated with roadway infrastructure (i.e. ditches), these tend to be dry with only occasional flowing water conditions. Furthermore, the hummocky topography creates an abundance of inward draining topographic features which have closed drainage resulting in no offsite drainage contributions, while serving to locally recharge the groundwater system, particularly in areas of permeable soils which generally exist across the Secondary Plan area. As such within the SSA there is a lack of open water features and a lack of formal drainage outlets due to the hummocky topography.

The surface water three (3) year monitoring program has been developed with consideration to the lack of surface water features within the SSA. GRCA recommended that a spotflow program for the groundwater field assessment be utilized given the headwater conditions (i.e., small intermittent systems). Based on the need for a full seasonal understanding of the local flow regime, continuous water level monitoring has been conducted to supplement spotflow measurements, coupled with rainfall monitoring.

4.1.1 Rainfall

The City of Guelph and GRCA both have rainfall gauges within their jurisdiction; notwithstanding (ref. Figure 7), an additional rain gauge has been installed for the three (3) year monitoring period in the PSA. The rainfall gauge has been installed (July 14, 2016) on the roof of the Guelph Home Building Supply, located at 500 Maltby Road East (ref. Figure 5). The rain gauge has been installed concurrent with the streamflow monitoring (July 2016 to June 2019). Rainfall data have been downloaded on a monthly basis.

Monthly precipitation (rainfall) data from the Clair-Maltby gauge for the months of August to November 2016 have been summarized in Table 4.1.1 and compared to the monthly totals from Environment Canada's (EC) Elora gauge. The rainfall gauges are approximately 30 km apart which explains the difference in monthly rainfall amounts.

Monthly Rainfall totals for both the Clair-Maltby gauge and the Elora gauge for the months of August to November are 276.4 mm and 371.1 mm, with the 1981-2010 climate normal for the same period being 326.2 mm. As such the Clair-Maltby August to November rainfall total was approximately 15% below normal. It is worth noting that the months of April to June were also considered below normal based on the Elora gauge monthly amounts compared to the monthly climate normal.

Table 4.1.1: Monthly Precipitation Totals for 2016 and Climate Normals (mm)			
Month	**2016 Total[2.]**	**1981-2010 Climate Normal[1.]**	**Percent Difference[2.]**
April	57.8 (NA)	74.5	-22.42% (NA)
May	57.3 (NA)	82.3	-30.38% (NA)
June	53.0 (NA)	82.4	-35.68% (NA)
July	102.4 (NA)	98.6	+3.85% (NA)
August	152.6 (134.4)	83.9	+81.88% (+60.19%)
September	77.1 (58.2)	87.8	-12.19% (-33.71%)
October	85.8 (43.8)	67.4	+27.30% (-35.01%)
November	55.6 (40)	87.1	-36.17% (-54.08%)
December	90.1 (NA)	71.2	+26.54% (NA)
TOTAL	731.7 (NA)	735.2	-0.48% (NA)

1 From Environment Canada Waterloo Wellington Airport
2 First value is based on Environment Canada's Elora RCS gauge, value in brackets is based on Clair Maltby Project gauge

In addition to the monthly data presented in Table 4.1.1, daily rainfall totals for days with major storm events and high recorded water levels have been summarized in Table 4.1.2 for all data sources (ref. Figure 7) (EC Elora, Clair-Maltby and City of Guelph's Clair Road rainfall gauges). Where storm systems have lasted multiple days, values have been summed. Daily rainfall amounts between the three (3) gauges for most storm events demonstrate fairly consistent rainfall recordings. The City and the Amec Foster Wheeler rainfall gauges recorded storm event totals that are considered reliable, as there is limited deviation in the rainfall amounts, apart for the July 14-15, 2017 event.

Three (3) storm events are above 25 mm and are considered significant. The August 20th event had a duration of 1 hour and 58.6 mm rainfall total, as such it is considered almost a 100 year storm event based on a 1 hour rainfall total of 59.7 mm at the Guelph Turfgrass Institute (Intensity Duration Frequency (IDF) relationship for 1954 to 2003). Using the same IDF relationship the August 25th (1 hour duration) and September 7th (8.5 hours duration) storm events would be a 5 year storm event and just less than a 2 year event respectively.

Table 4.1.2: Summary of Daily Rainfall Totals for Major Rainfall Events of 2016 (mm)			
Day (M/D/Y)	**Environment Canada Elora RCS Gauge Total**	**Amec Foster Wheeler Clair Maltby Project Gauge Total**	**City of Guelph Clair Road Emergency Services Gauge Total**
07/14/17 - 07/15/17	20.4	13.0	34.0
07/25/17	36.0	20.0	17.4
08/05/17	1.0	10.0	7.0

Table 4.1.2: Summary of Daily Rainfall Totals for Major Rainfall Events of 2016 (mm)

Day (M/D/Y)	Environment Canada Elora RCS Gauge Total	Amec Foster Wheeler Clair Maltby Project Gauge Total	City of Guelph Clair Road Emergency Services Gauge Total
08/11/17 - 08/13/17	59.6	21.0	17.2
08/16/17	24.4	10.6	14.2
08/19/17 - 08/21/17	25.6	58.6	59.2
08/25/17 – 08/26/17	30.3	31.8	33.6
09/07/17 – 09/08/17	41.8	33.6	27.0
09/17/17 - 09/18/17	10.8	8.8	9.6
09/26/17	8.6	6.2	7.2
09/29/17 - 09/30/17	0	7.4	9.6
10/08/17	3.3	8.0	5.2
10/20/17 – 10/21/17	19.4	16.2	16.4
11/02/17 – 11/03/17	NA	8.6	NA
11/19/17	11.5	9.6	NA
11/24/17 – 11/26/17	10.0	10.4	NA
11/28/17 – 11/30/17	12.5	9.0	NA

"NA" indicates that data is not available.

4.1.2 Surface Water

The surface water monitoring consists of both water level and quality monitoring as per the following.

4.1.2.1 Quantity

The location of the surface water monitoring locations are depicted in Figure 7. The location for one (1) gauge to monitor the Mill Creek Subwatershed has been established near the south-east limit of the PSA (Station 14). Two (2) gauge locations (Stations 9A – Kilkenny Place and 9B – Serena Lane) were tested in July of 2016 to monitor the discharge from the Hanlon Creek Subwatershed, draining to the north. Some minor flow responses were observed at the Serena Lane monitoring location for storms on August 20, August 25, and September 7 (ref. plots in in Appendix A). However, the responses were minimal, and not considered to be significant enough to continue the monitoring at this location in 2017. A new location outside the PSA in the Hanlon Creek Subwatershed is being sought in consultation with the City and GRCA for surface water monitoring during 2017.

In the absence of a station with flow in the Hanlon Creek Subwatershed in 2016, one surface water level logger and quality station was established in the southern extent of the large pond within Hall's Pond Provincially Significant Wetland (Station 7) in July 2016, with surface water level and quality data collected over the summer and fall of 2016.

Summary plots showing the observed water levels at Halls Pond for 2016 have been included in Appendix A. Key statistics from the observed data are presented in Table 4.1.3.

Table 4.1.3: Estimated Peak Flows for Major Storm Events Based on 2016 Rating Curves (m^3/s)

Date (M/D/Y)	Puslinch Channel (Station 14)
Minimum Water Level	0 (dry)
Maximum Water Level	0.33

Continuous water level monitoring was conducted for an open watercourse south of the study limits, within the municipality of Puslinch. The site is located on a private property at the end of Hammersely Road (Station 14). The site had a continuously observed flow at all times during the monitoring period, suggesting a potential groundwater flow contribution. Velocity metering was conducted at this site over the course of 2016, which has been used to develop a preliminary rating curve for the site. The rating curve fit has been completed using a simplified HEC-RAS hydraulic model, based on topographic survey data completed by Matrix Solutions on November 4, 2016.

Plots of the developed rating curve, and the resulting recorded flow series at the Hammersley Road site have been included in Appendix A. Peak flows for the major recorded storm events of 2015 are presented in Table 4.1.4.

Table 4.1.4: Estimated Peak Flows at Monitoring Station 14 (Hammersley Road) for Major Storm Events Based on 2016 Rating Curves

Date (M/D/Y)	Observed Rainfall (mm)	Observed Peak Flow (m^3/s)
7/25/2016	19.2	0.02
8/20/2016	52.0	0.10
8/25/2016	24.0	0.06
9/7/2016	33.6	0.02
11/2/2016	4.2	0.02

4.1.2.2 Quality and Temperature

The water level gauges include temperature sensors which provide a continuous scan of water temperature over the monitoring period. Although the gauges were not installed until July, 2016, in the following two years (2017-2018) the gauges will be installed from post-freshet (i.e., late March or early April) to freeze-up (typically late November to early December). Tables 4.1.5 and 4.1.6 summarize the temperature monitoring results for the Puslinch Channel (Station 14) and Halls Pond respectively.

Table 4.1.5: Observed 2016 Water Temperatures – Puslinch Channel (Station 14)					
Month	Monthly Extremes		Monthly Averages		
	Daily Minimum	Daily Maximum	Daily Minimum	Daily Average	Daily Maximum
July	9.26	16.06	10.77	12.28	14.33
August	9.80	18.78	11.22	12.86	14.92
September	7.90	17.20	10.09	11.38	12.91
October	4.06	15.05	7.99	9.24	10.47
November	1.95	11.35	5.28	6.45	7.61
December	1.55	7.46	3.69	4.30	4.85

Table 4.1.6: Observed 2016 Water Temperatures – Halls Pond					
Month	Monthly Extremes		Monthly Averages		
	Daily Minimum	Daily Maximum	Daily Minimum	Daily Average	Daily Maximum
July	18.05	28.37	20.74	23.10	25.94
August	16.14	36.61	19.24	23.76	31.34
September	N/A	N/A	N/A	N/A	N/A
October	N/A	N/A	N/A	N/A	N/A
November	N/A	N/A	N/A	N/A	N/A
December	N/A	N/A	N/A	N/A	N/A

The daily minimum and maximum temperature values for Station 14 surface water monitoring station are all below 19°C, which is within the colder water fishery temperature range of < 19 °C. The temperatures within Halls Pond have been above 30 °C which is considered to be a warmwater fishery (>25 °C). In September the temperature gauges became exposed to air due to the water level within the Halls Pond dropping and water temperatures were not recorded until the gauges were removed for the winter. Water temperature graphs have been provided in Appendix A.

In addition to water temperature, the CEIS Work Plan requires water quality sampling as part of the surface water monitoring effort. The water quality parameters recommended by GRCA (ref. Table 4.1.7) have been supplemented by metal and pesticides as agreed to by the City. Grab samples are being collected in both dry and wet periods in the spring, summer and fall at each of the two (2) water gauge locations over the three (3) year monitoring plan (2016-2018). Due to the substantial expense of testing for pesticides, the Consulting Team recommended more targeted testing (i.e., single samples at up to six locations across the PSA in the fall of 2017, rather than three samples annually – spring, summer and fall – at all stations over two years), which has been agreed to by the City..

Water quality sampling has been undertaken in 2016 at Station 7 (in the Hanlon Creek Subwatershed) and Station 14 (in the Mill Creek Subwatershed) over the summer and fall, and an additional station with flows in the Hanlon Creek Subwatershed remains to be established in 2017. In 2017 and 2018, these samples will be collected in conjunction with wetland water quality sample collection (ref. Figure 7).

Table 4.1.7: Water Quality Parameters Agreed to in the Original Work Plan

Water Quality Parameter	Mechanism of Analysis	Comments
► Total Suspended Solids (TSS) ► Total Dissolved Solids (TDS) ► Orthophosphate (P) ► Total Phosphorus (TP) ► Dissolved Sulphate (SO^4) ► Dissolved Chloride (Cl) ► Total Kjeldahl Nitrogen (TKN) ► Nitrite (NO^2) ► Nitrate (NO^3) ► Ammonia (NH^3)	To be analyzed from grab samples sent to a laboratory	Parameters suggested by GRCA in their comments on the Draft Clair-Maltby MESP Secondary Plan TOR (City of Guelph, 2015a).
► water temperature	To be measured continuously by the data logger and verified in situ three times over the season by field staff (with a water quality meter)	Parameter suggested by GRCA in their comments on the Draft Clair-Maltby MESP Secondary Plan TOR (City of Guelph, 2015a).
► pH ► conductivity, and ► dissolved oxygen (DO)	To be measured in situ by field staff (with a water quality meter)	Parameters suggested by GRCA in their comments on the Draft Clair-Maltby MESP Secondary Plan TOR (City of Guelph, 2015a).
► Metals ► Pesticides*	To be analyzed from grab samples sent to a laboratory	Additional parameters suggested by the Consulting Team and agreed to by City.

Table 4.1.8 summarizes the water quality sampling events of 2016. Water quality sampling did not occur during the spring season due to the July 2016 commencement of the surface water monitoring program. The rainfall amounts for the wet weather water quality events are considered to be on the low side (i.e. <15 mm), that said, there were only six (6) rainfall events of 15 mm or

greater during the 2016 monitoring term. For the 2017 monitoring program, an effort should be made to sample wet weather events of greater magnitude.

Table 4.1.8: Summary of 2016 Water Quality Sampling Events

Date	Sites Sampled	Type of Event	Inter-Event Period (days)[1]	24-Hour Rainfall Total (mm)[2.]
August 4, 2016	Station 7, Station 14	Dry	10	0
August 17, 2016	Station 7, Station 14	Wet	5	10.6
September 22, 2016	Station 7, Station 14	Wet	6	6.0
October 20, 2016	Station 7, Station 14	Wet	12	7.0

"NA" indicates not applicable (dry weather samples)

1. Between sampling time and end of last event exceeding 5 mm
2. Rainfall depth for 24-hour period prior to sampling
3. Rainfall statistics based on project rainfall gauge

Key water quality parameter concentrations have been provided within Table 4.1.9. Exceedances of the Provincial Water Quality Objectives (PWQO) have been highlighted in yellow. Based on the results in Table 4.1.9, there are limited exceedances (6) of the key water quality parameters for Station 14. Exceedances occur primarily for Ammonia and Zinc, resulting from the groundwater that discharges to the watercourse. Station 7 (Halls Pond) has PWQO exceedances in Total Phosphorous, Ammonia, Aluminium, Iron and Lead, but not Zinc. The wetland feature water levels receded during the months of August to October, which may have contributed to contaminant concentrations increasing over time.

Table 4.1.9: Comparison of Measured Concentrations for Key Water Quality Parameters

Date	Location	Contaminant Concentration (mg/L)									
		TSS	TKN	Total P	Ammonia	Chloride	Aluminum	Copper	Iron	Lead	Zinc
	PWQO Guidelines	n/a	n/a	0.03	0.02[1]	n/a	0.075	0.005[2]	0.3	0.001[2]	0.02
August 4, 2016	Station 7	6.8	1.41	0.054	0.028	9.92	0.027	<0.0010	0.371	0.00038	0.0043
	Station 14	<2.0	0.26	0.0056	<0.02	38.0	<0.010	<0.0010	<0.050	<0.0001	0.0890
August 17, 2016	Station 7	10.7	1.65	0.0742	<0.02	10.1	0.027	<0.0010	0.457	0.00053	0.0032
	Station 14	2.5	<0.15	0.0094	0.043	33.5	<0.010	<0.0010	<0.050	<0.0001	0.0760
Sept. 22, 2016	Station 7	79.4	2.3	0.173	0.025	12.3	0.263	<0.0010	0.491	0.00207	0.0100
	Station 14	<2.0	0.21	0.0069	0.032	36.7	<0.010	<0.0010	<0.050	<0.0001	0.0759
October 20, 2016	Station 7	15.8	1.68	0.0743	0.082	12.7	<0.010	<0.0010	<0.050	<0.0001	<0.0030
	Station 14	4.0	0.31	0.0075	0.074	33.6	<0.010	<0.0010	<0.050	<0.0001	<0.0030

1. PWQO is for un-ionized Ammonia
2. PWQO varies with hardness as $CaCO_3$, value presented is most stringent limit (lead) or based on initial PWQO (copper)

Table 4.1.10 summarizes field measured water quality parameters. Station 14 water temperatures are always below temperatures at Station 7 due to Station 14 being a groundwater fed. The same premise is used to explain that all over parameters in Table 4.1.10 are higher for Station 14 than Station 7.

The number of PWQO exceedances for wall water quality parameters at Station 7 is significantly more than recorded at Station 14 in Table 4.1.11 due to the groundwater fed system at Station 14.

Table 4.1.10: Comparison of Field Measured Parameters

Date	Air Temperature (deg C)	Location	Field Water Temperature (deg C)	Field Conductivity (mS/cm)	Laboratory Total Dissolved Solids (mg/L)	Field Dissolved Oxygen (mg/L)	Field pH
August 4, 2016	29.9	Station 7	23.01	0.214	178	4.44	7.12
		Station 14	10.97	0.441	388	13.51	7.52
August 17, 2016	25.4	Station 7	23.20	NA	170	2.97	8.13
		Station 14	12.30	NA	362	10.04	8.71
Sept. 22, 2016	27.6	Station 7	19.19	0.272	149	0.95	5.79
		Station 14	12.53	0.474	379	13.30	7.11
October 20, 2016	11.5	Station 7	13.394	NA	153	9.42	6.70
		Station 14	10.211	NA	350	9.59	7.46

Na. Not available

Table 4.1.11:	Summary of PWQO Exceedances for the 2016 Monitoring Program	
Date	Total Number of PWQO Exceedances by Location	
	Station 7	Station 14
August 4, 2016	4	1
August 17, 2016	3	2
Sept. 22, 2016	5	2
October 20, 2016	2	1

4.2 Ground Water

The groundwater field program was designed to support refinements to the existing hydrogeological characterization and establish baseline conditions within the SPA and PSA. An understanding of the three dimensional and time-varying (e.g., seasonal) characteristics of the integrated surface water and groundwater flow systems will be required to support the establishment of Community Structure plans for the SPA. In addition, the field program will contribute to a water balance evaluation of groundwater function, identify constraints and opportunities, and provide monitoring locations that will form part of the long-term monitoring network.
The groundwater field work was coordinated with the work being completed by the other disciplines in recognition of the inter-relationship between the hydrogeological and hydrologic systems, other users of water for anthropogenic needs, and the local ecosystem.

This section provides the methodology used by Matrix Solutions Inc. (Matrix) to complete the 2016 hydrogeological field program. Preliminary results are also provided. Specifically, this field program included:

- Borehole Drilling and Monitoring Well Installations
- Downhole Geophysical Logging
- Drive Point Mini Piezometer Installations
- Groundwater Level Monitoring
- Groundwater Quality Sampling
- Single Well Hydraulic Response Testing
- Guelph Permeameter Testing
- Surface Water Spot Flow Measurements
- Pond Bathymetry Surveys
- Seeps and Springs Observations

4.2.1 Borehole Drilling and Monitoring Well Installation

A drilling and well installation program was supervised by Matrix staff between July 25 and August 24, 2016. The installation of monitoring wells was intended to understand the function of the upper aquifer(s), vertical gradients, groundwater flow directions, and to collect water quality samples. Drilling was carried out using a truck-mounted, dual rotary, drill rig operated by Highland Water Well Drilling Inc. (Highland). Ontario One Call was contacted before the start of drilling and

registered utility owners in the area were notified of the upcoming work. Matrix personnel completed a pre-drilling site visit at all proposed drilling locations to meet with landowners (where available) and to look for visual onsite indications of non-registered buried infrastructure. On one agricultural property, two well nests (MW05-S/D and MW06-S/D) were installed near the edge of the field under cultivation. With the agreement of the farmer, crop damage was estimated by measuring the area trampled by drilling equipment during site access and drilling activities. The farmer was compensated for the damaged crop based on the measured area, average yield and market price of the crop.

In total, 17 boreholes at 9 locations were advanced and all boreholes were completed as monitoring wells. The borehole locations were strategically positioned across the study area in a series of three transects trending northwest to southeast with each transect crossing a topographic low through the centre of the transect (Figure 3). At each location, one shallow and one deep 152 mm borehole was drilled side by side and completed as an overburden monitoring well nest; except at MW07, where only one well was completed due to the availability of existing shallow monitoring wells in the area. The target depth for each deep borehole was just above the top of bedrock, which was guided by the City's Tier Three Water Budget Study. At each deep borehole, soil samples were collected from the cuttings cyclone of the drill rig approximately every 1.5 m. Matrix personnel were onsite to record observations on the geologic logs including lithology, texture, colour, moisture and monitoring well completion details. Geologic logs indicating borehole lithology and monitoring well installation details are provided in Appendix B1.

Each monitoring well was completed using a 52 mm diameter slotted (010) screen and solid Schedule 40 PVC pipe. Each monitoring well was completed with a 1.52 m section of screened interval. The annular space between the PVC pipe and the wall of the borehole was backfilled with a sand filter pack to approximately 0.10 to 0.30 m above the top of the screened section and a bentonite based granular and/or grout seal was installed in the remaining annulus to ground surface to prevent downward surface water migration. The monitoring wells were installed with riser pipes extending approximately 0.7 m above ground surface and were covered with a protective 152 mm steel surface casing, well cap and lock. Highland developed each well by airlifting using the air compressor of the drill rig.

Matrix personnel were onsite to monitor the turbidity of the produced water and the overall development of the each well. The ground and top of casing elevations of the newly installed monitoring wells were geodetically surveyed using an RTK rover and total station following installation by Beacon Environmental Ltd. (Beacon). Well marker warning flags were installed at MW02-S, MW02-D, MW09-S, and MW09-D due to their proximity to the road within the right of way (ROW) to protect from potential damage from snow plows. Monitoring well completion data are summarized in Table B1.

Matrix monitoring wells were installed in the following stratigraphic layers:

- MW01-S, MW02-S, MW02-D, MW03-S, MW03-D, MW05-S, MW05-D, MW06-S, MW06-D, MW07-D, MW08-S, MW08-D and MW09-S were completed in primarily sand/gravel to silty sand
- MW01-D, MW04-S, MW04-D, and MW09-D were completed in clayey to sandy silt

4.2.2 Downhole Geophysical Logging

On September 3, 2016, Lotowater Technical Services Inc. (Lotowater) completed downhole gamma logging to help distinguish between clay-rich soils from clay-poor soils and to improve the local stratigraphic interpretation across the transitional ice margin deposits of the Paris Moraine within the study area. The logging was conducted in three monitoring wells to test its utility: MW01-D, MW02-D and MW03-D (Figure 3). The geophysical logs are provided in Appendix B2.

Due to the coarse-grained nature of the soils encountered and the relative lack of clay, the results did not support completing downhole survey in the other six monitoring well locations.

4.2.3 Drive Point Mini Piezometer Installations

In August and September 2016, a total of 18 drive point mini piezometers were installed by Matrix personnel at 14 locations identified as areas of potential groundwater – surface water interaction and where property access was granted (Figure 3). These locations were also coordinated with the wetland surface water quantity and quality stations, as well as flow stations where possible (Figure 7). At four of the locations, pairs of shallow and deep mini piezometers were installed to more closely examine vertical hydraulic gradients. The mini piezometers were constructed using 0.3 m x 20 mm stainless steel drive point tips with steel pipe extensions up to approximately 1.0 m above ground surface. The depth of each piezometer ranged from 0.86 to 2.42 m bgs. Installation details and observed vertical hydraulic gradients are presented in Table B2. The ground and top of casing elevations of the mini piezometers were geodetically surveyed by Beacon following installation.

4.2.4 Groundwater Level Monitoring

Groundwater levels are being monitored at all installed monitoring wells and mini piezometers, as well as three additional, pre-existing wells (MW1-11, MW2-11, and MW3-11) located at 132 Clair Road with the landowner's permission (Figure 3). All wells and piezometers are being monitored using manual measurements every three months and, with the exception of MW1-11 and MW2-11, are all equipped with a Solinst™ Levelogger Model 3001 non-vented pressure transducer automatically recording every 60 minutes. The pressure transducers were removed from the mini piezometers on December 13, 2016 to protect them from freezing and will be re-installed as early as possible following the spring melt. Data from a Solinst™ Barologger recording atmospheric pressure at MW02-S is used to correct the water level pressure recordings to gauge pressure. The manual water level is measured at each well and piezometer relative to the top of the PVC/steel pipe using a Solinst™ electronic water level tape.

Groundwater elevations at each station were calculated by subtracting measured depths to water from the surveyed top of casing/pipe elevations. Manual groundwater levels obtained from the

monitoring wells and mini piezometers since their installation are presented in Tables B1 and B2, respectively. Hydrographs showing automatically recorded seasonal groundwater fluctuations in each monitoring well and mini piezometer outfitted with a pressure transducer are presented in Appendix B3. Hydrographs also display precipitation data from two stations. One station was installed by AMEC Foster-Wheeler as a part of the CEIS, while the second is a Government of Canada climate station located at the Region of Waterloo International Airport (YKF). No hydrographs are available for MP01-S and MP02 as these locations were dry during all site visits in 2016.

4.2.5 Groundwater Quality Sampling

On October 19 to 21, 2016, Matrix personnel conducted groundwater quality sampling at all Matrix monitoring wells. The wells were purged prior to groundwater sampling to obtain samples that represent the water quality in the formation. Matrix personnel purged three casing volumes as per the CCME (1994) method or until dry before collecting groundwater samples using dedicated inertial lift Waterra™ sampling pumps or dedicated Waterra™ bailers.

Field-measured parameters including pH, EC, temperature, dissolved oxygen and turbidity were conducted on groundwater samples collected from the wells once purging was complete. The instruments were checked for calibration and corrected where necessary prior to measuring the field parameters.

Groundwater samples from each Matrix monitoring well were collected into the appropriate, laboratory supplied, pre-labeled sample bottles. Each groundwater sample collected for dissolved metals analysis was field-filtered using disposable 0.45 micron filters.

Samples collected in 2016 were analyzed for the following parameters:

- general and inorganic parameters, including pH, EC, calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), iron (Fe), manganese (Mn), chloride (Cl), carbonate (as $CaCO_3$), bicarbonate (as $CaCO_3$), hydroxide (as $CaCO_3$), sulphate (SO_4), nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N), total Kjeldahl nitrogen (TKN), total dissolved solids (TDS), total hardness (as $CaCO_3$) and total alkalinity (as $CaCO_3$).
- dissolved metals including silver (Ag), aluminum (Al), arsenic (As), boron (B), barium (Ba), beryllium (Be), bismuth (Bi), cadmium (Cd), cesium (Cs), cobalt (Co), chromium (Cr), copper (Cu), lithium (Li), molybdenum (Mo), nickel (Ni), phosphorus (P), lead (Pb), rubidium (Rb), sulfur (S), antimony (Sb), selenium (Se), silicon (Si), tin (Sn), strontium (Sr), tellurium (Te), thorium (Th), titanium (Ti), thallium (Tl), uranium (U), vanadium (V), tungsten (W), zinc (Zn), and zirconium (Zr)

Collected samples were stored in ice-chilled coolers and transported to ALS Laboratory Group in Waterloo, Ontario for analysis. A chain-of-custody form indicating sample numbers was submitted to and signed at the laboratory. Copies of the signed forms were placed in the project files and are available upon request. Laboratory results were downloaded into Matrix's database

management system and are presented in Tables B3 (Field and Routine Parameters) and B4 (Dissolved Metals). Copies of the laboratory Certificates of Analysis are provided in Appendix B4.

All samples meet the criteria outlined in the Ontario Drinking Water Quality Standards (MOE, 2006) with the exception of the following:

- Samples collected from MW02-S/D and MW05-S/D exceeded the OWDS aesthetic objective for iron. In these wells, iron levels ranged between 0.346 mg/L and 2.25 mg/L compared to the ODWS aesthetic objective of 0.3 mg/L.
- Samples collected from MW02-S/D, MW04-S, MW05-S/D and MW07-D exceeded the OWDS aesthetic objective for manganese. In these wells, manganese levels ranged between 0.0575 mg/L and 0.459 mg/L compared to the ODWS aesthetic objective of 0.05 mg/L.
- Samples collected from MW01-S and MW08-D exceeded the OWDS aesthetic objective for total dissolved solids. In these wells, total dissolved solids concentrations ranged between 550 mg/L and 639 mg/L compared to the ODWS aesthetic objective of 500 mg/L.
- Samples collected from all monitoring wells exceeded the OWDS operational guidelines for total hardness. In these wells, total hardness levels ranged between 131 mg/L and 410 mg/L compared to the ODWS operational guidelines of 80 to 100 mg/L.
- Field samples collected from MW01-S/D, MW02-S/d, MW03-D, MW05-S/D, MW06-S/D, MW07-D and MW08-S/D exceeded the OWDS aesthetic objective for turbidity. In these wells, field turbidity levels ranged between 122.6 NTU and >1100 NTU compared to the ODWS aesthetic objective of 5 NTU (MOE 2006)
- A sample collected from MW05-S exceeded the ODWS maximum acceptable concentration for uranium where the concentration was reported as 0.024 mg/L compared to the ODWS maximum acceptable concentration of 0.02 mg/L.

4.2.6 Enriched Tritium Analyses

Matrix personnel collected samples for enriched tritium analysis on October 28, 2016 from four monitoring wells (MW05-S, MW05-D, MW03-S, and MW07; Figure 3). Tritium levels provide insights on the age of groundwater, which may help the understanding of the recharge function of the Paris Moraine and surrounding area. The samples were placed in laboratory-supplied containers and transported to Isotope Tracer Technologies in Waterloo, Ontario for analysis. A chain-of-custody form indicating sample numbers was submitted to and signed at the laboratory. The results are provided in Table B5, where tritium is summarized to range from 6.4 TU to 13.1 TU.

4.2.7 Single Well Hydraulic Response Testing

Hydraulic response tests for all Matrix monitoring wells were completed on September 23, 28 and 30, 2016 in order to estimate the horizontal hydraulic conductivity of the hydrostratigraphic units being tested. This data will help refine the parameterization of the groundwater system in the numerical model. Tests consisted of displacing a known volume of groundwater in the well by rapidly inserting a plastic slug or a known volume of deionized water and then monitoring the rate at which the water level returned to equilibrium. The water level recoveries were measured using

the dedicated Solinst Leveloggers that were calibrated to manual water level readings collected at regular timed intervals until the water level returned to at least 80% of the initial static level.

The hydraulic response test data were interpreted using AQTESOLV™ software (HydroSOLVE 2007). The Bouwer-Rice (1976), Hyder et al. (KGS; 1994) and Springer-Gelhar (1991) methods for partially penetrating wells were selected to estimate the hydraulic conductivity values. The results are summarized in Table B1 and the analytical solution curves are provided in Appendix B5. Results show that the hydraulic conductivity values ranged from 7E-08 m/s to 2E-03 m/s for materials ranging from silt to sandy gravel. One result (MW03-S) is considered suspect and has not been presented.

4.2.8 Guelph Permeameter Testing

In-situ soil hydraulic conductivity testing using a Guelph Permeameter was conducted on November 1 and 2, 2016 at testing locations adjacent to the nine monitoring wells (Figure 3). The Guelph Permeameter uses the constant head principle to determine the field saturated hydraulic conductivity of near surface soils. The testing was conducted using both single head and double head methods in shallow hand augered holes ranging from 0.19 m to 0.41 m deep. For either method, the drop in reservoir water level was recorded until a constant rate of water infiltration was achieved. The field saturated hydraulic conductivity results are summarized in Table B6, where values range from 4E-08 m/s to 1E-05 m/s.

4.2.9 Surface Water Spot Flow Measurements

In 2016, surface water spot flow measurements were collected during summer (August/September) and fall (November) field events to observe the seasonal variability in base flow and spatial variability along watercourses. Spot flow locations were initially selected at watercourse crossings near the SPA and PSA and were also guided by preliminary particle tracking from the City's Tier Three Water Budget model. Initial locations included measurements within the Hanlon Creek, Mill Creek and Lower Speed River subwatersheds (Figure 4). Since the initial spot flow event, locations were refined with the addition of three locations in the Torrance Creek Subwatershed and an additional location in the Mill Creek Subwatershed for a total of 27 locations (Figure 4). To ensure representative baseflow values were obtained, field measurements were not collected until total cumulative precipitation was less than 5 mm in the three days preceding the monitoring event.

Spot flow measurements were completed by securing a measuring tape across the banks of the stream and dividing the cross section of the stream into approximately 10 panels of equal width. A Son-Tek FlowTracker Acoustic Doppler Velocimeter (ADV) was used to record the width, water depth and flow velocity in each panel to produce a final discharge value for the stream at each monitoring location. Surface water temperature was also collected at each location where the ADV was used. The surface water spot flow measurement results collected to date are summarized in Table 7 and shown spatially on Figure 4. Stream discharge ranged across the regional study area from 0 L/s in headwater areas to 187 L/s (November 2016) at the most downstream station along Mill Creek.

4.2.10 Pond Bathymetry Surveys

On November 14, 2016, Groundwater Science Corp. completed bathymetry surveys of Halligan's Pond, located in the southeast ROW at Victoria Road South and Maltby Road East; Neumann's Pond A, located at 132 Clair Road; and, at an unnamed pond located in the east portion of 950 Southgate Drive (Figure 5).

Halligan's Pond and Neumann's Pond were both surveyed using a remote controlled boat equipped with a GPS, Sonar and mapping software capable of recording the depth to the pond bottom while the boat was driven in numerous transects across each pond (Figure 5). Because of shallow conditions, the unnamed pond at 950 Southgate Drive was surveyed by Groundwater Science Corp. along two transects assumed to be the deepest portions of the pond using a pressure transducer/datalogger (In Situ model RT100) and measuring tape. The datalogger was attached to the measuring tape and was pulled across the pond in regular increments with a pause at each increment for the logger to record pond depth. The data was downloaded and the water depth (compensated pressure reading) for each increment of distance was obtained. The depth profiles of each transect is shown on Figure 6. The approximate location of each transect is also shown on Figure 5. This method of measurement assumes that the datalogger travels in a straight line from start to end and that the distance pulled is equal to the horizontal distance (i.e., there is very little vertical movement).

The data from these surveys will be used to modify the topography of the wetland/pond areas in the integrated groundwater / surface water model. The modelled topography represents the true land surface and not the water surface as would normally be the case in a numerical model.

4.2.11 Seeps and Springs Observations

No seeps or springs were observed by Matrix field staff during the 2016 program; however, a spring was noted by a resident on his property at 63 Brock Road in the Mill Creek Subwatershed. More springs / seeps associated with this approximate ground surface elevation are anticipated in the Mill Creek, Hanlon Creek and Speed River subwatersheds. Two groundwater seeps were also noted previously at 132 Clair Rd., south of Neumann's Pond A (Aquafor Beech 2012). Matrix will continue to look for these features during subsequent monitoring events.

4.3 Wetlands

The purpose of the wetland water level and quality monitoring is to (a) provide study-area wide baseline information of the pre-development condition of these features, and (b) help inform the understanding of surface and groundwater interactions in the PSA.

Sampling locations (ref. Figure 7) were identified based on the objective of including samples:

a. From a representative selection of wetlands located within the PSA, as well as falling within both the Hanlon and Mill Creek Subwatersheds;
b. From wetlands expected to be protected for the long-term, therefore within confirmed Provincially Significant Wetlands (PSWs);
c. From wetlands expected to have standing water in them all year round, even in dry years;

d. From a representative selection of wetlands within different land use contexts (e.g., agricultural, natural, near roads); and
e. In proximity to proposed groundwater stations to allow for integration and comparison of the surface water and groundwater data from the same wetlands.

5.0 OVERVIEW OF PROPOSED 2017 MONITORING

The following provides an overview of the proposed 2017 monitoring program.

5.1 Surface Water

The 2017 surface water field assessments will commence in early spring, with the same locations and monitoring equipment as the 2016 field program with the exception Station 9 (Serena Lane) being relocated to Station 15 (Hanlon Creek, Dog Walking Park). As such the surface water monitoring program will include:

- Rainfall monitoring at Guelph Home Building Supply
- Continuous water level and temperature monitoring at Stations 7 (Halls Pond), Station 14 (Puslinch Channel) and Station 15 (Hanlon Creek).
- Establishment of a flow rating curve at Station 15
- Grab water quality sampling at Stations 7, 14 and 15 for dry weather and wet weather events throughout spring, summer, and fall of 2017.

5.2 Groundwater)

The 2016 groundwater field program included the establishment of hydrogeological monitoring locations and the installation of monitoring equipment. In 2017, Matrix will continue regular monitoring of these monitoring locations. This monitoring will include:

- Quarterly water level monitoring of monitoring wells (manual water levels and transducer downloads)
- Quarterly water level monitoring of mini-piezometers (manual water levels and transducer downloads). Transducers will be re-installed into the mini-piezometers in the spring.
- Water quality sampling in the spring and fall at all Matrix-installed monitoring wells. Samples will be analyzed for general and inorganic parameters and dissolved metals.
- Spot baseflow measurements at the 2016 locations in the spring, summer and fall.
- Ongoing recording of observations of seeps and / or springs.

5.3 Natural Heritage

The bulk of the natural heritage monitoring and assessments will take place over 2017. These will include:

- A scoped headwater drainage feature assessment based on primarily desktop information supplemented with some targeted field assessments;
- Ecological Land Classification (ELC) refinements and wetland updates within the SPA based on primarily desktop information (ref. Figure 8) supplemented with some field assessments and scoped botanical surveys where access has been provided (ref. Figure 2);
- One to two rounds of winter wildlife surveys along identified transects, with the option to undertake an additional round in 2018 if two cannot be accommodated in 2017 due to lack of snow (ref. Figure 9);
- Calling amphibian (i.e., frogs and toads) surveys at 22 wetland stations (ref. Figure 9);

- Amphibian movement surveys (salamanders and anurans) along seven transects located on Maltby Road, Victoria Road and Gordon Street in locations where these species have previously been documented or would be anticipated to be moving between suitable habitats;
- Turtle basking surveys at seven ponds / wetlands (ref. Figure 9);
- Breeding bird surveys at 15 point count stations (ref. Figure 9); and
- Incidental observations of snakes and other wildlife, as well as of potential wildlife habitats such as seepage areas, during the course of other surveys.

5.3.1 Wetland Water Monitoring

Wetland water monitoring was not initiated in 2016, with the exception of preliminary sampling at Station 7. The focus of the 2016 was in confirming the locations of monitoring stations meeting the criteria above, and securing access to them.

The complete wetland water monitoring program will begin in April 2017 and extend until October or November of 2018:

- Wetland water levels and surface temperatures will be measured continuously with data loggers [Solnist brand, (model 3001) at 12 locations (see Figure 7) within the PSA. Quality will be assessed by collecting grab samples at these same locations. Loggers will record water levels in each wetland at 15 minute intervals from April to October over 2017 and 2018. Data from these loggers will be downloaded during the water quality sampling events (see below) or at least twice a year in July and October. Manual water depth measurements will be taken during the logger downloads for reference.
- The Team will collect water quality data from each of the 12 stations three times a year (i.e. once in spring, summer and fall) over two years (i.e., 2017 and 2018). Water quality parameters to be measured will be those listed in Table 1 (ref. CEIS).

Pesticides will be sampled at a subset of these stations once in the fall of 2017. Locations have been selected adjacent to land uses where pesticides would be expected (see Figure 7). Sample collection in the fall will maximize the chances of detecting pesticides that have been used over the course of the season.

6.0 References

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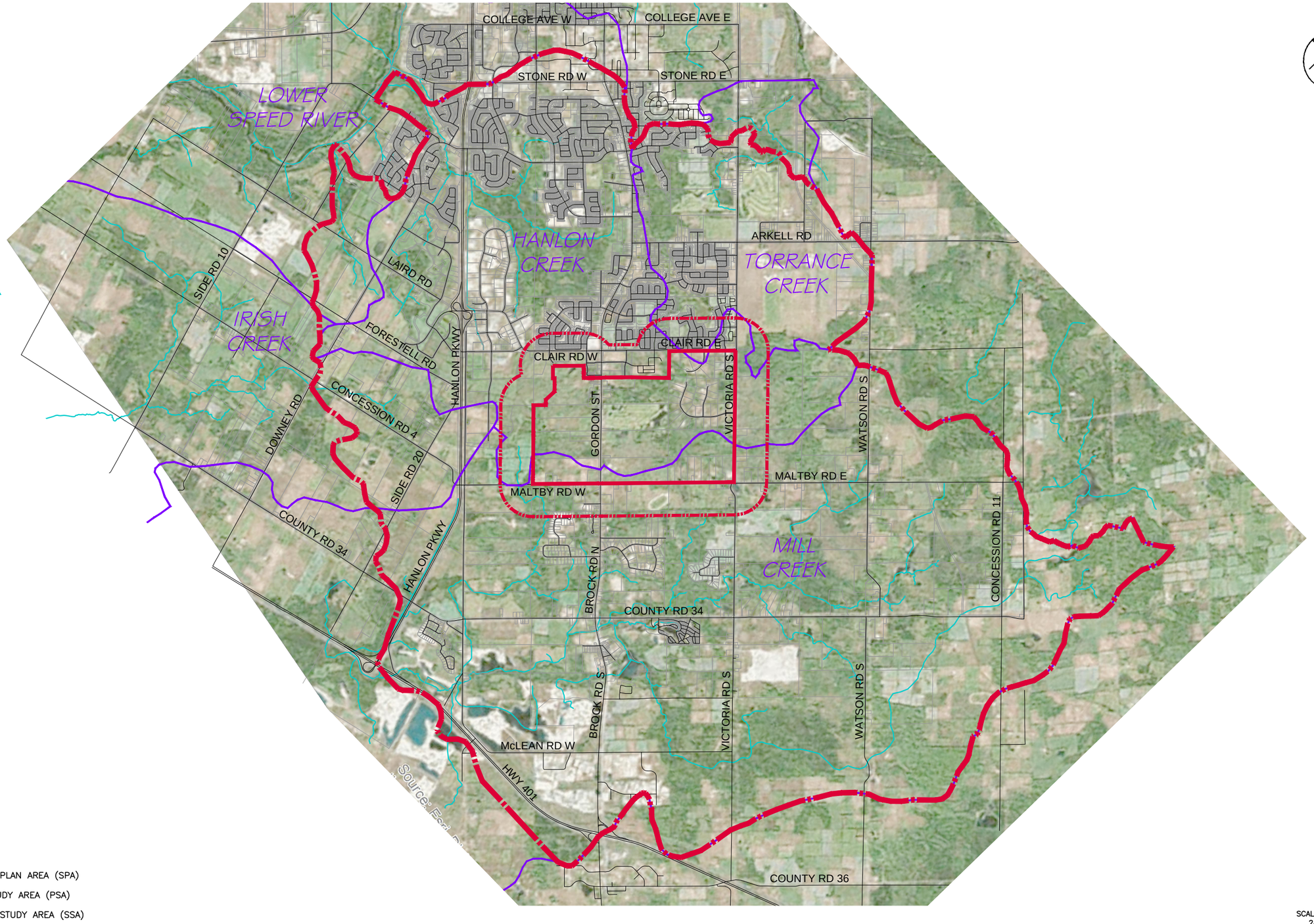

LEGEND

- SECONDARY PLAN AREA (SPA)
- PRIMARY STUDY AREA (PSA)
- SECONDARY STUDY AREA (SSA)
- SUBWATERSHED BOUNDARY
- WATERCOURSE
- ROADWAY
- PROPERTY BOUNDARY

SCALE VALID ONLY FOR 24"x36" VERSION

CLAIRE-MALTBY MASTER ENVIRONMENTAL SERVICING PLAN & SECONDARY PLAN
CITY OF GUELPH

STUDY AREA PLAN

amec foster wheeler

Scale 1:30000
0 250 500 1000

Consultant File No.
TPB168050

Figure No.
1

Plotted: 2016-10-06
Last Saved: 2016-10-06
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Path: P:\2016\Projects\TPB168050 - Clair Maltby\06_DES-ENG\01_CAD\02_DWGS\05_WR\01_PROJECT\2016-10\Fig1 StudyArea.dwg

Access

Figure 2

Clair-Maltby Master Environmental Servicing Plan (MESP) & Secondary Plan

Legend

- Secondary Plan Area Boundary
- Primary Study Area Boundary
- Parcel Fabric

Type of Access Granted

- Deep groundwater monitoring (well)
- Deep groundwater, shallow ground water (mini-piezometers), and surface water monitoring
- Shallow groundwater and surface water monitoring
- Deep and shallow groundwater, surface water, amphibian, bird and vegetation monitoring
- Shallow groundwater, surface water and amphibian monitoring
- Shallow groundwater, surface water, amphibian, bird and vegetation monitoring
- Deep and shallow groundwater, surface water and amphibian monitoring

First Base Solutions
Web Mapping Service 2010

UTM Zone 17 N, NAD 83

0 145 290 580 Metres

1:14,200

City of Guelph Natural Heritage System
- Significant Natural Areas
- Natural Areas
- Natural Areas Overlay
- Ecological Linkages
- Restoration Areas

Wildlife Crossings
- Amphibian Crossings
- Deer Crossings
- Other Wildlife Crossing Opportunities

County of Wellington Greenlands System
- Core Greenlands
- Greenlands
- Paris Moraine ANSI (LIO, 2016)

BEACON ENVIRONMENTAL

Project 216002
March, 2017

Easting (m)

560000 561000 562000 563000 564000 565000 566000 567000 568000 569000 570000 571000 572000

Northing (m)

4822000 4821000 4820000 4819000 4818000 4817000 4816000 4815000 4814000 4813000 4812000

Speed River
Eramosa River
Torrance Creek
Hanlon Creek
Mill Creek
Irish Creek

HANLON EXPY
VICTORIA RD S
GORDON ST
ARKELL RD
GOODWIN DR
MALTBY RD E
SOUTHGATE DR
CLAIR RD W
FORESTELL RD
CONCESSION 4
BROCK RD
WELLINGTON ROAD 34

TC-C1
TC-V2
TC-V1
HC-HR1
HC-HR3
HC-HR2
HC-T1
LSR-P3
LSR-P2
LSR-P1
LSR-L1
LSR-D2
MW01-S/D
MW02-S/D
MP09-S/D
MW03-S/D
MP08
MP04
MW04-S/D
MP13-S/D
MW05-S/D
MP07-S/D
MP01-S/D
MW1-11
MP02
MP03
MW06-S/D
MW2-11
MW3-11
MP06
MP12
MP05
MW07
MW08-S/D
MP14
MC-V2
MP10
MW09-S/D
MP11
MC-M3
MC-GN2
MC-GN1
MC-WL3
MC-WL4
MC-GN3
MC-G1
MC-V1
MC-GN4
MC-C72
MC-C71
MC-SR1
MC-M2
MC-W2

N

bing™

Primary Study Area Boundary
Secondary Plan Area Boundary
Water Body
Watercourse
Highway
Road
Mini Piezometer
Spotflow Station
Monitoring Well (Matrix)
Monitoring Well (132 Clair Rd.)

1:45,000 m
460 0 460 920

Reference: Data provided by the City of Guelph and GeoBase® used under license.
Imagery obtained from © 2013 Microsoft Corporation and its data suppliers

NAD 1983 UTM Zone 17N

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph
Clair-Maltby Comprehensive Environmental Impact Study
Year 1 Monitoring Report

Hydrogeology Monitoring Locations - Regional Extent

DRAFT

Date:	Project:	Technical:	Reviewer:	Drawn:
02 Mar 2017	23089	J. Melchin	S. Davies	M. Urtheil

Figure 3

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Easting (m)

560000 561000 562000 563000 564000 565000 566000 567000 568000 569000 570000 571000 572000

Northing (m)

4822000 4821000 4820000 4819000 4818000 4817000 4816000 4815000 4814000 4813000 4812000

N

Speed River
Eramosa River
Torrance Creek
Hanlon Creek
Irish Creek
Mill Creek
Trib.

HANLON EXPY
VICTORIA RDS
GORDON ST
ARKELL RD
GOODWIN DR
MALTBY RDE
SOUTHGATE DR
CLAIR RD W
FORESTELL RD
CONCESSION 4
BROCK RD
WELLINGTON ROAD 34

Lower Speed River
Torrance Creek
Hanlon Creek
Irish Creek
Mill Creek

TC-C1
S: --
F: 0.0

TC-V2
S: --
F: 0.0

TC-V1
S: --
F: 4.0

HC-HR1
S: 63.3
F: 59.9

HC-HR3
S: 2.1
F: 2.6

HC-HR2
S: 0.0
F: 0.0

HC-T1
S: 14.0
F: 11.6

LSR-P3
S: 0.1
F: 0.3

LSR-P2
S: 0.0
F: 0.0

LSR-P1
S: 0.1
F: 0.1

LSR-L1
S: 0.0
F: 0.0

LSR-D2
S: 0.0
F: 0.0

MC-M2
S: --
F: 0.0

MC-W2
S: 8.3
F: 5.6

MC-V2
S: 11.2
F: 5.8

MC-M3
S: 0.0
F: 0.0

MC-GN2
S: 1.9
F: 2.4

MC-GN1
S: 1.9
F: 4.7

MC-WL3
S: 76.9
F: 65.8

MC-WL4
S: 8.4
F: 13.5

MC-GN3
S: 73.8
F: 58.2

MC-GN4
S: 105.7
F: 111.4

MC-G1
S: 36.9
F: 43.4

MC-V1
S: 16.5
F: 12.0

MC-C72
S: 0.0
F: 0.8

MC-C71
S: 0.0
F: 0.0

MC-SR1
S: 174.3
F: 187.2

Primary Study Area Boundary
Secondary Plan Area Boundary
Water Body
Watercourse
Highway
Road
Spot Flow Location

Subwatershed

Hanlon Creek
Irish Creek
Lower Speed River
Mill Creek
Torrance Creek

HC-D2 Spot Flow Location
S:0 Summer (Aug.30/31,Sept. 1) Flow Rate (L/s)
F:0 Fall (Nov.9/10) Flow Rate (L/s)

1:45,000 m
460 0 460 920

Reference: Data provided by the City of Guelph and GeoBase® used under license.

NAD 1983 UTM Zone 17N

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph
Clair-Maltby Comprehensive Environmental Impact Study
Year 1 Monitoring Report

Surface Water Spotflow Results

DRAFT

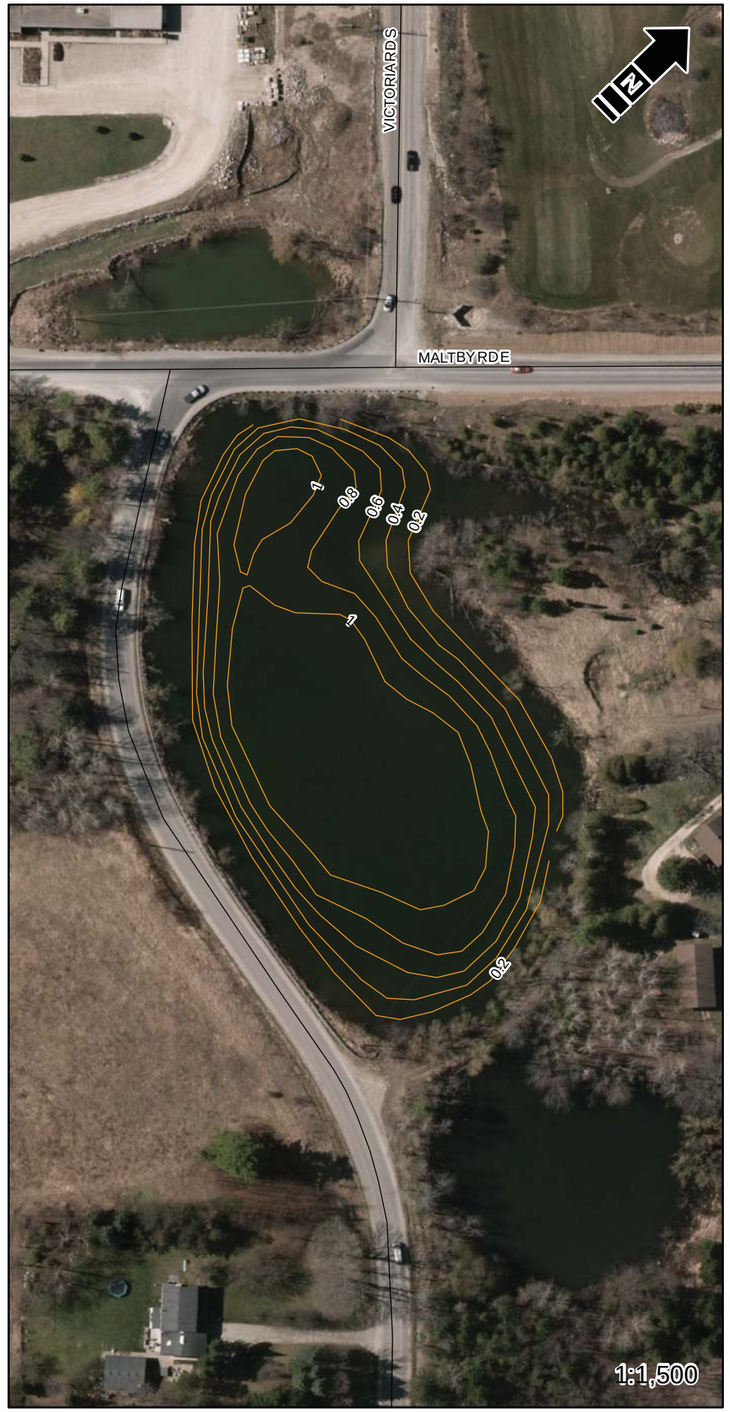
Date:	Project:	Technical:	Reviewer:	Drawn:
02 Mar 2017	23089	J. Melchin	S. Davies	M. Urtheil

Figure 4

I:\City of Guelph\23089\Figures and Tables\QHG\2016 Report Work plan\Figure-4_Surface_Water_Spotflow_Results_Regional_Extent.mxd

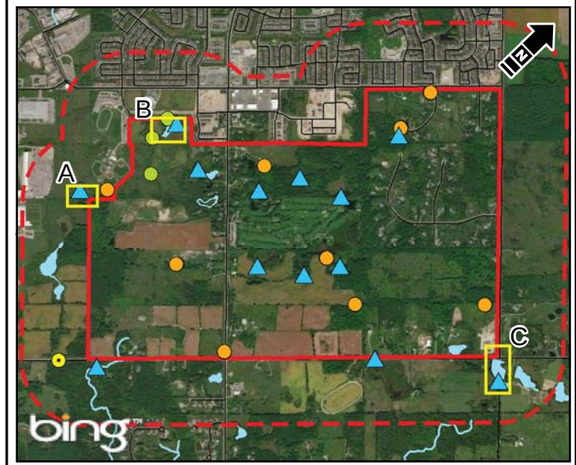
B - Neumann's Pond A

A - Unnamed Pond at 950 Southgate Dr.



C - Halligan's Pond

- Primary Study Area Boundary
- Secondary Plan Area Boundary
- Water Body
- Watercourse
- Mini Piezometer
- Spotflow Station
- Monitoring Well (Matrix)
- Monitoring Well (132 Clair Rd.)
- Pond Depth Profile Location
- Pond Bathymetry Contour (m)
- Road



1:45,000

600 0 600 1,200 m

NAD 1983 UTM Zone 17N

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

City of Guelph

Clair-Maltby Comprehensive Environmental Impact Study
Year 1 Monitoring Report

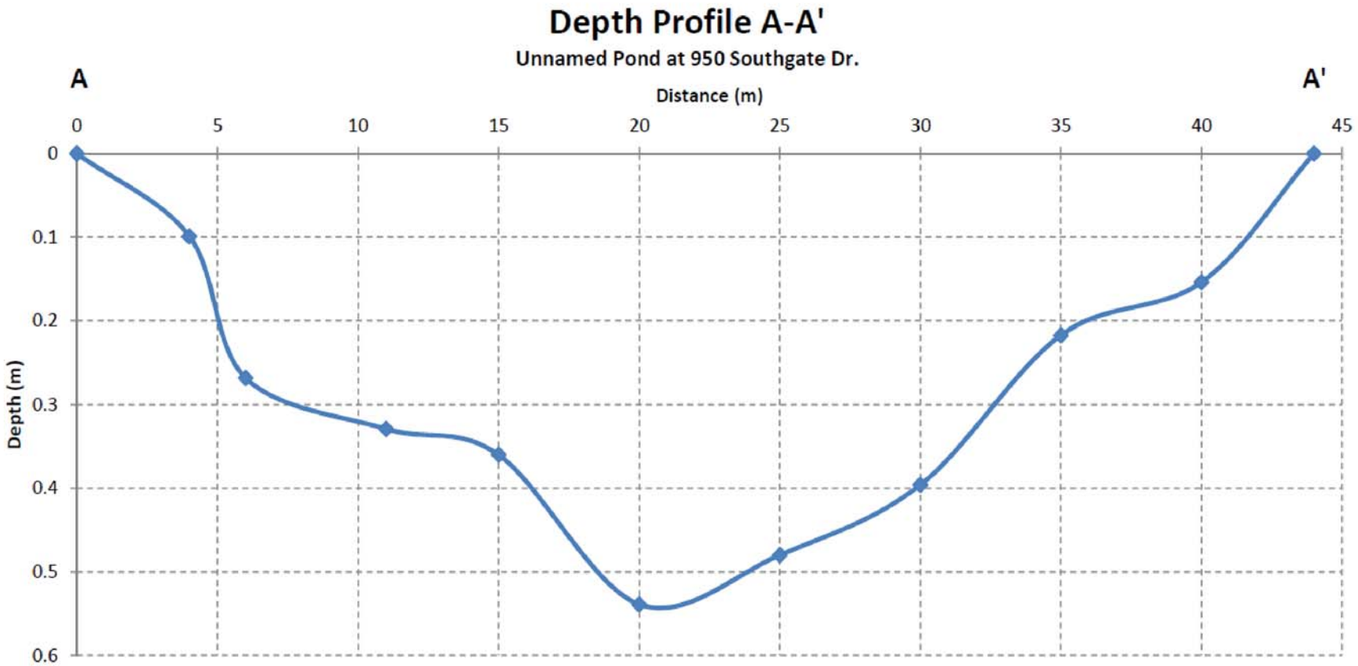
Pond Bathymetry

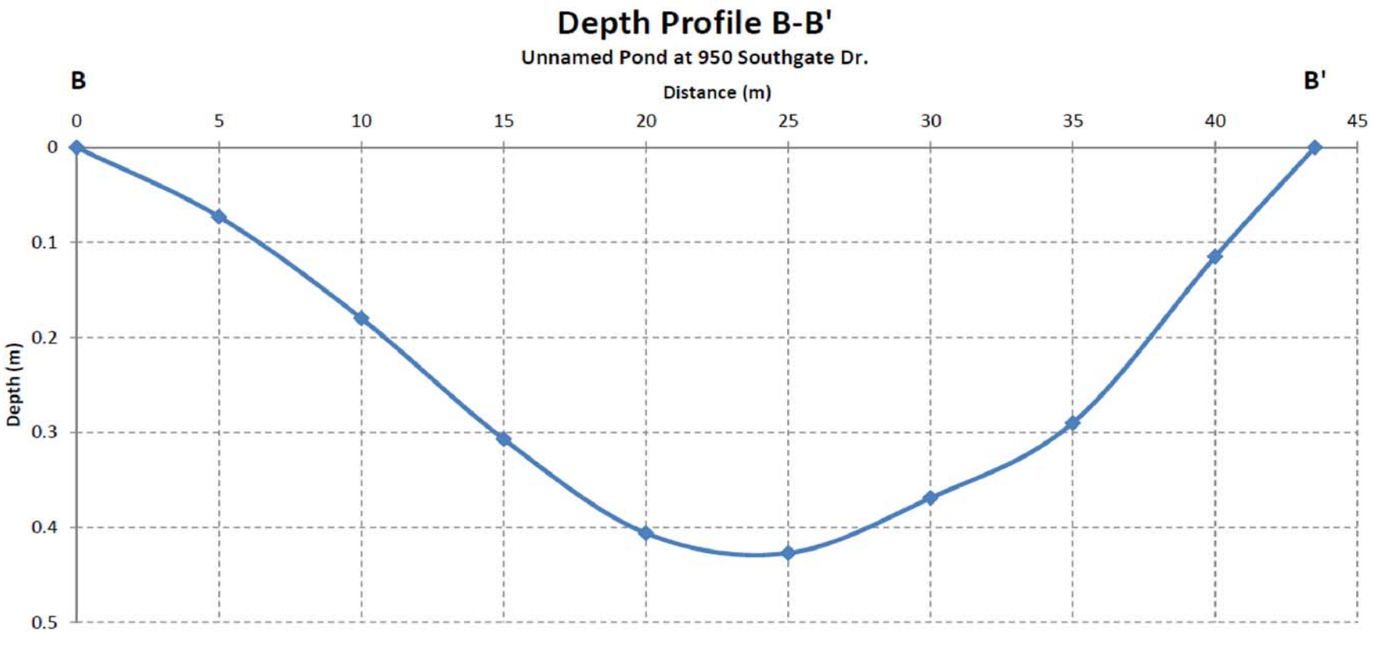
DRAFT

Date:	Project:	Technical:	Reviewer:	Drawn:
02 Mar 2017	23089	J. Melchin	S. Davies	M.Urtheil

Figure 5

I:\C\yo\Guelph\23089\Figures\and\Tables\QHG\2016ReportWorkplan\Figure-5-Pond_Bathymetry.mxd





Refer to Figure 5 for profile locations.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

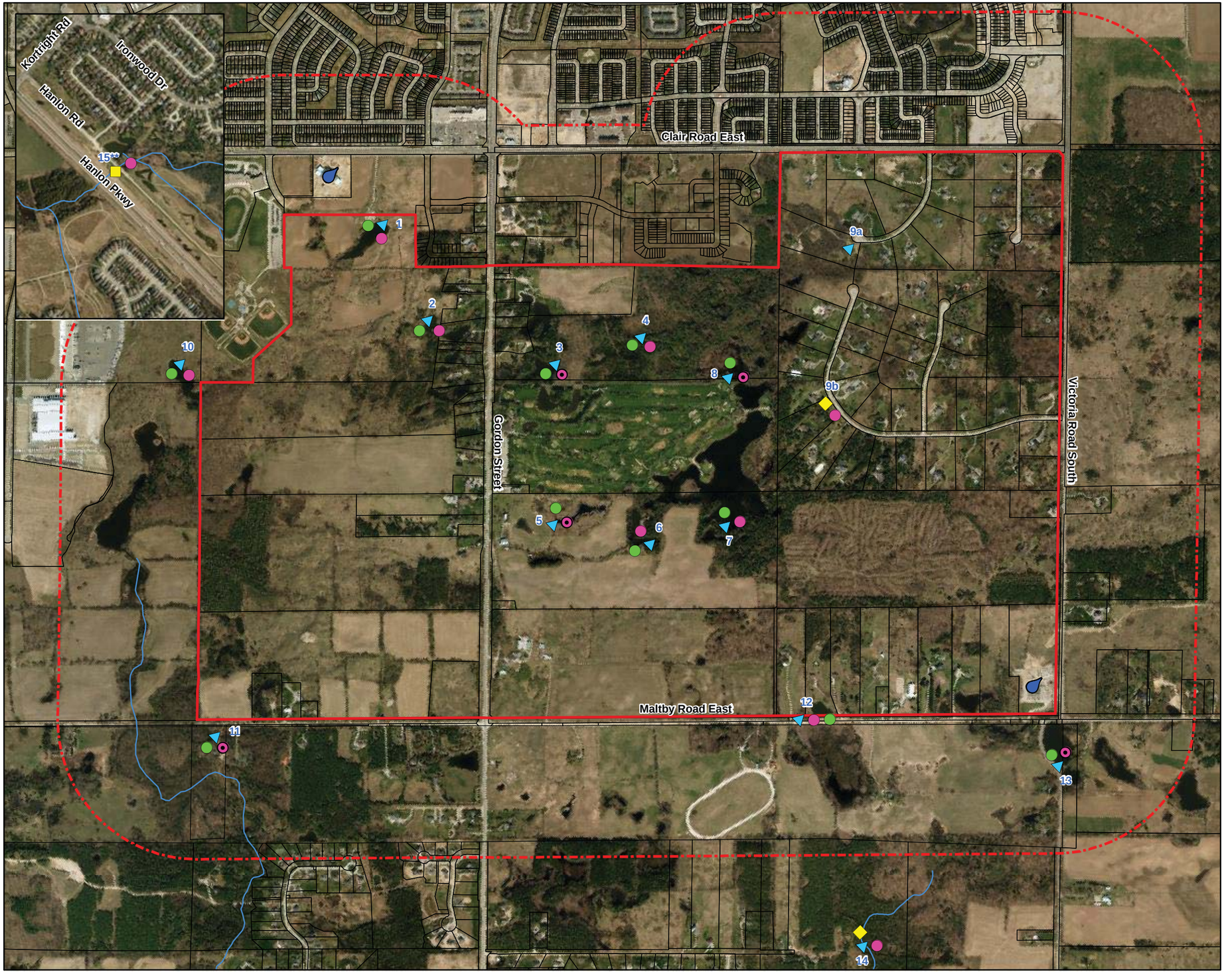
City of Guelph
Clair-Maltby Comprehensive Environmental Impact Study
Year 1 Monitoring Report

Unnamed Pond Depth Profiles
950 Southgate Dr.

Date:	Project:	Technical:	Reviewer:	Drawn:
02 Mar 2017	23089	J. Melchin	S. Davies	M.Urtheil

Figure 6

I:\Chor\Guelph\23089\Figures\and\Tables\QHG\2018 Report\Workplan\Figure-6-Bathymetry_Profiles_950_Southgate.mxd



Surface Water Monitoring

Figure 7

Clair-Maltby Master Environmental Servicing Plan (MESP) & Secondary Plan

Legend

- Secondary Plan Area Boundary
- Primary Study Area Boundary
- Watercourse
- CoG Parcel Fabric

Monitoring Stations

- Surface Water Quality*
- Surface Water Quality* + Pesticides
- Surface Water Quantity
- Shallow Groundwater
- Surface Water Flow
- Rain Gauge

* Water Quality Sampling Parameters include: TSS, TDS, PTP, SO^4, Cl, TKN, NO^2, NO^3, NH^3, Temp, pH, Conductivity, DO and Metals.
** Proposed station. No equipment has been installed and no samples have been taken to date.

First Base Solutions
Web Mapping Service 2010

UTM Zone 17 N, NAD 83

0 145 290 580 Metres

1:14,200

BEACON ENVIRONMENTAL

Project 216002
March, 2017

Available Natural Heritage Data

Figure 8

Clair-Maltby Master Environmental Servicing Plan (MESP) & Secondary Plan

Legend

- Secondary Plan Area Boundary
- Primary Study Area Boundary
- Parcel Fabric

Available Natural Heritage Data

- Vegetation Data
- Vegetation and Wildlife Data
- Vegetation, Wildlife and Fisheries Data

City of Guelph Natural Heritage System

- Significant Natural Areas
- Natural Areas
- Natural Areas Overlay
- Ecological Linkages
- Restoration Areas

Wildlife Crossings

- Amphibian Crossings
- Deer Crossings
- Other Wildlife Crossing Opportunities

County of Wellington Greenlands System

- Core Greenlands
- Greenlands
- Paris Moraine ANSI (LIO, 2016)

Note
* This map shows data available from site-specific studies undertaken within the Primary Study Area between 2001 and 2016.

First Base Solutions
Web Mapping Service 2010

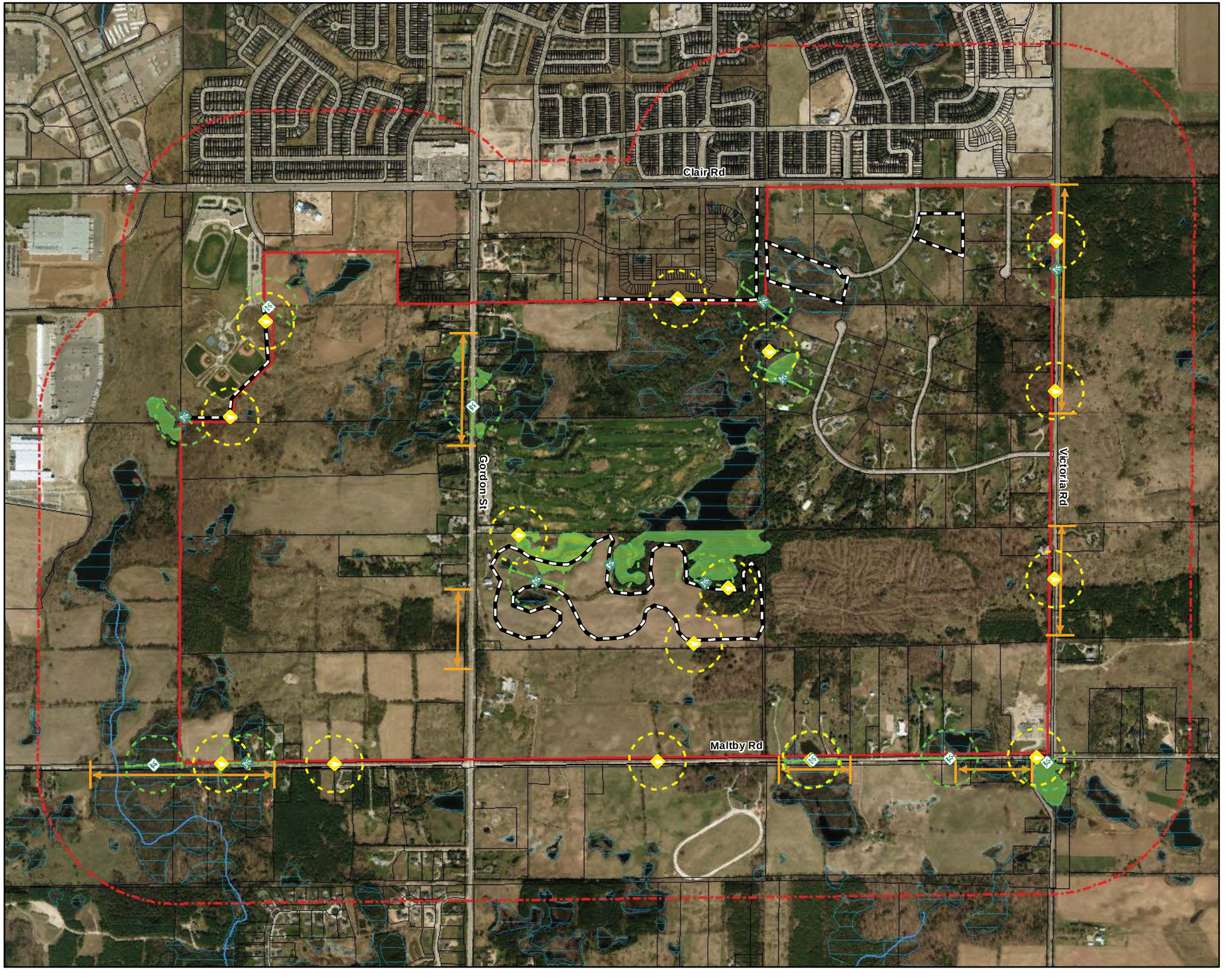
UTM Zone 17 N, NAD 83

0 145 290 580 Metres

1:14,000

BEACON ENVIRONMENTAL

Project 216002
March, 2017



Wildlife Monitoring

Figure 9

Clair-Maltby Master Environmental Servicing Plan (MESP) & Secondary Plan

Legend

- Secondary Plan Area Boundary
- Primary Study Area Boundary
- Parcel Fabric
- Wetland
- Watercourse
- Amphibian Monitoring Stations (22)
- Breeding Bird Stations (15)
- Basking Turtle Monitoring Stations (8)
- Winter Wildlife Transects (5)
- Wildlife Road Transects (6)

First Base Solutions
Web Mapping Service 2010

UTM Zone 17 N, NAD 83

0 145 290 580 Metres

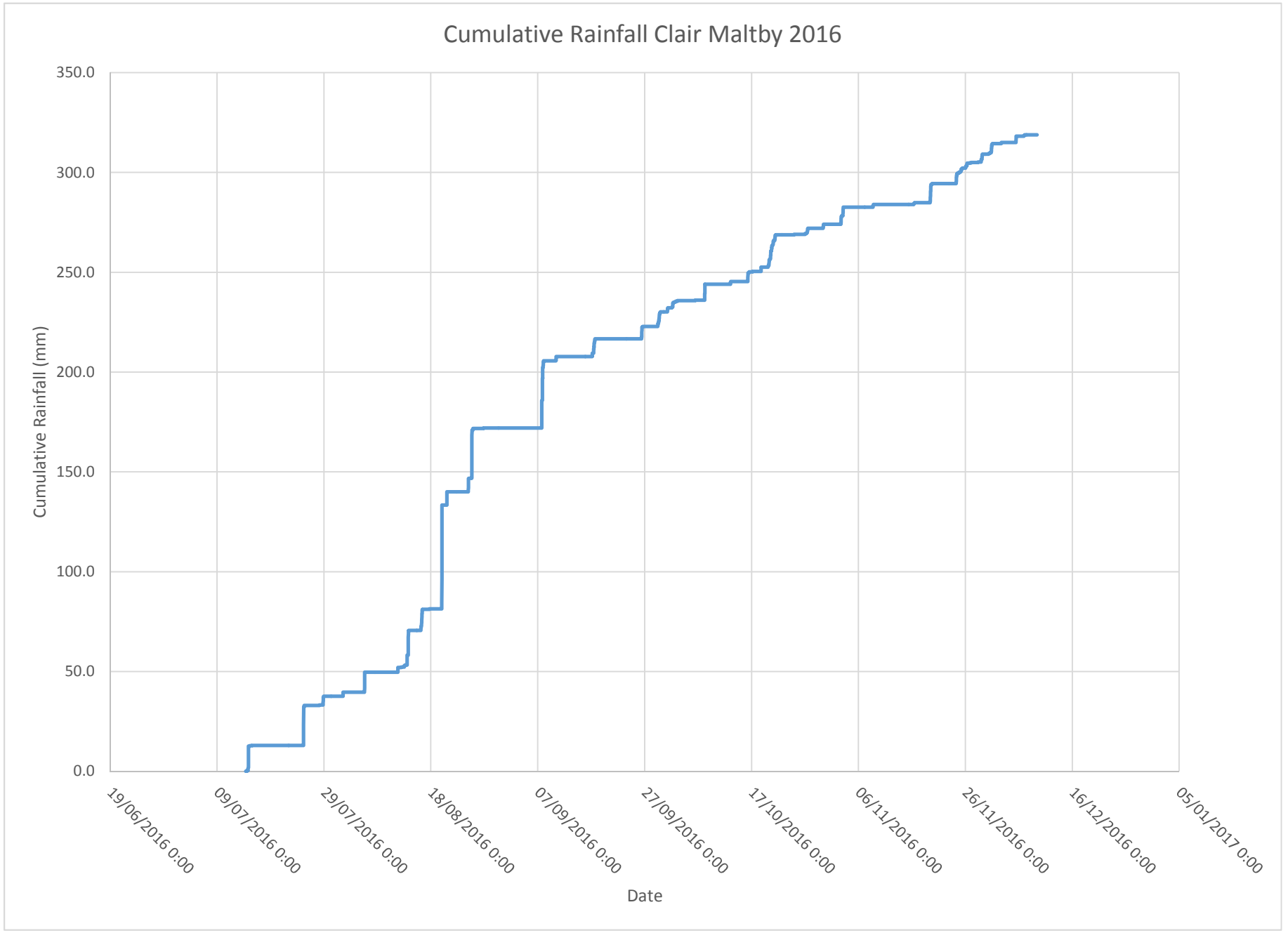
1:14,000

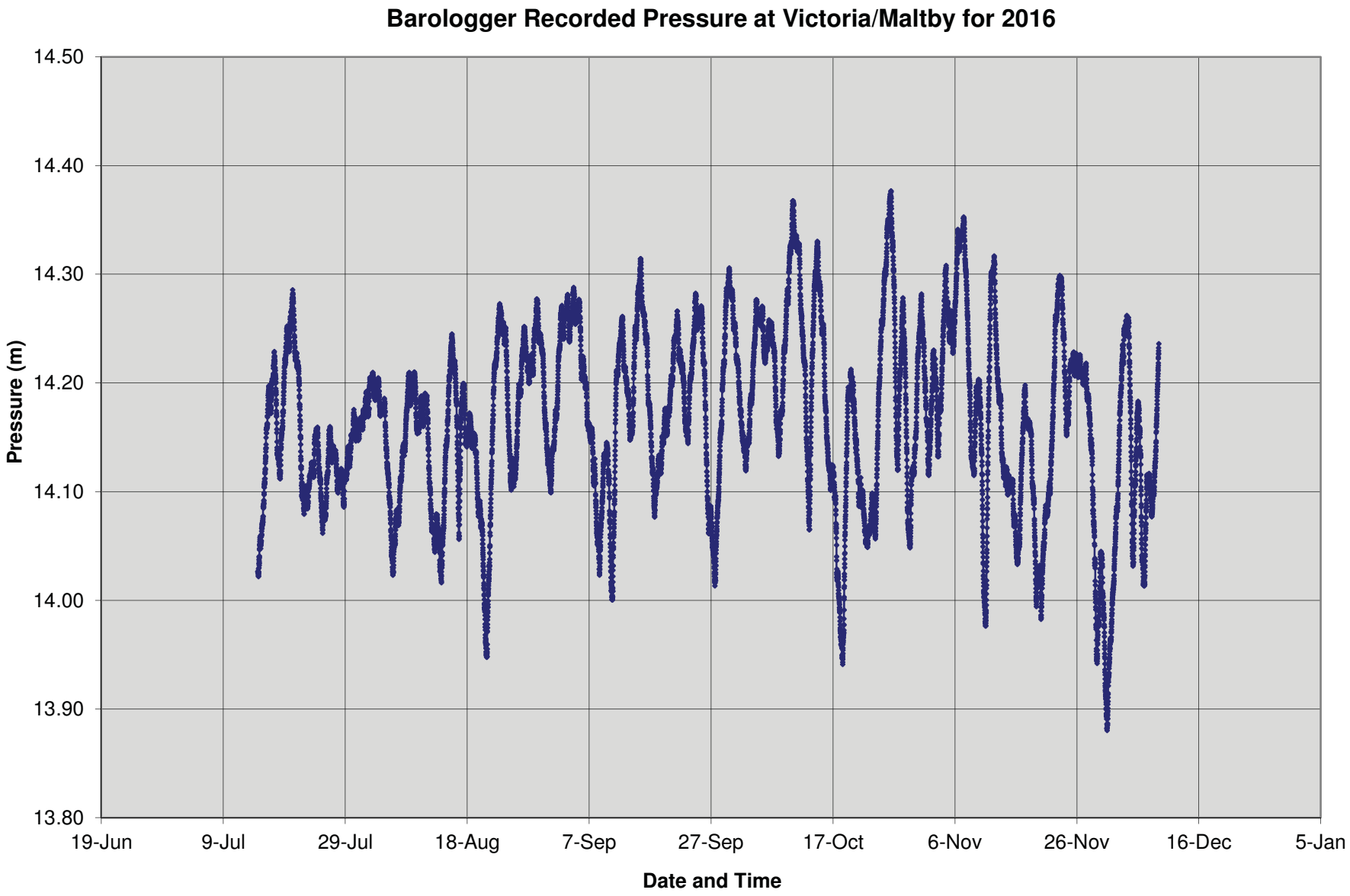
BEACON ENVIRONMENTAL

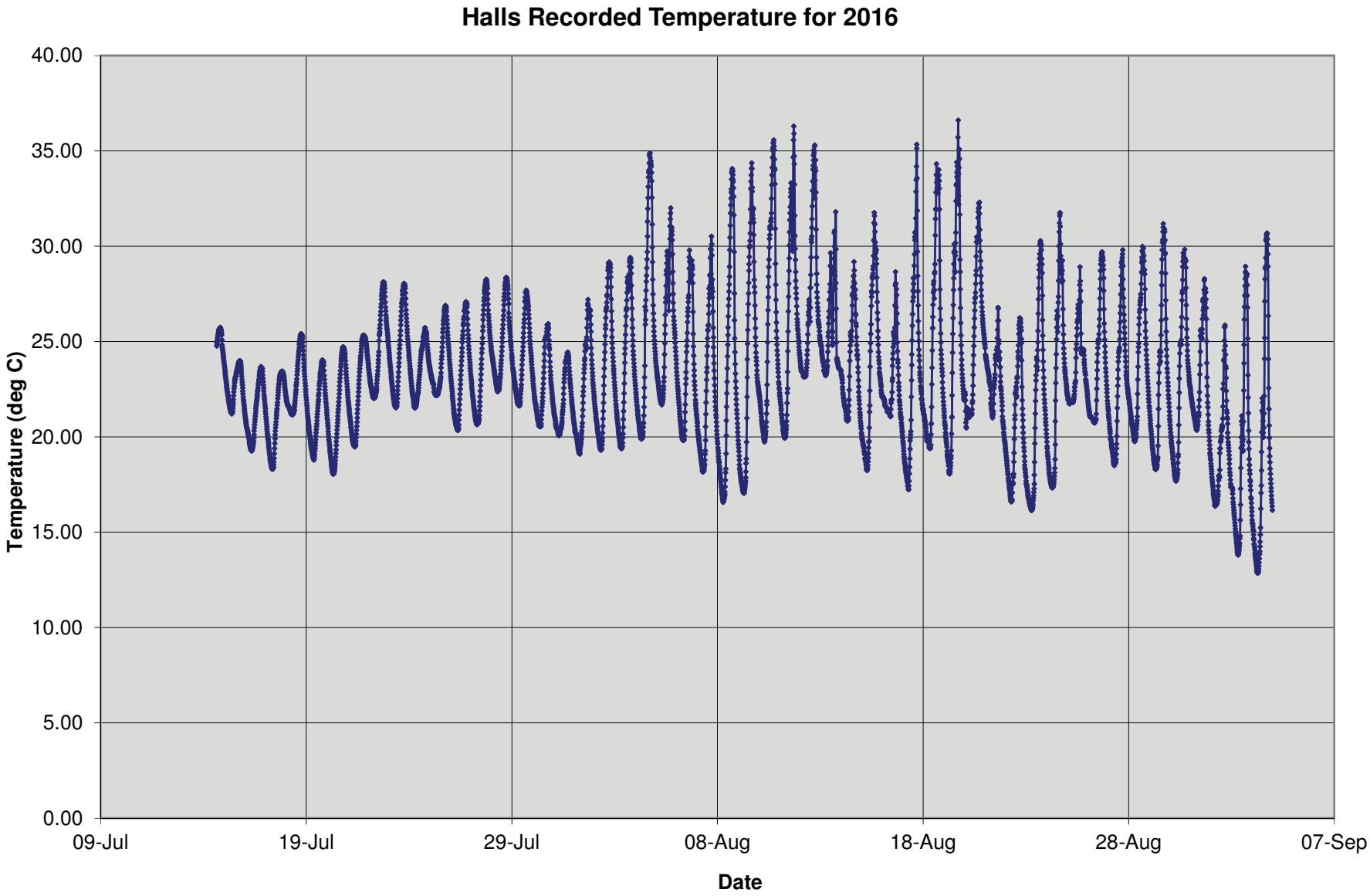
Project 216002
March, 2017

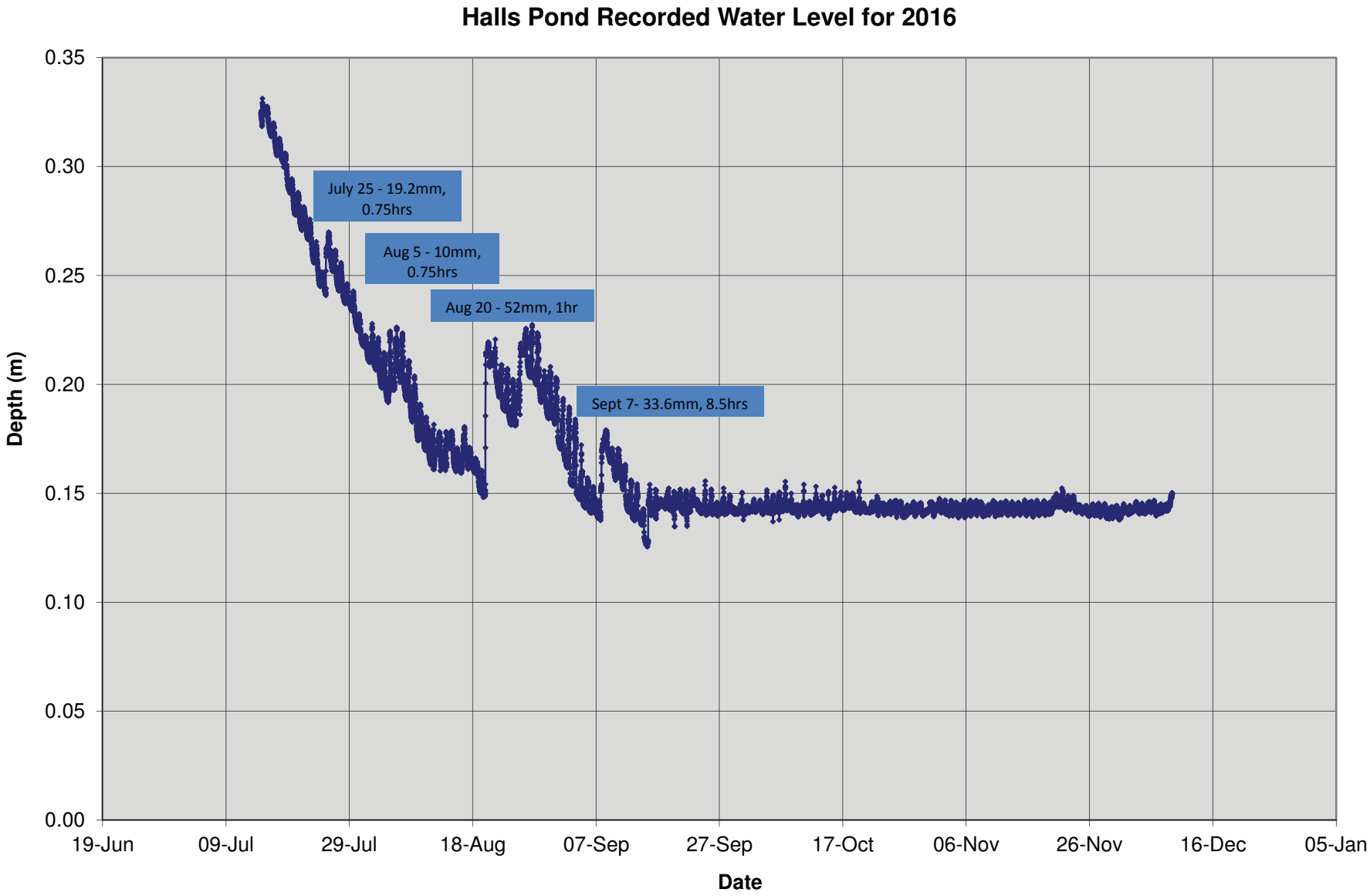
Appendix A

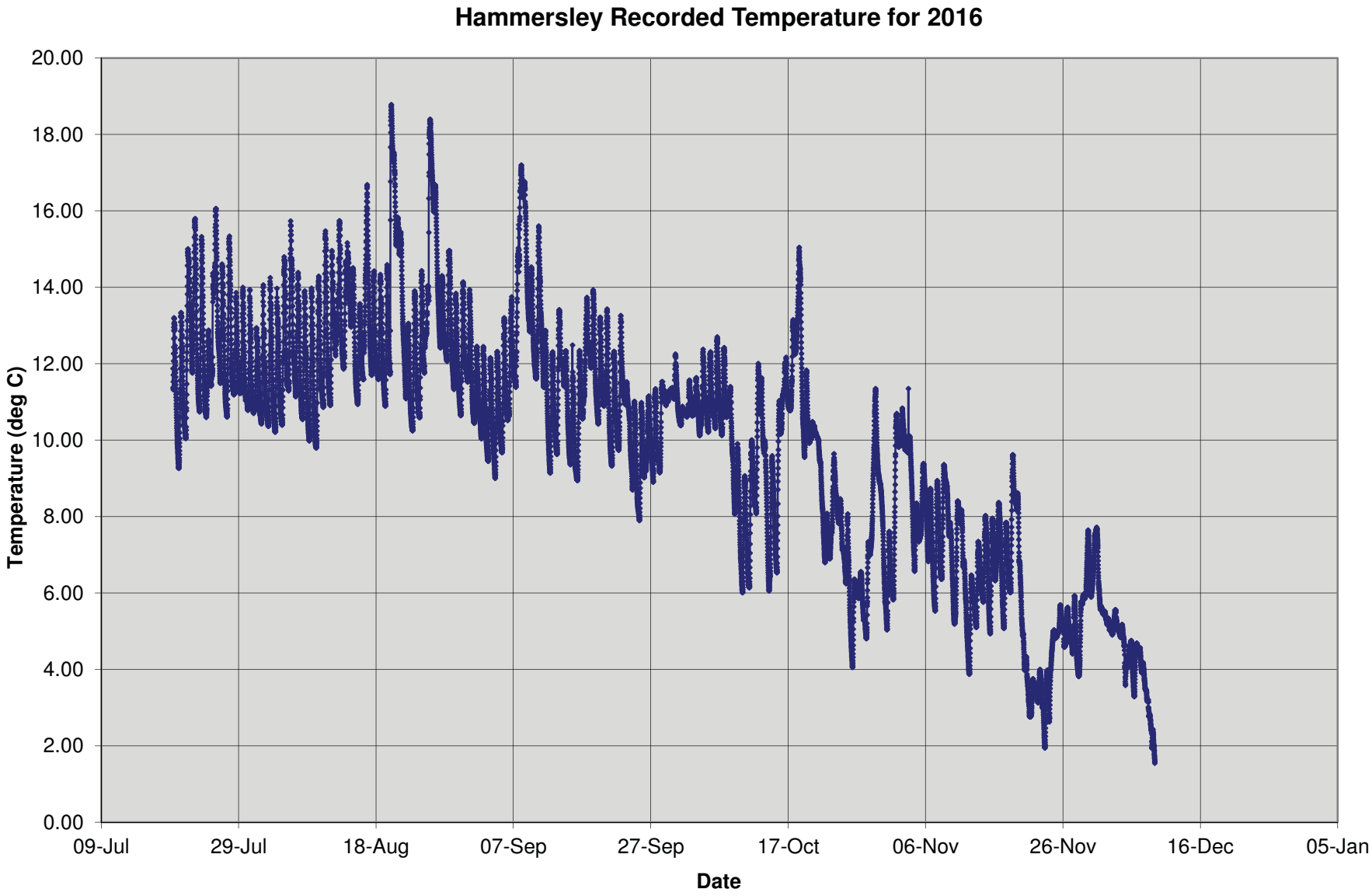
Surface Water

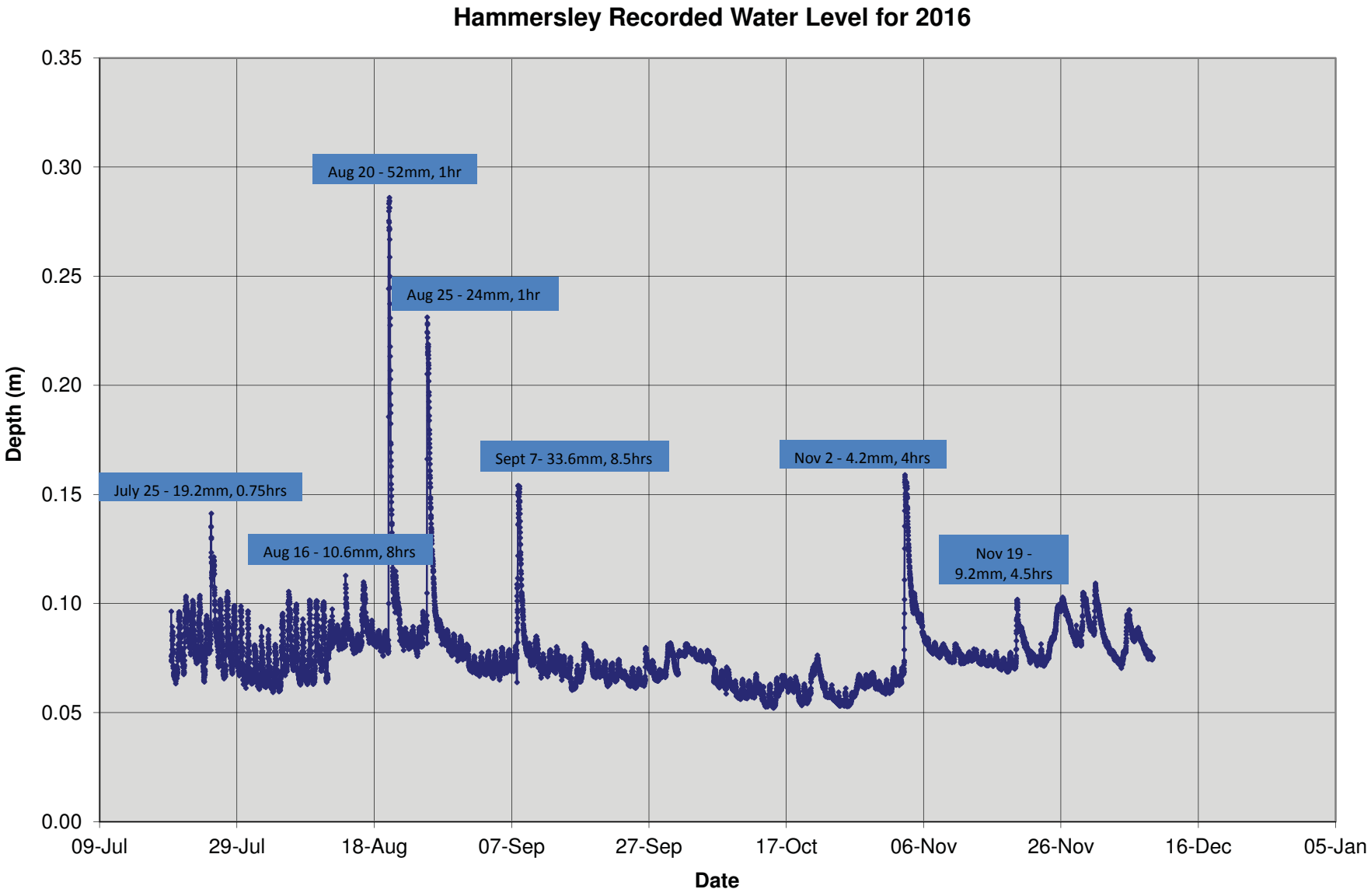

Cumulative Rainfall Clair Maltby 2016
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Cumulative Rainfall (mm)
19/06/2016 0:00
09/07/2016 0:00
29/07/2016 0:00
18/08/2016 0:00
07/09/2016 0:00
27/09/2016 0:00
17/10/2016 0:00
06/11/2016 0:00
26/11/2016 0:00
16/12/2016 0:00
05/01/2017 0:00
Date

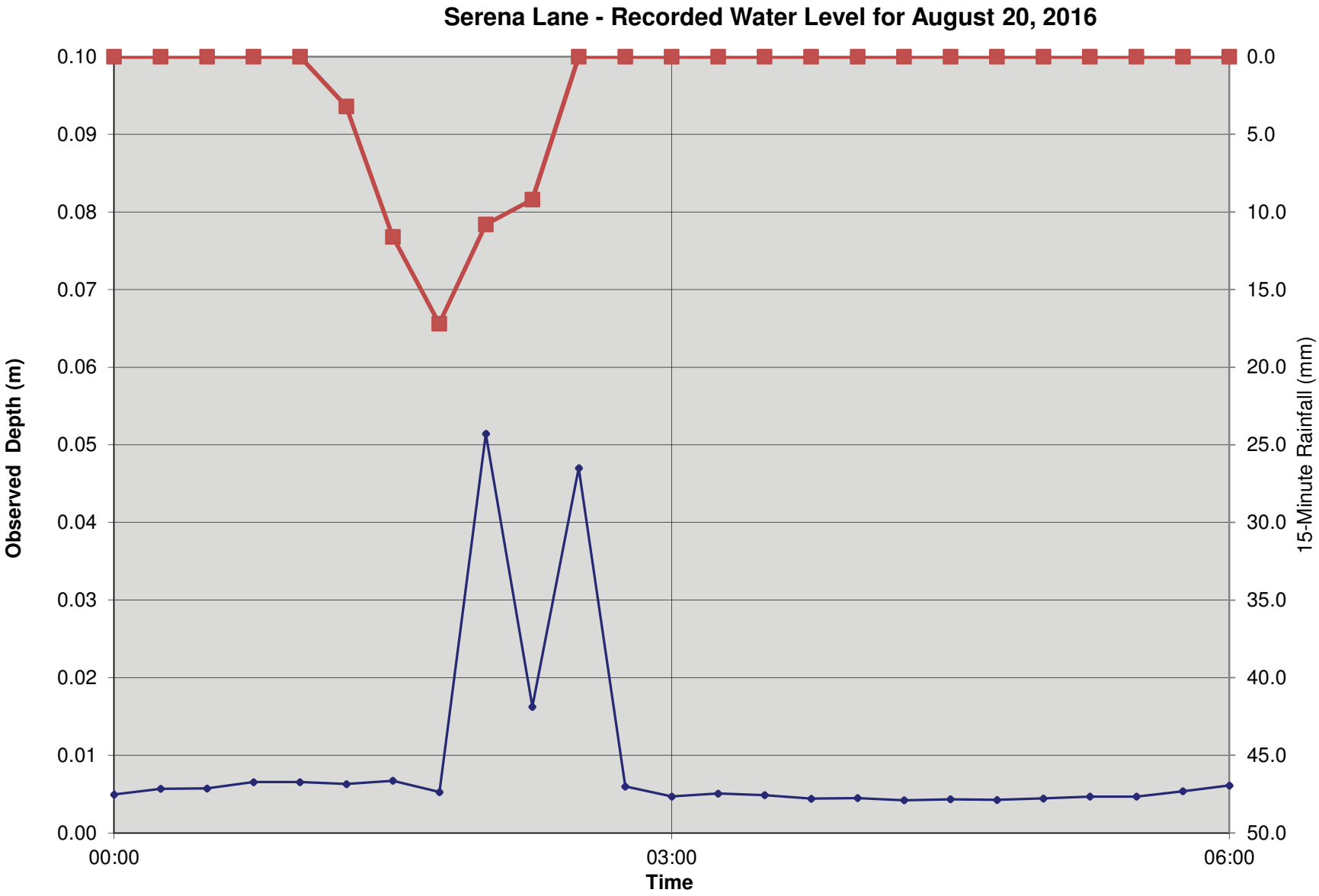

Barologger Recorded Pressure at Victoria/Maltby for 2016
Pressure (m)
14.50
14.40
14.30
14.20
14.10
14.00
13.90
13.80
19-Jun
9-Jul
29-Jul
18-Aug
7-Sep
27-Sep
17-Oct
6-Nov
26-Nov
16-Dec
5-Jan
Date and Time

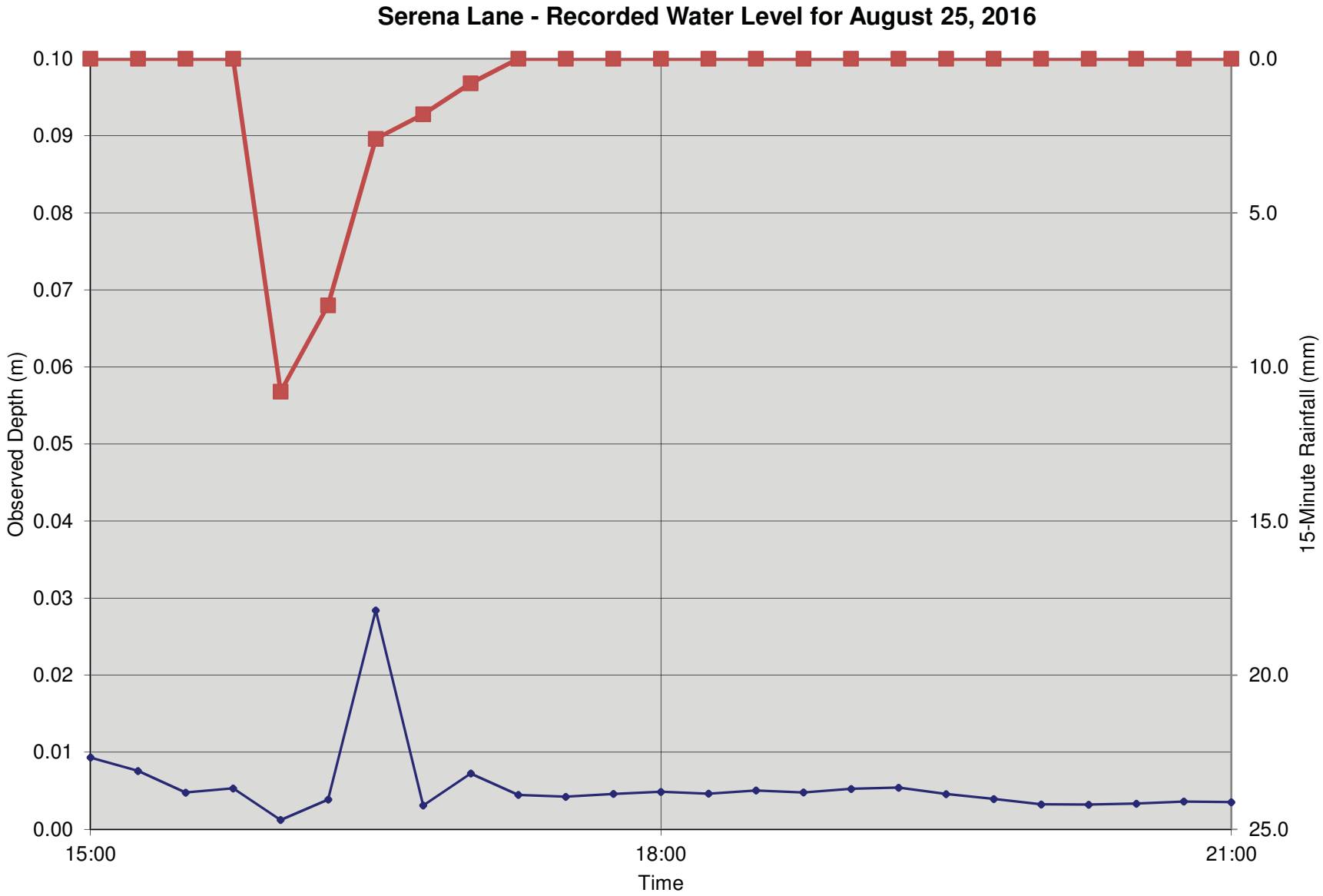

Halls Recorded Temperature for 2016
Temperature (deg C)
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
09-Jul
19-Jul
29-Jul
08-Aug
18-Aug
28-Aug
07-Sep
Date

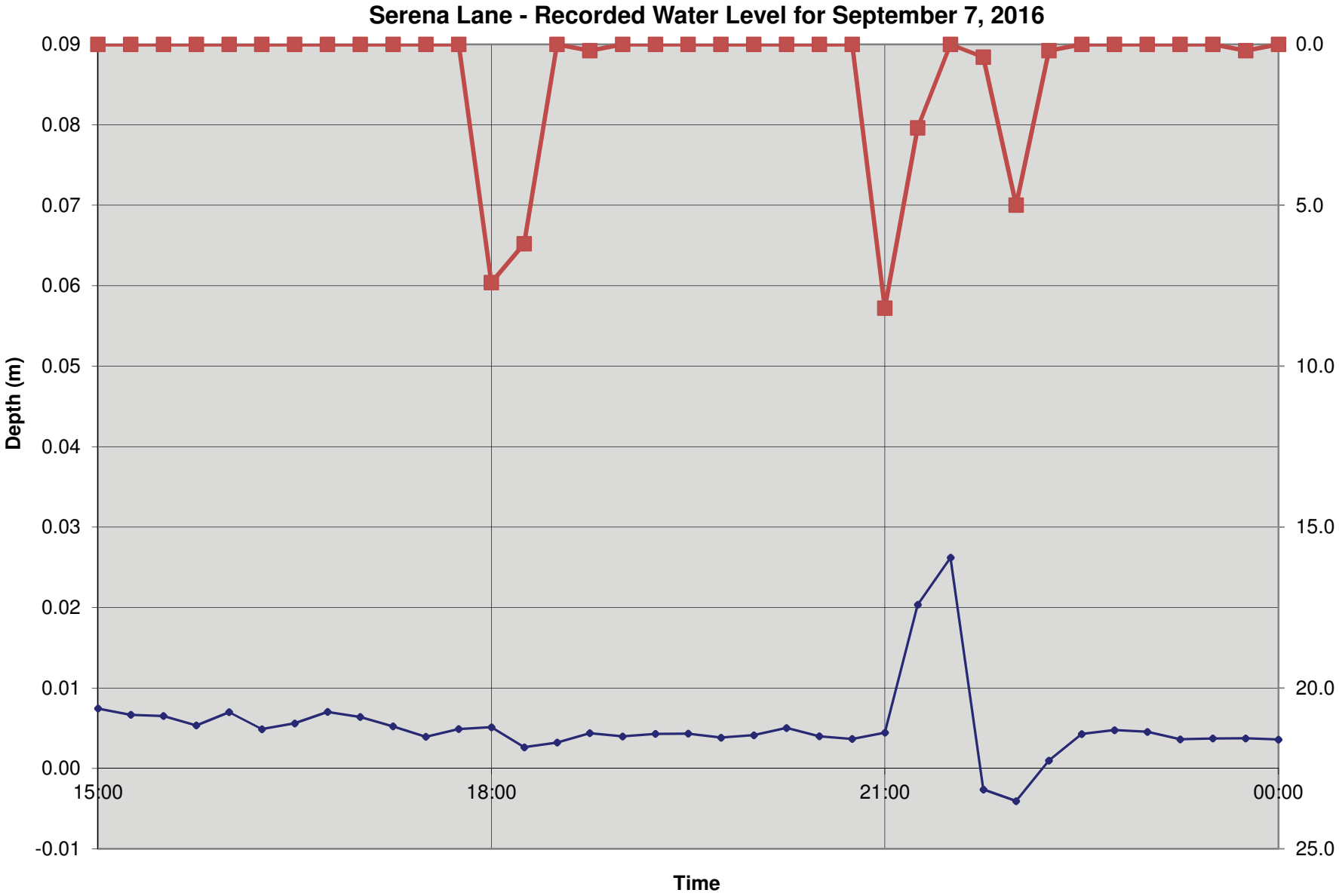

Halls Pond Recorded Water Level for 2016
Depth (m)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
July 25 - 19.2mm, 0.75hrs
Aug 5 - 10mm, 0.75hrs
Aug 20 - 52mm, 1hr
Sept 7- 33.6mm, 8.5hrs
19-Jun
09-Jul
29-Jul
18-Aug
07-Sep
27-Sep
17-Oct
06-Nov
26-Nov
16-Dec
05-Jan
Date

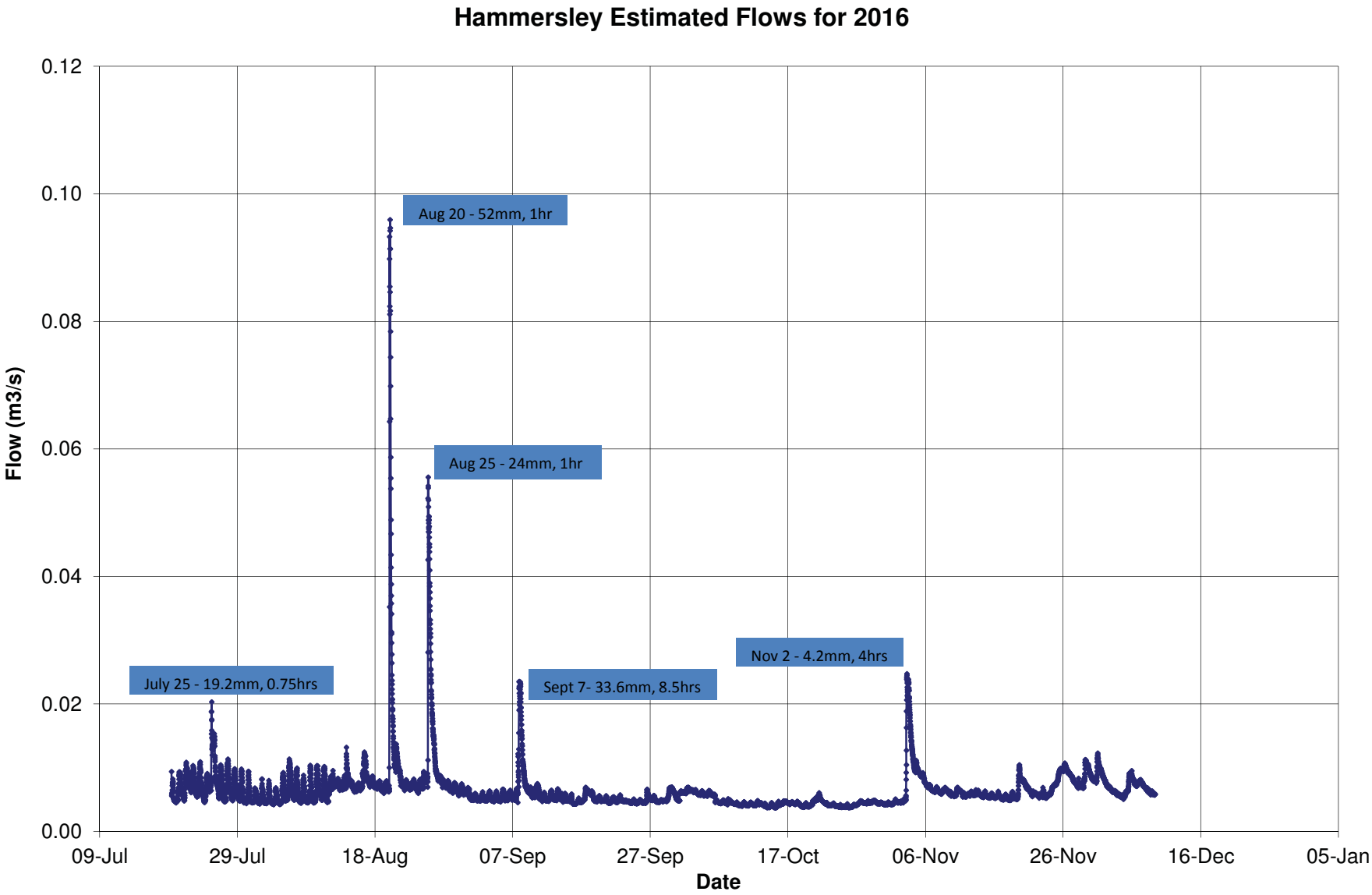

Hammersley Recorded Temperature for 2016
Temperature (deg C)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
09-Jul
29-Jul
18-Aug
07-Sep
27-Sep
17-Oct
06-Nov
26-Nov
16-Dec
05-Jan
Date

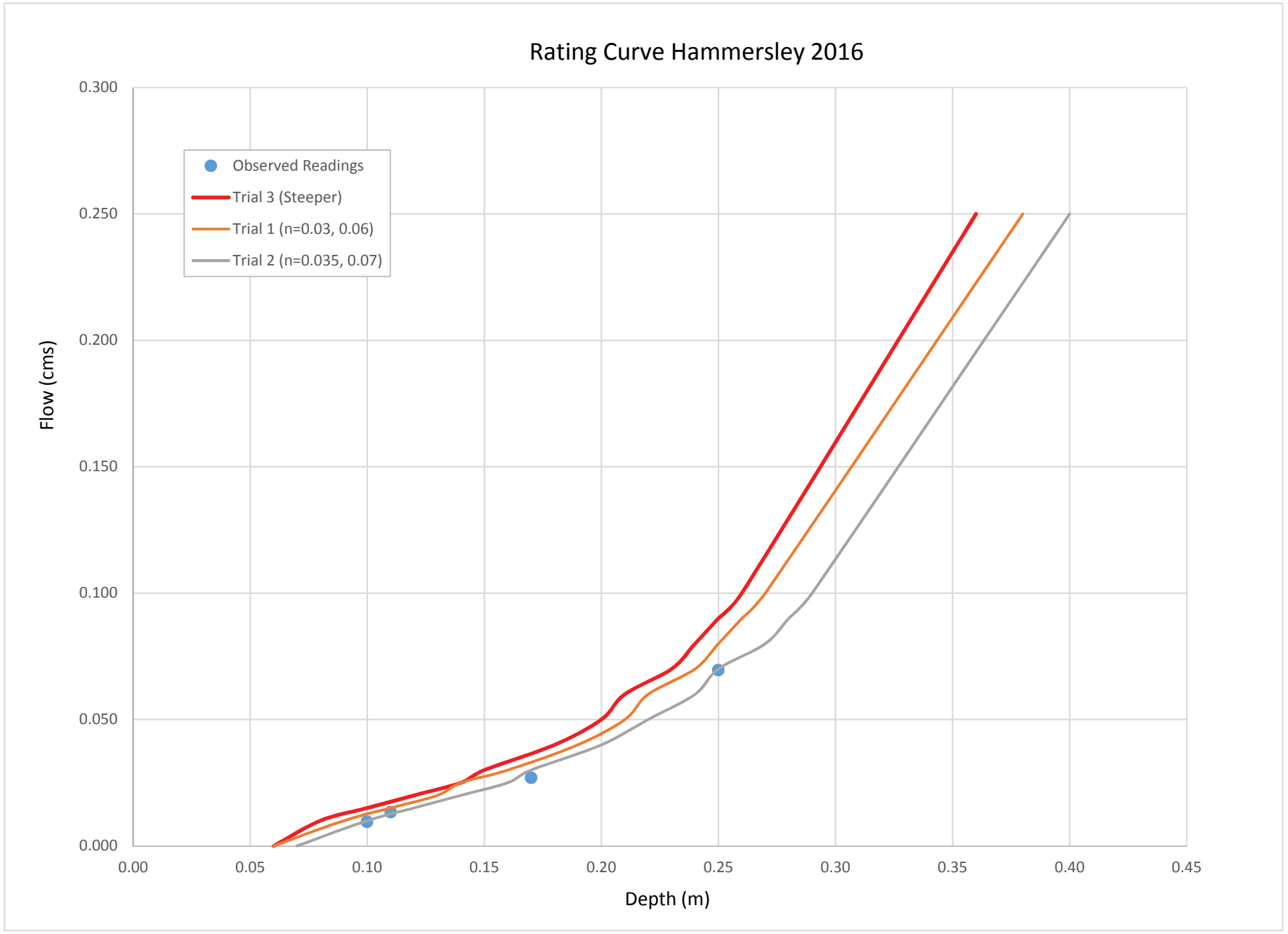

Hammersley Recorded Water Level for 2016
Depth (m)
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
09-Jul
29-Jul
18-Aug
07-Sep
27-Sep
17-Oct
06-Nov
26-Nov
16-Dec
05-Jan
Date
Aug 20 - 52mm, 1hr
Aug 25 - 24mm, 1hr
Sept 7- 33.6mm, 8.5hrs
Nov 2 - 4.2mm, 4hrs
July 25 - 19.2mm, 0.75hrs
Aug 16 - 10.6mm, 8hrs
Nov 19 - 9.2mm, 4.5hrs


Serena Lane - Recorded Water Level for August 20, 2016
Observed Depth (m)
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
15-Minute Rainfall (mm)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
00:00
03:00
06:00
Time


Serena Lane - Recorded Water Level for August 25, 2016
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
Observed Depth (m)
0.0
5.0
10.0
15.0
20.0
25.0
15-Minute Rainfall (mm)
15:00
18:00
21:00
Time


Serena Lane - Recorded Water Level for September 7, 2016
Depth (m)
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
0.0
5.0
10.0
15.0
20.0
25.0
15:00
18:00
21:00
00:00
Time


Hammersley Estimated Flows for 2016
Flow (m3/s)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Aug 20 - 52mm, 1hr
Aug 25 - 24mm, 1hr
July 25 - 19.2mm, 0.75hrs
Sept 7- 33.6mm, 8.5hrs
Nov 2 - 4.2mm, 4hrs
09-Jul
29-Jul
18-Aug
07-Sep
27-Sep
17-Oct
06-Nov
26-Nov
16-Dec
05-Jan
Date


Rating Curve Hammersley 2016
Observed Readings
Trial 3 (Steeper)
Trial 1 (n=0.03, 0.06)
Trial 2 (n=0.035, 0.07)
Flow (cms)
Depth (m)
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
0.40
0.45

Station 7 WQ 2016 Summary 216002 - Clair/Maltby				4-Aug-2016 11:00	17-Aug-2016 11:40	22-Sep-2016 14:55	20-Oct-2016 13:55
Parameter	Lowest Detection Limit	Units	PWQO Surface Water Parameter Limits	8/4/2016 (11:00)	8/17/2016 (11:40)	9/22/2016 (14:55)	10/20/2016 (13:55)
Physical Tests (Water)							
Total Suspended Solids	2.0	mg/L		6.8	10.7	79.4	15.8
Total Dissolved Solids	20	mg/L		178	170	149	153
Anions and Nutrients (Water)							
Ammonia, Total (as N)	0.020	mg/L	0.02	0.028	<0.020	0.025	0.082
Bromide (Br)	0.10	mg/L		<0.10	<0.10	<0.10	<0.10
Chloride (Cl)	0.50	mg/L		9.92	10.1	12.3	12.7
Fluoride (F)	0.020	mg/L		0.042	0.043	0.067	0.044
Nitrate (as N)	0.020	mg/L		<0.020	<0.020	<0.020	<0.020
Nitrite (as N)	0.010	mg/L		<0.010	<0.010	<0.010	<0.010
Total Kjeldahl Nitrogen	0.15	mg/L		1.41	1.65	2.30	1.68
Orthophosphate-Dissolved (as P)	0.0030	mg/L		<0.0030	<0.0030	<0.0030	<0.0030
Phosphorus, Total	0.0030	mg/L	0.03	**0.0540**	**0.0742**	**0.173**	**0.0743**
Sulfate (SO4)	0.30	mg/L		<0.30	<0.30	<0.30	<0.30
Total Metals (Water)							
Aluminum (Al)-Total	0.010	mg/L	0.075	**0.027**	**0.027**	**0.263**	<0.010
Antimony (Sb)-Total	0.00010	mg/L	0.02	<0.00010	0.00012	<0.00010	0.00018
Arsenic (As)-Total	0.00010	mg/L	0.1	0.00064	0.00079	0.00062	0.00049
Barium (Ba)-Total	0.00020	mg/L		0.0502	0.0130	0.0123	0.0084
Beryllium (Be)-Total	0.00010	mg/L	0.011	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth (Bi)-Total	0.000050	mg/L		<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total	0.010	mg/L	0.2	0.013	0.014	0.015	0.011
Cadmium (Cd)-Total	0.000010	mg/L	0.0002	<0.000010	<0.000010	0.000022	<0.000010
Calcium (Ca)-Total	0.50	mg/L		32.7	30.9	24.4	30.6
Cesium (Cs)-Total	0.000010	mg/L		<0.000010	<0.000010	0.000026	<0.000010
Chromium (Cr)-Total	0.00050	mg/L		<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)-Total	0.00010	mg/L	0.0009	<0.00010	<0.00010	0.00015	<0.00010
Copper (Cu)-Total	0.0010	mg/L	0.005	<0.0010	<0.0010	<0.0010	<0.0010
Iron (Fe)-Total	0.050	mg/L	0.3	**0.371**	**0.457**	**0.491**	<0.050
Lead (Pb)-Total	0.00010	mg/L	0.001	0.00038	0.00053	**0.00207**	<0.00010
Magnesium (Mg)-Total	0.050	mg/L		8.72	7.55	7.65	6.98
Manganese (Mn)-Total	0.00050	mg/L		0.111	0.0780	0.0317	0.0150
Molybdenum (Mo)-Total	0.000050	mg/L	0.04	<0.000050	<0.000050	0.000069	<0.000050
Nickel (Ni)-Total	0.00050	mg/L	0.025	<0.00050	<0.00050	<0.00050	<0.00050
Potassium (K)-Total	0.050	mg/L		1.37	1.80	1.26	2.02
Rubidium (Rb)-Total	0.00020	mg/L		0.00045	0.00073	0.00088	0.00105
Selenium (Se)-Total	0.000050	mg/L	0.1	0.000062	0.000068	0.000082	<0.000050
Silicon (Si)-Total	0.050	mg/L		0.685	1.13	1.42	0.72
Silver (Ag)-Total	0.000050	mg/L	0.0001	<0.000050	<0.000050	<0.000050	<0.000050

Strontium (Sr)-Total	0.0010	mg/L		0.0650	0.0368	0.0340	0.0412
Sulfur (S)-Total	0.50	mg/L		0.52	<0.50	<0.50	<0.50
Tellurium (Te)-Total	0.00020	mg/L		<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Total	0.000010	mg/L	0.0003	<0.000010	<0.000010	<0.000010	<0.000010
Thorium (Th)-Total	0.00010	mg/L		<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Total	0.00010	mg/L		0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total	0.00030	mg/L		0.00051	0.00078	0.00690	<0.00030
Tungsten (W)-Total	0.00010	mg/L	0.03	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Total	0.000010	mg/L	0.005	<0.000010	<0.000010	0.000016	<0.000010
Vanadium (V)-Total	0.00050	mg/L	0.006	<0.00050	<0.00050	0.00083	<0.00050
Zinc (Zn)-Total	0.0030	mg/L	0.02	0.0043	0.0032	0.0100	<0.0030
Zirconium (Zr)-Total	0.00030	mg/L	0.004	<0.00030	<0.00030	<0.00030	<0.00030

Station 14 WQ 2016 Summary 216002- Clair/Maltby				4-Aug-2016 10:12	17-Aug-2016 10:55	22-Sep-2016 14:17	20-Oct-2016 13:55
Parameter	Lowest Detection Limit	Units	PWQO Surface Water Parameter Limits	8/4/2016 (10:12)	8/17/2016 (10:55)	9/22/2016 (14:17)	10/20/2016 (13:55)
Physical Tests (Water)							
Total Suspended Solids	2.0	mg/L		<2.0	2.5	<2.0	4.0
Total Dissolved Solids	20	mg/L		388	362	379	350
Anions and Nutrients (Water)							
Ammonia, Total (as N)	0.020	mg/L	0.02	<0.020	0.043	0.032	0.074
Bromide (Br)	0.10	mg/L		<0.10	<0.10	<0.10	<0.10
Chloride (Cl)	0.50	mg/L		38.0	33.5	36.7	33.6
Fluoride (F)	0.020	mg/L		0.050	0.051	0.064	0.042
Nitrate (as N)	0.020	mg/L		0.741	0.610	0.704	0.497
Nitrite (as N)	0.010	mg/L		<0.010	<0.010	<0.010	<0.010
Total Kjeldahl Nitrogen	0.15	mg/L		0.26	<0.15	0.21	0.31
Orthophosphate-Dissolved (as P)	0.0030	mg/L		0.0046	0.0097	0.0050	<0.0030
Phosphorus, Total	0.0030	mg/L	0.03	0.0056	0.0094	0.0069	0.0075
Sulfate (SO4)	0.30	mg/L		20.0	17.2	18.9	18.1
Total Metals (Water)							
Aluminum (Al)-Total	0.010	mg/L	0.075	<0.010	<0.010	<0.010	<0.010
Antimony (Sb)-Total	0.00010	mg/L	0.02	<0.00010	0.00011	<0.00010	0.00018
Arsenic (As)-Total	0.00010	mg/L	0.1	0.00017	0.00020	0.00017	0.00049
Barium (Ba)-Total	0.00020	mg/L		0.0609	0.0519	0.0586	0.00840
Beryllium (Be)-Total	0.00010	mg/L	0.011	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth (Bi)-Total	0.000050	mg/L		<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)-Total	0.010	mg/L	0.2	0.010	0.011	0.011	0.011
Cadmium (Cd)-Total	0.000010	mg/L	0.0002	0.000050	0.000052	0.000042	<0.000010
Calcium (Ca)-Total	0.50	mg/L		83.0	74.8	80.2	30.6
Cesium (Cs)-Total	0.000010	mg/L		<0.000010	<0.000010	<0.000010	<0.000010
Chromium (Cr)-Total	0.00050	mg/L		<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)-Total	0.00010	mg/L	0.0009	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)-Total	0.0010	mg/L	0.005	<0.0010	<0.0010	<0.0010	<0.0010
Iron (Fe)-Total	0.050	mg/L	0.3	<0.050	<0.050	<0.050	<0.050
Lead (Pb)-Total	0.00010	mg/L	0.001	<0.00010	<0.00010	<0.00010	<0.00010
Magnesium (Mg)-Total	0.050	mg/L		28.0	24.8	24.8	6.98
Manganese (Mn)-Total	0.00050	mg/L		0.0103	0.0145	0.0101	0.0150
Molybdenum (Mo)-Total	0.000050	mg/L	0.04	0.000432	0.000412	0.000419	<0.000050
Nickel (Ni)-Total	0.00050	mg/L	0.025	<0.00050	<0.00050	0.00053	<0.00050
Potassium (K)-Total	0.050	mg/L		1.24	1.11	1.15	2.02
Rubidium (Rb)-Total	0.00020	mg/L		0.00135	0.00122	0.00127	0.00105
Selenium (Se)-Total	0.000050	mg/L	0.1	0.000154	0.000160	0.000145	<0.000050
Silicon (Si)-Total	0.050	mg/L		5.24	4.89	4.84	0.716
Silver (Ag)-Total	0.000050	mg/L	0.0001	<0.000050	<0.000050	<0.000050	<0.000050

Strontium (Sr)-Total	0.0010	mg/L		0.107	0.107	0.109	0.0412
Sulfur (S)-Total	0.50	mg/L		7.40	6.42	6.59	<0.50
Tellurium (Te)-Total	0.00020	mg/L		<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Total	0.000010	mg/L	0.0003	0.000017	0.000013	0.000012	<0.000010
Thorium (Th)-Total	0.00010	mg/L		<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Total	0.00010	mg/L		<0.00010	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total	0.00030	mg/L		<0.00030	<0.00030	<0.00030	<0.00030
Tungsten (W)-Total	0.00010	mg/L	0.03	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Total	0.000010	mg/L	0.005	0.000577	0.000501	0.000538	<0.000010
Vanadium (V)-Total	0.00050	mg/L	0.006	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Total	0.0030	mg/L	0.02	**0.0890**	**0.0760**	**0.0759**	<0.0030
Zirconium (Zr)-Total	0.00030	mg/L	0.004	<0.00030	<0.00030	<0.00030	<0.00030

Appendix B

Ground Water

Appendix B1
Monitoring Well Logs

DRILLING LOG | Clair - Maltby Subwatershed Study | MW1-D

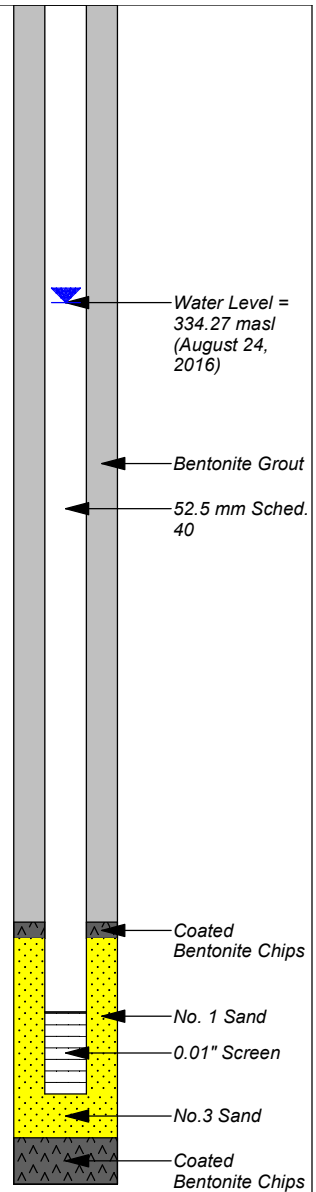
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **J. Melchin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 18, 2016**
Ground Elevation: **337.269 m asl**
Total Depth: **21.64 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **18.75 - 20.27 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **17.37 - 21.09 m**

Stick Up: **0.51 m**
Northing: **4817765.42**
Easting: **566643.99**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
337	0		**CLAYEY SILT, trace fine to coarse sand, brown, dry**	0 / 337.27				
336	1				5	CS	NA	NA
335	2		**SANDY GRAVEL, coarse sand, fine to very coarse gravel, brown, poorly sorted, angular to subrounded, dry**	1.52 / 335.75				
334	3				10	CS	NA	NA
333	4				15	CS	NA	NA
332	5							
331	6				20	CS	NA	NA
330	7				25	CS	NA	NA
329	8							
328	9				30	CS	NA	NA
327	10		**@ 9.75 m bgs: drill producing water**		35	CS	NA	NA
326	11							
325	12				40	CS	NA	NA
324	13				45	CS	NA	NA
323	14			14.63 / 322.64				
322	15		**CLAYEY SILT, some fine to coarse sand, trace fine gravel, grey (TILL)**		50	CS	NA	NA
321	16				55	CS	NA	NA
320	17				60	CS	NA	NA
319	18				65	CS	NA	NA
318	19							
317	20				70	CS	NA	NA
316	21							
315	22		**PROBABLE BEDROCK** **END OF BOREHOLE @ 21.95 m bgs**	21.95 / 315.32				
	23							



NOTES: m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW1-S

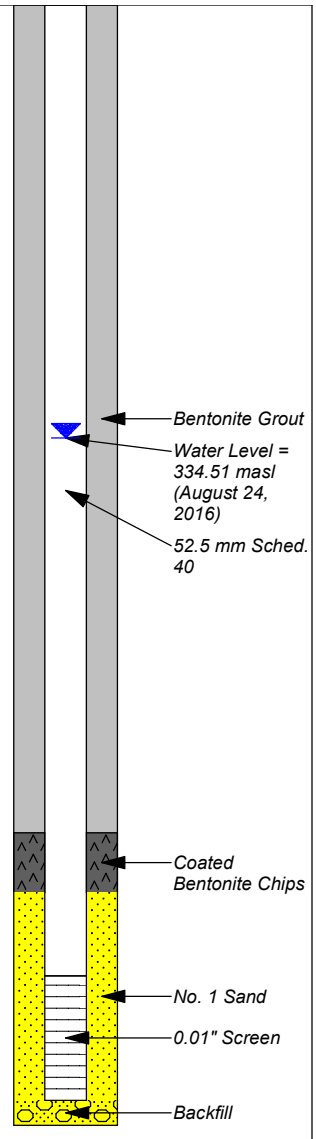
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **J. Melchin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 19, 2016**
Ground Elevation: **337.198 masl**
Total Depth: **13.72 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **11.89 - 13.41 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **10.87 - 13.41 m**

Stick Up: **0.42 m**
Northing: **4817762.85**
Easting: **566641.90**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
337	0		**CLAYEY SILT, trace fine to coarse sand, brown, dry**	0 / 337.20				
336	1			1.52 / 335.67	5	CS	NA	NA
335	2		**SANDY GRAVEL, coarse sand, fine to very coarse gravel, brown, poorly sorted, angular to subrounded, dry**		10	CS	NA	NA
334	3				15	CS	NA	NA
333	4				20	CS	NA	NA
332	5				25	CS	NA	NA
331	6				30	CS	NA	NA
330	7				35	CS	NA	NA
329	8		**@ 9.14 m bgs: drill producing water**		40	CS	NA	NA
328	9				45	CS	NA	NA
327	10			13.72 / 323.48				
326	11							
325	12							
324	13							
323	14		**END OF BOREHOLE @ 13.72 m bgs**					
322	15							



NOTES:
0.00 to 7.62 m bgs logged from MW1-D
m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW2-D

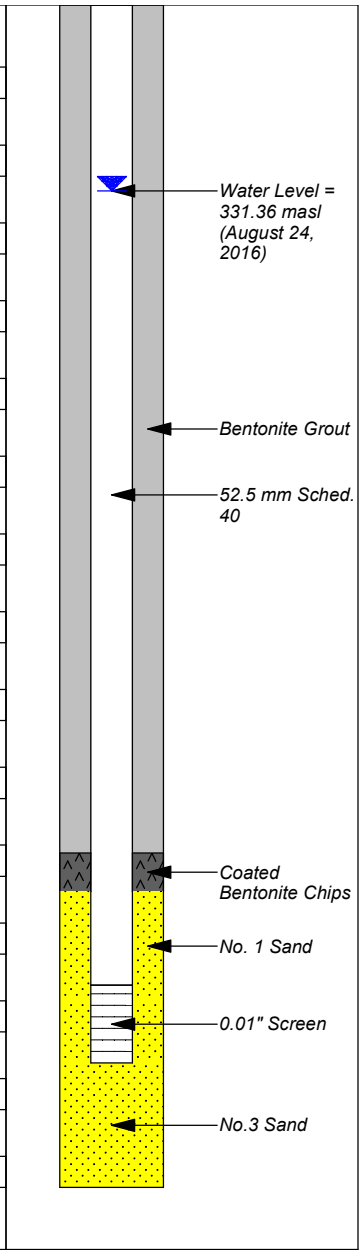
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **S. Miller/J. Melchin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 3, 2016**
Ground Elevation: **335.294 masl**
Total Depth: **23.16 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **19.20 - 20.73 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **17.37 - 23.16 m**

Stick Up: **0.83 m**
Northing: **4817418.83**
Easting: **566680.83**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
335	0		**SANDY GRAVEL, fine to coarse sand, medium to fine gravel fining downwards, brown, poorly sorted, angular to subrounded, dry**	0 / 335.29				
					5	CS	NA	NA
334	1							
					10	CS	NA	NA
333	2							
	3							
332								
	4		**@4.57 m bgs: moist**		15	CS	NA	NA
331								
	5							
330								
	6		**@ 6.10 m bgs: drill producing water**		20	CS	NA	NA
329								
	7							
328					25	CS	NA	NA
	8							
327								
	9			9.14 / 326.15	30	CS	NA	NA
326			**GRAVELLY SAND, fine to coarse sand, fine to medium gravel, grey, poorly sorted, angular to sub rounded, saturated**					
	10							
325				10.67 / 324.63	35	CS	NA	NA
	11		**fine to very fine SAND, fining downwards, grey, well sorted, saturated**					
324								
	12				40	CS	NA	NA
323								
	13							
322					45	CS	NA	NA
	14							
321								
	15				50	CS	NA	NA
320				15.85 / 319.44				
	16		**SILTY fine SAND, grey, moderately well sorted, saturated**		55	CS	NA	NA
319								
	17							
318								
	18			18.29 / 317.01	60	CS	NA	NA
317			**GRAVELY SAND, medium to coarse sand, fine to medium gravel, poorly sorted, subangular to subrounded, saturated**					
	19							
316								
	20				65	CS	NA	NA
315								
	21							
314					70	CS	NA	NA
	22							
313								
	23				75	CS	NA	NA
312				23.16 / 312.13				
	24		**END OF BOREHOLE @ 23.16 m bgs**					
311								



NOTES: m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW2-S

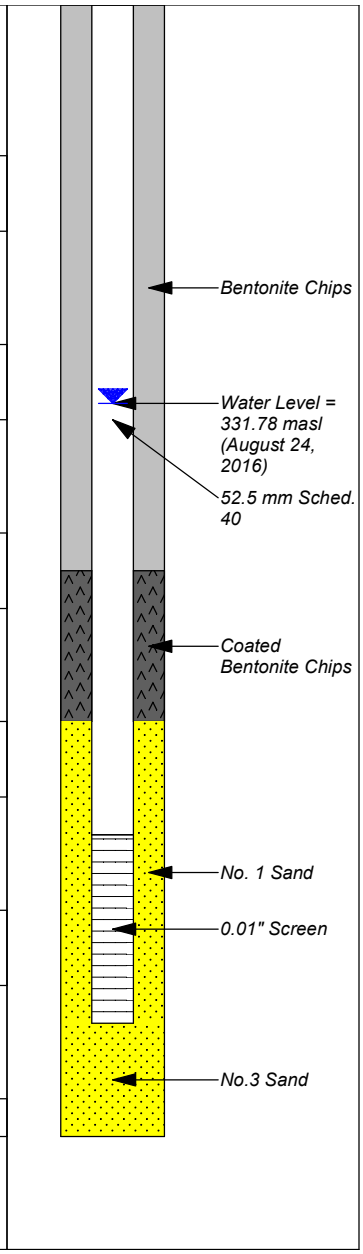
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **S. Miller/J. Melchin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 4, 2016**
Ground Elevation: **335.402 masl**
Total Depth: **9.14 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **6.71 - 8.23 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **5.79 - 9.14 m**

Stick Up: **0.91 m**
Northing: **4817425.33**
Easting: **566681.67**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
335	0		**SANDY GRAVEL, fine to coarse sand, medium to fine gravel fining downwards, brown, poorly sorted, angular to subrounded, dry**	0 / 335.40				
334	1				5	CS	NA	NA
333	2							
332	3				10	CS	NA	NA
331	4							
330	5		**@ 4.57 m bgs: moist**		15	CS	NA	NA
329	6		**@ 6.10 m bgs: drill producing water**		20	CS	NA	NA
328	7							
327	8				25	CS	NA	NA
326	9			9.14 / 326.26	30	CS	NA	NA
	10		**END OF BOREHOLE @ 9.14 m bgs**					



NOTES:
0.00 to 6.10 m bgs logged from MW2-D
m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW3-D

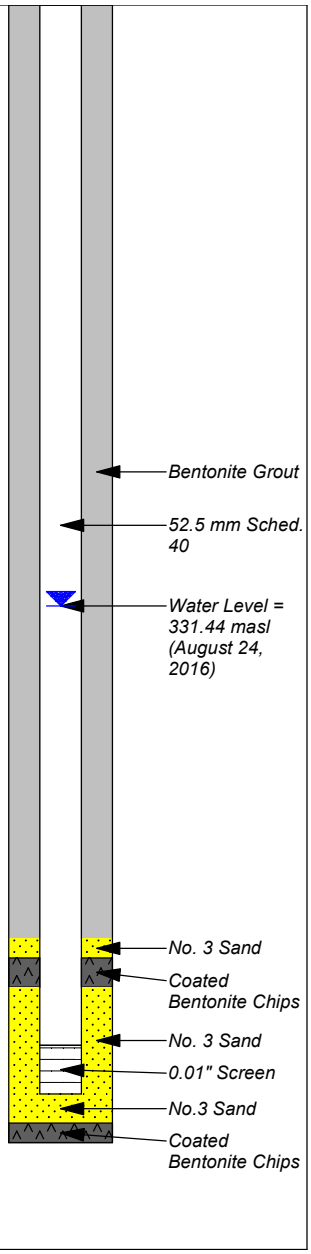
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **S. Miller**
Driller: **Highland Water Well Drilling Inc**

Date: **July 25, 2016**
Ground Elevation: **350.052 masl**
Total Depth: **35.66 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **32.61 - 34.14 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **30.78 - 35.05 m**

Stick Up: **0.70 m**
Northing: **4816950.32**
Easting: **568080.23**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
350	0			0 / 350.05				
349	1		**fine to medium SAND, some fine to coarse gravel, brown, poorly sorted, subangular to subrounded gravel, dry**		5	CS	NA	NA
348	2							
347	3				10	CS	NA	NA
346	4							
345	5				15	CS	NA	NA
344	6							
343	7				20	CS	NA	NA
342	8							
341	9				25	CS	NA	NA
340	10							
339	11				30	CS	NA	NA
338	12							
337	13				35	CS	NA	NA
336	14							
335	15				40	CS	NA	NA
334	16							
333	17				45	CS	NA	NA
332	18							
331	19		**@18.90 m bgs: moist**		50	CS	NA	NA
330	20							
329	21				55	CS	NA	NA
328	22							
327	23				60	CS	NA	NA
326	24							
325	25		**medium SAND, brown, well sorted, wet, loose**	24.38 / 325.67	65	CS	NA	NA
324	26		**fine to coarse GRAVEL, some coarse sand, poorly sorted, angular to subrounded, wet**	25.91 / 324.14				
323	27				70	CS	NA	NA
322	28							
321	29				75	CS	NA	NA
320	30							
319	31				80	CS	NA	NA
318	32							
317	33				85	CS	NA	NA
316	34		**SILTY fine to coarse SAND, trace fine to coarse gravel, grey, poorly sorted, wet**	33.53 / 316.52				
315	35				90	CS	NA	NA
314	36		**PROBABLE BEDROCK**	35.36 / 314.70				
313	37		**END OF BOREHOLE @ 35.66 m bgs**	35.66 / 314.39	95	CS	NA	NA
312	38							
	39				100	CS	NA	NA
					105	CS	NA	NA
					110	CS	NA	NA
					115	CS	NA	NA



NOTES: m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW3-S

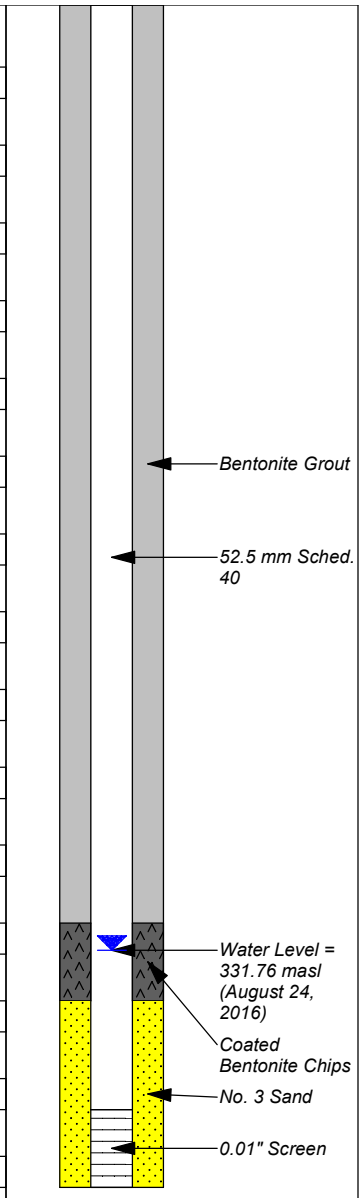
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **S. Miller**
Driller: **Highland Water Well Drilling Inc**

Date: **July 26, 2016**
Ground Elevation: **349.947 masl**
Total Depth: **23.16 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **21.64 - 23.16 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **19.51 - 23.16 m**

Stick Up: **0.68 m**
Northing: **4816948.56**
Easting: **568083.16**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
349	0–1		**fine to medium SAND, some fine to coarse gravel, brown, poorly sorted, subangular to subrounded gravel, dry**	0 / 349.95				
348	1–2				5	CS	NA	NA
347	2–3				10	CS	NA	NA
346	3–4				15	CS	NA	NA
345	4–5				20	CS	NA	NA
344	5–6				25	CS	NA	NA
343	6–7				30	CS	NA	NA
342	7–8				35	CS	NA	NA
341	8–9				40	CS	NA	NA
340	9–10				45	CS	NA	NA
339	10–11				50	CS	NA	NA
338	11–12				55	CS	NA	NA
337	12–13				60	CS	NA	NA
336	13–14				65	CS	NA	NA
335	14–15				70	CS	NA	NA
334	15–16				75	CS	NA	NA
333	16–17							
332	17–18		**@18.90 m bgs: moist**					
331	18–19							
330	19–20							
329	20–21							
328	21–22							
327	22–23							
326	23–24		**END OF BOREHOLE @ 23.16 m bgs**	23.16 / 326.78				



NOTES:
0.00 to 19.81 m bgs logged from MW3-D
m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW4-D

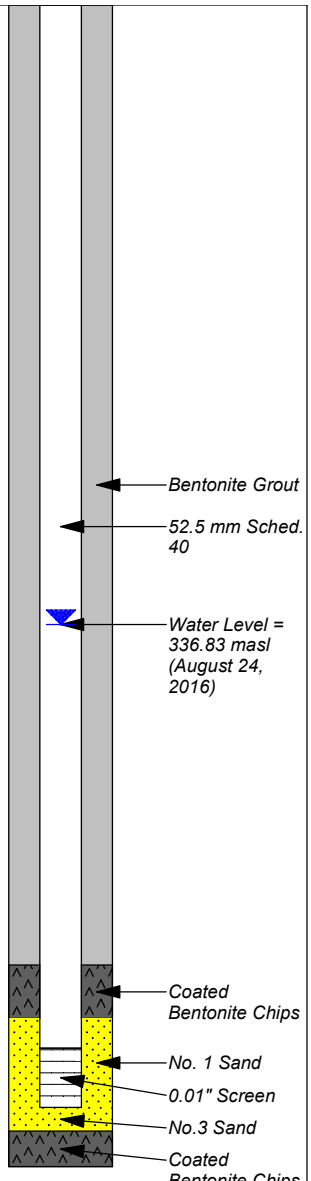
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **D. Martin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 22, 2016**
Ground Elevation: **349.598 masl**
Total Depth: **29.87 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **26.82 - 28.35 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **26.00 - 29.08 m**

Stick Up: **0.76 m**
Northing: **4816485.40**
Easting: **566169.17**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
349	0			0 / 349.60				
348	1		**SILTY fine to coarse SAND, some fine to medium gravel, grey, poorly sorted, angular, damp (TILL)**		5	CS	NA	NA
347	2							
346	3				10	CS	NA	NA
345	4							
344	5				15	CS	NA	NA
343	6		**@6.10 m bgs: cleaner SILTY SAND lense, trace fine gravel**		20	CS	NA	NA
342	7							
341	8				25	CS	NA	NA
340	9							
339	10		**fine to coarse SAND, some fine gravel, trace silt, grey, poorly sorted, subrounded, damp**	9.91 / 339.69	30	CS	NA	NA
338	11			11.43 / 338.17				
337	12		**fine to course SANDY SILT to SILTY SAND, occasional layers of fine to medium gravel, grey, very poorly sorted, angular (possible TILL)**		35	CS	NA	NA
336	13		**@13.72 m bgs: saturated**					
335	14				40	CS	NA	NA
334	15							
333	16				45	CS	NA	NA
332	17		**@ 16.76 m bgs: lense of increased SILT content**					
331	18				50	CS	NA	NA
330	19							
329	20				55	CS	NA	NA
328	21							
327	22				60	CS	NA	NA
326	23		**@ 22.86 m bgs: layer of fine GRAVELY coarse SAND, trace silt, poorly sorted**					
325	24				65	CS	NA	NA
324	25							
323	26				70	CS	NA	NA
322	27							
321	28		**@ 27.43 m bgs: layer of fine GRAVELY coarse SAND, trace silt, poorly sorted**		75	CS	NA	NA
320	29		**@ 28.96 m bgs: layer of fine GRAVELY coarse SAND, trace silt, poorly sorted**					
319	30			29.57 / 320.03	80	CS	NA	NA
318	31		**PROBABLE BEDROCK**	29.87 / 319.73				
	32		**END OF BOREHOLE @ 29.87 m bgs**		85	CS	NA	NA
					90	CS	NA	NA
					95	CS	NA	NA
					97	CS	NA	NA



NOTES: m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW4-S

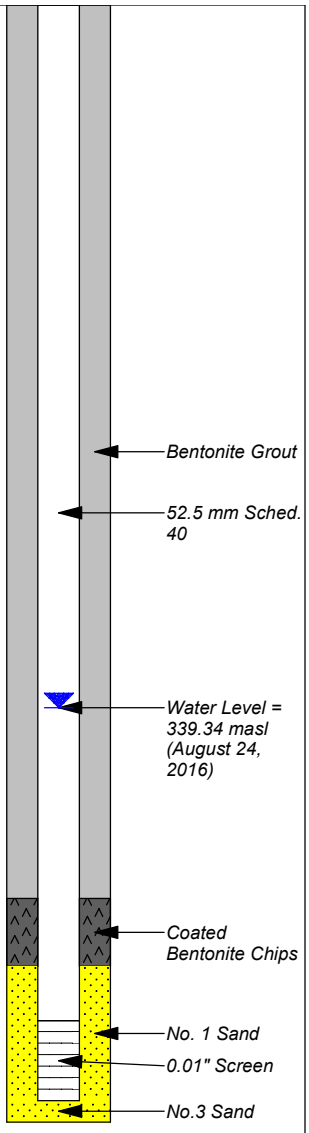
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **D. Martin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 22 - 23, 2016**
Ground Elevation: **349.633 masl**
Total Depth: **21.34 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **19.40 - 20.93 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **18.36 - 21.34 m**

Stick Up: **0.81 m**
Northing: **4816488.20**
Easting: **566170.83**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
349	0		**SILTY fine to coarse SAND, some fine to medium gravel, grey, poorly sorted, angular, damp (TILL)**	0 / 349.63				
348	1				5	CS	NA	NA
347	2							
346	3				10	CS	NA	NA
345	4							
344	5				15	CS	NA	NA
343	6		**@6.10 m bgs: cleaner SILTY SAND lense, trace fine gravel**					
342	7				20	CS	NA	NA
341	8							
340	9				25	CS	NA	NA
339	10		**fine to coarse SAND, some fine gravel, trace silt, grey, poorly sorted, subrounded, damp**	9.91 / 339.73				
338	11				30	CS	NA	NA
337	12		**fine to course SANDY SILT to SILTY SAND, occasional layers of fine to medium gravel, grey, very poorly sorted, angular, damp (possible TILL)**	11.43 / 338.20				
336	13				35	CS	NA	NA
335	14		**@13.72 m bgs: saturated**					
334	15				40	CS	NA	NA
333	16							
332	17		**@ 16.76 m bgs: lense of increased SILT content**		45	CS	NA	NA
331	18							
330	19				50	CS	NA	NA
329	20							
328	21				55	CS	NA	NA
327	22		**END OF BOREHOLE @ 21.34 m bgs**	21.34 / 328.30				
326	23				60	CS	NA	NA
					65	CS	NA	NA
					70	CS	NA	NA



NOTES:
0.00 to 16.76 m bgs logged from MW4-D
m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW5-D

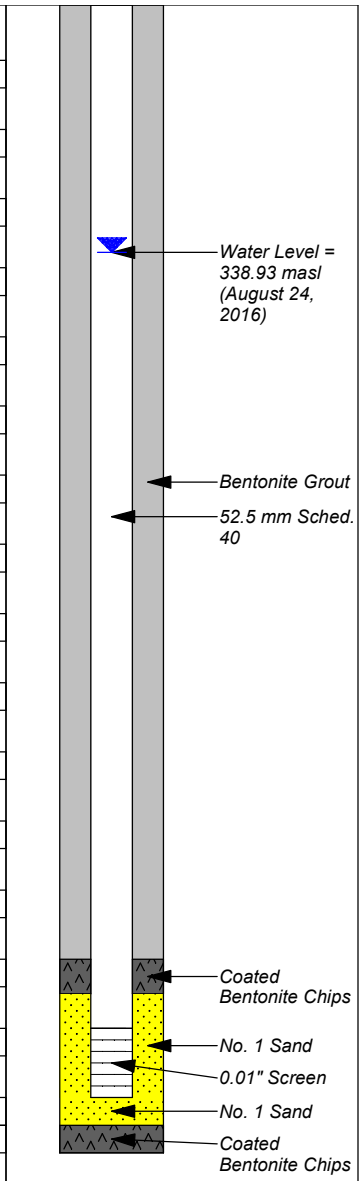
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **D. Martin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 10 - 11, 2016**
Ground Elevation: **340.167 masl**
Total Depth: **25.30 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **22.56 - 24.08 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **21.79 - 24.69 m**

Stick Up: **0.71 m**
Northing: **4816336.75**
Easting: **567001.03**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
340	0		fine clean GRAVEL, well sorted, angular to sub rounded, dry	0 / 340.17				
339	1							
338	2		medium to coarse SAND and fine to medium GRAVEL, brown, moderately well sorted, well rounded, dry	1.52 / 338.64	5	CS	NA	NA
337	3		SILTY GRAVELY fine to coarse SAND, fine gravel, brown, poorly sorted, angular to subangular, saturated (TILL)	3.05 / 337.12	10	CS	NA	NA
336	4							
335	5				15	CS	NA	NA
334	6				20	CS	NA	NA
333	7							
332	8				25	CS	NA	NA
331	9		coarse SAND and fine GRAVEL, brown, moderately well sorted, well rounded, saturated	8.38 / 331.79	30	CS	NA	NA
330	10							
329	11				35	CS	NA	NA
328	12		SILTY very coarse SAND, some fine gravel, grey, poorly sorted, angular, saturated	11.43 / 328.74	40	CS	NA	NA
327	13							
326	14				45	CS	NA	NA
325	15		fine to very coarse GRAVEL up to COBBLES, some coarse sand, poorly sorted, subrounded	14.48 / 325.69	50	CS	NA	NA
324	16							
323	17		coarse SAND fining downwards to fine SAND, grey, well sorted, sub rounded, saturated	16.76 / 323.40	55	CS	NA	NA
322	18				60	CS	NA	NA
321	19							
320	20				65	CS	NA	NA
319	21				70	CS	NA	NA
318	22							
317	23		@22.86 m bgs: very trace SILT		75	CS	NA	NA
316	24							
315	25		PROBABLE BEDROCK	24.38 / 315.78	80	CS	NA	NA
314	26		END OF BOREHOLE @ 25.30 m bgs	25.30 / 314.87	83	CS	NA	NA
313	27							



NOTES:
m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG

Clair - Maltby Subwatershed Study

MW5-S

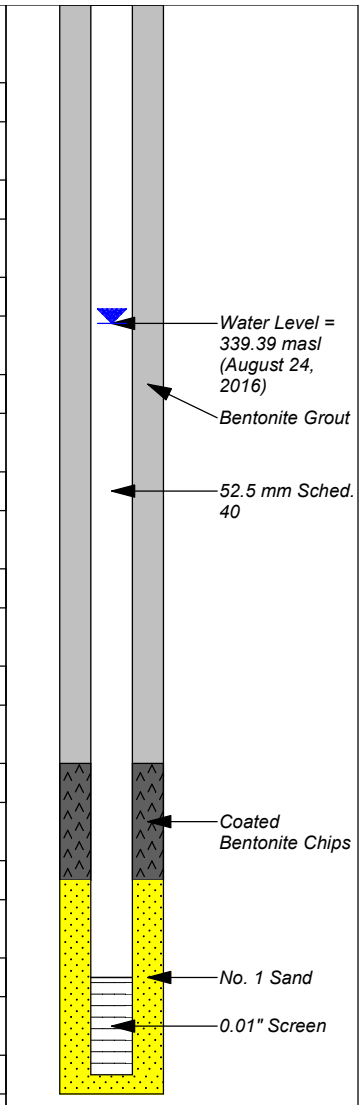
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **D. Martin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 11, 2016**
Ground Elevation: **340.163 masl**
Total Depth: **17.07 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **15.24 - 16.76 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **13.72 - 16.76 m**

Stick Up: **0.76 m**
Northing: **4816334.91**
Easting: **566998.56**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
340	0			0 / 340.16				
339	1		fine GRAVEL, well sorted, angular to sub rounded, dry	1.52 / 338.64	5	CS	NA	NA
338	2		medium to coarse SAND and fine to medium GRAVEL, brown, moderately well sorted, well rounded, dry	3.05 / 337.12	10	CS	NA	NA
337	3				15	CS	NA	NA
336	4		SILTY GRAVELY fine to coarse SAND, fine gravel, brown, poorly sorted, angular to subangular, saturated (TILL)		20	CS	NA	NA
335	5				25	CS	NA	NA
334	6			8.38 / 331.78	30	CS	NA	NA
333	7				35	CS	NA	NA
332	8			11.43 / 328.73	40	CS	NA	NA
331	9		coarse SAND and fine GRAVEL, brown, moderately well sorted, well rounded, saturated		45	CS	NA	NA
330	10			14.48 / 325.69	50	CS	NA	NA
329	11				55	CS	NA	NA
328	12		SILTY very coarse SAND, some fine gravel, grey, poorly sorted, angular, saturated	17.07 / 323.09				
327	13							
326	14							
325	15		fine to very coarse GRAVEL up to COBBLES, some coarse sand, fine to very coarse gravel, poorly sorted, subrounded					
324	16							
323	17		END OF BOREHOLE @ 17.07 m bgs					
322	18							
321	19							



NOTES:
0.00 to 10.67 m bgs logged from MW5-D
m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG

Clair - Maltby Subwatershed Study

MW6-D

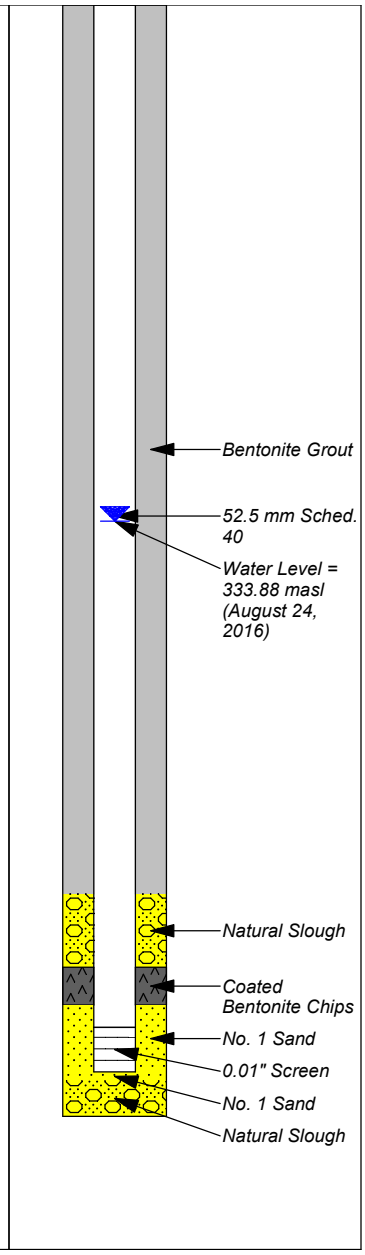
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **D. Martin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 15, 2016**
Ground Elevation: **352.380 masl**
Total Depth: **38.10 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **35.05 - 36.58 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **34.32 - 36.88 m**

Stick Up: **0.79 m**
Northing: **4816249.90**
Easting: **567400.42**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery	Completion Details
352	0		**GRAVELY SAND, fine to coarse sand, fine to medium gravel, brown, poorly sorted, subangular to subrounded, dry to damp**	0 / 352.38					
351	1				5	CS			
350	2				10	CS			
349	3				15	CS			
348	4				20	CS			
347	5				25	CS			
346	6				30	CS			
345	7				35	CS			
344	8				40	CS			
343	9		**@ 9.91 to 12.95 m bgs: GRAVEL, some fine to coarse SAND**		45	CS			
342	10				50	CS			
341	11				55	CS			
340	12				60	CS			
339	13				65	CS			
338	14				70	CS			
337	15		**fine to very coarse SANDY SILT to SILTY SAND, brown, poorly sorted, angular to subangular, damp**	14.48 / 337.90	75	CS			
336	16			16.00 / 336.38	80	CS			
335	17		**fine to medium SAND coarsening downwards to a GRAVELY SAND, angular to subrounded, damp @18.29 m bgs: saturated**		85	CS			
334	18				90	CS			
333	19				95	CS			
332	20				100	CS			
331	21				105	CS			
330	22		**SILT, trace clay, trace coarse sand, grey, poorly sorted, saturated**	22.10 / 330.28	110	CS			
329	23			23.62 / 328.76	115	CS			
328	24		**SILTY fine to medium SAND, fining downwards, brown, poorly sorted, saturated, very loose**		120	CS			
327	25				124	CS			
326	26								
325	27								
324	28								
323	29								
322	30								
321	31								
320	32								
319	33								
318	34								
317	35			35.81 / 316.57					
316	36		**GRAVELY SAND (fine to medium gravel, fine to coarse sand), trace silt, grey, poorly sorted, saturated**	37.19 / 315.19					
315	37								
314	38		**SILTY CLAY, some fine GRAVEL, grey, poorly sorted, angular to subangular, saturated (TILL)**	37.80 / 314.58					
313	39								
312	40		**END OF BOREHOLE @ 37.80 m bgs**						
311	41								
310	42								



NOTES: m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW6-S

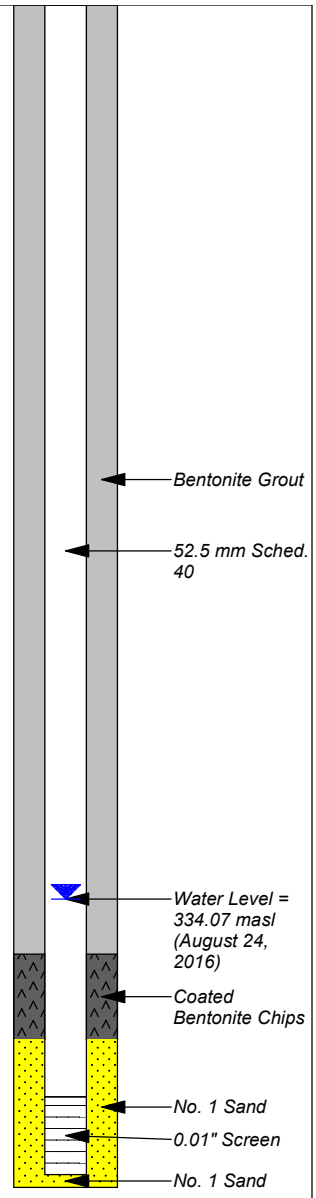
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **D. Martin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 16-17, 2016**
Ground Elevation: **352.406 masl**
Total Depth: **23.17 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **21.39 - 22.91 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **20.27 - 23.16 m**

Stick Up: **0.79 m**
Northing: **4816246.66**
Easting: **567401.07**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
352	0		**GRAVELY SAND, fine to coarse sand, fine to medium gravel, brown, poorly sorted, subangular to subrounded, dry to damp**	0 / 352.41				
351	1				5	CS		
350	2							
349	3				10	CS		
348	4							
347	5				15	CS		
346	6							
345	7				20	CS		
344	8							
343	9				25	CS		
342	10		**@ 9.91 to 12.95 m bgs: GRAVEL, some fine to coarse SAND**					
341	11				30	CS		
340	12							
339	13				35	CS		
338	14							
337	15		**fine to very coarse SANDY SILT to SILTY SAND, brown, poorly sorted, angular to subangular, damp**	14.48 / 337.93	40	CS		
336	16		**fine to medium SAND coarsening downwards to a poorly sorted GRAVELY SAND, angular to subrounded, damp**	16.00 / 336.40				
335	17				45	CS		
334	18		**@18.29 m bgs: saturated**					
333	19				50	CS		
332	20							
331	21				55	CS		
330	22		**SILT, trace clay, trace coarse sand, grey, poorly sorted, saturated**	22.10 / 330.31				
329	23		**END OF BOREHOLE @ 22.86 m bgs**	22.86 / 329.55	60	CS		
	24							
					65	CS		
					70	CS		
					75	CS		



NOTES:
0.00 to 15.24 m bgs logged from MW6-D
m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW7-D

Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **D. Martin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 23, 2016**
Ground Elevation: **347.035 masl**
Total Depth: **35.46 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **33.07 - 34.59 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **32.16 - 34.82 m**

Stick Up: **0.76 m**
Northing: **4815512.35**
Easting: **565478.72**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery	Completion Details
347–309	0–39		**GRAVELY SAND (fine to medium gravel, medium to coarse sand), brown, poorly sorted, subrounded, dry**	0 / 347.04	5–115	CS			Bentonite Grout; 52.5 mm Sched. 40; Water Level = 331.94 masl (August 24, 2016); Coated Bentonite Chips; No. 1 Sand; 0.01" Screen; No.3 Sand; Coated Bentontite Chips
			SILT, trace clay coarsening downwards to SANDY SILT, trace fine gravel, brown, angular, dry	5.33 / 341.70					
			SANDY GRAVEL, medium to coarse sand, fine to medium gravel, brown, poorly sorted, angular to subangular, moist	11.43 / 335.61					
			medium to coarse SAND fining downwards, grey, well sorted, saturated	20.57 / 326.46					
			SANDY SILT to SILTY SAND fining downwards to SILT, grey, well sorted, saturated	26.67 / 320.37					
			CLAYEY SILT, grey, moderately well sorted, saturated	31.24 / 315.79					
			SANDY GRAVEL, fine gravel, fine to coarse sand, grey, poorly sorted, angular to subangular, saturated	32.77 / 314.27					
			END OF BOREHOLE @ 35.36 m bgs	35.36 / 311.68					

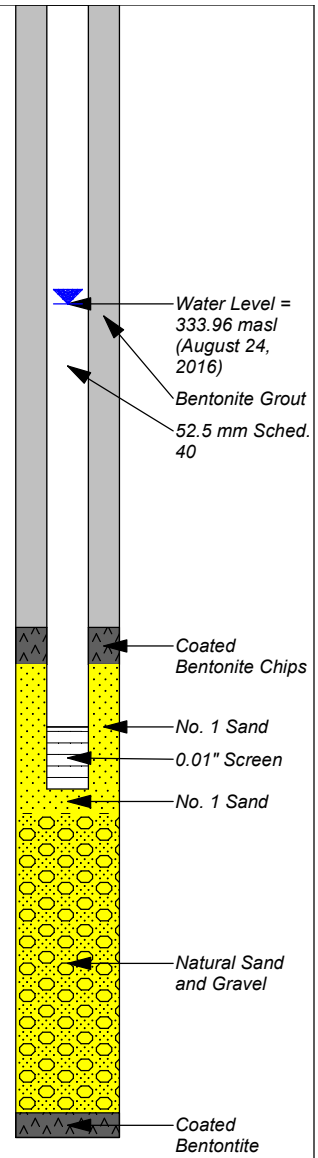
NOTES: m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW8-D

Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **D. Martin/J. Melchin**
Driller: **Highland Water Well Drilling Inc.**
Date: **August 9, 2016**
Ground Elevation: **338.477 masl**
Total Depth: **27.74 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**
Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **17.68 - 19.20 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **16.15 - 19.81 m**
Stick Up: **0.87 m**
Northing: **4815489.34**
Easting: **566248.11**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
338	0		**fine to coarse SAND and fine to medium GRAVEL, trace silt, brown, poorly sorted, angular to sub-rounded, damp to moist**	0 / 338.48				
337	1				5	CS		
336	2							
335	3				10	CS		
334	4		**@4.57 m bgs: saturated**					
333	5				15	CS		
332	6				20	CS		
331	7							
330	8				25	CS		
329	9				30	CS		
328	10							
327	11				35	CS		
326	12				40	CS		
325	13		**very coarse SAND and fine GRAVEL, slight coarsening downwards to medium coarse gravel, grey, moderately well sorted, saturated**	12.95 / 325.52				
324	14				45	CS		
323	15				50	CS		
322	16							
321	17				55	CS		
320	18				60	CS		
319	19							
318	20				65	CS		
317	21				70	CS		
316	22							
315	23				75	CS		
314	24		**SILTY CLAY, some fine to coarse sand, some fine to medium gravel, grey, very poorly sorted, angular, saturated (TILL)**	23.62 / 314.86				
313	25				80	CS		
312	26							
311	27			27.13 / 311.35	85	CS		
310	28		**SAND and fine GRAVEL, poorly sorted, subrounded**	27.43 / 311.05	90	CS		
309	29		**PROBABLE BEDROCK**	27.74 / 310.74				
308	30		**END OF BOREHOLE @ 27.74 m bgs**					



NOTES: m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW8-S

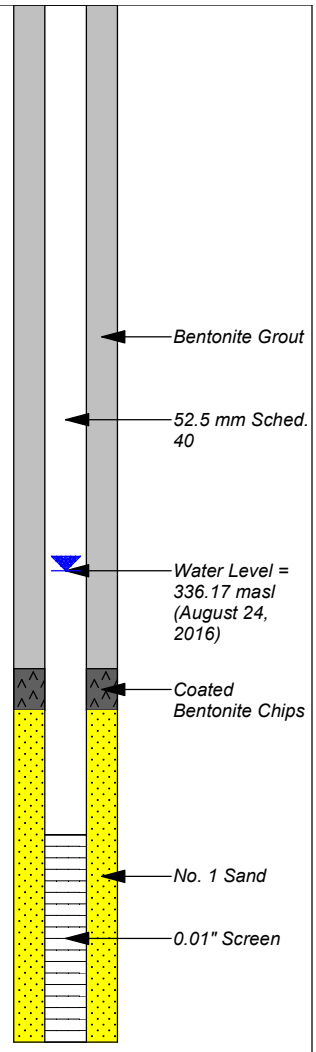
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **D. Martin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 10, 2016**
Ground Elevation: **338.481 masl**
Total Depth: **7.62 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **6.10 - 7.62 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **5.18 - 7.62 m**

Stick Up: **0.84 m**
Northing: **4815493.95**
Easting: **566250.11**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery	Completion Details
338	0		**fine to coarse SAND and fine to medium GRAVEL, trace silt, brown, poorly sorted, angular to sub-rounded, damp to moist**	0 / 338.48					
337	1				5	CS			
336	2								
335	3				10	CS			
334	4		**@4.57 m bgs: saturated**		15	CS			
333	5								
332	6				20	CS			
331	7			7.62 / 330.86	25	CS			
330	8		**END OF BOREHOLE @ 7.62 m bgs**						
	9								



NOTES:
0.00 to 6.10 m bgs logged from MW8-D
m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW9-D

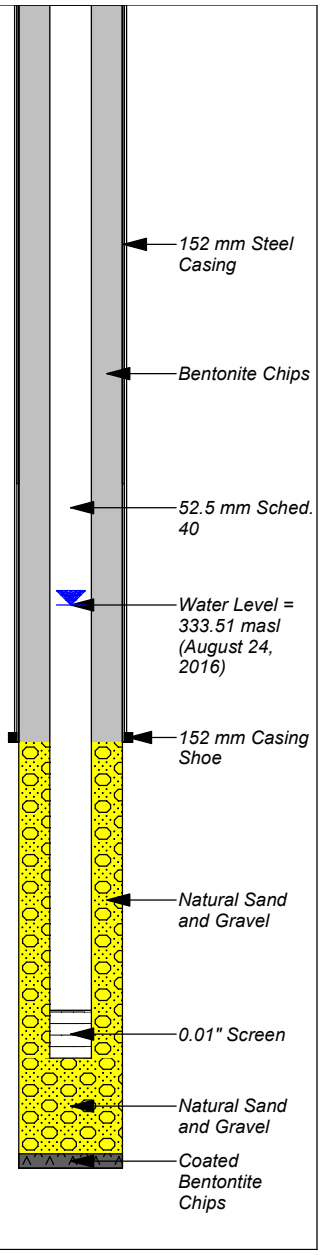
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **S. Miller/J. Melchin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 4, 2016**
Ground Elevation: **350.505 masl**
Total Depth: **37.03 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **32.00 - 33.53 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **29.26 - 36.58 m**

Stick Up: **0.55 m**
Northing: **4815294.75**
Easting: **566970.16**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery	Completion Details
350	0		**GRAVELY SAND (fine gravel, medium to coarse sand) coarsening with depth, brown, moderately well sorted, subrounded to rounded, dry**	0 / 350.51					
349	1		**@1.52 m bgs: some silt, trace clay**		5	CS			
348	2								
347	3				10	CS			
346	4								
345	5				15	CS			
344	6								
343	7				20	CS			
342	8								
341	9				25	CS			
340	10								
339	11				30	CS			
338	12								
337	13				35	CS			
336	14								
335	15		**@ 15.24 m bgs: trace silt**		40	CS			
334	16		**fine to medium SAND, brown, moderately well sorted, dry**	16.00 / 334.50					
333	17				45	CS			
332	18			17.53 / 332.98					
331	19		**medium to coarse SAND and fine GRAVEL, brown, moderately well sorted, subrounded to rounded, saturated**		50	CS			
330	20								
329	21				55	CS			
328	22								
327	23				60	CS			
326	24		**medium to very coarse SAND, trace fine gravel, fining slightly with depth, brown, subrounded, saturated**	23.62 / 326.88					
325	25				65	CS			
324	26								
323	27				70	CS			
322	28			28.19 / 322.31					
321	29		**very fine SANDY SILT, fining downwards to silt, grey, well sorted, saturated**		75	CS			
320	30								
319	31			31.24 / 319.26	80	CS			
318	32		**fine to medium GRAVEL, trace to some coarse sand, grey, subangular to subrounded, saturated**						
317	33				85	CS			
316	34								
315	35				90	CS			
314	36			36.58 / 313.93					
313	37		**PROBABLE BEDROCK**	37.03 / 313.47	95	CS			
312	38								
311	39		**END OF BOREHOLE @ 37.03 m bgs**		100	CS			
					105	CS			
					110	CS			
					115	CS			
					120	CS			



NOTES: m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

DRILLING LOG | Clair - Maltby Subwatershed Study | MW9-S

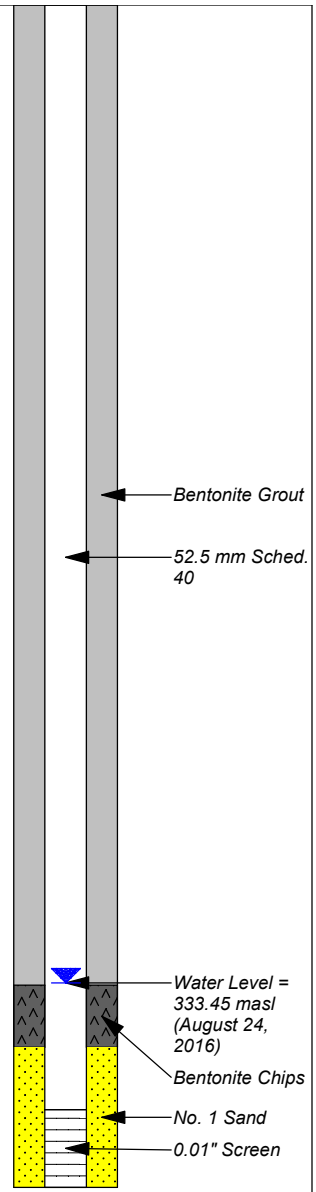
Client: **City of Guelph**
Project Area: **Clair - Maltby**
Project No.(MSI): **23089**
Field Staff: **S.Miller/J. Melchin**
Driller: **Highland Water Well Drilling Inc**

Date: **August 8, 2016**
Ground Elevation: **350.456 masl**
Total Depth: **23.16 m**
Drill Rig: **Foremost DR-12**
Boring Diameter: **152 mm**

Screen Type: **52.5 mm PVC Sched. 40**
Screened Interval: **21.64 - 23.16 m**
Slot Size: **0.01"**
Casing Diameter: **52.5 mm**
Sand Pack: **20.42 - 23.16 m**

Stick Up: **0.46 m**
Northing: **4815292.49**
Easting: **566972.15**
Datum/Zone: **NAD83 17T**

m asl	m bgs	Lithology	Stratigraphic Description	Depth (m bgs)/ Elev. (m asl)	Sample ID	Sample Type	Blow Counts (N Value)	% Recovery
350	0			0 / 350.46				
349	1		**GRAVELY SAND, fine gravel, medium to coarse sand coarsening with depth, brown, subrounded to rounded, dry**		5	CS		
348	2		**@1.52 m bgs: some silt, trace clay**					
347	3				10	CS		
346	4				15	CS		
345	5							
344	6				20	CS		
343	7				25	CS		
342	8							
341	9				30	CS		
340	10				35	CS		
339	11							
338	12				40	CS		
337	13				45	CS		
336	14							
335	15		**@ 15.24 m bgs: trace silt**		50	CS		
334	16		**fine to medium SAND, brown, moderately well sorted, dry**	16.00 / 334.45	55	CS		
333	17			17.53 / 332.93				
332	18		**medium to coarse SAND and fine GRAVEL, brown, subrounded to rounded, saturated**		60	CS		
331	19							
330	20				65	CS		
329	21							
328	22				70	CS		
327	23				75	CS		
	24		**END OF BOREHOLE @ 23.16 m bgs**	23.16 / 327.29				



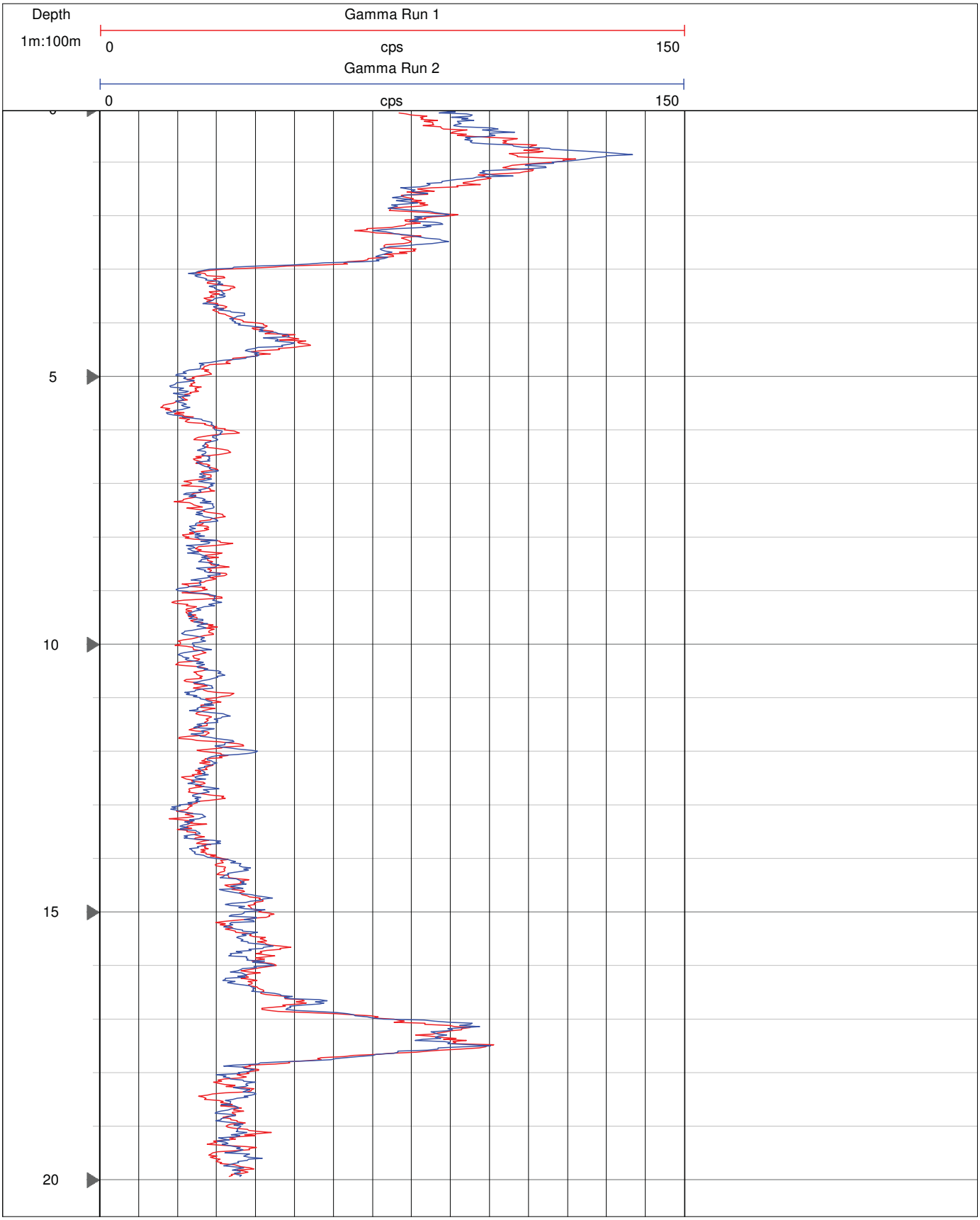
NOTES:
0.00 to 18.29 m bgs logged from MW9-D
m asl = metres above sea level
m bgs = metres below ground surface
CS = cyclone sample

Matrix Solutions Inc.

Appendix B2
Geophysical Logs

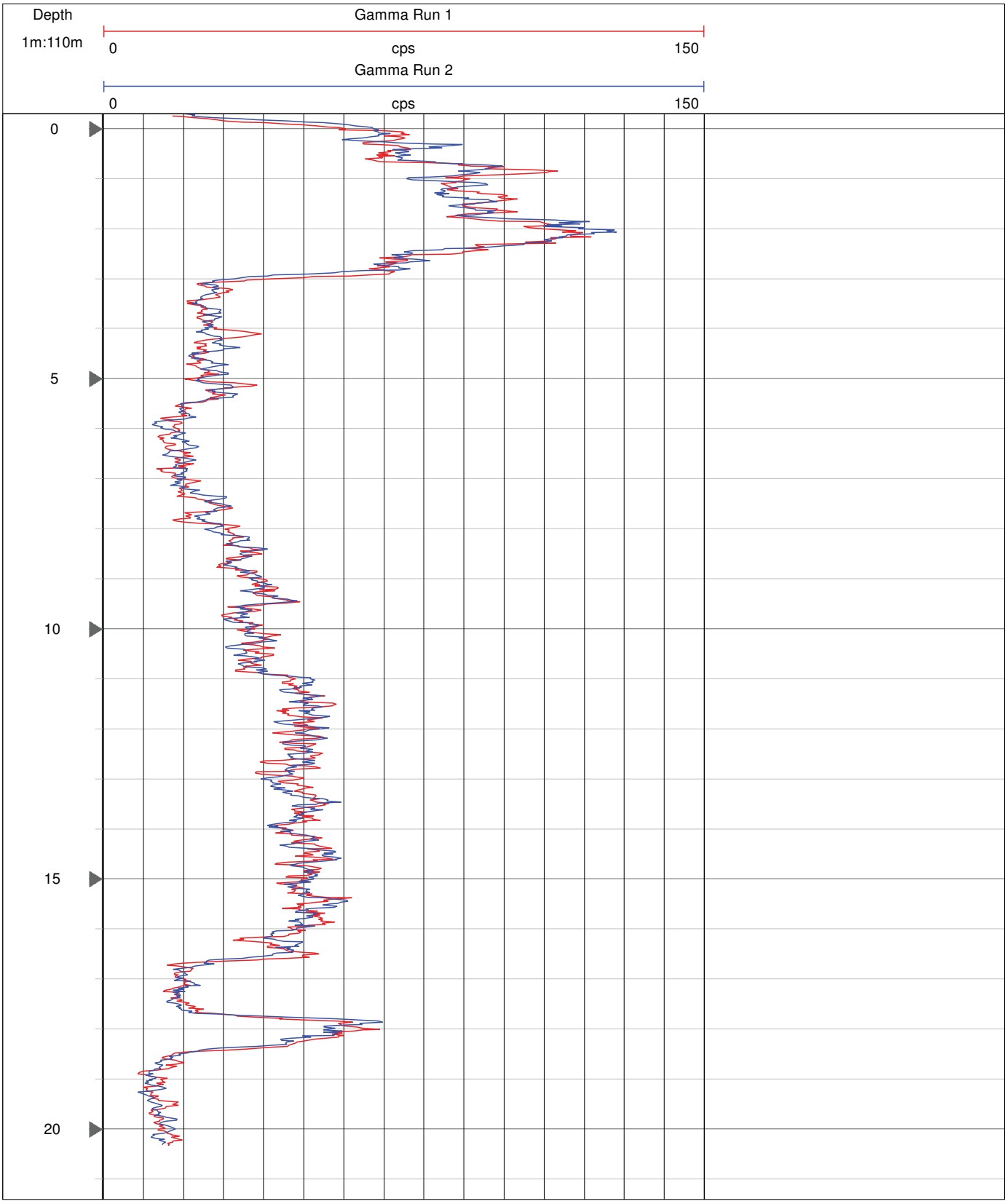
Lotowater
TECHNICAL SERVICES INC.

Client:	Matrix Solutions	Measuring Point:	Ground Surface
Well Name:	MW1-D	Measuring Point Elev:	N/A
Location:	1 Kilkenny Guelph	Logged By:	J. Dion
Project No:	033-188	Logging Date:	September 23, 2016



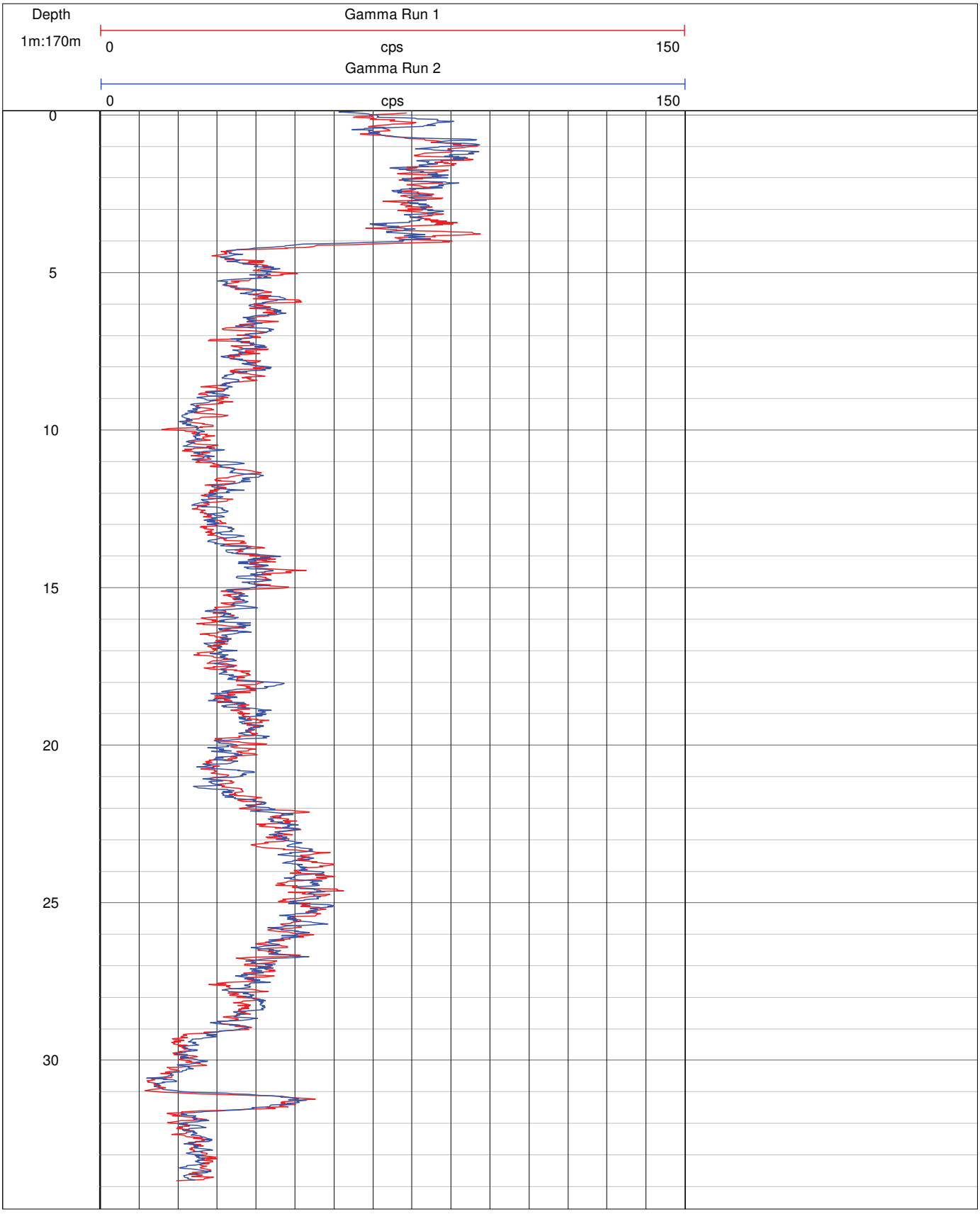
Lotowater
TECHNICAL SERVICES INC.

Client:	Matrix Solutions Inc	Measuring Point:	Ground Surface
Well Name:	MW2-D	Measuring Point Elev:	N/A
Location:	12 Kilkenny Pl. Guelph	Logged By:	J. Dion
Project No:	033-188	Logging Date:	September 23, 2016



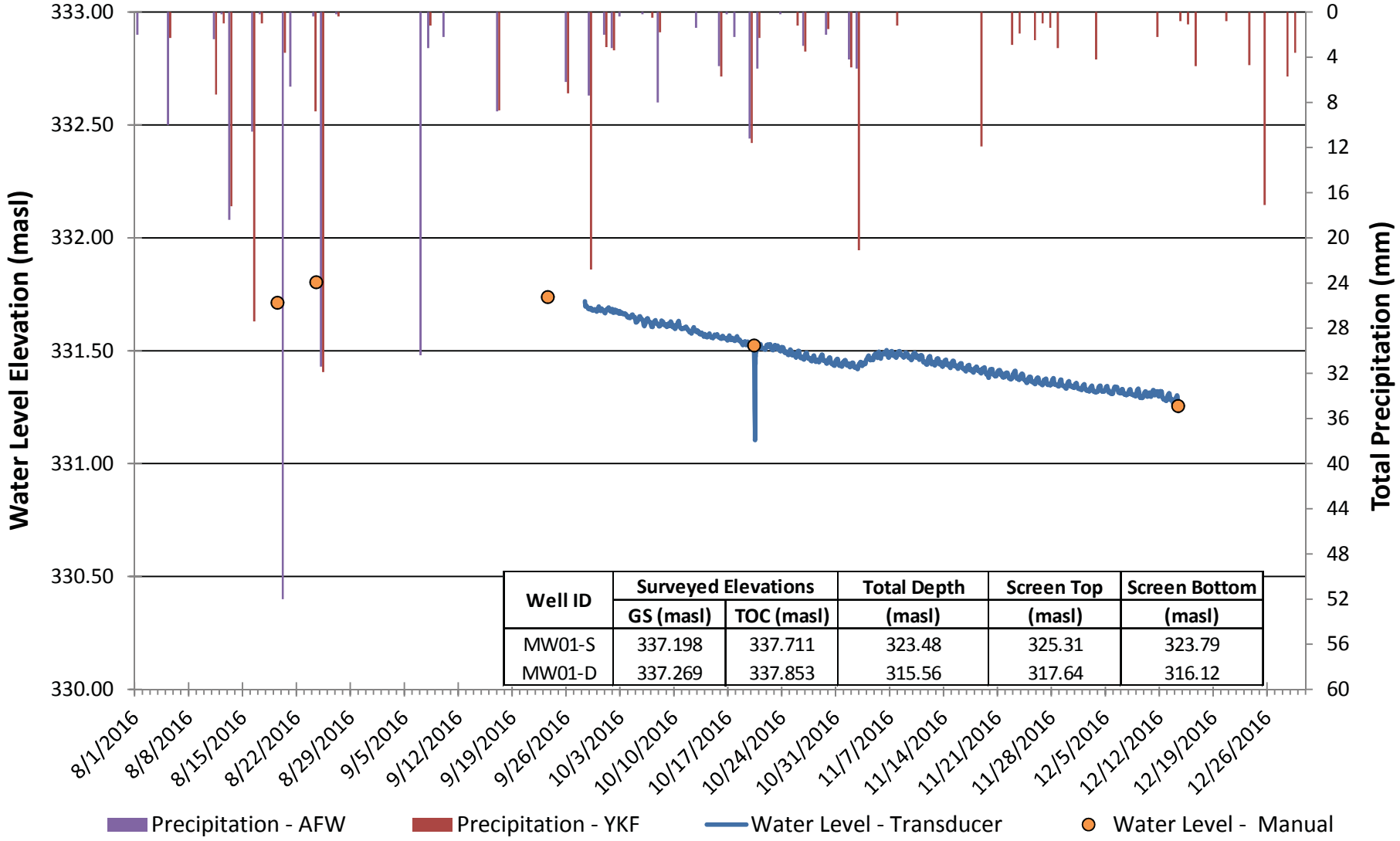
Lotowater
TECHNICAL SERVICES INC.

Client:	Matrix Solutions	Measuring Point:	Ground Surface
Well Name:	MW3-D	Measuring Point Elev:	N/A
Location:	500 Maltby Guelph	Logged By:	J. Dion
Project No:	033-188	Logging Date:	September 23, 2015



Appendix B3
Monitoring Well Hydrographs

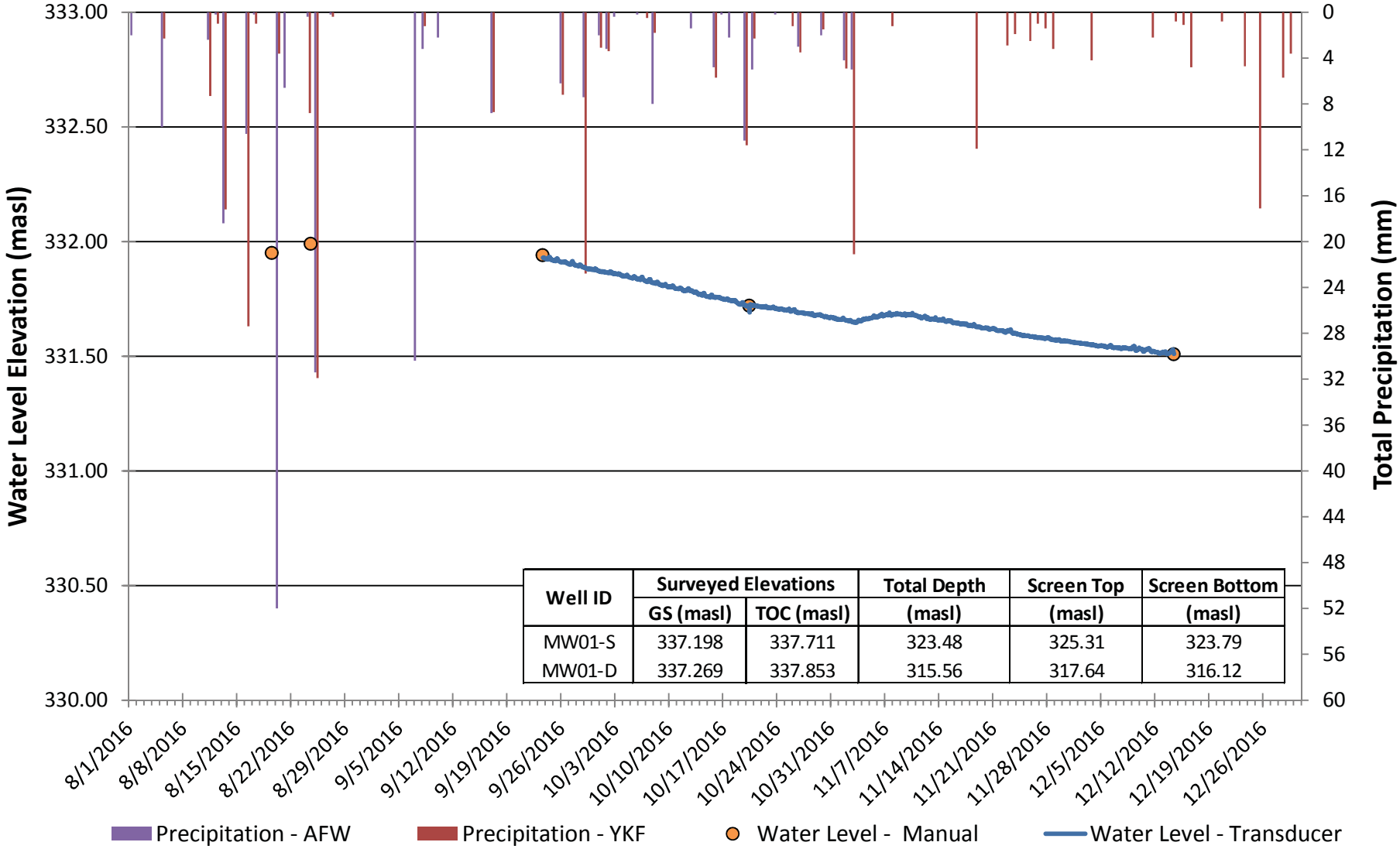
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW1-D



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW01-S	337.198	337.711	323.48	325.31	323.79
MW01-D	337.269	337.853	315.56	317.64	316.12

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF)

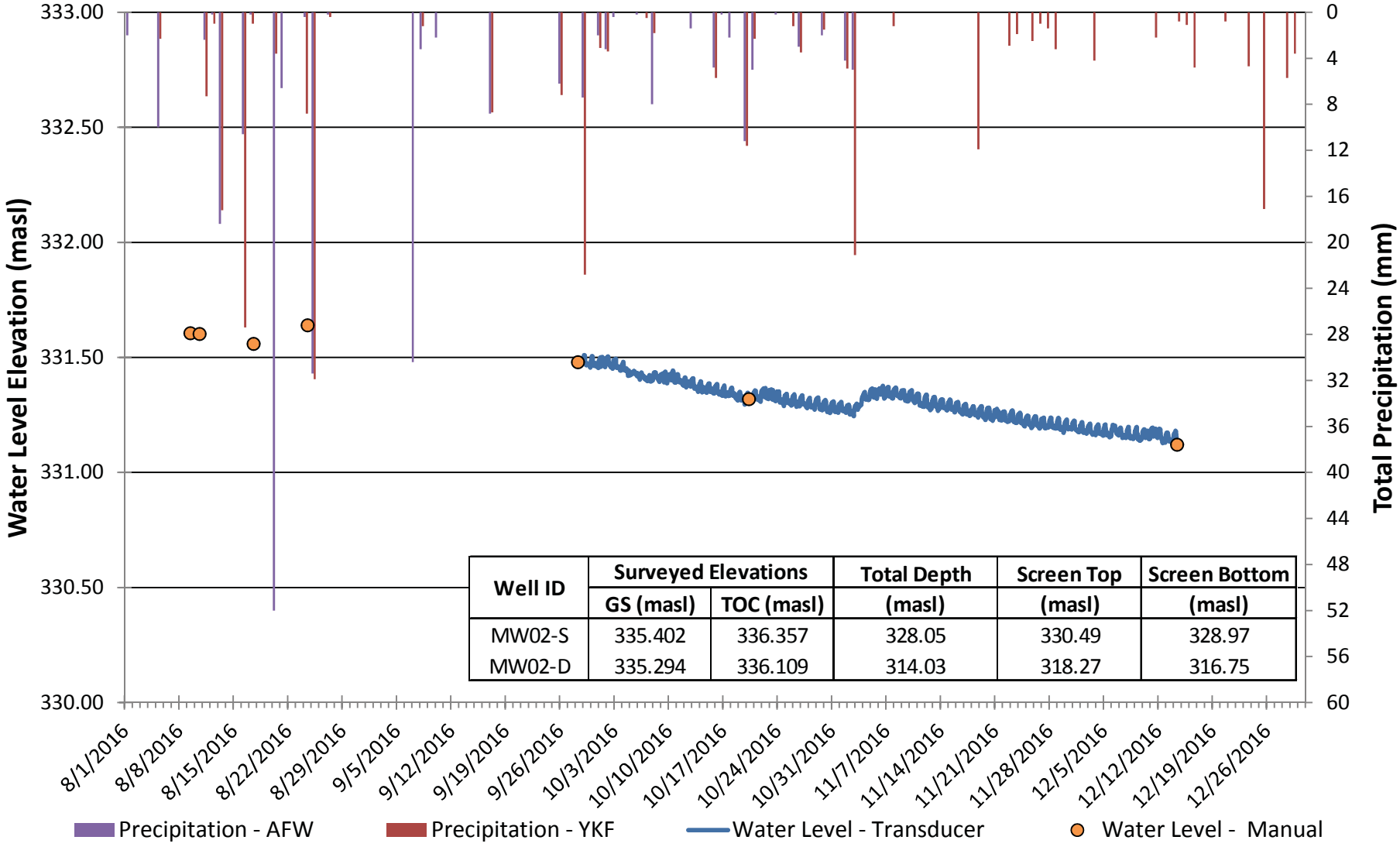
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW1-S



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW01-S	337.198	337.711	323.48	325.31	323.79
MW01-D	337.269	337.853	315.56	317.64	316.12

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

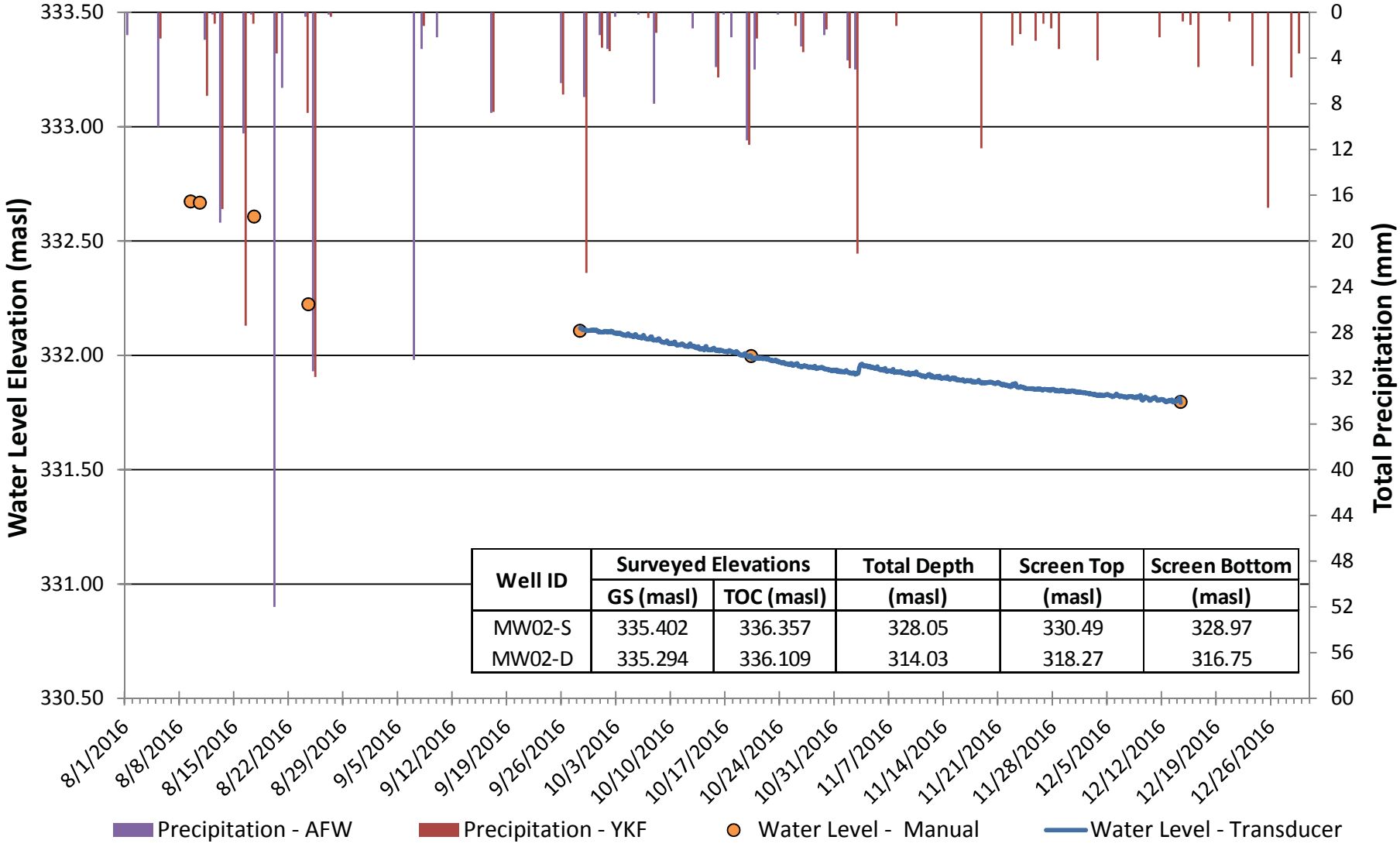
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW2-D



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW02-S	335.402	336.357	328.05	330.49	328.97
MW02-D	335.294	336.109	314.03	318.27	316.75

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

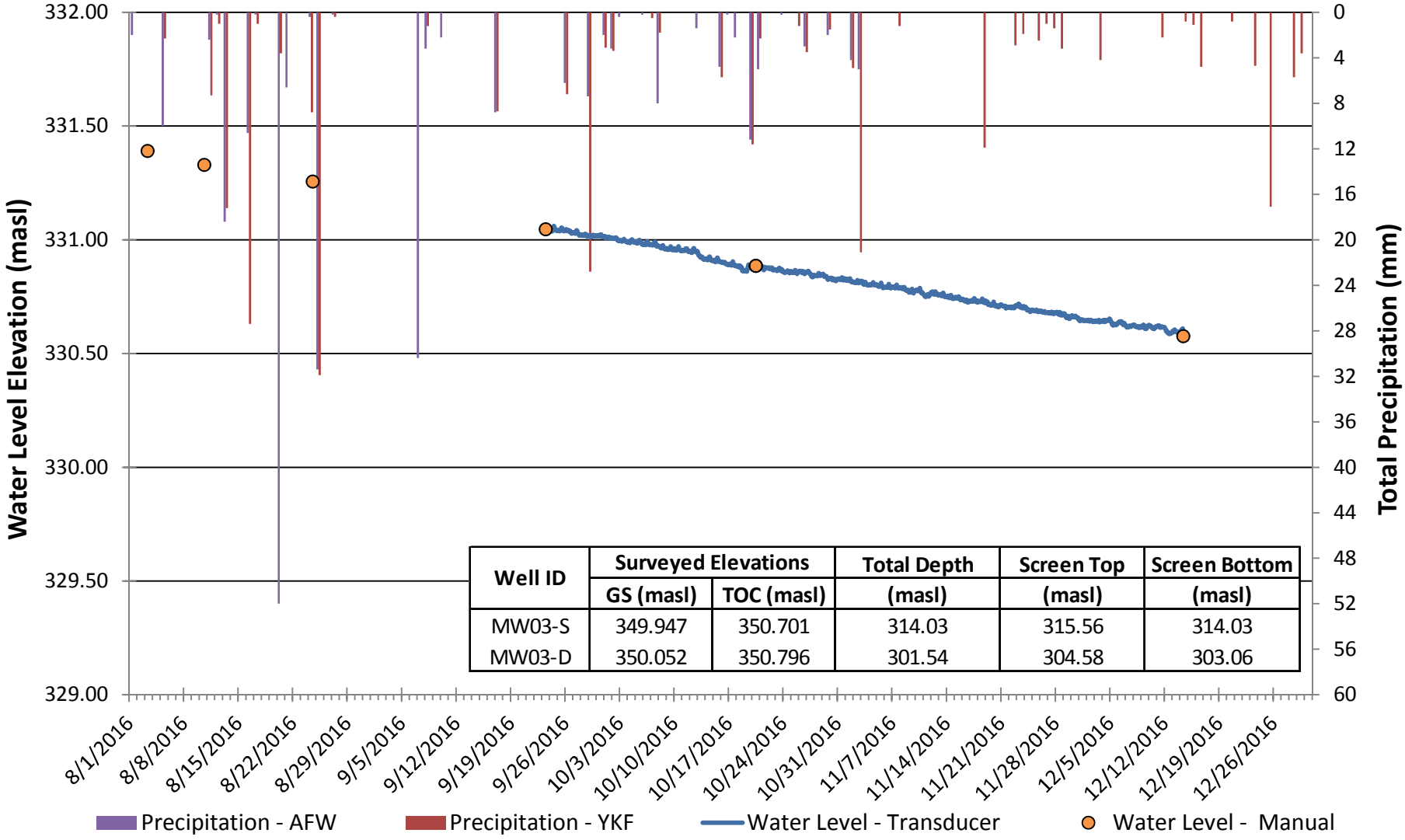
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW2-S



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW02-S	335.402	336.357	328.05	330.49	328.97
MW02-D	335.294	336.109	314.03	318.27	316.75

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

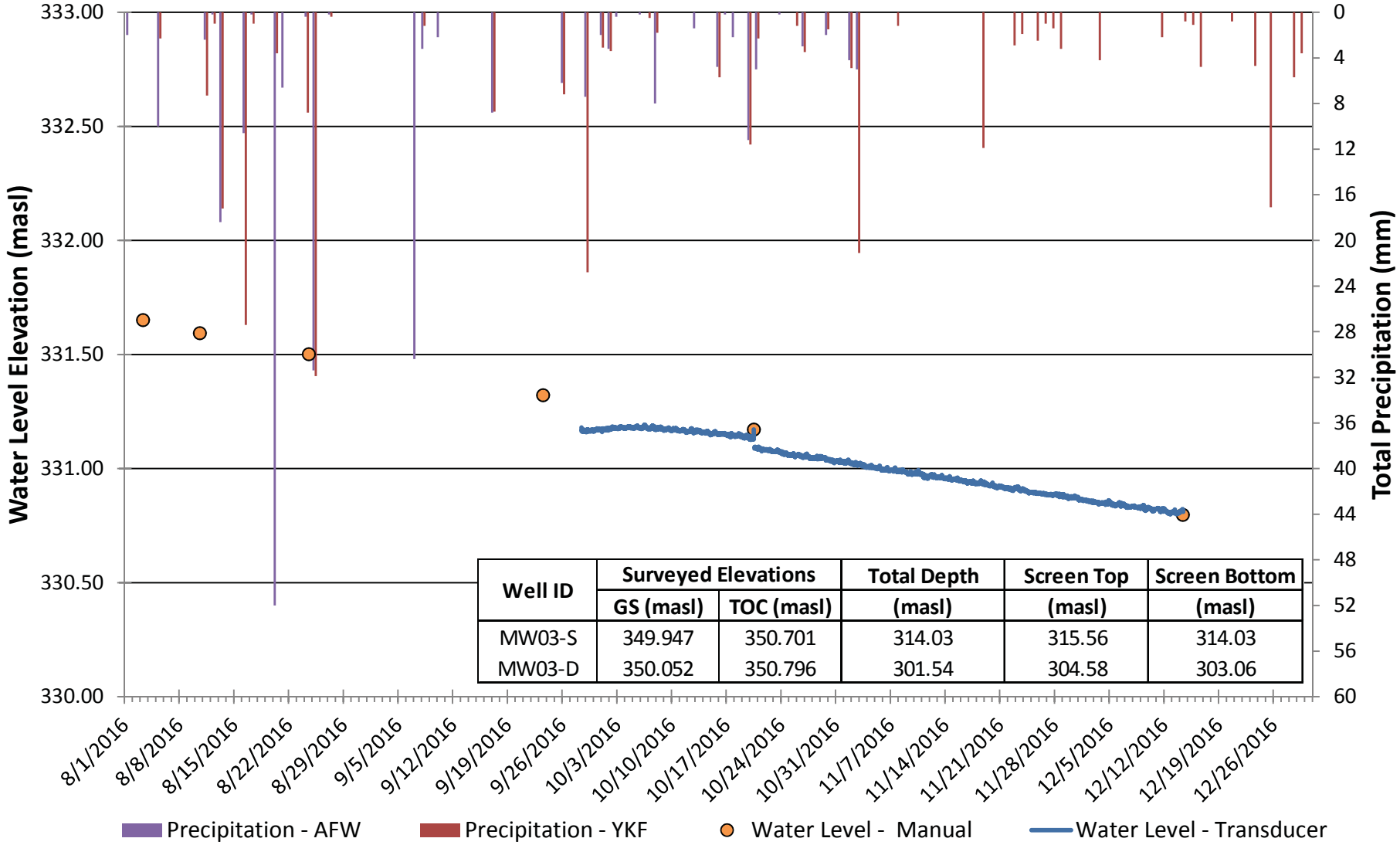
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW3-D



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW03-S	349.947	350.701	314.03	315.56	314.03
MW03-D	350.052	350.796	301.54	304.58	303.06

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

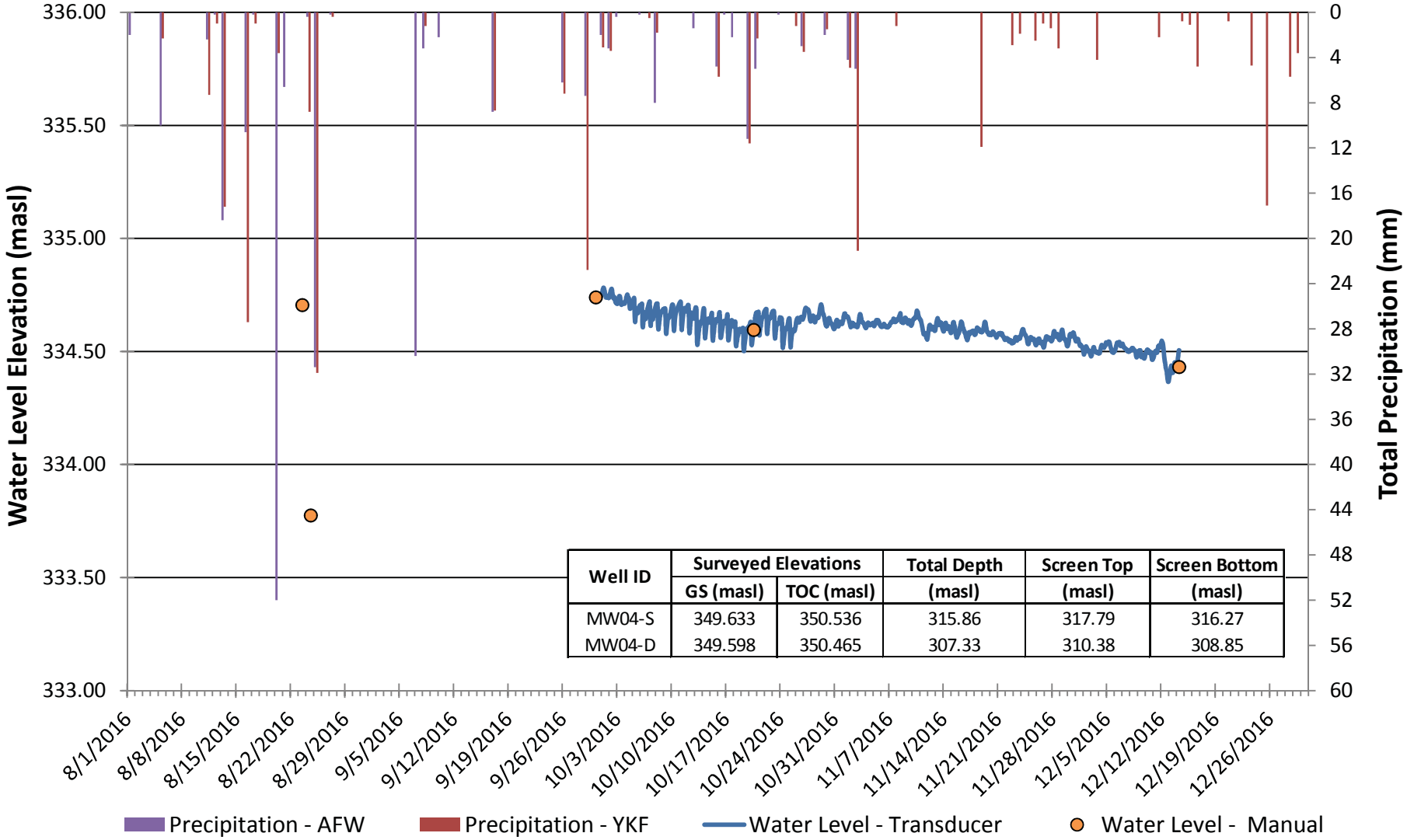
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW3-S



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW03-S	349.947	350.701	314.03	315.56	314.03
MW03-D	350.052	350.796	301.54	304.58	303.06

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

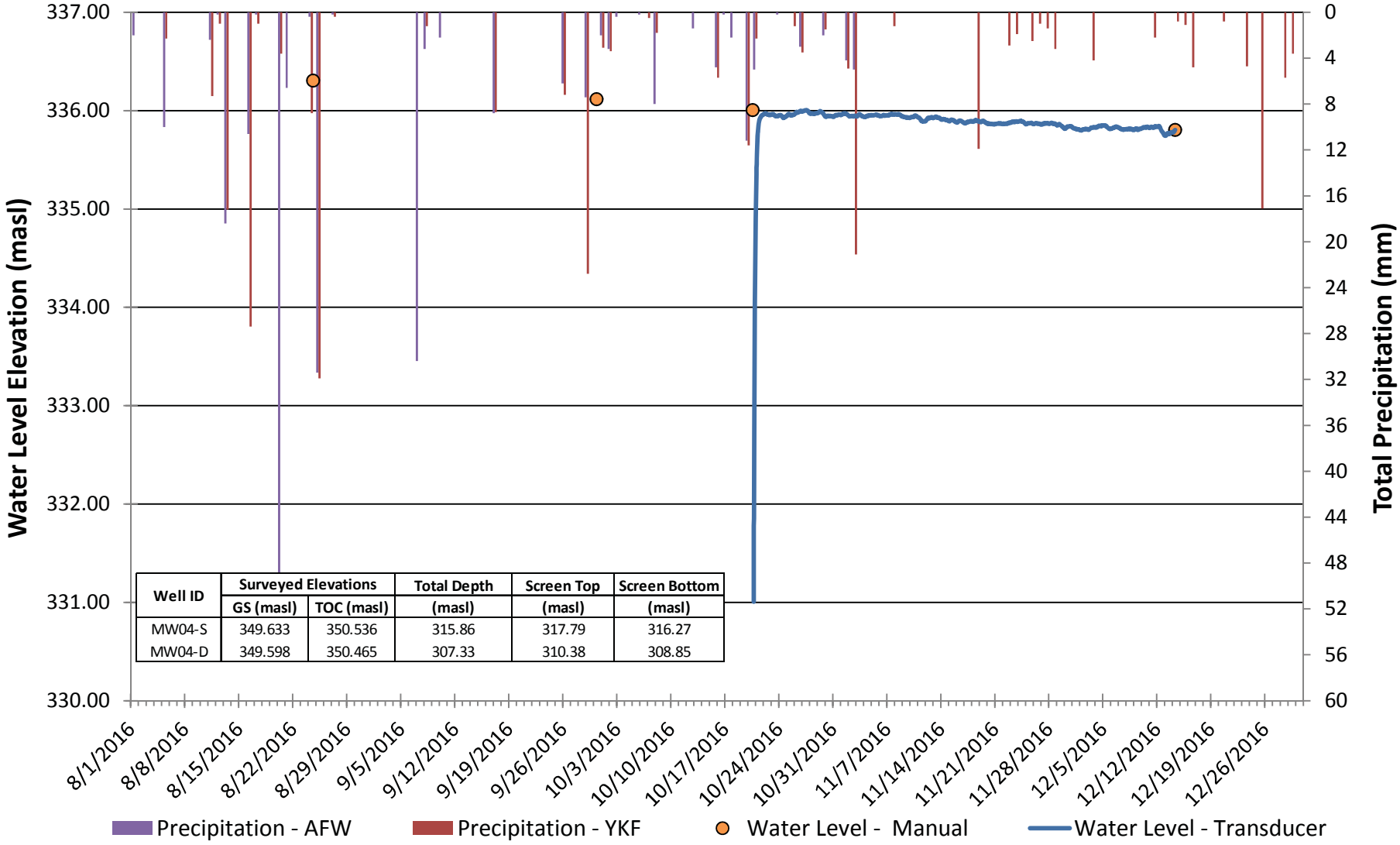
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW4-D



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW04-S	349.633	350.536	315.86	317.79	316.27
MW04-D	349.598	350.465	307.33	310.38	308.85

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

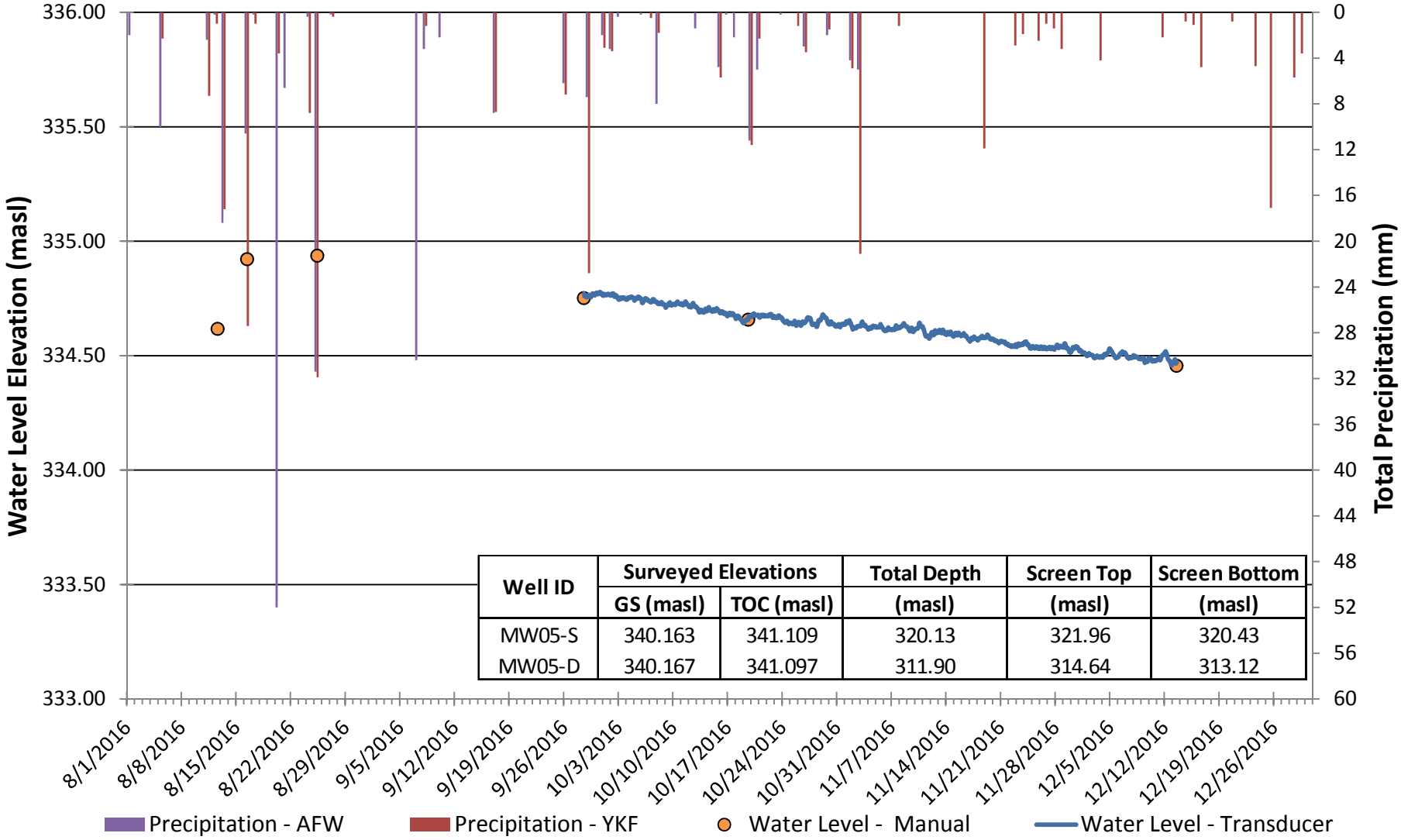
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW4-S



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW04-S	349.633	350.536	315.86	317.79	316.27
MW04-D	349.598	350.465	307.33	310.38	308.85

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

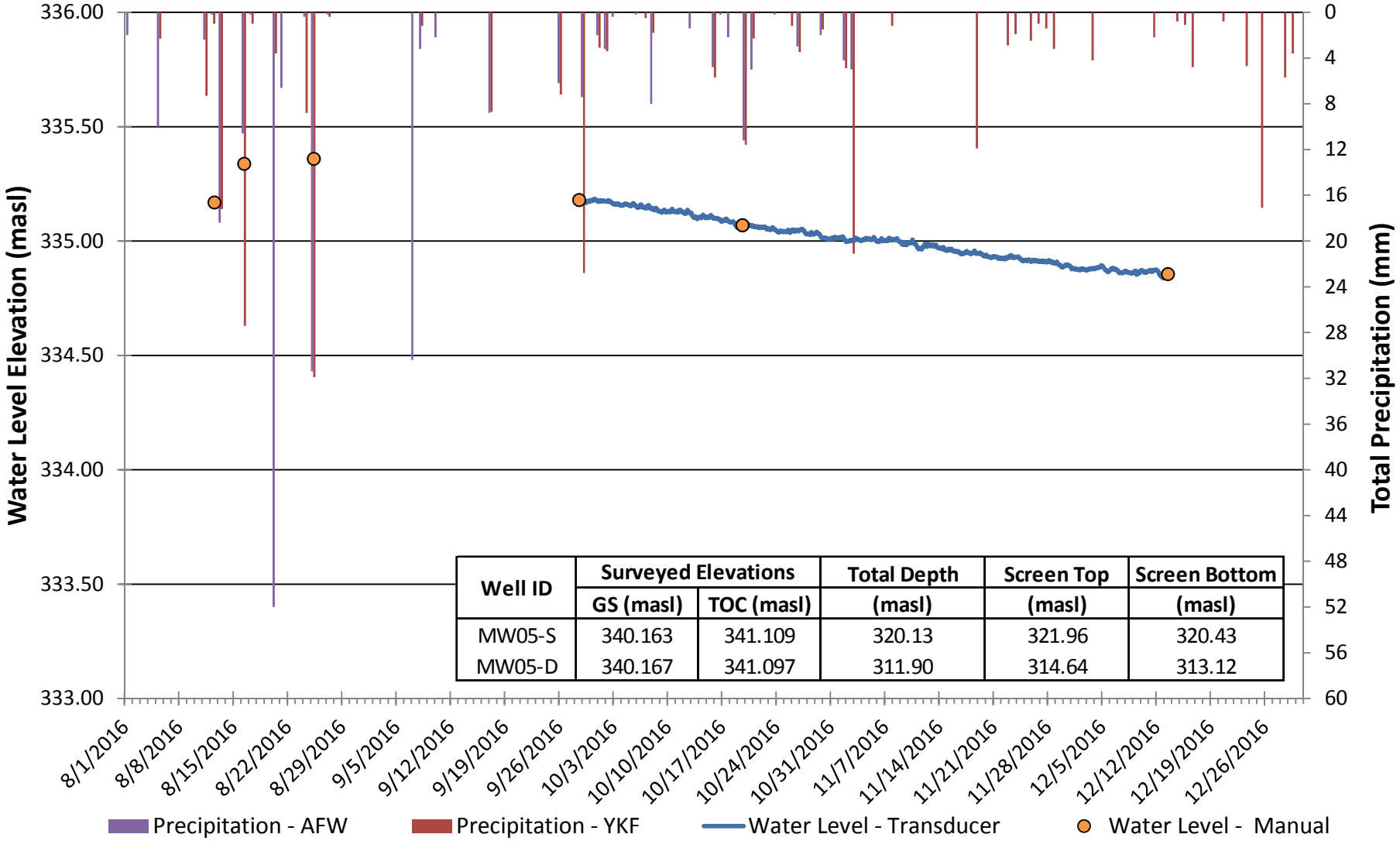
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW5-D



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW05-S	340.163	341.109	320.13	321.96	320.43
MW05-D	340.167	341.097	311.90	314.64	313.12

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

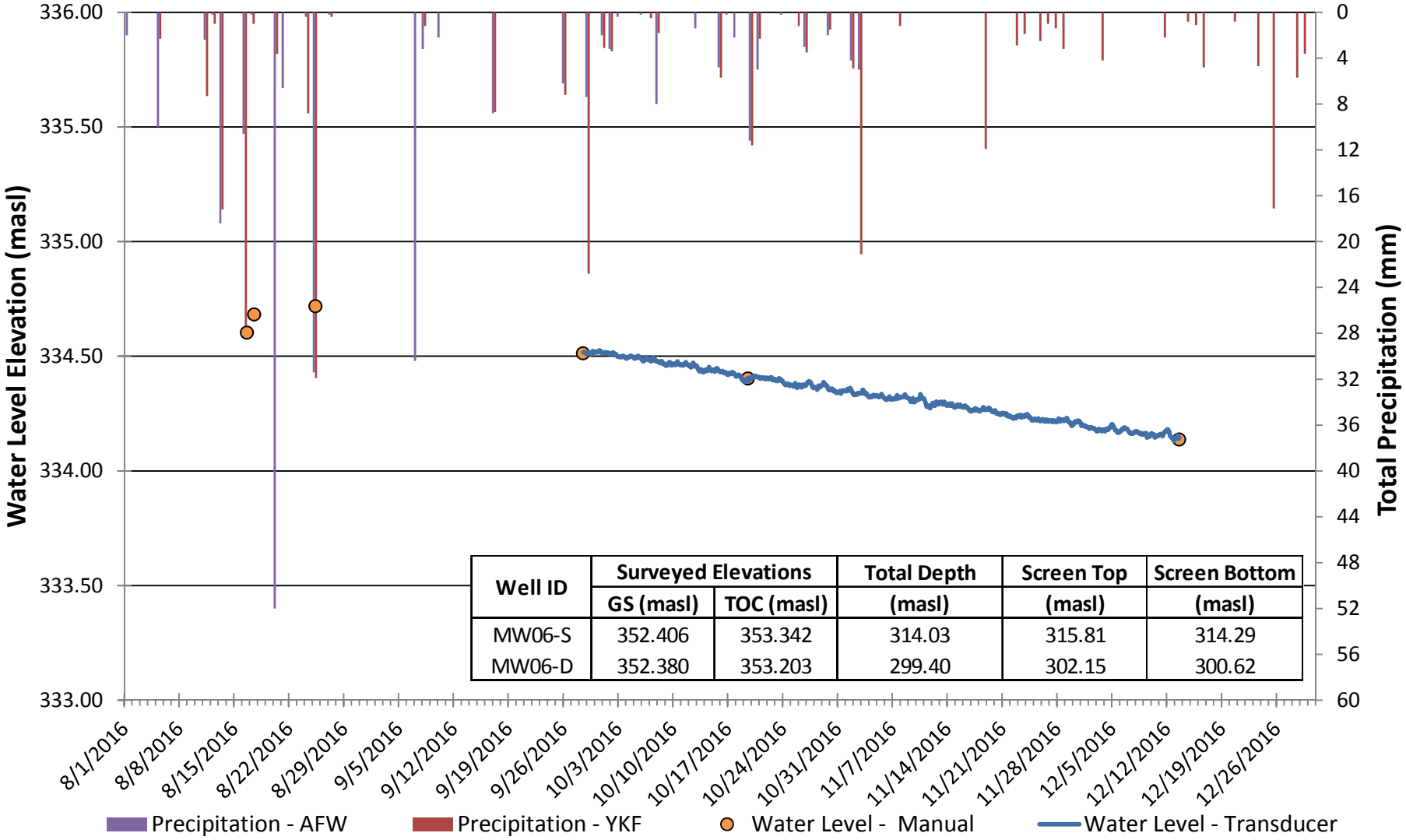
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW5-S



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW05-S	340.163	341.109	320.13	321.96	320.43
MW05-D	340.167	341.097	311.90	314.64	313.12

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

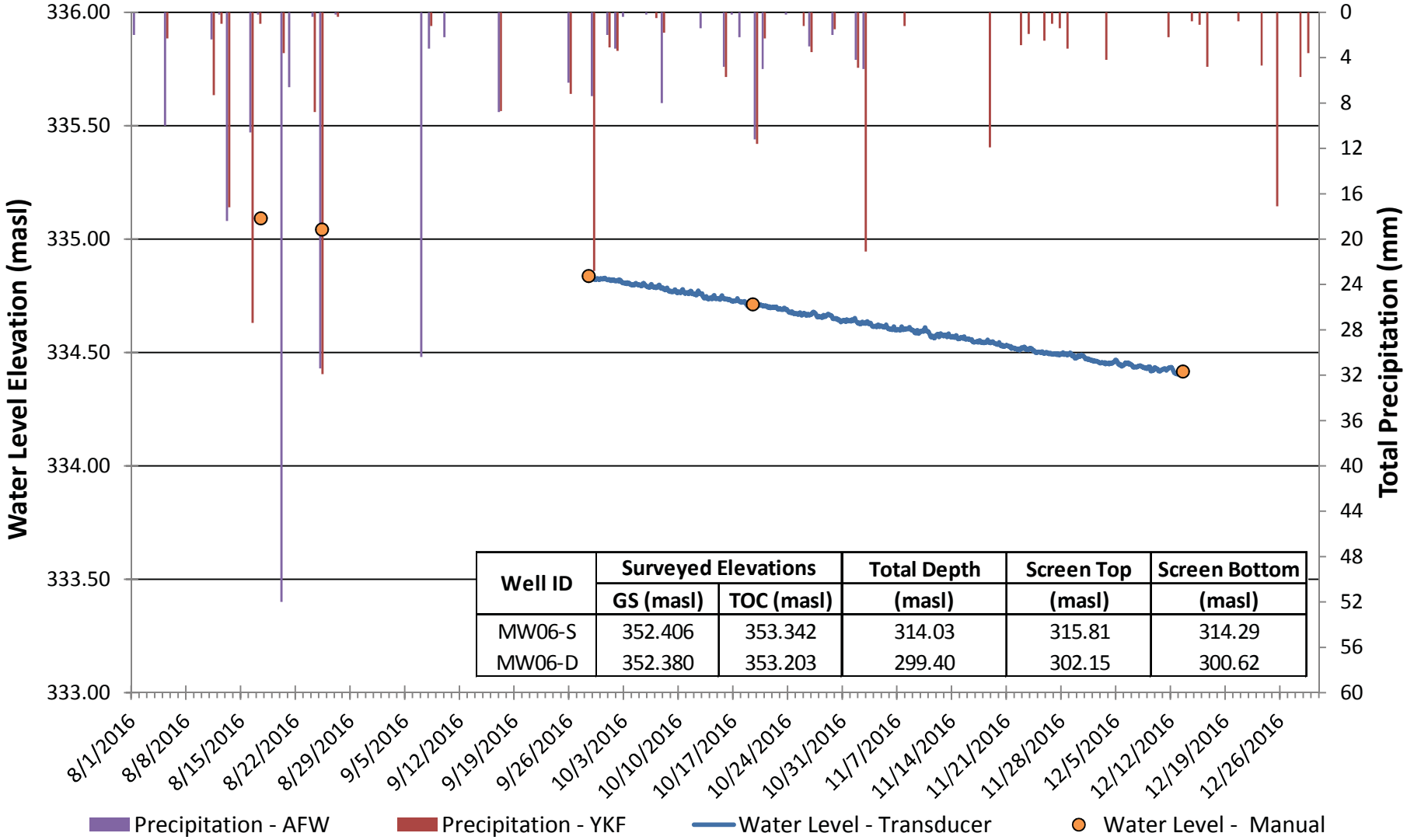
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW6-D



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW06-S	352.406	353.342	314.03	315.81	314.29
MW06-D	352.380	353.203	299.40	302.15	300.62

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

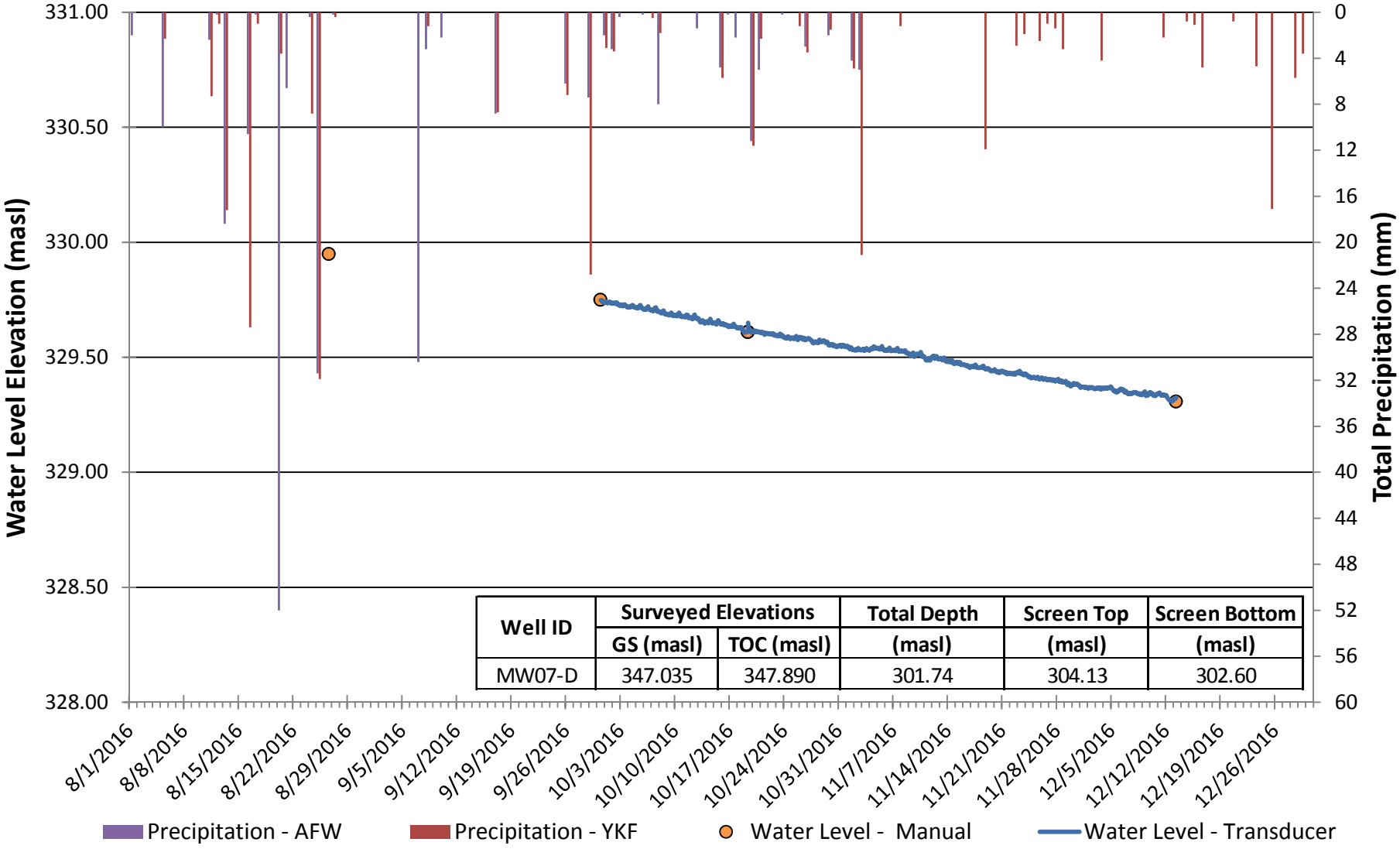
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW6-S



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW06-S	352.406	353.342	314.03	315.81	314.29
MW06-D	352.380	353.203	299.40	302.15	300.62

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

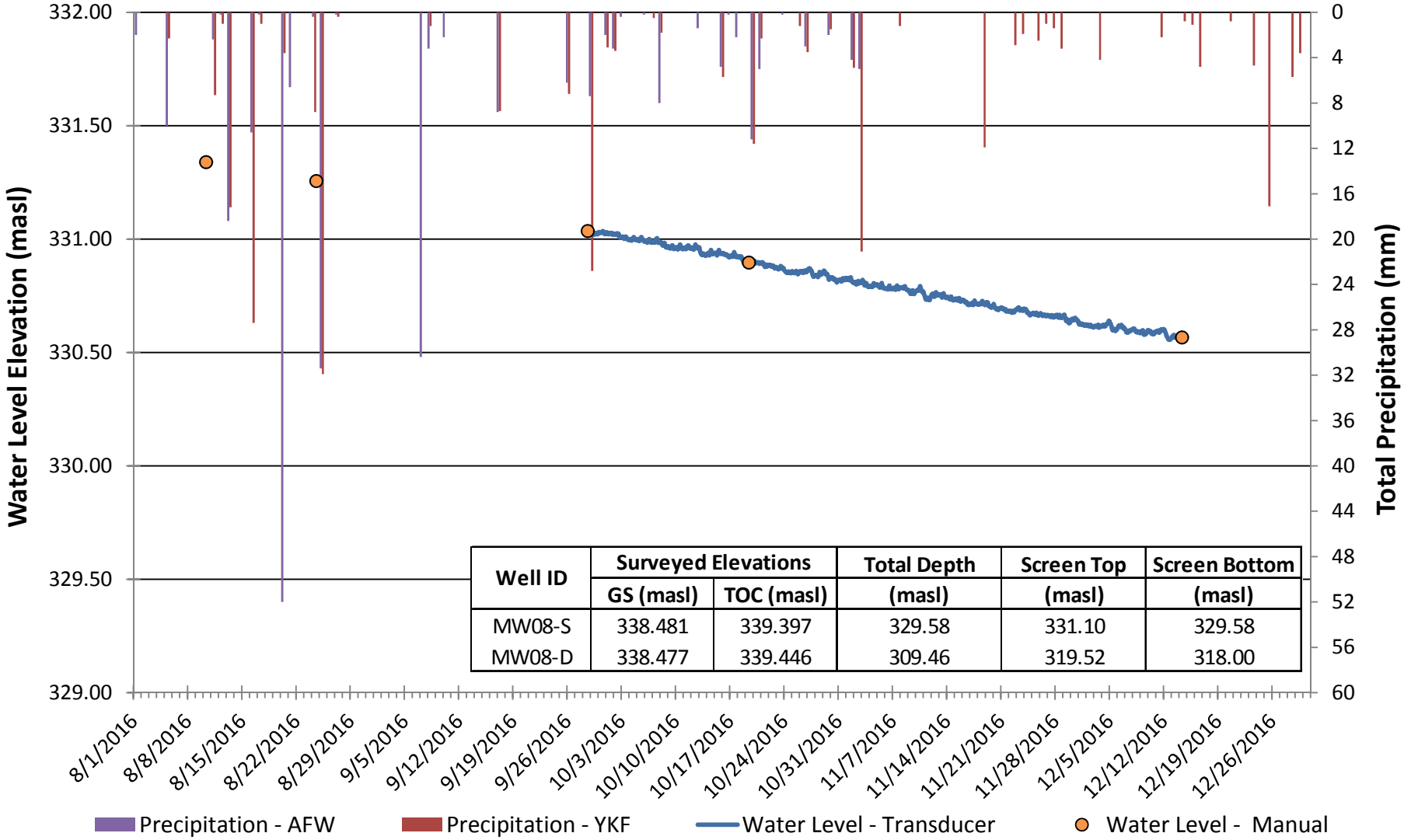
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW7-D



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW07-D	347.035	347.890	301.74	304.13	302.60

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

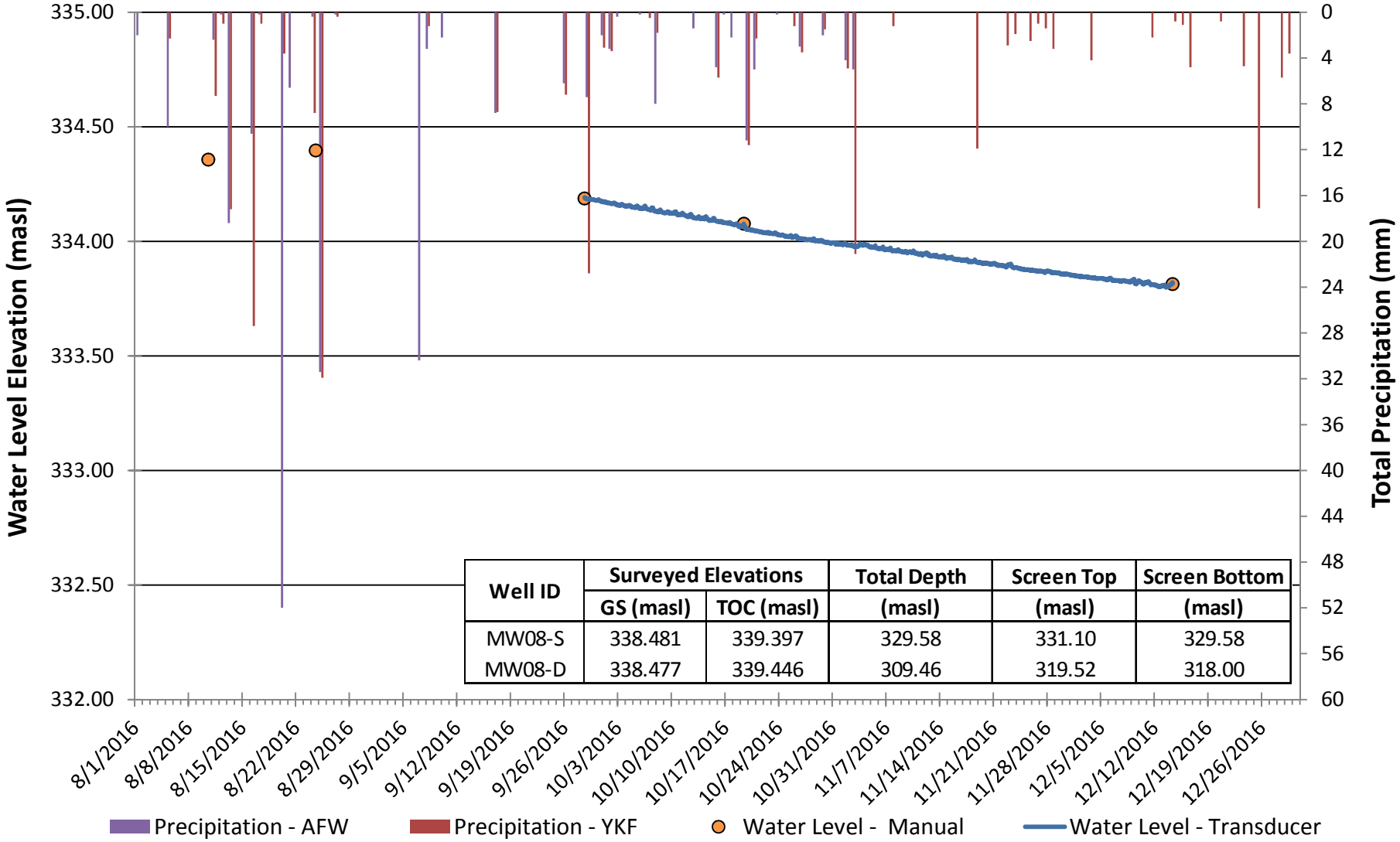
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW8-D



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW08-S	338.481	339.397	329.58	331.10	329.58
MW08-D	338.477	339.446	309.46	319.52	318.00

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

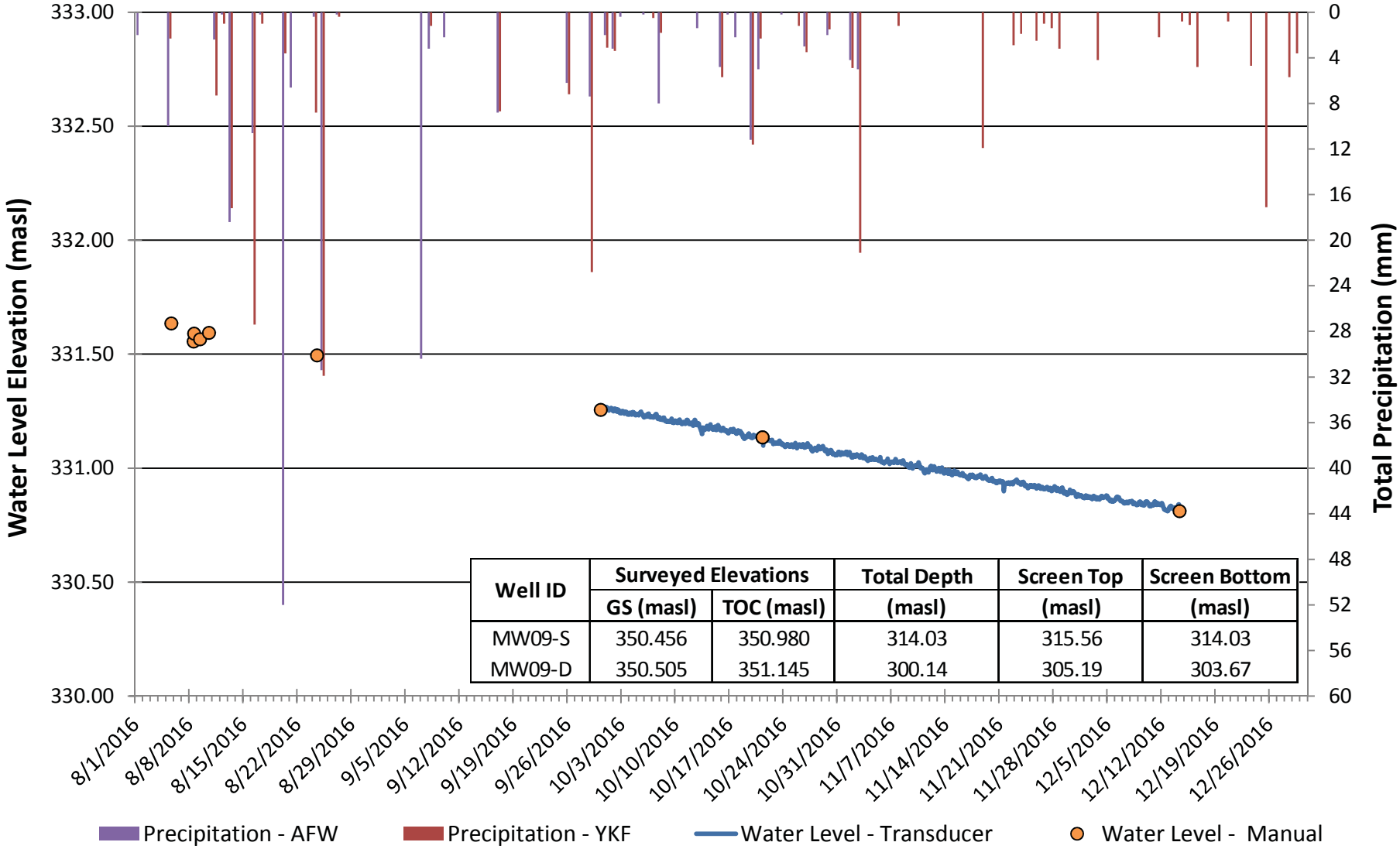
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW8-S



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW08-S	338.481	339.397	329.58	331.10	329.58
MW08-D	338.477	339.446	309.46	319.52	318.00

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

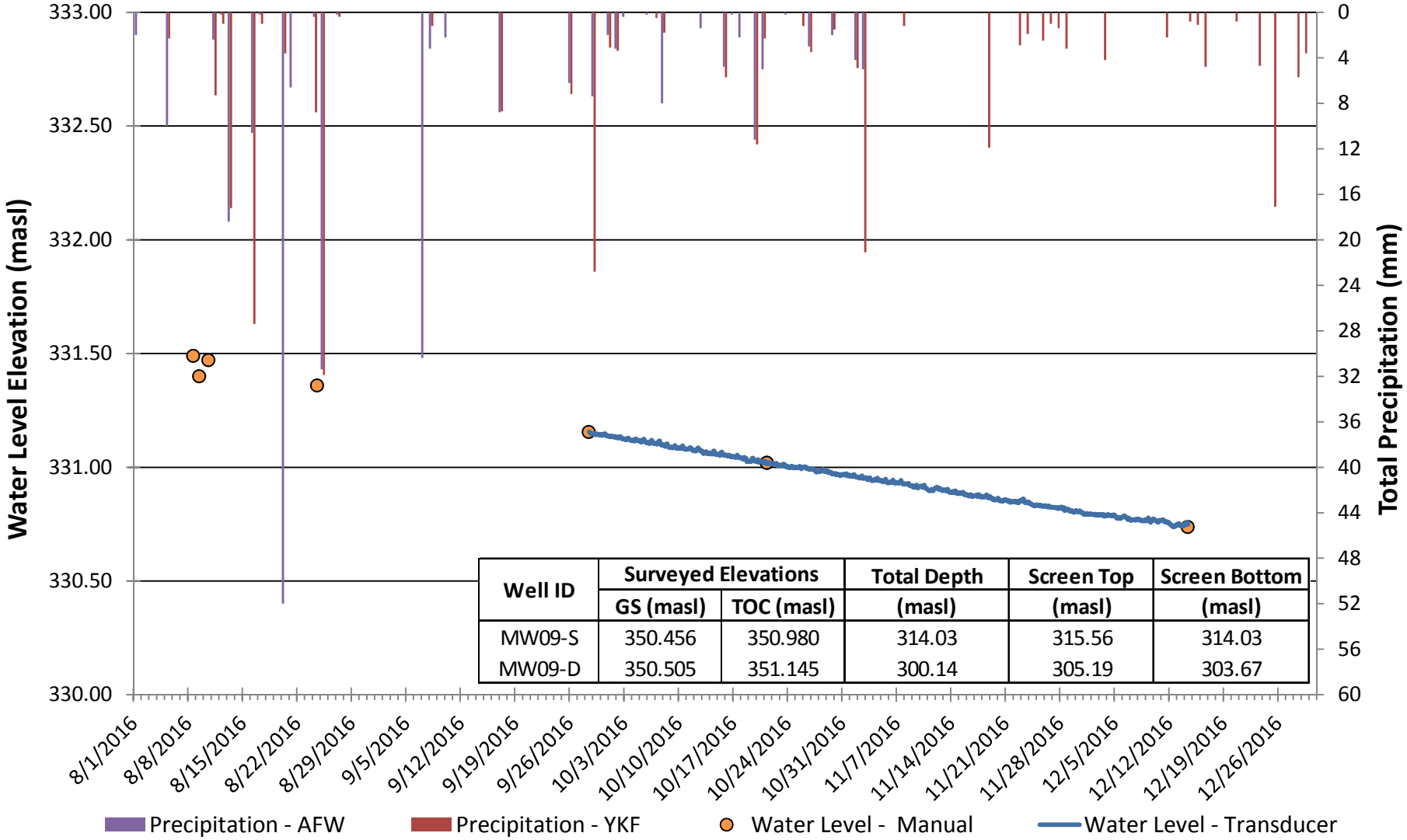
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW9-D



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW09-S	350.456	350.980	314.03	315.56	314.03
MW09-D	350.505	351.145	300.14	305.19	303.67

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

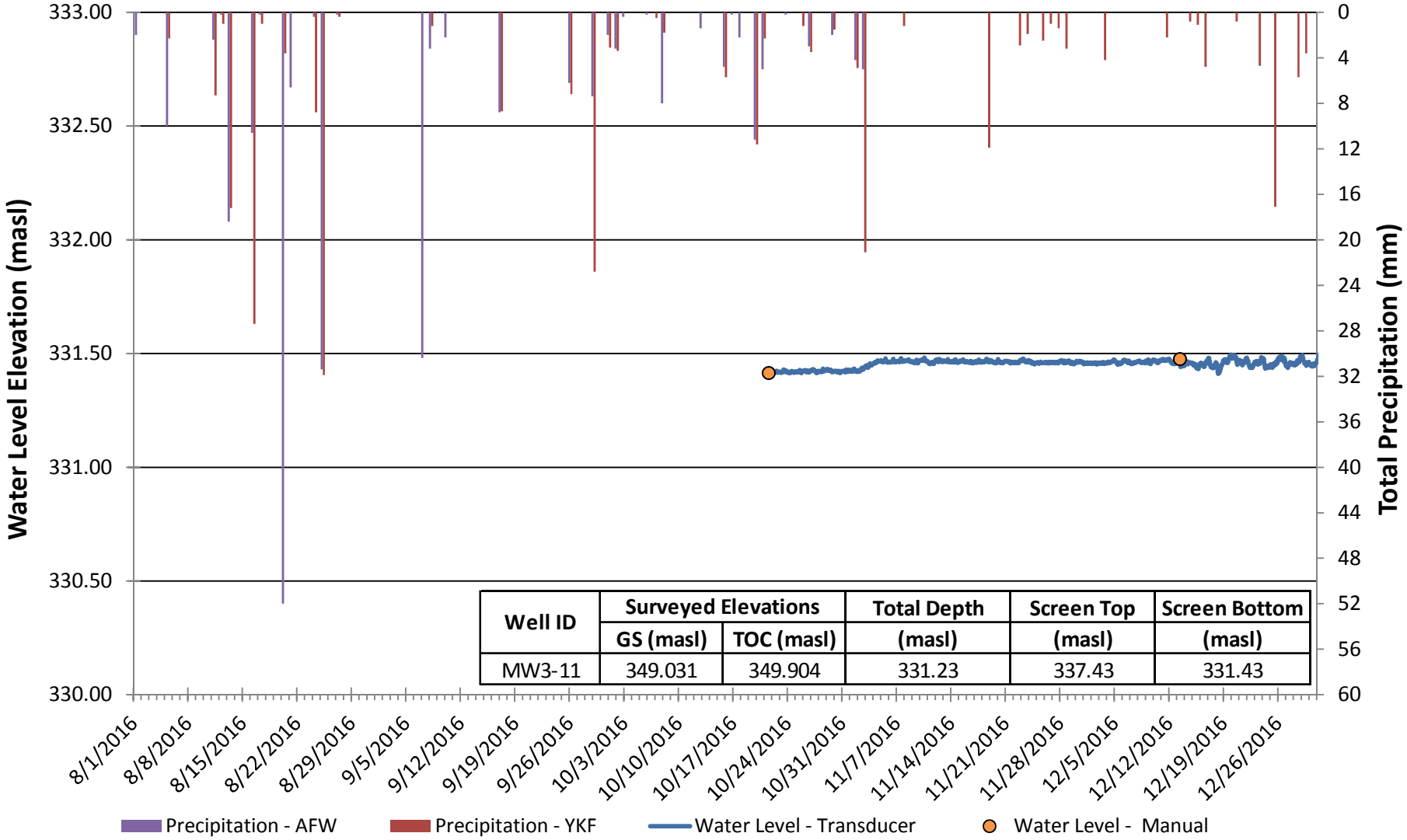
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW9-S



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW09-S	350.456	350.980	314.03	315.56	314.03
MW09-D	350.505	351.145	300.14	305.19	303.67

Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

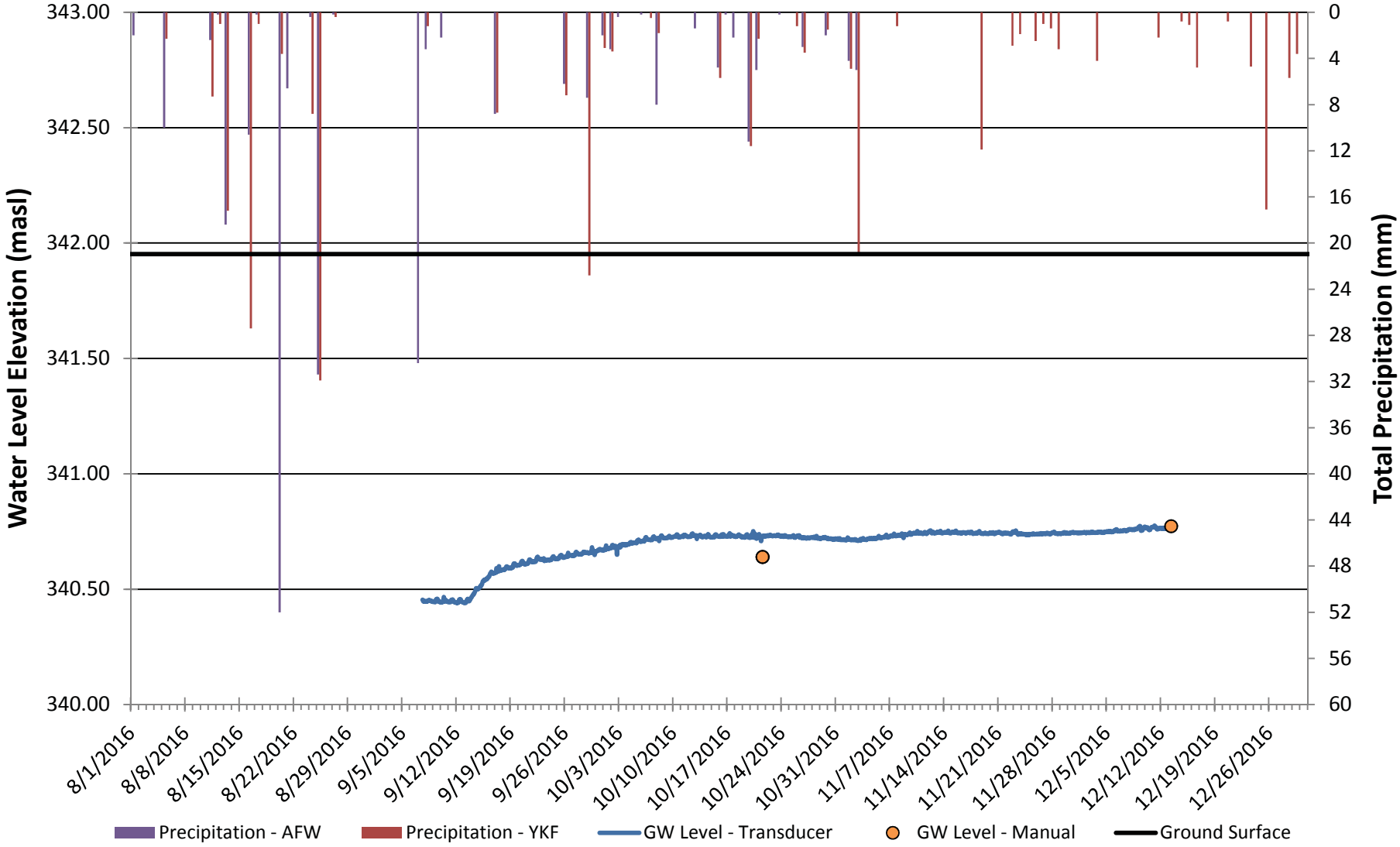
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MW3-11 (132 Clair Rd.)



Well ID	Surveyed Elevations		Total Depth	Screen Top	Screen Bottom
	GS (masl)	TOC (masl)	(masl)	(masl)	(masl)
MW3-11	349.031	349.904	331.23	337.43	331.43

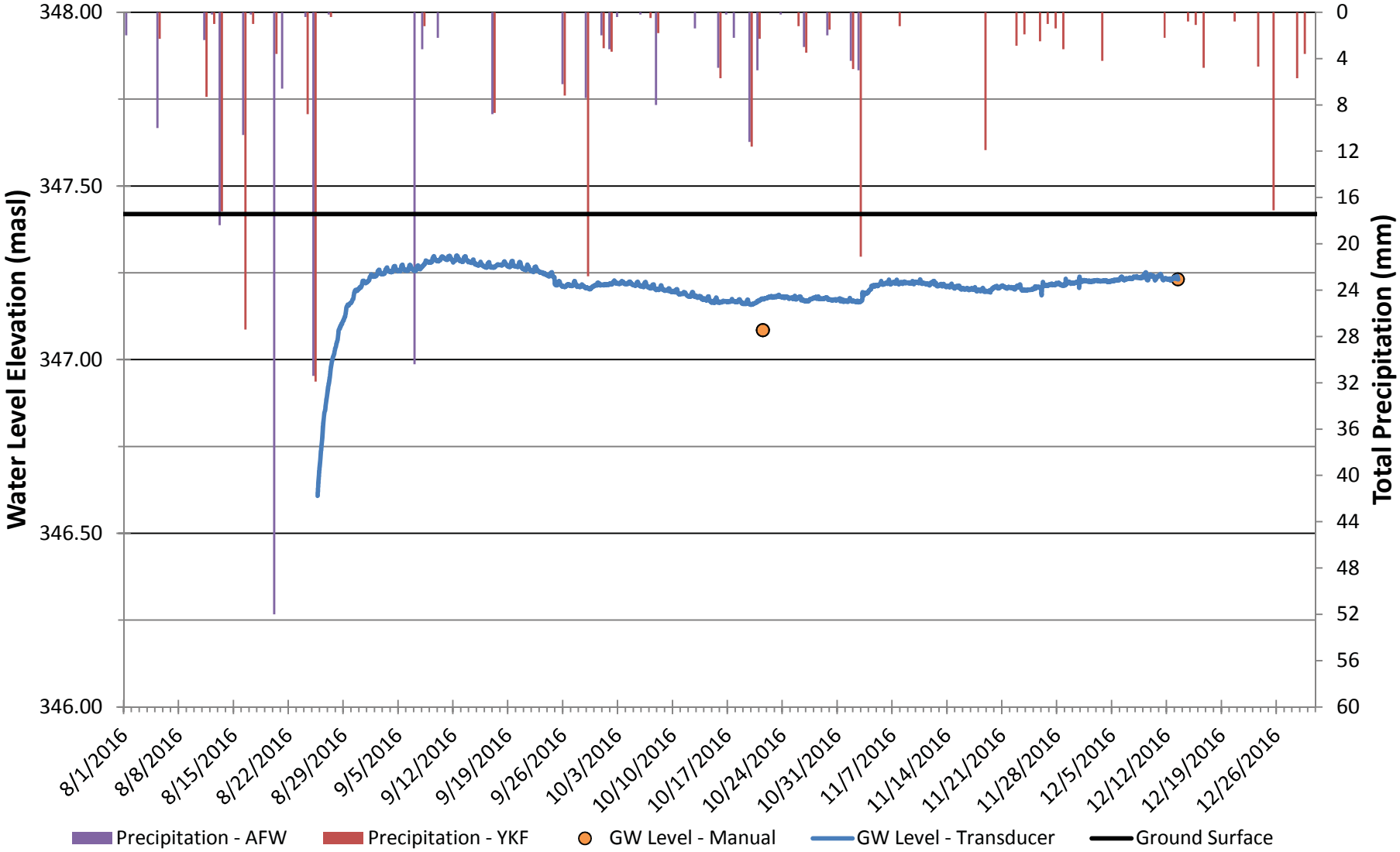
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP1-D



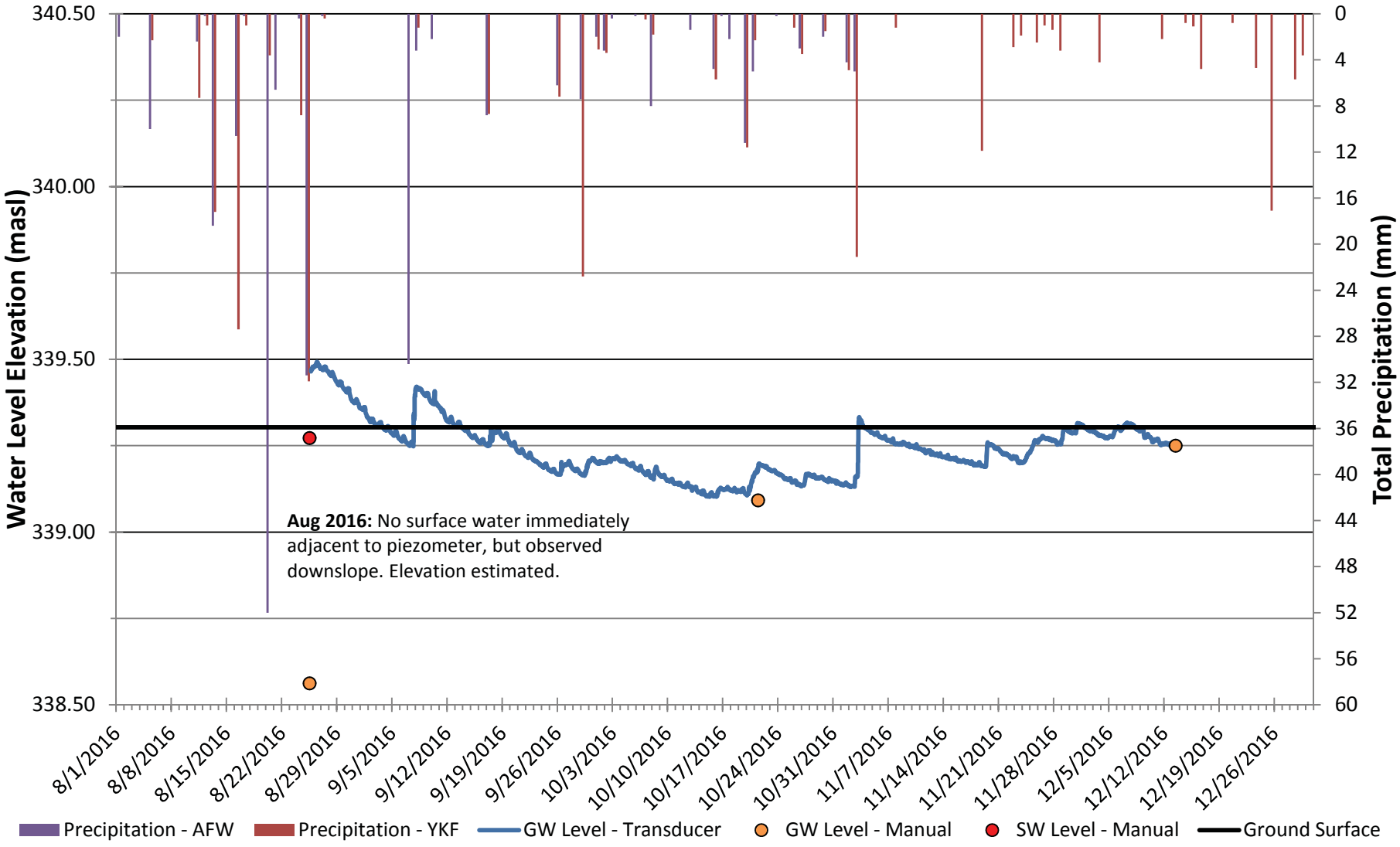
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP3



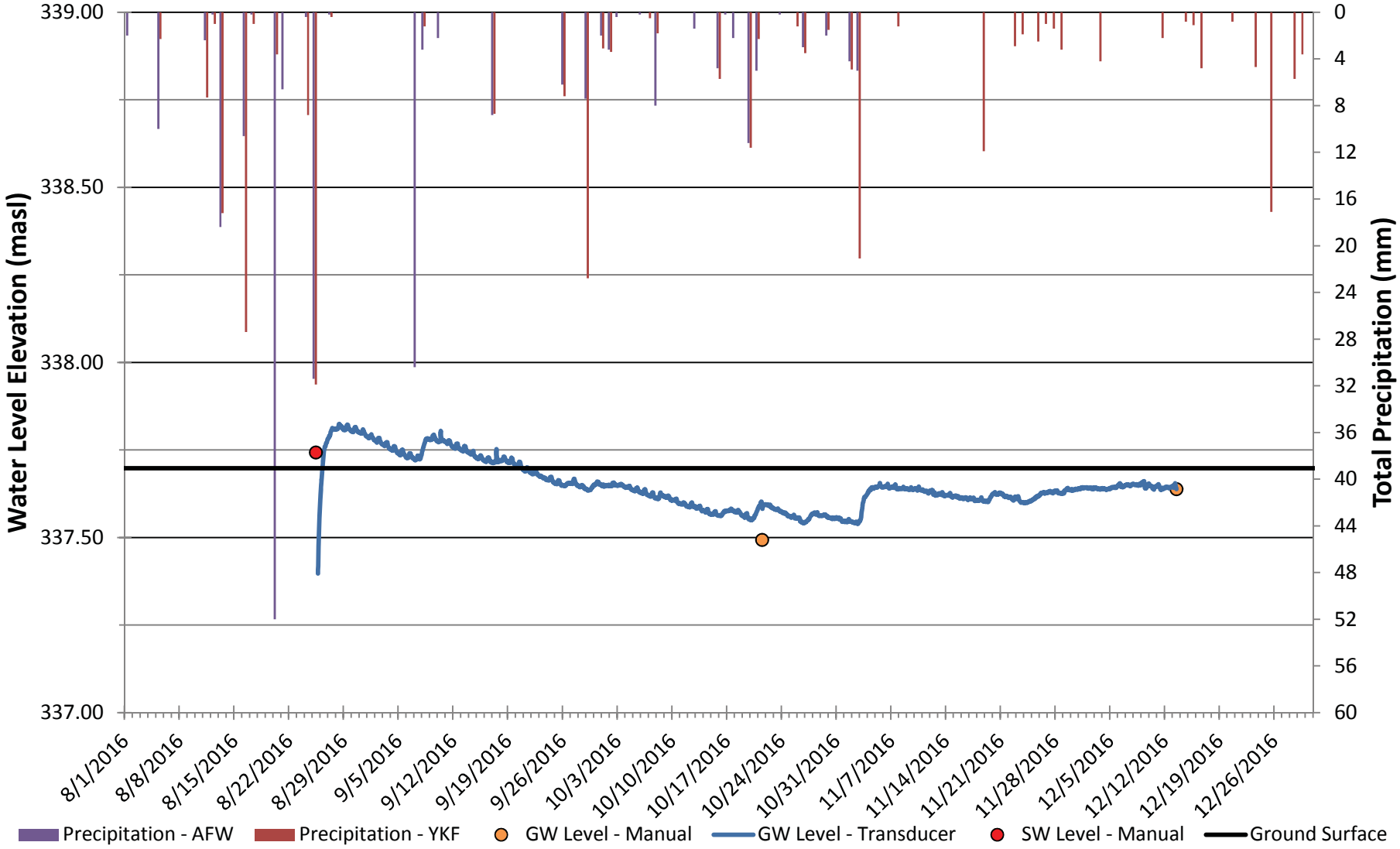
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP4



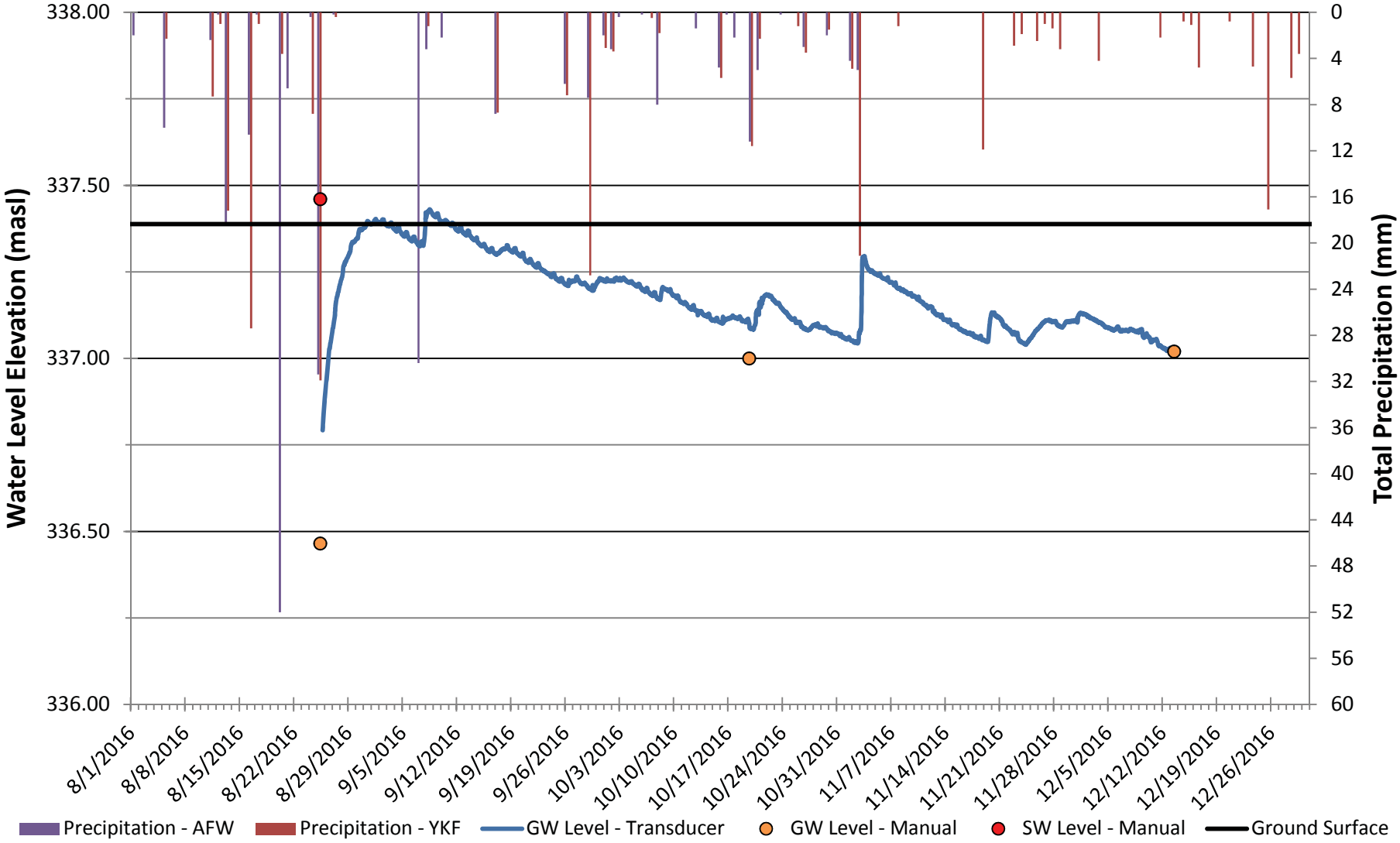
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP5



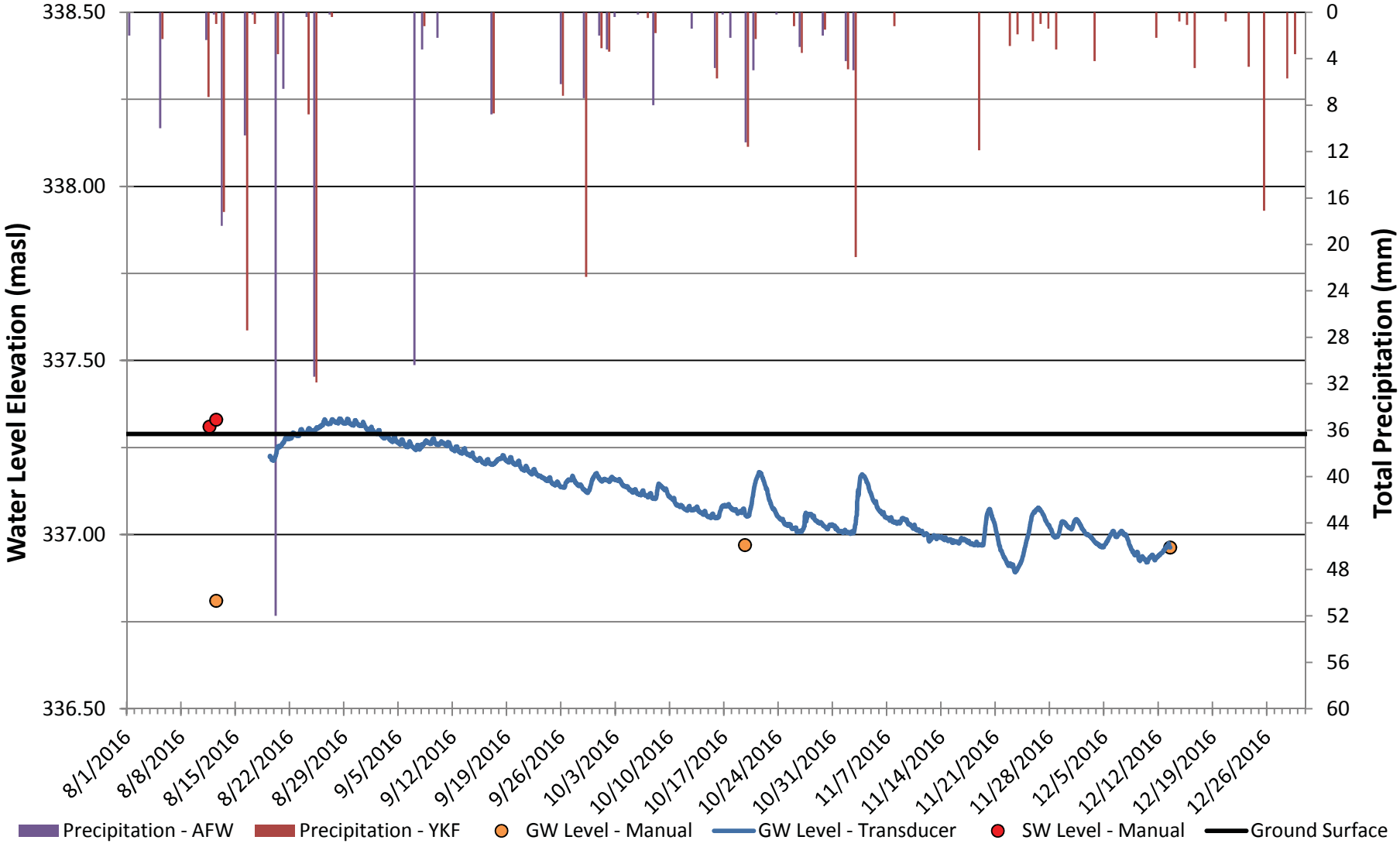
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP6



Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

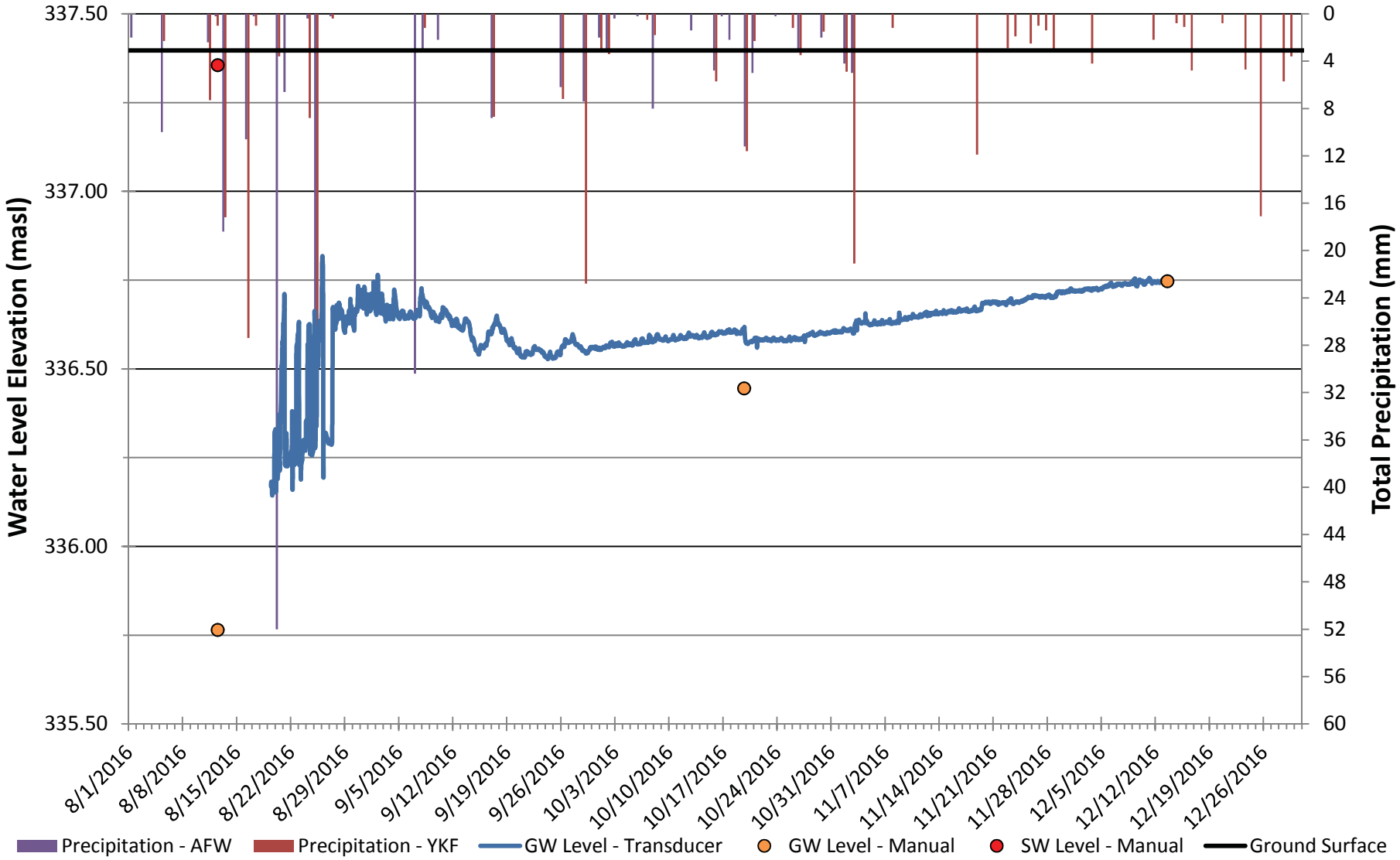
Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP7-S



Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

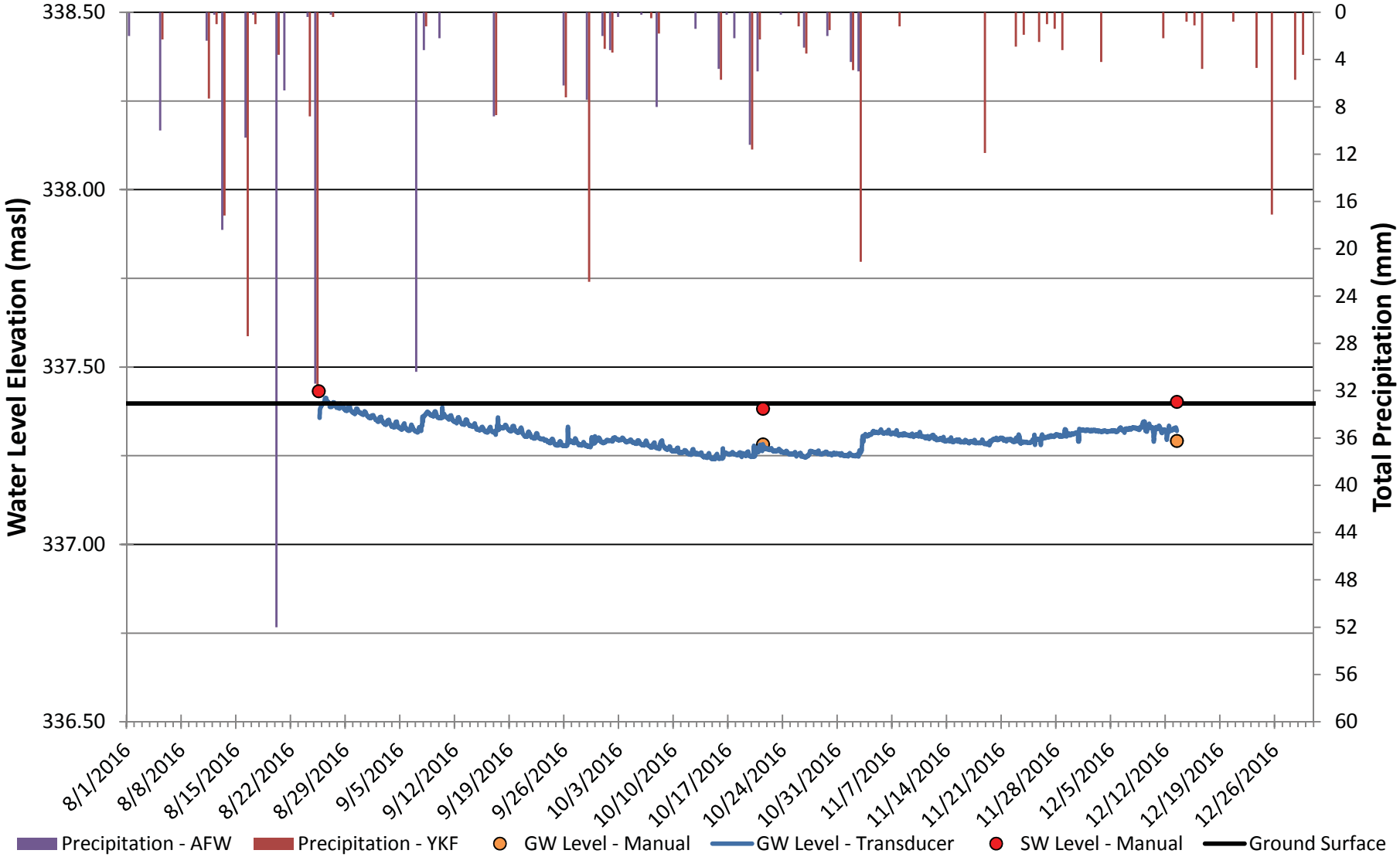
Aug 2016: No surface water immediately adjacent to piezometer, but observed downslope. Elevation estimated.

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP7-D



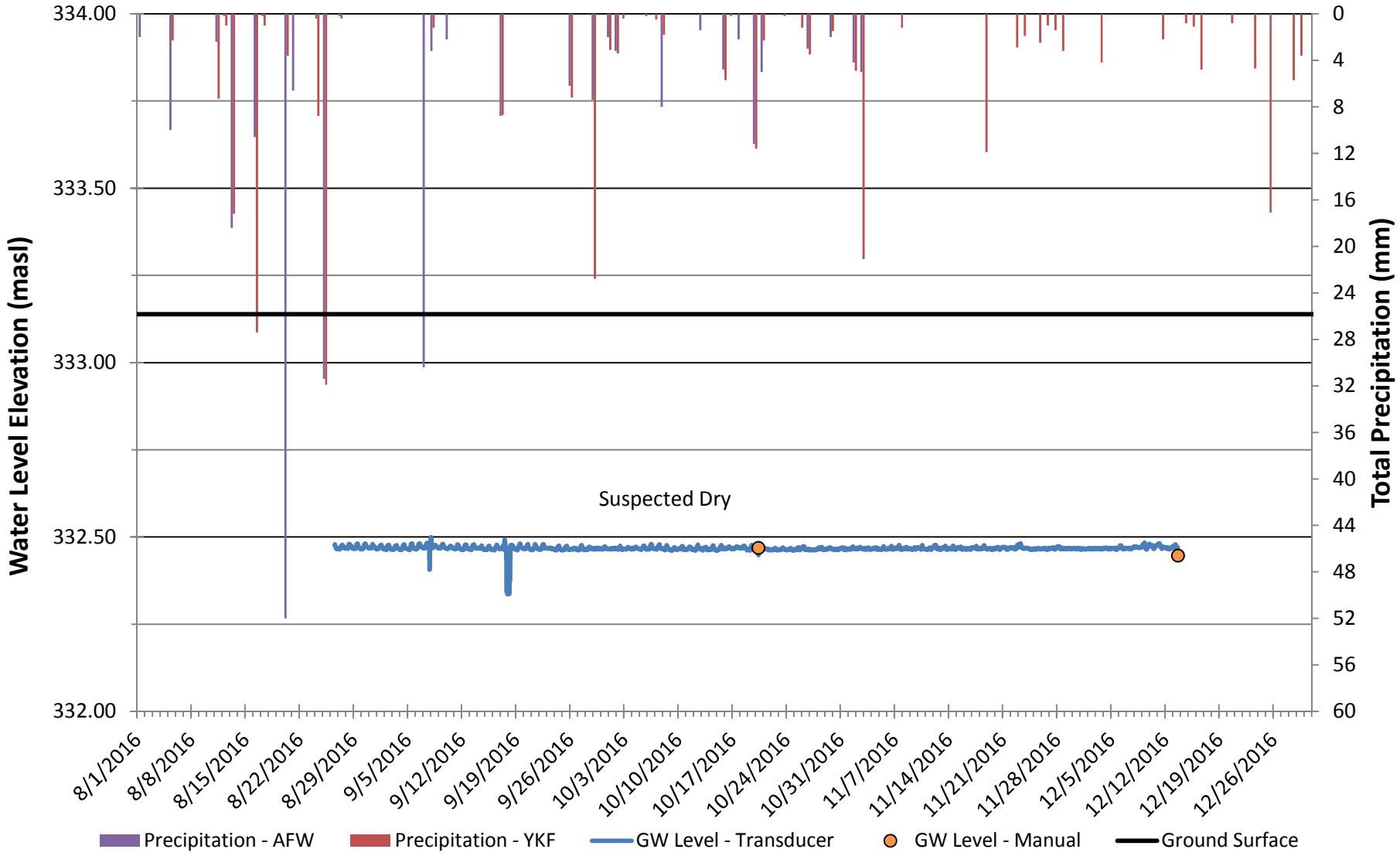
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP8



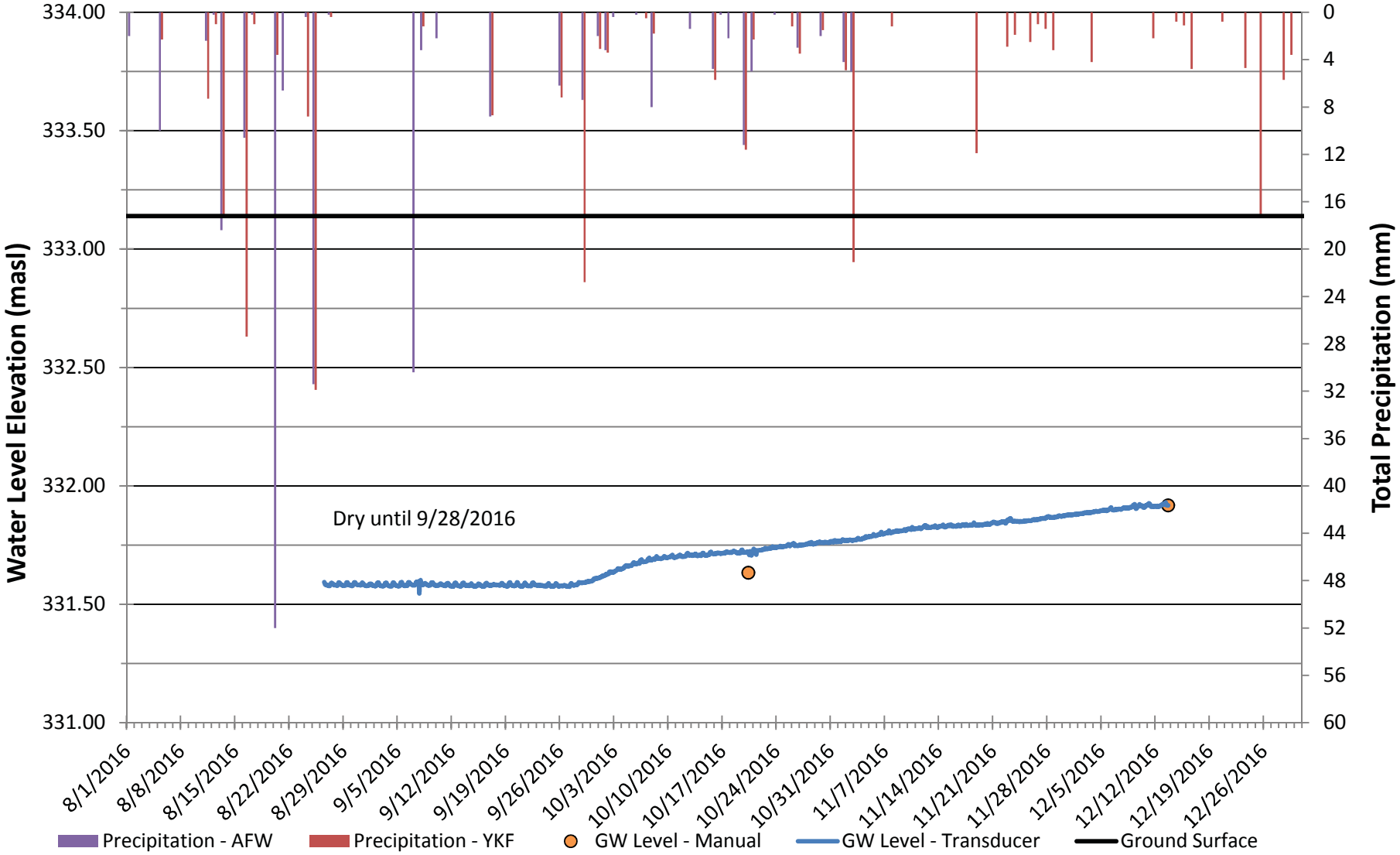
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP9-S



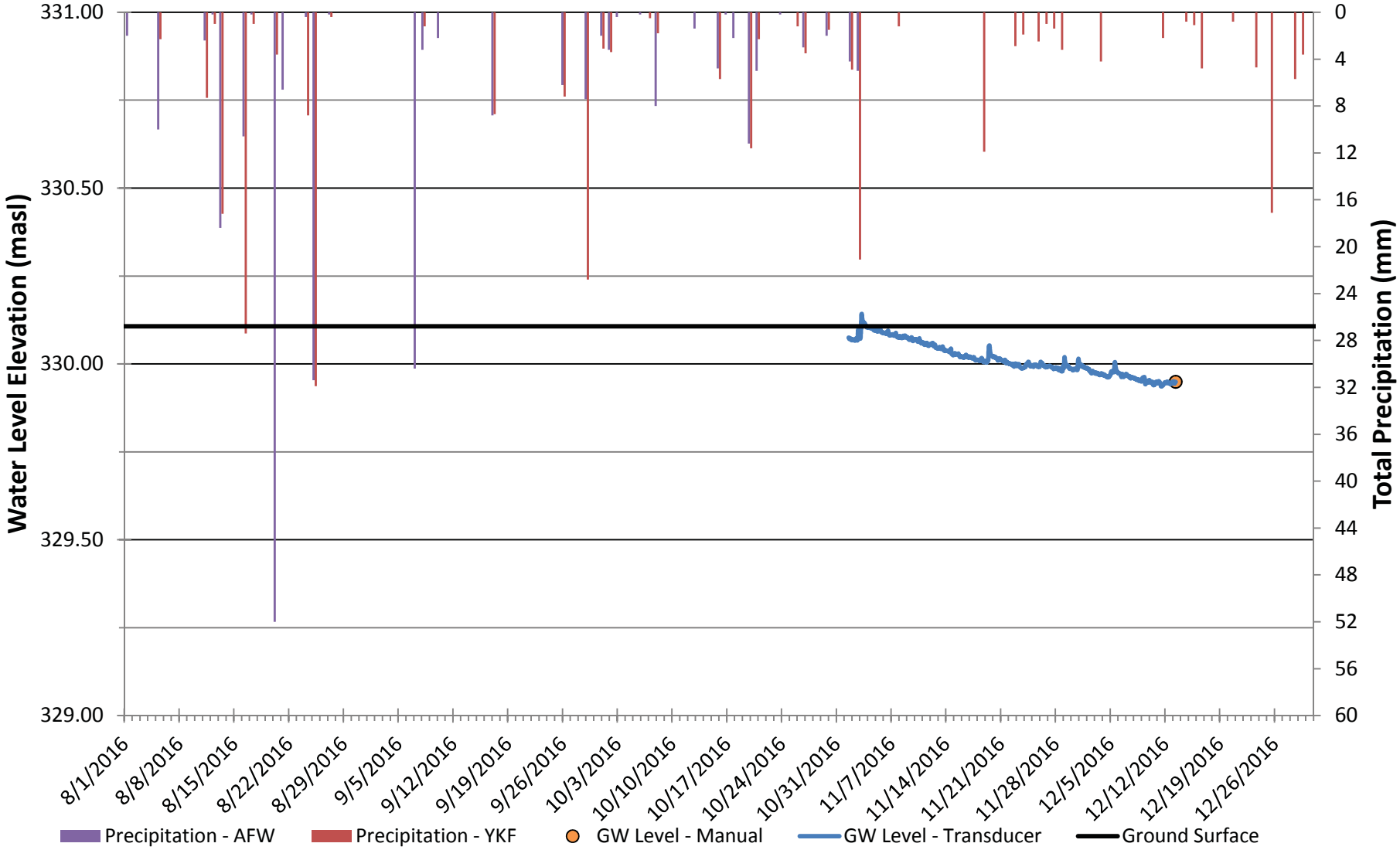
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP9-D



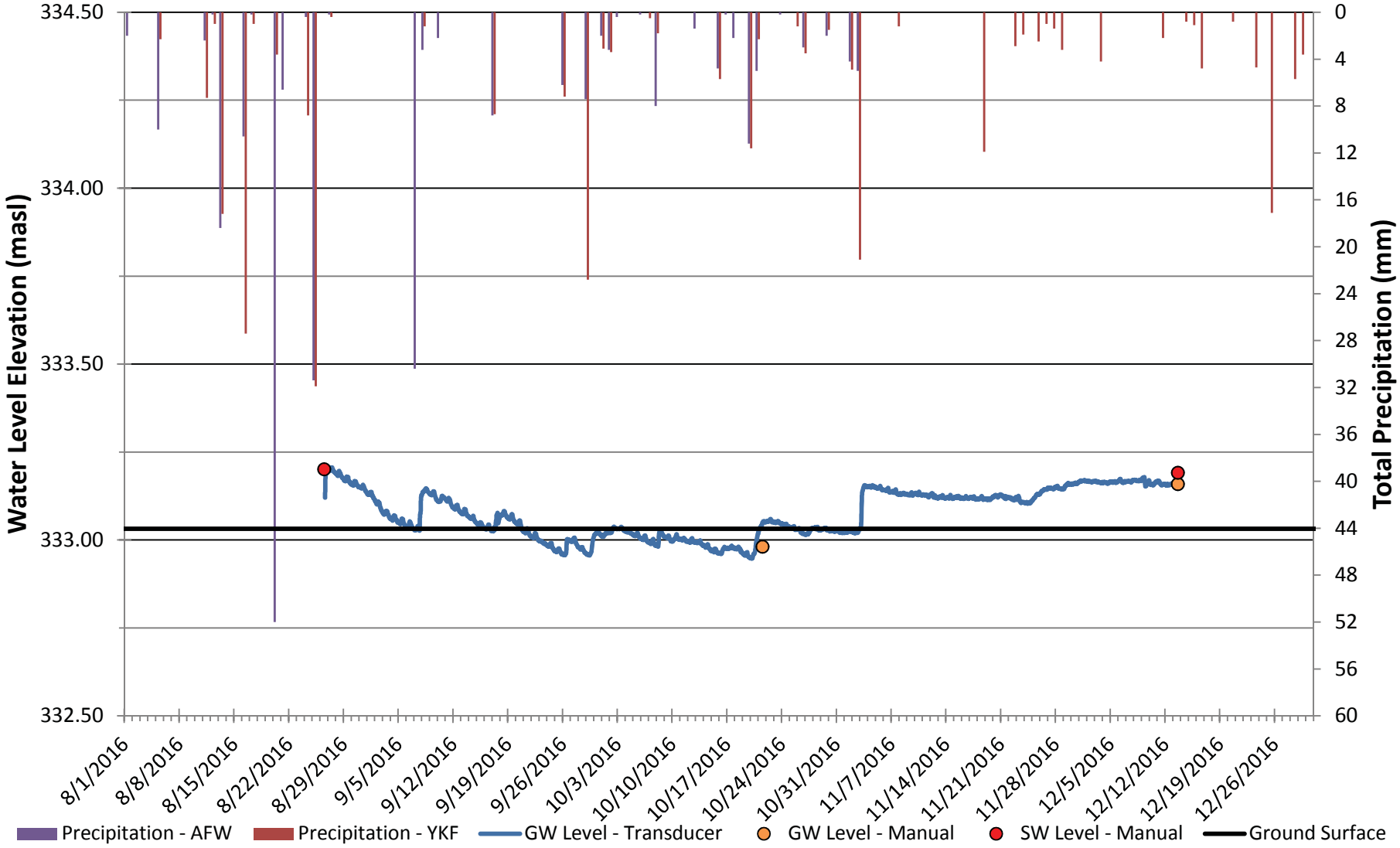
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP10



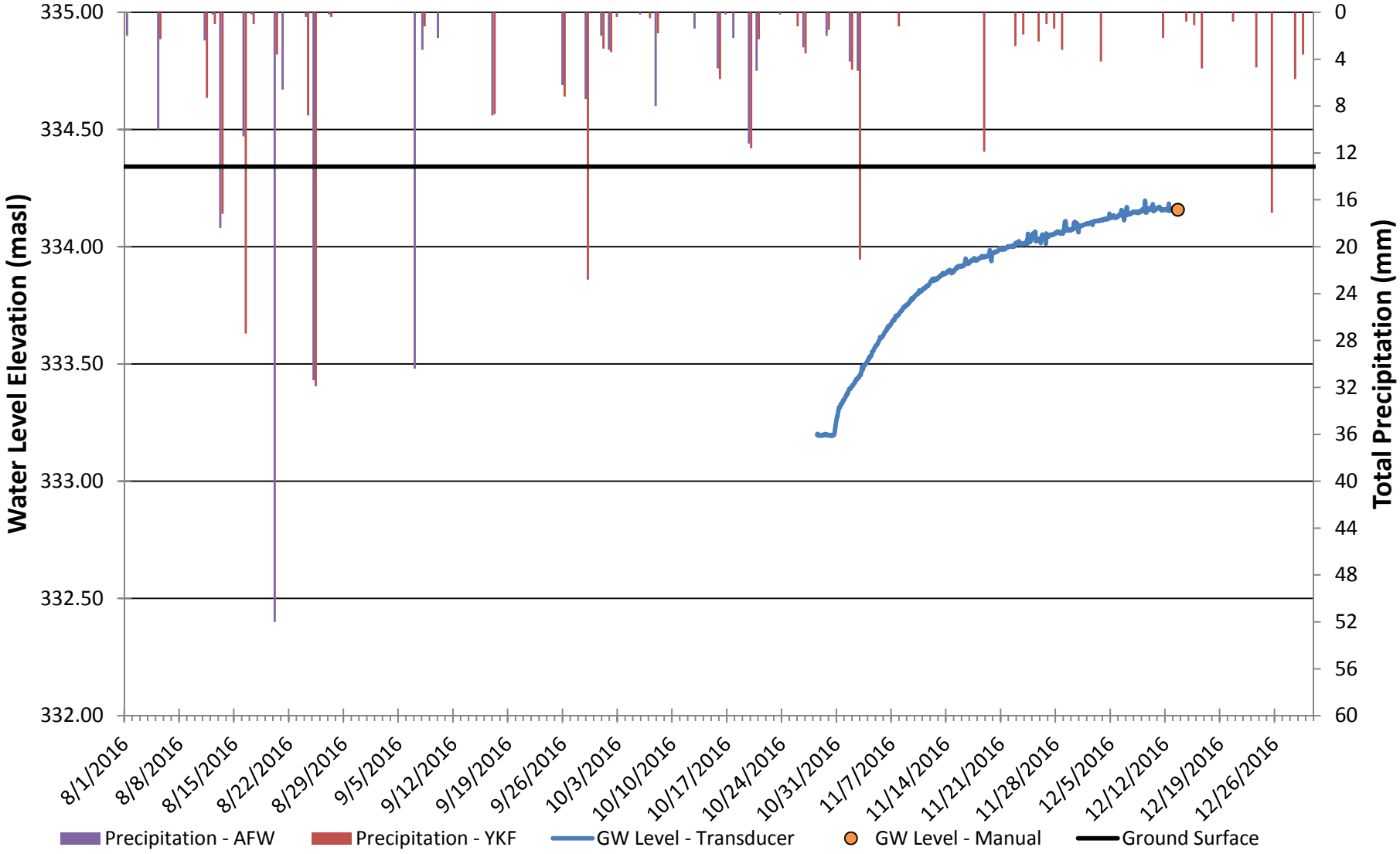
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP11



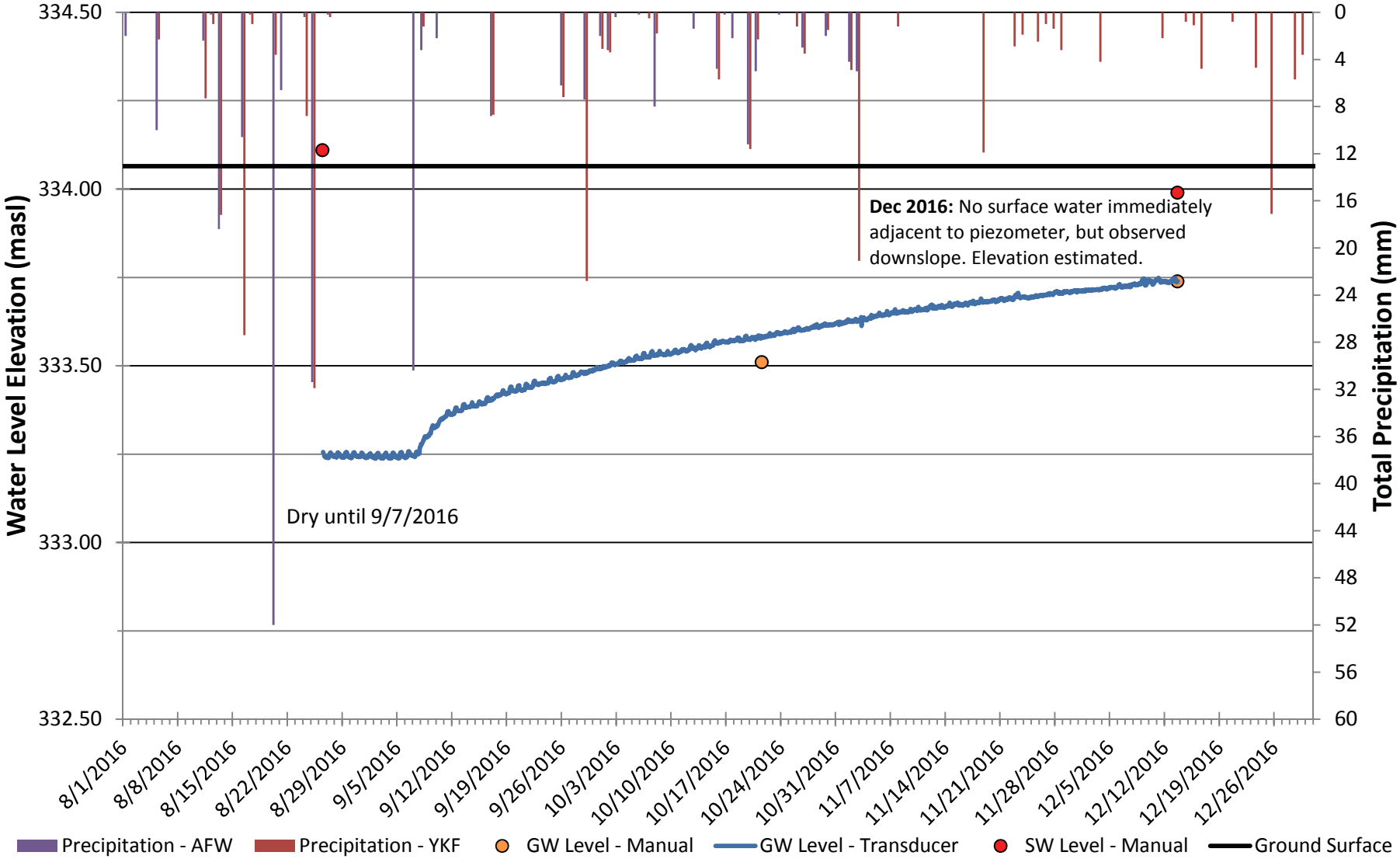
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP12



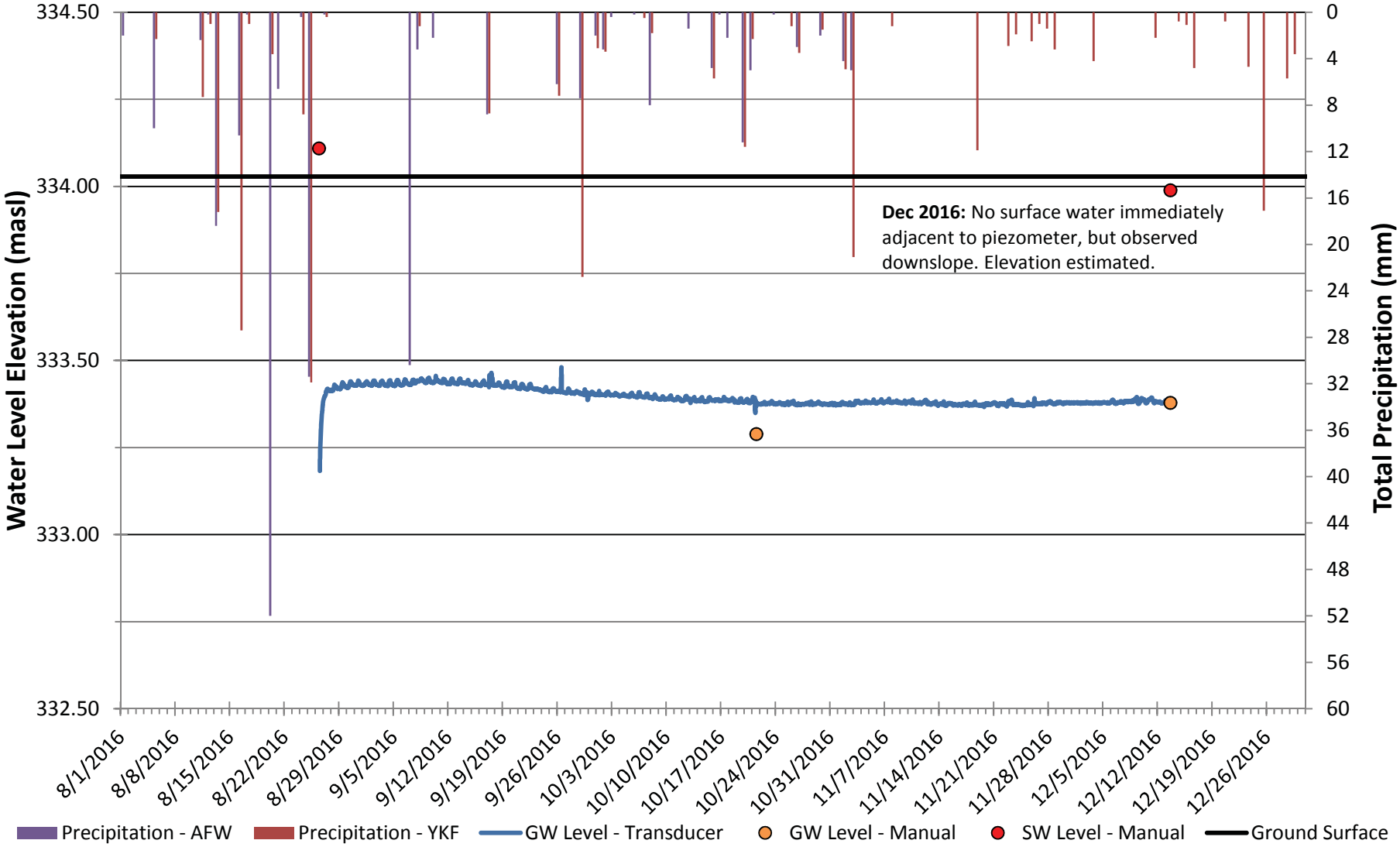
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP13-S



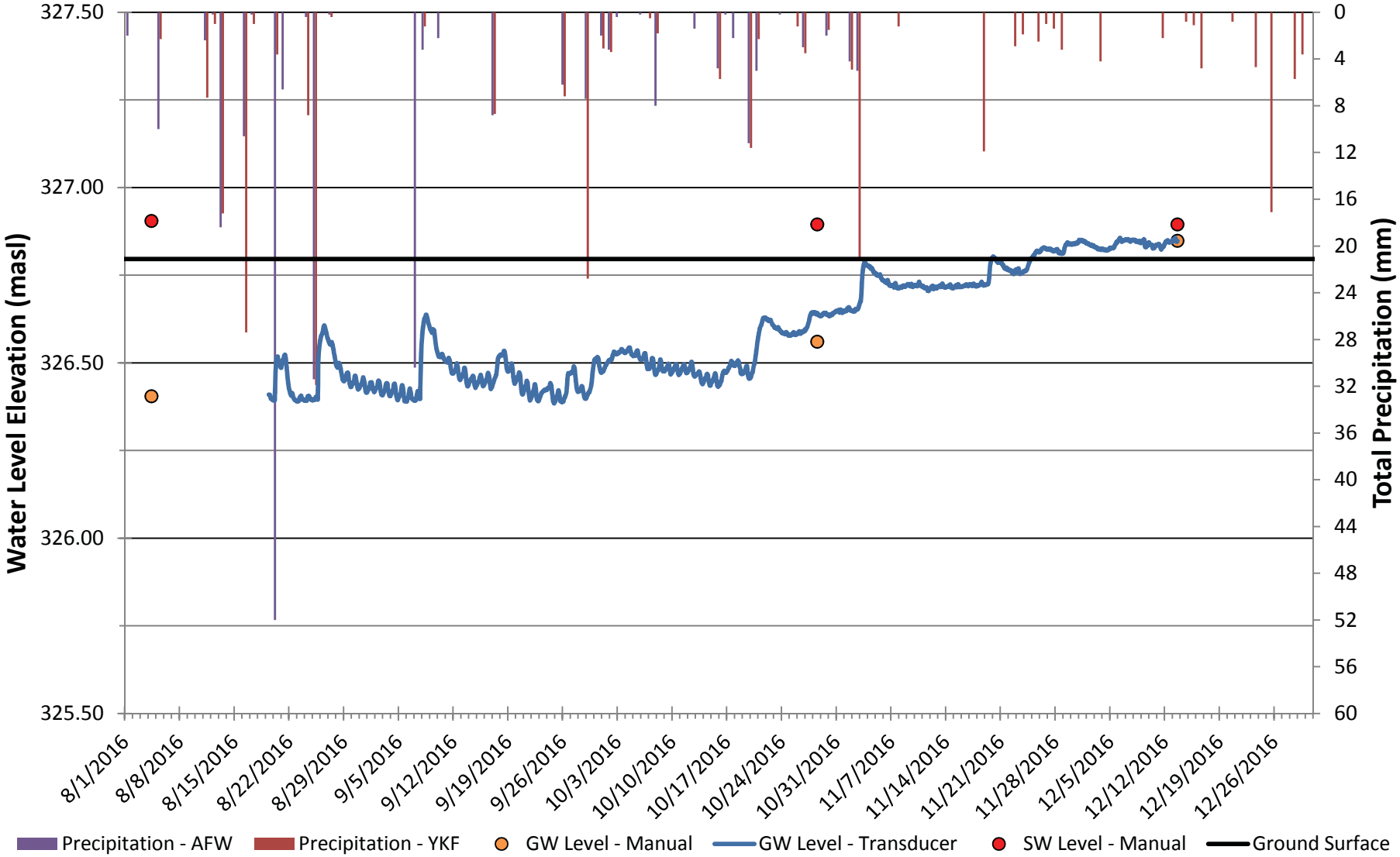
Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP13-D



Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Clair-Maltby Secondary Plan
Long Term Groundwater Level Monitoring
MP14



Precipitation - AFW: Data set from rain gauge installed by AMEC Foster-Wheeler at 500 Maltby Rd. E. **Precipitation - YKF:** Data set from weather station at Region of Waterloo International Airport (YKF).

Appendix B4
Laboratory Certificates of Analysis

MATRIX SOLUTIONS INC.
ATTN: Scott Miller
31 Beacon Point Court
Breslau ON N0B 1M0

Date Received: 19-OCT-16
Report Date: 27-OCT-16 09:12 (MT)
Version: FINAL

Client Phone: 519-772-3777

Certificate of Analysis

Lab Work Order #: L1845890

Project P.O. #: CLAIRE-MALTBY
Job Reference: 23089-528
C of C Numbers: 81837
Legal Site Desc:

Gayle Braun
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1845890-1	L1845890-2	L1845890-3	L1845890-4	L1845890-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	19-OCT-16	19-OCT-16	19-OCT-16	19-OCT-16	19-OCT-16
	Sampled Time	10:30	12:30	12:50	15:30	15:55
	Client ID	23089161019001 MW7	23089161019002 MW8D	23089161019003 MW8S	23089161019004 MW6D	23089161019005 MW6S
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (umhos/cm)	696	1180	569	460	602
	pH (pH units)	7.44 DLDS	7.23 DLDS	7.25 DLDS	7.64 DLDS	7.53 DLDS
	Total Dissolved Solids (mg/L)	386	639	295	259	351
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	276	336	288	229	282
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<10	<10	<10	<10	<10
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<10	<10	<10	<10	<10
	Alkalinity, Total (as CaCO3) (mg/L)	276	336	288	229	282
	Chloride (Cl) (mg/L)	39.6	189 DLDS	14.4	4.32	9.21
	Computed Conductivity (uS/cm)	630	1060	493	416	561
	Conductivity % Difference (%)	-9.8	-10.7	-14.3	-10.0	-7.1
	Hardness (as CaCO3) (mg/L)	325	388	288	213	295
	Ion Balance (%)	109	101	112	112	108
	Langelier Index	0.3	0.3	0.2	0.3	0.4
	Nitrate (as N) (mg/L)	0.318	1.49 DLDS	1.04	<0.020	<0.020
	Nitrite (as N) (mg/L)	0.028	<0.050 DLDS	<0.010	<0.010	<0.010
	Total Kjeldahl Nitrogen (mg/L)	<0.15	0.51	0.76	0.19	0.28
	Saturation pH (pH)	7.11	6.95	7.08	7.35	7.16
	TDS (Calculated) (mg/L)	383	656	303	254	348
	Sulfate (SO4) (mg/L)	47.4	32.0 DLDS	4.79	24.7	55.6
	Anion Sum (me/L)	6.67	11.6	5.31	4.40	6.05
	Cation Sum (me/L)	7.27	11.7	5.96	4.94	6.52
	Cation - Anion Balance (%)	4.3	0.3	5.8	5.7	3.8
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Antimony (Sb)-Dissolved (mg/L)	0.00017	0.00012	0.00036	<0.00010	0.00030
	Arsenic (As)-Dissolved (mg/L)	0.00037	<0.00010	0.00028	0.00166	0.00104
	Barium (Ba)-Dissolved (mg/L)	0.127	0.144	0.0167	0.121	0.124
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.013	0.011	0.012	0.014
	Cadmium (Cd)-Dissolved (mg/L)	0.000015	0.000067	0.000043	<0.000010	<0.000010
	Calcium (Ca)-Dissolved (mg/L)	79.3	105	77.7	50.9	69.2
	Cesium (Cs)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Chromium (Cr)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Cobalt (Co)-Dissolved (mg/L)	0.00062	0.00085	0.00018	0.00013	0.00020
	Copper (Cu)-Dissolved (mg/L)	0.00103	0.00201	0.00158	0.00037	0.00046
	Iron (Fe)-Dissolved (mg/L)	0.024	<0.010	<0.010	0.067	0.012

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1845890-6	L1845890-7			
	Description	WATER	WATER			
	Sampled Date	19-OCT-16	19-OCT-16			
	Sampled Time	17:15	17:30			
	Client ID	23089161019006 MW5S	23089161019007 MW5D			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (umhos/cm)	750	663			
	pH (pH units)	7.17	7.17			
	Total Dissolved Solids (mg/L)	430 DLDS	396 DLDS			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	327	366			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<10	<10			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<10	<10			
	Alkalinity, Total (as CaCO3) (mg/L)	327	366			
	Chloride (Cl) (mg/L)	10.0	11.9			
	Computed Conductivity (uS/cm)	712	617			
	Conductivity % Difference (%)	-5.3	-7.2			
	Hardness (as CaCO3) (mg/L)	410	347			
	Ion Balance (%)	112	101			
	Langelier Index	0.2	0.3			
	Nitrate (as N) (mg/L)	0.429	<0.020			
	Nitrite (as N) (mg/L)	0.056	<0.010			
	Total Kjeldahl Nitrogen (mg/L)	0.62	4.1 DLM			
	Saturation pH (pH)	6.94	6.92			
	TDS (Calculated) (mg/L)	446	394			
	Sulfate (SO4) (mg/L)	89.4	36.0			
	Anion Sum (me/L)	7.54	7.09			
	Cation Sum (me/L)	8.48	7.16			
	Cation - Anion Balance (%)	5.9	0.4			
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	<0.0050	<0.0050			
	Antimony (Sb)-Dissolved (mg/L)	0.00041	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00333	0.00080			
	Barium (Ba)-Dissolved (mg/L)	0.126	0.145			
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	0.000019	<0.000010			
	Calcium (Ca)-Dissolved (mg/L)	105	94.3			
	Cesium (Cs)-Dissolved (mg/L)	<0.000010	0.000011			
	Chromium (Cr)-Dissolved (mg/L)	<0.00050	<0.00050			
	Cobalt (Co)-Dissolved (mg/L)	0.00092	0.00011			
	Copper (Cu)-Dissolved (mg/L)	0.00046	<0.00020			
	Iron (Fe)-Dissolved (mg/L)	0.346	2.25			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1845890-1	L1845890-2	L1845890-3	L1845890-4	L1845890-5
Description	WATER	WATER	WATER	WATER	WATER
Sampled Date	19-OCT-16	19-OCT-16	19-OCT-16	19-OCT-16	19-OCT-16
Sampled Time	10:30	12:30	12:50	15:30	15:55
Client ID	23089161019001 MW7	23089161019002 MW8D	23089161019003 MW8S	23089161019004 MW6D	23089161019005 MW6S
Grouping **Analyte**					
WATER					
Dissolved Metals Lead (Pb)-Dissolved (mg/L)	0.000155	0.000614	0.000051	<0.000050	<0.000050
Lithium (Li)-Dissolved (mg/L)	0.0032	0.0034	<0.0010	0.0027	0.0017
Magnesium (Mg)-Dissolved (mg/L)	30.7	30.5	22.8	20.8	29.7
Manganese (Mn)-Dissolved (mg/L)	0.0787	0.0434	0.00707	0.0154	0.0453
Molybdenum (Mo)-Dissolved (mg/L)	0.00118	0.000662	0.000655	0.00230	0.00323
Nickel (Ni)-Dissolved (mg/L)	0.00174	0.00310	0.00945	<0.00050	<0.00050
Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
Potassium (K)-Dissolved (mg/L)	1.55	3.18	1.29	1.28	2.20
Rubidium (Rb)-Dissolved (mg/L)	0.00127	0.00225	0.00069	0.00075	0.00159
Selenium (Se)-Dissolved (mg/L)	0.000098	0.000251	0.000132	<0.000050	0.000053
Silicon (Si)-Dissolved (mg/L)	6.12	5.51	3.66	6.43	4.20
Silver (Ag)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Sodium (Na)-Dissolved (mg/L)	17.1	88.3	4.17	15.1	13.0
Strontium (Sr)-Dissolved (mg/L)	0.114	0.180	0.115	0.123	0.256
Sulfur (S)-Dissolved (mg/L)	15.5	10.9	1.48	8.63	18.1
Tellurium (Te)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Dissolved (mg/L)	0.000018	0.000048	<0.000010	<0.000010	<0.000010
Thorium (Th)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Tin (Sn)-Dissolved (mg/L)	0.00055	<0.00010	0.00123	0.00016	0.00061
Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Tungsten (W)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Uranium (U)-Dissolved (mg/L)	0.00148	0.000649	0.000231	0.00202	0.00545
Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved (mg/L)	0.0149	0.192	0.0101	0.0038	0.0509
Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1845890-6	L1845890-7			
	Description	WATER	WATER			
	Sampled Date	19-OCT-16	19-OCT-16			
	Sampled Time	17:15	17:30			
	Client ID	23089161019006 MW5S	23089161019007 MW5D			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Lead (Pb)-Dissolved (mg/L)	0.000154	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0043	0.0018			
	Magnesium (Mg)-Dissolved (mg/L)	35.8	27.0			
	Manganese (Mn)-Dissolved (mg/L)	0.159	0.0829			
	Molybdenum (Mo)-Dissolved (mg/L)	0.0235	0.000176			
	Nickel (Ni)-Dissolved (mg/L)	0.00372	0.00090			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	1.63	0.837			
	Rubidium (Rb)-Dissolved (mg/L)	0.00240	0.00075			
	Selenium (Se)-Dissolved (mg/L)	0.000167	<0.000050			
	Silicon (Si)-Dissolved (mg/L)	4.01	9.08			
	Silver (Ag)-Dissolved (mg/L)	<0.000050	<0.000050			
	Sodium (Na)-Dissolved (mg/L)	5.53	4.71			
	Strontium (Sr)-Dissolved (mg/L)	0.143	0.135			
	Sulfur (S)-Dissolved (mg/L)	31.0	11.6			
	Tellurium (Te)-Dissolved (mg/L)	<0.00020	<0.00020			
	Thallium (Tl)-Dissolved (mg/L)	0.000020	<0.000010			
	Thorium (Th)-Dissolved (mg/L)	<0.00010	<0.00010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00038			
	Tungsten (W)-Dissolved (mg/L)	<0.00010	<0.00010			
	Uranium (U)-Dissolved (mg/L)	0.0240	0.000113			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00062			
	Zinc (Zn)-Dissolved (mg/L)	0.0276	0.0019			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00051			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfate (SO4)	MS-B	L1845890-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-SPEC-WT	Water	Speciated Alkalinity	EPA 310.2
CL-IC-WT	Water	Chloride by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
EC-WT	Water	Conductivity	APHA 2510 B
Water samples can be measured directly by immersing the conductivity cell into the sample.			
IONBALANCE-OP03-WT	Water	Detailed Ion Balance Calculation	APHA 1030E, 2330B, 2510A
MET-D-CCMS-WT	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).			
NO2-IC-WT	Water	Nitrite in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
NO3-IC-WT	Water	Nitrate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
PH-ALK-WT	Water	pH	APHA 4500 H-Electrode
Water samples are analyzed directly by a calibrated pH meter.			
SO4-IC-N-WT	Water	Sulfate in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
SOLIDS-TDS-WT	Water	Total Dissolved Solids	APHA 2540C
A well-mixed sample is filtered though glass fibres filter. A known volume of the filtrate is evaporated and dried at 105–5°C overnight and then 180–10°C for 1hr.			
TKN-WT	Water	Total Kjeldahl Nitrogen	APHA 4500-N
Sample is digested to convert the TKN to ammonium sulphate. The ammonia ions are heated to produce a colour complex. The absorbance measured by the instrument is proportional to the concentration of ammonium sulphate in the sample and is reported as TKN.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

81837

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: MATRIX SOLUTIONS INC.
31 Beacon Point Court
Breslau ON N0B 1M0
Contact: Scott Miller

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-SPEC-WT	**Water**							
Batch R3576806								
WG2415367-3 CRM		**WT-ALK-CRM**						
Alkalinity, Total (as CaCO3)			102.8		%		80-120	20-OCT-16
WG2415367-2 LCS								
Alkalinity, Total (as CaCO3)			102.5		%		85-115	20-OCT-16
WG2415367-1 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	20-OCT-16
CL-IC-WT	**Water**							
Batch R3579307								
WG2415943-12 LCS								
Chloride (Cl)			100.7		%		70-130	23-OCT-16
WG2415943-7 LCS								
Chloride (Cl)			101.0		%		70-130	23-OCT-16
WG2415943-11 MB								
Chloride (Cl)			<0.50		mg/L		0.5	23-OCT-16
WG2415943-6 MB								
Chloride (Cl)			<0.50		mg/L		0.5	23-OCT-16
EC-WT	**Water**							
Batch R3575583								
WG2414036-14 LCS								
Conductivity			102.1		%		90-110	20-OCT-16
WG2414036-13 MB								
Conductivity			<3.0		umhos/cm		3	20-OCT-16
MET-D-CCMS-WT	**Water**							
Batch R3576471								
WG2415171-2 LCS								
Aluminum (Al)-Dissolved			97.1		%		80-120	20-OCT-16
Antimony (Sb)-Dissolved			97.4		%		80-120	20-OCT-16
Arsenic (As)-Dissolved			96.9		%		80-120	20-OCT-16
Barium (Ba)-Dissolved			101.5		%		80-120	20-OCT-16
Beryllium (Be)-Dissolved			95.4		%		80-120	20-OCT-16
Bismuth (Bi)-Dissolved			101.0		%		80-120	20-OCT-16
Boron (B)-Dissolved			93.5		%		80-120	20-OCT-16
Cadmium (Cd)-Dissolved			95.4		%		80-120	20-OCT-16
Calcium (Ca)-Dissolved			97.3		%		80-120	20-OCT-16
Cesium (Cs)-Dissolved			97.2		%		80-120	20-OCT-16
Chromium (Cr)-Dissolved			95.8		%		80-120	20-OCT-16
Cobalt (Co)-Dissolved			96.3		%		80-120	20-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3576471								
WG2415171-2 LCS								
Copper (Cu)-Dissolved			96.5		%		80-120	20-OCT-16
Iron (Fe)-Dissolved			93.5		%		80-120	20-OCT-16
Lead (Pb)-Dissolved			97.6		%		80-120	20-OCT-16
Lithium (Li)-Dissolved			93.9		%		80-120	20-OCT-16
Magnesium (Mg)-Dissolved			96.9		%		80-120	20-OCT-16
Manganese (Mn)-Dissolved			97.5		%		80-120	20-OCT-16
Molybdenum (Mo)-Dissolved			94.4		%		80-120	20-OCT-16
Nickel (Ni)-Dissolved			96.2		%		80-120	20-OCT-16
Phosphorus (P)-Dissolved			92.5		%		80-120	20-OCT-16
Potassium (K)-Dissolved			97.0		%		80-120	20-OCT-16
Rubidium (Rb)-Dissolved			101.7		%		80-120	20-OCT-16
Selenium (Se)-Dissolved			95.6		%		80-120	21-OCT-16
Silicon (Si)-Dissolved			101.3		%		80-120	20-OCT-16
Silver (Ag)-Dissolved			100.8		%		80-120	21-OCT-16
Sodium (Na)-Dissolved			97.5		%		80-120	20-OCT-16
Strontium (Sr)-Dissolved			99.8		%		80-120	20-OCT-16
Sulfur (S)-Dissolved			96.0		%		80-120	20-OCT-16
Tellurium (Te)-Dissolved			96.3		%		80-120	20-OCT-16
Thallium (Tl)-Dissolved			96.0		%		80-120	20-OCT-16
Thorium (Th)-Dissolved			94.6		%		80-120	20-OCT-16
Tin (Sn)-Dissolved			94.1		%		80-120	20-OCT-16
Titanium (Ti)-Dissolved			95.9		%		80-120	20-OCT-16
Tungsten (W)-Dissolved			97.5		%		80-120	20-OCT-16
Uranium (U)-Dissolved			99.2		%		80-120	20-OCT-16
Vanadium (V)-Dissolved			97.5		%		80-120	20-OCT-16
Zinc (Zn)-Dissolved			91.7		%		80-120	20-OCT-16
Zirconium (Zr)-Dissolved			91.4		%		80-120	20-OCT-16
WG2415171-1 MB								
Aluminum (Al)-Dissolved			<0.0050		mg/L		0.005	20-OCT-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	20-OCT-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	20-OCT-16
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	20-OCT-16
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	20-OCT-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	20-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3576471								
WG2415171-1 MB								
Boron (B)-Dissolved			<0.010		mg/L		0.01	20-OCT-16
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	20-OCT-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	20-OCT-16
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	20-OCT-16
Chromium (Cr)-Dissolved			<0.00050		mg/L		0.0005	20-OCT-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	20-OCT-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	20-OCT-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	20-OCT-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	20-OCT-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	20-OCT-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	20-OCT-16
Manganese (Mn)-Dissolved			<0.00050		mg/L		0.0005	20-OCT-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	20-OCT-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	20-OCT-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	20-OCT-16
Potassium (K)-Dissolved			<0.050		mg/L		0.05	20-OCT-16
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	20-OCT-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	21-OCT-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	20-OCT-16
Silver (Ag)-Dissolved			<0.000050		mg/L		0.00005	21-OCT-16
Sodium (Na)-Dissolved			<0.50		mg/L		0.5	20-OCT-16
Strontium (Sr)-Dissolved			<0.0010		mg/L		0.001	20-OCT-16
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	20-OCT-16
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	20-OCT-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	20-OCT-16
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	20-OCT-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	20-OCT-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	20-OCT-16
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	20-OCT-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	20-OCT-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	20-OCT-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	20-OCT-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	20-OCT-16
NO2-IC-WT	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-WT	**Water**							
Batch R3579307								
WG2415943-12 LCS								
Nitrite (as N)			103.5		%		70-130	23-OCT-16
WG2415943-7 LCS								
Nitrite (as N)			104.0		%		70-130	23-OCT-16
WG2415943-11 MB								
Nitrite (as N)			<0.010		mg/L		0.01	23-OCT-16
WG2415943-6 MB								
Nitrite (as N)			<0.010		mg/L		0.01	23-OCT-16
NO3-IC-WT	**Water**							
Batch R3579307								
WG2415943-12 LCS								
Nitrate (as N)			100.2		%		70-130	23-OCT-16
WG2415943-7 LCS								
Nitrate (as N)			100.5		%		70-130	23-OCT-16
WG2415943-11 MB								
Nitrate (as N)			<0.020		mg/L		0.02	23-OCT-16
WG2415943-6 MB								
Nitrate (as N)			<0.020		mg/L		0.02	23-OCT-16
PH-ALK-WT	**Water**							
Batch R3575575								
WG2414537-10 LCS								
pH			6.97		pH units		6.9-7.1	20-OCT-16
SO4-IC-N-WT	**Water**							
Batch R3579307								
WG2415943-12 LCS								
Sulfate (SO4)			100.8		%		90-110	23-OCT-16
WG2415943-7 LCS								
Sulfate (SO4)			100.6		%		90-110	23-OCT-16
WG2415943-11 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	23-OCT-16
WG2415943-6 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	23-OCT-16
SOLIDS-TDS-WT	**Water**							
Batch R3580302								
WG2418394-2 LCS								
Total Dissolved Solids			95.4		%		85-115	25-OCT-16
WG2418394-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SOLIDS-TDS-WT	**Water**							
Batch R3580302								
WG2418394-1 MB								
Total Dissolved Solids			<10		mg/L		10	25-OCT-16
TKN-WT	**Water**							
Batch R3577223								
WG2415564-2 LCS								
Total Kjeldahl Nitrogen			98.3		%		75-125	21-OCT-16
WG2415564-1 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	21-OCT-16

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1845890 ESmith 28 19-Oct-16 19D

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

COC # M 81837

Page: 1 of 1

Lab Submitted to: ALS Waterloo
Lab Agreement no: Q58595
Lab Job ID:

Invoice to: Require Report: Y ✓ N

Company Name: MATRIX SOLUTIONS
Contact Name: Scott Miller
Address: 31 Beaver Point Court
Bracebridge ON PC:
Phone / Fax#: Ph: Fax:

Copy of Report to:
Matrix Solutions - Data Management
Suite 200, 150 - 13th Avenue SW
Calgary, Alberta, Canada
T2R 0V2
Ph: 403-237-0606 Fax: 403-263-2493
Fax draft copy of invoice to Matrix Solutions Inc.

Matrix Project #: 23089-528
Matrix Proj. Name: Claire-Maltby
Location:
Sampler's Name(s): S. Miller

AFE #:

REGULATORY REQUIREMENTS: (check)
- [ ] Alberta Tier 1
- [ ] SPIGEC
- [ ] Freshwater Aquatic Life (Low Level Metals)
- [ ] Canadian Drinking Water
- [ ] BC Regs
- [ ] Other: 149006.02.03

SERVICE REQUESTED:
- [ ] RUSH (Please ensure you contact the lab) Due Date:
- [x] REGULAR Turnaround

REPORT DISTRIBUTION: always send to data_management@matrix-solutions.com
- [ ] Additional Emails: SMiller@matrix-solutions.com

	Sample Number (14 digits only) yr-mth-day	Sample Point Name	Depth (cm)	Sample Type	Date/Time Sampled	Quantity # of Jars	Quantity # of Bags	Analysis Required: Q58595	Lab Sample Number
1	23089161019001	MW7	—	Water	Oct 19 10:30	3	—	X	1
2	002	MW8D	—		12:30	3	—	X	2
3	003	MW8S	—		12:50	3	—	X	3
4	004	MW6D	—		15:30	3	—	X	4
5	005	MW6S	—		15:55	3	—	X	5
6	006	MW5S	—		17:15	3	—	X	6
7	23089161019 007	MW5D	—		Oct 19 17:30	3	—	X	7
8									
9									
10									
11									
12									
13									
14									
15									

L1845890-COFC

*For metals in water samples indicate if you want Total (T), Dissolved (D) or Extractable (E) as part of "Analysis Required" Preserved/Filtered

Relinquished by: Scott Miller Date/Time: Oct 19/16 19:30
Signature:
Received by: ELS Date/Time: Oct 19/2016 19:35
Signature:

COMMENTS/SPECIAL INSTRUCTIONS
Call Scott with any questions 403 589 1599
See Quote Q58595 / Metals are dissolved & field filtered

TEMP on arrival: 8.7 ECS.

MATRIX SOLUTIONS INC.
ATTN: Scott Miller
31 Beacon Point Court
Breslau ON N0B 1M0

Date Received: 20-OCT-16
Report Date: 28-OCT-16 14:49 (MT)
Version: FINAL

Client Phone: 519-772-3777

Certificate of Analysis

Lab Work Order #: L1846629

Project P.O. #: NOT SUBMITTED
Job Reference: 23089-528 CLAIRE-MALTBY
C of C Numbers:
Legal Site Desc:

Gayle Braun
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1846629-1	L1846629-2	L1846629-3	L1846629-4	L1846629-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	20-OCT-16	20-OCT-16	20-OCT-16	20-OCT-16	20-OCT-16
	Sampled Time	11:30	11:40	12:05	12:15	14:30
	Client ID	23089161020001-MW25	23089161020002-MW2D	23089161020003-MW1D	23089161020004-MW1S	23089161020005-MW3D
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (umhos/cm)	862	723	411	947	517
	pH (pH units)	6.85 DLDS	7.15 DLDS	7.96 DLDS	7.20 DLDS	7.54 DLDS
	Total Dissolved Solids (mg/L)	495	416	246	550	293
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	375	354	188	291	248
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<10	<10	<10	<10	<10
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<10	<10	<10	<10	<10
	Alkalinity, Total (as CaCO3) (mg/L)	375	354	188	291	248
	Chloride (Cl) (mg/L)	61.3	18.4	13.2 DLDS	106	12.6
	Computed Conductivity (uS/cm)	732	631	365	822	457
	Conductivity % Difference (%)	-16.3	-13.5	-11.8	-14.2	-12.2
	Hardness (as CaCO3) (mg/L)	349	352	131	339	249
	Ion Balance (%)	101	106	104	100	103
	Langelier Index	0.0	0.2	0.2	0.1	0.3
	Nitrate (as N) (mg/L)	<0.020	<0.020	<0.10 DLDS	2.12	<0.020
	Nitrite (as N) (mg/L)	<0.010	<0.010	<0.050 DLDS	<0.010	<0.010
	Total Kjeldahl Nitrogen (mg/L)	0.48	0.44	0.67	0.43	0.23
	Saturation pH (pH)	6.90	6.92	7.81	7.07	7.27
	TDS (Calculated) (mg/L)	464	399	223	507	278
	Sulfate (SO4) (mg/L)	20.2	34.9	23.4 DLDS	49.3	27.7
	Anion Sum (me/L)	8.30	7.05	3.96	8.95	5.02
	Cation Sum (me/L)	8.42	7.45	4.10	8.95	5.19
	Cation - Anion Balance (%)	0.7	2.7	1.7	0.0	1.7
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0064	<0.0050	0.0070	<0.0050	<0.0050
	Antimony (Sb)-Dissolved (mg/L)	0.00049	0.00046	0.00024	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.0230	0.0104	0.00763	0.00012	0.00238
	Barium (Ba)-Dissolved (mg/L)	0.0647	0.0901	0.0345	0.0573	0.0806
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.028	0.015	0.078	0.021	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	0.000195	<0.000010
	Calcium (Ca)-Dissolved (mg/L)	98.3	97.0	20.7	87.8	57.9
	Cesium (Cs)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Chromium (Cr)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Cobalt (Co)-Dissolved (mg/L)	0.00300	0.00137	0.00022	<0.00010	0.00013
	Copper (Cu)-Dissolved (mg/L)	0.00056	0.00056	0.00059	0.00129	0.00032
	Iron (Fe)-Dissolved (mg/L)	1.27	0.452	<0.010	<0.010	0.222

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1846629-6	L1846629-7	L1846629-8		
	Description	WATER	WATER	WATER		
	Sampled Date	20-OCT-16	20-OCT-16	20-OCT-16		
	Sampled Time	14:45	16:45	16:55		
	Client ID	23089161020006-MW3S	23089161020007-MW4S	23089161020008-MW4D		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (umhos/cm)	680	568	484		
	pH (pH units)	7.38	7.66	7.76		
	Total Dissolved Solids (mg/L)	385 DLDS	323 DLDS	278 DLDS		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	317	227	239		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<10	<10	<10		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<10	<10	<10		
	Alkalinity, Total (as CaCO3) (mg/L)	317	227	239		
	Chloride (Cl) (mg/L)	28.6	26.8	9.95		
	Computed Conductivity (uS/cm)	595	513	430		
	Conductivity % Difference (%)	-13.4	-10.2	-11.8		
	Hardness (as CaCO3) (mg/L)	316	237	214		
	Ion Balance (%)	106	102	103		
	Langelier Index	0.3	0.3	0.3		
	Nitrate (as N) (mg/L)	1.65	<0.020	<0.020		
	Nitrite (as N) (mg/L)	<0.010	0.028	<0.010		
	Total Kjeldahl Nitrogen (mg/L)	<1.5 DLM	5.0 DLM	0.18		
	Saturation pH (pH)	7.04	7.35	7.42		
	TDS (Calculated) (mg/L)	370	312	263		
	Sulfate (SO4) (mg/L)	20.4	48.8	25.7		
	Anion Sum (me/L)	6.56	5.51	4.76		
	Cation Sum (me/L)	6.96	5.62	4.91		
	Cation - Anion Balance (%)	3.0	1.0	1.6		
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00040	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00019	0.00030	0.00812		
	Barium (Ba)-Dissolved (mg/L)	0.0832	0.0793	0.0637		
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.011	0.018	0.015		
	Cadmium (Cd)-Dissolved (mg/L)	0.000064	<0.000010	<0.000010		
	Calcium (Ca)-Dissolved (mg/L)	80.5	53.2	41.9		
	Cesium (Cs)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Chromium (Cr)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00023	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00081	0.00037	0.00033		
	Iron (Fe)-Dissolved (mg/L)	<0.010	<0.010	0.288		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1846629-1 WATER 20-OCT-16 11:30 23089161020001-MW25	L1846629-2 WATER 20-OCT-16 11:40 23089161020002-MW2D	L1846629-3 WATER 20-OCT-16 12:05 23089161020003-MW1D	L1846629-4 WATER 20-OCT-16 12:15 23089161020004-MW1S	L1846629-5 WATER 20-OCT-16 14:30 23089161020005-MW3D
WATER						
Dissolved Metals	Lead (Pb)-Dissolved (mg/L)	0.000266	0.000163	<0.000050	0.000180	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0014	0.0017	0.0016	0.0016	0.0023
	Magnesium (Mg)-Dissolved (mg/L)	25.1	26.7	19.3	29.0	25.4
	Manganese (Mn)-Dissolved (mg/L)	0.459	0.157	0.0157	0.00157	0.0174
	Molybdenum (Mo)-Dissolved (mg/L)	0.00192	0.00136	0.00453	0.000284	0.000905
	Nickel (Ni)-Dissolved (mg/L)	0.0126	0.00619	0.00152	0.00082	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	0.868	1.01	0.798	1.65	0.986
	Rubidium (Rb)-Dissolved (mg/L)	0.00182	0.00129	0.00082	0.00260	0.00056
	Selenium (Se)-Dissolved (mg/L)	0.000151	<0.000050	<0.000050	0.000229	<0.000050
	Silicon (Si)-Dissolved (mg/L)	3.84	5.60	4.60	4.00	6.41
	Silver (Ag)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Sodium (Na)-Dissolved (mg/L)	32.8	8.90	33.7	49.0	4.38
	Strontium (Sr)-Dissolved (mg/L)	0.144	0.142	0.314	0.326	0.109
	Sulfur (S)-Dissolved (mg/L)	6.40	11.2	7.99	16.5	8.95
	Tellurium (Te)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	0.000021	<0.000010
	Thorium (Th)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	0.00014	<0.00010	0.00012
	Titanium (Ti)-Dissolved (mg/L)	<0.00040 DLUI	<0.00030	<0.00030	<0.00030	<0.00030
	Tungsten (W)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Uranium (U)-Dissolved (mg/L)	0.00961	0.00489	0.00232	0.000809	0.00149
	Vanadium (V)-Dissolved (mg/L)	0.00128	<0.00050	0.00100	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.183	0.0404	0.0042	0.111	0.0053
	Zirconium (Zr)-Dissolved (mg/L)	0.00053	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1846629-6	L1846629-7	L1846629-8		
	Description	WATER	WATER	WATER		
	Sampled Date	20-OCT-16	20-OCT-16	20-OCT-16		
	Sampled Time	14:45	16:45	16:55		
	Client ID	23089161020006-MW3S	23089161020007-MW4S	23089161020008-MW4D		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Lead (Pb)-Dissolved (mg/L)	0.000158	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	0.0029		
	Magnesium (Mg)-Dissolved (mg/L)	28.0	25.4	26.6		
	Manganese (Mn)-Dissolved (mg/L)	0.0130	0.0575	0.0135		
	Molybdenum (Mo)-Dissolved (mg/L)	0.000447	0.00660	0.00315		
	Nickel (Ni)-Dissolved (mg/L)	0.00083	0.00647	<0.00050		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	1.62	2.80	1.48		
	Rubidium (Rb)-Dissolved (mg/L)	0.00205	0.00208	0.00062		
	Selenium (Se)-Dissolved (mg/L)	0.000258	0.000206	<0.000050		
	Silicon (Si)-Dissolved (mg/L)	5.02	5.85	8.69		
	Silver (Ag)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Sodium (Na)-Dissolved (mg/L)	13.7	18.5	13.5		
	Strontium (Sr)-Dissolved (mg/L)	0.110	0.256	0.158		
	Sulfur (S)-Dissolved (mg/L)	6.67	15.5	8.32		
	Tellurium (Te)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020		
	Thallium (Tl)-Dissolved (mg/L)	0.000024	0.000014	<0.000010		
	Thorium (Th)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	0.00070	0.00013		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Tungsten (W)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Uranium (U)-Dissolved (mg/L)	0.00102	0.00248	0.00112		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0648	0.0039	0.0272		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1846629-1, -2, -3, -4, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DLUI	Detection Limit Raised: Unknown Interference generated an apparent false positive test result.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-SPEC-WT	Water	Speciated Alkalinity	EPA 310.2
CL-IC-WT	Water	Chloride by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Water	Conductivity	APHA 2510 B

Water samples can be measured directly by immersing the conductivity cell into the sample.

IONBALANCE-OP03-WT	Water	Detailed Ion Balance Calculation	APHA 1030E, 2330B, 2510A
MET-D-CCMS-WT	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

NO2-IC-WT	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-WT	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-ALK-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

SO4-IC-N-WT	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-WT	Water	Total Dissolved Solids	APHA 2540C

A well-mixed sample is filtered though glass fibres filter. A known volume of the filtrate is evaporated and dried at 105–5°C overnight and then 180–10°C for 1hr.

TKN-WT	Water	Total Kjeldahl Nitrogen	APHA 4500-N

Sample is digested to convert the TKN to ammonium sulphate. The ammonia ions are heated to produce a colour complex. The absorbance measured by the instrument is proportional to the concentration of ammonium sulphate in the sample and is reported as TKN.

Reference Information

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: MATRIX SOLUTIONS INC.
31 Beacon Point Court
Breslau ON N0B 1M0
Contact: Scott Miller

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-SPEC-WT	**Water**							
Batch R3577280								
WG2416369-3 CRM		**WT-ALK-CRM**						
Alkalinity, Total (as CaCO3)			98.9		%		80-120	21-OCT-16
WG2416369-4 DUP		**L1846629-1**						
Alkalinity, Total (as CaCO3)		375	373		mg/L	0.5	20	21-OCT-16
WG2416369-2 LCS								
Alkalinity, Total (as CaCO3)			100.2		%		85-115	21-OCT-16
WG2416369-1 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	21-OCT-16
CL-IC-WT	**Water**							
Batch R3580587								
WG2418167-9 DUP		**L1846629-2**						
Chloride (Cl)		18.4	18.4		mg/L	0.2	25	25-OCT-16
WG2418167-7 LCS								
Chloride (Cl)			100.9		%		70-130	25-OCT-16
WG2418167-6 MB								
Chloride (Cl)			<0.50		mg/L		0.5	25-OCT-16
WG2418167-10 MS		**L1846629-2**						
Chloride (Cl)			101.4		%		70-130	25-OCT-16
EC-WT	**Water**							
Batch R3577079								
WG2416125-8 DUP		**L1846629-1**						
Conductivity		862	866		umhos/cm	0.1	10	22-OCT-16
WG2416125-2 LCS								
Conductivity			99.5		%		90-110	22-OCT-16
WG2416125-6 LCS								
Conductivity			100.0		%		90-110	22-OCT-16
WG2416125-1 MB								
Conductivity			<3.0		umhos/cm		3	22-OCT-16
WG2416125-5 MB								
Conductivity			<3.0		umhos/cm		3	22-OCT-16
Batch R3582038								
WG2420644-4 DUP		**L1846629-3**						
Conductivity		411	416		umhos/cm	0.0	10	28-OCT-16
WG2420644-2 LCS								
Conductivity			99.9		%		90-110	28-OCT-16
WG2420644-1 MB								
Conductivity			<3.0		umhos/cm		3	28-OCT-16
MET-D-CCMS-WT	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3578737								
WG2416020-2 LCS								
Aluminum (Al)-Dissolved			91.6		%		80-120	21-OCT-16
Antimony (Sb)-Dissolved			100.8		%		80-120	21-OCT-16
Arsenic (As)-Dissolved			93.6		%		80-120	21-OCT-16
Barium (Ba)-Dissolved			93.9		%		80-120	21-OCT-16
Beryllium (Be)-Dissolved			85.4		%		80-120	21-OCT-16
Bismuth (Bi)-Dissolved			98.1		%		80-120	21-OCT-16
Boron (B)-Dissolved			88.0		%		80-120	21-OCT-16
Cadmium (Cd)-Dissolved			95.5		%		80-120	21-OCT-16
Calcium (Ca)-Dissolved			89.8		%		80-120	21-OCT-16
Cesium (Cs)-Dissolved			97.0		%		80-120	21-OCT-16
Chromium (Cr)-Dissolved			93.0		%		80-120	21-OCT-16
Cobalt (Co)-Dissolved			93.4		%		80-120	21-OCT-16
Copper (Cu)-Dissolved			95.1		%		80-120	21-OCT-16
Iron (Fe)-Dissolved			93.7		%		80-120	21-OCT-16
Lead (Pb)-Dissolved			97.0		%		80-120	21-OCT-16
Lithium (Li)-Dissolved			85.6		%		80-120	21-OCT-16
Magnesium (Mg)-Dissolved			93.1		%		80-120	21-OCT-16
Manganese (Mn)-Dissolved			92.8		%		80-120	21-OCT-16
Molybdenum (Mo)-Dissolved			92.4		%		80-120	21-OCT-16
Nickel (Ni)-Dissolved			94.4		%		80-120	21-OCT-16
Phosphorus (P)-Dissolved			96.3		%		80-120	21-OCT-16
Potassium (K)-Dissolved			93.3		%		80-120	21-OCT-16
Rubidium (Rb)-Dissolved			93.1		%		80-120	21-OCT-16
Selenium (Se)-Dissolved			96.8		%		80-120	21-OCT-16
Silicon (Si)-Dissolved			97.2		%		80-120	21-OCT-16
Silver (Ag)-Dissolved			93.1		%		80-120	21-OCT-16
Sodium (Na)-Dissolved			93.3		%		80-120	21-OCT-16
Strontium (Sr)-Dissolved			96.6		%		80-120	21-OCT-16
Sulfur (S)-Dissolved			91.4		%		80-120	21-OCT-16
Tellurium (Te)-Dissolved			92.1		%		80-120	21-OCT-16
Thallium (Tl)-Dissolved			95.0		%		80-120	21-OCT-16
Thorium (Th)-Dissolved			94.2		%		80-120	21-OCT-16
Tin (Sn)-Dissolved			95.4		%		80-120	21-OCT-16
Titanium (Ti)-Dissolved			88.9		%		80-120	21-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3578737								
WG2416020-2 LCS								
Tungsten (W)-Dissolved			96.0		%		80-120	21-OCT-16
Uranium (U)-Dissolved			100.5		%		80-120	21-OCT-16
Vanadium (V)-Dissolved			94.2		%		80-120	21-OCT-16
Zinc (Zn)-Dissolved			91.6		%		80-120	21-OCT-16
Zirconium (Zr)-Dissolved			88.4		%		80-120	21-OCT-16
WG2416020-1 MB								
Aluminum (Al)-Dissolved			<0.0050		mg/L		0.005	21-OCT-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	21-OCT-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	21-OCT-16
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	21-OCT-16
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	21-OCT-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	21-OCT-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	21-OCT-16
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	21-OCT-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	21-OCT-16
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	21-OCT-16
Chromium (Cr)-Dissolved			<0.00050		mg/L		0.0005	21-OCT-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	21-OCT-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	21-OCT-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	21-OCT-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	21-OCT-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	21-OCT-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	21-OCT-16
Manganese (Mn)-Dissolved			<0.00050		mg/L		0.0005	21-OCT-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	21-OCT-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	21-OCT-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	21-OCT-16
Potassium (K)-Dissolved			<0.050		mg/L		0.05	21-OCT-16
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	21-OCT-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	21-OCT-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	21-OCT-16
Silver (Ag)-Dissolved			<0.000050		mg/L		0.00005	21-OCT-16
Sodium (Na)-Dissolved			<0.50		mg/L		0.5	21-OCT-16
Strontium (Sr)-Dissolved			<0.0010		mg/L		0.001	21-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3578737								
WG2416020-1 MB								
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	21-OCT-16
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	21-OCT-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	21-OCT-16
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	21-OCT-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	21-OCT-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	21-OCT-16
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	21-OCT-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	21-OCT-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	21-OCT-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	21-OCT-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	21-OCT-16
NO2-IC-WT	**Water**							
Batch R3580587								
WG2418167-9 DUP		**L1846629-2**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	25	25-OCT-16
WG2418167-7 LCS								
Nitrite (as N)			104.0		%		70-130	25-OCT-16
WG2418167-6 MB								
Nitrite (as N)			<0.010		mg/L		0.01	25-OCT-16
WG2418167-10 MS		**L1846629-2**						
Nitrite (as N)			101.0		%		70-130	25-OCT-16
NO3-IC-WT	**Water**							
Batch R3580587								
WG2418167-9 DUP		**L1846629-2**						
Nitrate (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	25	25-OCT-16
WG2418167-7 LCS								
Nitrate (as N)			99.9		%		70-130	25-OCT-16
WG2418167-6 MB								
Nitrate (as N)			<0.020		mg/L		0.02	25-OCT-16
WG2418167-10 MS		**L1846629-2**						
Nitrate (as N)			100.1		%		70-130	25-OCT-16
PH-ALK-WT	**Water**							
Batch R3576742								
WG2415568-10 LCS								
pH			6.99		pH units		6.9-7.1	21-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WT	**Water**							
Batch R3580587								
WG2418167-9 DUP		**L1846629-2**						
Sulfate (SO4)		34.9	34.9		mg/L	0.1	20	25-OCT-16
WG2418167-7 LCS								
Sulfate (SO4)			100.8		%		90-110	25-OCT-16
WG2418167-6 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	25-OCT-16
WG2418167-10 MS		**L1846629-2**						
Sulfate (SO4)			98.3		%		75-125	25-OCT-16
SOLIDS-TDS-WT	**Water**							
Batch R3580302								
WG2418394-2 LCS								
Total Dissolved Solids			95.4		%		85-115	25-OCT-16
WG2418394-1 MB								
Total Dissolved Solids			<10		mg/L		10	25-OCT-16
TKN-WT	**Water**							
Batch R3579625								
WG2417137-3 DUP		**L1846629-2**						
Total Kjeldahl Nitrogen		0.44	0.39		mg/L	10	20	25-OCT-16
WG2417133-2 LCS								
Total Kjeldahl Nitrogen			93.5		%		75-125	25-OCT-16
WG2417137-2 LCS								
Total Kjeldahl Nitrogen			97.8		%		75-125	25-OCT-16
WG2417133-1 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	25-OCT-16
WG2417137-1 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	25-OCT-16
WG2417137-4 MS		**L1846629-2**						
Total Kjeldahl Nitrogen			112.8		%		70-130	25-OCT-16
Batch R3580613								
WG2417995-2 LCS								
Total Kjeldahl Nitrogen			112.2		%		75-125	26-OCT-16
WG2417995-1 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	26-OCT-16

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

COC # M 81838

Page: 1 of 1

Lab Submitted to: ALS Waterloo
Lab Agreement no: Q58595
Lab Job ID:

Invoice to: Require Report: Y ✓ N

Company Name: MATRIX SOLUTIONS
Contact Name: Scott Miller
Address: 31 Beacon Pt Court
PC:
Phone / Fax#: Ph: Fax:

Copy of Report to:
Matrix Solutions - Data Management
Suite 200, 150 - 13th Avenue SW
Calgary, Alberta, Canada
T2R 0V2
Ph: 403-237-0606 Fax: 403-263-2493
Fax draft copy of invoice to Matrix Solutions Inc.

Matrix Project #: 23089-528
Matrix Proj. Name: Claire - Maltby
Location:
Sampler's Name(s): S. Miller

AFE #: 149006.02.03

REGULATORY REQUIREMENTS: (check)
- [ ] Alberta Tier 1
- [ ] SPIGEC
- [ ] Freshwater Aquatic Life (Low Level Metals)
- [ ] Canadian Drinking Water
- [ ] BC Regs
- [ ] Other:

SERVICE REQUESTED:
- [ ] RUSH (Please ensure you contact the lab) Due Date:
- [✓] REGULAR Turnaround

REPORT DISTRIBUTION: always send to data_management@matrix-solutions.com
- [✓] Additional Emails: smiller@matrix-solutions.com

	Sample Number (14 digits only) yr-mth-day	Sample Point Name	Depth (cm)	Sample Type	Date/Time Sampled	Quantity # of Jars	Quantity # of Bags	Analysis Required Q58595	Lab Sample Number
1	23089161020001	MW25	—	Water	Oct 20 11:30	3	—	X	1
2	002	MW2D	—		11:40	3	—	X	2
3	003	MW1D	—		12:05	3	—	X	3
4	004	MW15	—		12:15	3	—	X	4
5	005	MW30	—		14:30	3	—	X	5
6	006	MW35	—		14:45	3	—	X	6
7	007	MW45	—		16:45	3	—	X	7
8	23089161020008	MW4D	—	Water	Oct 20 16:55	3	—	X	8
9									
10									
11									
12									
13									
14									
15									

L1846629-COFC

*For metals in water samples indicate if you want Total (T), Dissolved (D) or Extractable (E) as part of "Analysis Required" Preserved/Filtered

Relinquished by: Scott Miller Date/Time: Oct 20/16 18:50
Signature:
Received by: Amanda Faoka Date/Time: Oct 20/16 @ 18:30
Signature:

COMMENTS/SPECIAL INSTRUCTIONS: CALL Scott With Questions 403 589-1599
Metals were field filtered. See Q58595

MATRIX SOLUTIONS INC.
ATTN: Scott Miller
31 Beacon Point Court
Breslau ON N0B 1M0

Date Received: 21-OCT-16
Report Date: 01-NOV-16 08:17 (MT)
Version: FINAL

Client Phone: 519-772-3777

Certificate of Analysis

Lab Work Order #: L1847231

Project P.O. #: CLAIRE-MALTBY
Job Reference: 23089-528
C of C Numbers: 81839
Legal Site Desc:

Gayle Braun
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1847231-1	L1847231-2			
	Description	WATER	WATER			
	Sampled Date	21-OCT-16	21-OCT-16			
	Sampled Time	11:30	11:45			
	Client ID	23089161021001 MW9D	23089161021002 MW95			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (umhos/cm)	445	583			
	pH (pH units)	7.56	7.28			
	Total Dissolved Solids (mg/L)	272 DLDS	346 DLDS			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	237	260			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<10	<10			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<10	<10			
	Alkalinity, Total (as CaCO3) (mg/L)	237	260			
	Chloride (Cl) (mg/L)	2.79	14.1			
	Computed Conductivity (uS/cm)	404	547			
	Conductivity % Difference (%)	-9.6	-6.4			
	Hardness (as CaCO3) (mg/L)	228	319			
	Ion Balance (%)	123	121			
	Langelier Index	0.3	0.2			
	Nitrate (as N) (mg/L)	<0.020	7.00			
	Nitrite (as N) (mg/L)	<0.010	<0.010			
	Total Kjeldahl Nitrogen (mg/L)	0.48	1.91			
	Saturation pH (pH)	7.30	7.08			
	TDS (Calculated) (mg/L)	243	339			
	Sulfate (SO4) (mg/L)	7.88	16.9			
	Anion Sum (me/L)	4.15	5.51			
	Cation Sum (me/L)	5.11	6.67			
	Cation - Anion Balance (%)	10.4	9.5			
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	<0.0050	<0.0050			
	Antimony (Sb)-Dissolved (mg/L)	0.00013	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00390	0.00012			
	Barium (Ba)-Dissolved (mg/L)	0.0908	0.0869			
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.017	0.012			
	Cadmium (Cd)-Dissolved (mg/L)	0.000019	0.000036			
	Calcium (Ca)-Dissolved (mg/L)	54.4	89.3			
	Cesium (Cs)-Dissolved (mg/L)	<0.000010	<0.000010			
	Chromium (Cr)-Dissolved (mg/L)	<0.00050	<0.00050			
	Cobalt (Co)-Dissolved (mg/L)	0.00023	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00054	0.00112			
	Iron (Fe)-Dissolved (mg/L)	0.024	<0.010			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1847231-1	L1847231-2			
	Description	WATER	WATER			
	Sampled Date	21-OCT-16	21-OCT-16			
	Sampled Time	11:30	11:45			
	Client ID	23089161021001 MW9D	23089161021002 MW95			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Lead (Pb)-Dissolved (mg/L)	0.000113	0.000060			
	Lithium (Li)-Dissolved (mg/L)	0.0027	<0.0010			
	Magnesium (Mg)-Dissolved (mg/L)	22.3	23.4			
	Manganese (Mn)-Dissolved (mg/L)	0.0367	0.00469			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00634	0.000203			
	Nickel (Ni)-Dissolved (mg/L)	0.00068	<0.00050			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	1.08	3.34			
	Rubidium (Rb)-Dissolved (mg/L)	0.00167	0.00047			
	Selenium (Se)-Dissolved (mg/L)	<0.000050	0.000314			
	Silicon (Si)-Dissolved (mg/L)	7.26	4.43			
	Silver (Ag)-Dissolved (mg/L)	<0.000050	<0.000050			
	Sodium (Na)-Dissolved (mg/L)	12.1	4.69			
	Strontium (Sr)-Dissolved (mg/L)	0.166	0.0948			
	Sulfur (S)-Dissolved (mg/L)	2.24	5.60			
	Tellurium (Te)-Dissolved (mg/L)	<0.00020	<0.00020			
	Thallium (Tl)-Dissolved (mg/L)	0.000020	<0.000010			
	Thorium (Th)-Dissolved (mg/L)	<0.00010	<0.00010			
	Tin (Sn)-Dissolved (mg/L)	0.00027	0.00027			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Tungsten (W)-Dissolved (mg/L)	<0.00010	<0.00010			
	Uranium (U)-Dissolved (mg/L)	0.00104	0.000262			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	0.0146	0.0604			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1847231-1, -2
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1847231-1, -2
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1847231-1, -2
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1847231-1, -2
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1847231-1, -2
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1847231-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1847231-1, -2
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1847231-1, -2
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1847231-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-SPEC-WT	Water	Speciated Alkalinity	EPA 310.2
CL-IC-WT	Water	Chloride by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

EC-WT	Water	Conductivity	APHA 2510 B

Water samples can be measured directly by immersing the conductivity cell into the sample.

IONBALANCE-OP03-WT	Water	Detailed Ion Balance Calculation	APHA 1030E, 2330B, 2510A
MET-D-CCMS-WT	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

NO2-IC-WT	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-WT	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-ALK-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

SO4-IC-N-WT	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-WT	Water	Total Dissolved Solids	APHA 2540C

A well-mixed sample is filtered though glass fibres filter. A known volume of the filtrate is evaporated and dried at 105–5°C overnight and then 180–10°C for 1hr.

TKN-WT	Water	Total Kjeldahl Nitrogen	APHA 4500-N

Sample is digested to convert the TKN to ammonium sulphate. The ammonia ions are heated to produce a colour complex. The absorbance measured by the instrument is proportional to the concentration of ammonium sulphate in the sample and is reported as TKN.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Reference Information

WT ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

81839

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: MATRIX SOLUTIONS INC.
31 Beacon Point Court
Breslau ON N0B 1M0
Contact: Scott Miller

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-SPEC-WT	**Water**							
Batch R3579263								
WG2417846-3 CRM		**WT-ALK-CRM**						
Alkalinity, Total (as CaCO3)			96.8		%		80-120	24-OCT-16
WG2417846-2 LCS								
Alkalinity, Total (as CaCO3)			104.4		%		85-115	24-OCT-16
WG2417846-1 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	24-OCT-16
CL-IC-WT	**Water**							
Batch R3581637								
WG2420201-12 LCS								
Chloride (Cl)			100.5		%		70-130	27-OCT-16
WG2420201-11 MB								
Chloride (Cl)			<0.50		mg/L		0.5	27-OCT-16
EC-WT	**Water**							
Batch R3579021								
WG2416673-2 LCS								
Conductivity			97.8		%		90-110	22-OCT-16
WG2416673-1 MB								
Conductivity			<3.0		umhos/cm		3	22-OCT-16
MET-D-CCMS-WT	**Water**							
Batch R3579149								
WG2417038-2 LCS								
Aluminum (Al)-Dissolved			104.3		%		80-120	25-OCT-16
Antimony (Sb)-Dissolved			98.1		%		80-120	25-OCT-16
Arsenic (As)-Dissolved			95.9		%		80-120	25-OCT-16
Barium (Ba)-Dissolved			97.3		%		80-120	25-OCT-16
Beryllium (Be)-Dissolved			101.8		%		80-120	25-OCT-16
Bismuth (Bi)-Dissolved			98.7		%		80-120	25-OCT-16
Boron (B)-Dissolved			100.6		%		80-120	25-OCT-16
Cadmium (Cd)-Dissolved			93.1		%		80-120	25-OCT-16
Calcium (Ca)-Dissolved			99.9		%		80-120	25-OCT-16
Cesium (Cs)-Dissolved			98.7		%		80-120	25-OCT-16
Chromium (Cr)-Dissolved			94.2		%		80-120	25-OCT-16
Cobalt (Co)-Dissolved			93.6		%		80-120	25-OCT-16
Copper (Cu)-Dissolved			91.7		%		80-120	25-OCT-16
Iron (Fe)-Dissolved			84.7		%		80-120	25-OCT-16
Lead (Pb)-Dissolved			95.2		%		80-120	25-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3579149								
WG2417038-2 LCS								
Lithium (Li)-Dissolved			106.8		%		80-120	25-OCT-16
Magnesium (Mg)-Dissolved			99.0		%		80-120	25-OCT-16
Manganese (Mn)-Dissolved			96.8		%		80-120	25-OCT-16
Molybdenum (Mo)-Dissolved			93.4		%		80-120	25-OCT-16
Nickel (Ni)-Dissolved			93.1		%		80-120	25-OCT-16
Phosphorus (P)-Dissolved			101.3		%		80-120	25-OCT-16
Potassium (K)-Dissolved			95.6		%		80-120	25-OCT-16
Rubidium (Rb)-Dissolved			99.8		%		80-120	25-OCT-16
Selenium (Se)-Dissolved			87.2		%		80-120	25-OCT-16
Silicon (Si)-Dissolved			106.1		%		80-120	25-OCT-16
Silver (Ag)-Dissolved			94.1		%		80-120	25-OCT-16
Sodium (Na)-Dissolved			96.8		%		80-120	25-OCT-16
Strontium (Sr)-Dissolved			98.7		%		80-120	25-OCT-16
Sulfur (S)-Dissolved			100.4		%		80-120	25-OCT-16
Tellurium (Te)-Dissolved			94.0		%		80-120	25-OCT-16
Thallium (Tl)-Dissolved			96.7		%		80-120	25-OCT-16
Thorium (Th)-Dissolved			92.1		%		80-120	25-OCT-16
Tin (Sn)-Dissolved			95.0		%		80-120	25-OCT-16
Titanium (Ti)-Dissolved			94.7		%		80-120	25-OCT-16
Tungsten (W)-Dissolved			93.5		%		80-120	25-OCT-16
Uranium (U)-Dissolved			93.2		%		80-120	25-OCT-16
Vanadium (V)-Dissolved			96.7		%		80-120	25-OCT-16
Zinc (Zn)-Dissolved			89.5		%		80-120	25-OCT-16
Zirconium (Zr)-Dissolved			93.7		%		80-120	25-OCT-16
WG2417038-1 MB								
Aluminum (Al)-Dissolved			<0.0050		mg/L		0.005	25-OCT-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	25-OCT-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	25-OCT-16
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	25-OCT-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	25-OCT-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3579149								
WG2417038-1 MB								
Cesium (Cs)-Dissolved			<0.000010		mg/L		0.00001	25-OCT-16
Chromium (Cr)-Dissolved			<0.00050		mg/L		0.0005	25-OCT-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	25-OCT-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	25-OCT-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	25-OCT-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	25-OCT-16
Manganese (Mn)-Dissolved			<0.00050		mg/L		0.0005	25-OCT-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	25-OCT-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	25-OCT-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	25-OCT-16
Potassium (K)-Dissolved			<0.050		mg/L		0.05	25-OCT-16
Rubidium (Rb)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	25-OCT-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	25-OCT-16
Silver (Ag)-Dissolved			<0.000050		mg/L		0.00005	25-OCT-16
Sodium (Na)-Dissolved			<0.50		mg/L		0.5	25-OCT-16
Strontium (Sr)-Dissolved			<0.0010		mg/L		0.001	25-OCT-16
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	25-OCT-16
Tellurium (Te)-Dissolved			<0.00020		mg/L		0.0002	25-OCT-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	25-OCT-16
Thorium (Th)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	25-OCT-16
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	25-OCT-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	25-OCT-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	25-OCT-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	25-OCT-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	25-OCT-16
NO2-IC-WT	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-WT	**Water**							
Batch R3581637								
WG2420201-12 LCS								
Nitrite (as N)			102.9		%		70-130	27-OCT-16
WG2420201-11 MB								
Nitrite (as N)			<0.010		mg/L		0.01	27-OCT-16
NO3-IC-WT	**Water**							
Batch R3581637								
WG2420201-12 LCS								
Nitrate (as N)			100.3		%		70-130	27-OCT-16
WG2420201-11 MB								
Nitrate (as N)			<0.020		mg/L		0.02	27-OCT-16
PH-ALK-WT	**Water**							
Batch R3577157								
WG2416472-9 DUP		**L1847231-2**						
pH		7.28	7.32	J	pH units	0.04	0.2	22-OCT-16
WG2416472-4 LCS								
pH			6.96		pH units		6.9-7.1	22-OCT-16
WG2416472-7 LCS								
pH			6.94		pH units		6.9-7.1	22-OCT-16
SO4-IC-N-WT	**Water**							
Batch R3581637								
WG2420201-12 LCS								
Sulfate (SO4)			100.3		%		90-110	27-OCT-16
WG2420201-11 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	27-OCT-16
SOLIDS-TDS-WT	**Water**							
Batch R3583278								
WG2419582-3 DUP		**L1847231-1**						
Total Dissolved Solids		272	270		mg/L	0.9	20	26-OCT-16
WG2419582-2 LCS								
Total Dissolved Solids			96.4		%		85-115	26-OCT-16
WG2419582-1 MB								
Total Dissolved Solids			<10		mg/L		10	26-OCT-16
TKN-WT	**Water**							
Batch R3584321								
WG2418960-2 LCS								
Total Kjeldahl Nitrogen			91.0		%		75-125	31-OCT-16
WG2418960-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TKN-WT	**Water**							
Batch R3584321								
WG2418960-1 MB								
Total Kjeldahl Nitrogen			<0.15		mg/L		0.15	31-OCT-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

L1847231 ESmith 21-Oct-16 21E

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

COC # M 81839

Page: 1 of 1

Lab Submitted to: ALS Waterloo
Lab Agreement no: ~~Q58595~~ Q58595
Lab Job ID:

Invoice to: Require Report: Y___ N___

Company Name: MATRIX SOLUTIONS
Contact Name: 31 Beacon Point Court
Address: Brestan, ON
PC:
Phone / Fax#: Ph: Fax:

Copy of Report to:
Matrix Solutions - Data Management
Suite 200, 150 - 13th Avenue SW
Calgary, Alberta, Canada
T2R 0V2
Ph: 403-237-0606 Fax: 403-263-2493
Fax draft copy of invoice to Matrix Solutions Inc.

Matrix Project #: 23089-528
Matrix Proj. Name: Claire - Maltby
Location:
Sampler's Name(s): S. Miller

AFE #: 149006.02.03

REGULATORY REQUIREMENTS: (check)
- [ ] Alberta Tier 1
- [ ] SPIGEC
- [ ] Freshwater Aquatic Life (Low Level Metals)
- [ ] Canadian Drinking Water
- [ ] BC Regs
- [ ] Other:

SERVICE REQUESTED:
- [ ] RUSH (Please ensure you contact the lab) Due Date:
- [x] REGULAR Turnaround

REPORT DISTRIBUTION: always send to data_management@matrix-solutions.com
- [x] Additional Emails: Smiller@matrix-solutions.com

	Sample Number (14 digits only) yr-mth-day	Sample Point Name	Depth (cm)	Sample Type	Date/Time Sampled	Quantity # of Jars	Quantity # of Bags	Analysis Required: Q58595	Lab Sample Number
1	23089161021001	MW9D		Water	Oct 21 11:30	3	—	X	1
2	23089161021002	MW9S		Water	Oct 21 11:45	3	—	X	2
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

L1847231-COFC

*For metals in water samples indicate if you want Total (T), Dissolved (D) or Extractable (E) as part of "Analysis Required" Preserved/Filtered

Relinquished by: Scott Miller Date/Time: Oct 21 18:15
Signature:
Received by: EKS Date/Time: Oct 20 2016 18:20
Signature:

COMMENTS/SPECIAL INSTRUCTIONS
CALL Scott With Questions 403 589 1599
Metals are Dissolved and were Field Filtered.
Temp: 12.0°C
EKS

ISOTOPE TRACER TECHNOLOGIES INC

Isotope Analyses for: Matrix Solutions Inc.

IT2 FILE # 160319

2016-12-22

Approved by:

Orfan Shouakar-Stash, PhD
Director
Isotope Tracer Technologies Inc.
695 Rupert St. Unit B, Waterloo, ON, N2V 1Z5
Tel: 519-886-5555 | Fax: 519-886-5575
Email: orfan@it2isotopes.com
Website: www.it2isotopes.com

2016-12-22

ISOTOPE TRACER TECHNOLOGIES INC

Client: Matrix Solutions Inc
31 Beacon Point Ct
Breslau, ON
N0B 1M0
Tel: 519-772-3777
Attn.: Jeff Melchin/Scott Miller
E-mail: jmelchin@matrix-solutions.com
E-mail: smiller@matrix-solutions.com

File Number: **160319**
Project Number: **23089-528**
Project Name: **Clair-Maltby**

#	Sample ID	Sample Name	Collection		Sample #	E^3H	Result	± 1σ	Repeat	± 1σ
			Date	Time						
1	23089161028001	MW5S	October 28, 2016	14:30	40284	X	10.9	1.0		
2	23089161028002	MW5D	October 28, 2016	14:45	40285	X	10.1	1.0		
3	23089161028003	MW3S	October 28, 2016	15:45	40286	X	13.1	1.4		
4	23089161028004	MW7	October 28, 2016	17:00	40287	X	6.4	1.1	6.8	1.1

Tritium is reported in Tritium Units.
1TU = 3.221 Picocurries/L per IAEA, 2000 Report.
1TU = 0.11919 Becquerels/L per IAEA, 2000 Report.

Approved by:

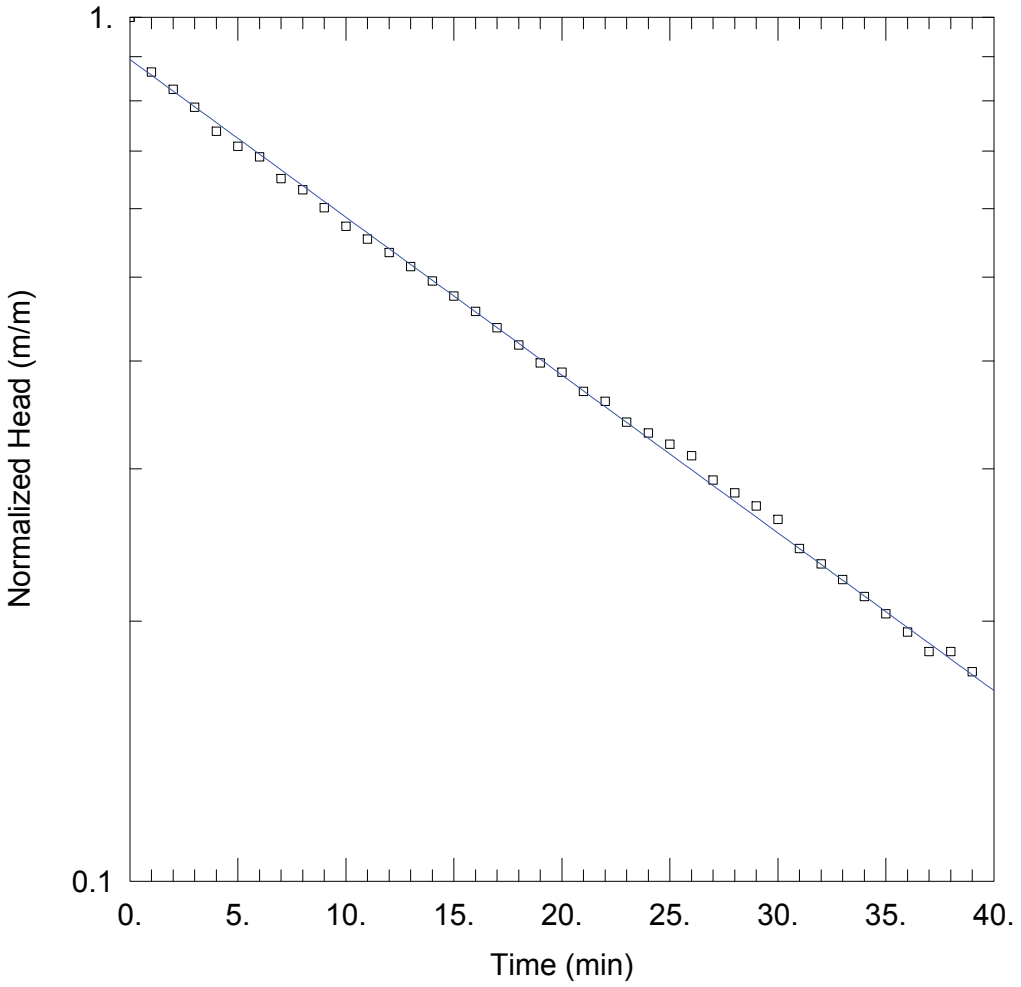
Orfan SStash

Orfan Shouakar-Stash, PhD
Director
Isotope Tracer Technologies Inc.
695 Rupert St. Unit B, Waterloo, ON, N2V 1Z5
Tel: 519-886-5555 | Fax: 519-886-5575
Email: orfan@it2isotopes.com
Website: www.it2isotopes.com

Appendix B5
Hydraulic Conductivity Test Results

MW1-D Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 5.8E-7 m/sec y0 = 0.276 m

AQUIFER DATA

Saturated Thickness: 16.34 m Anisotropy Ratio (Kz/Kr): 1.

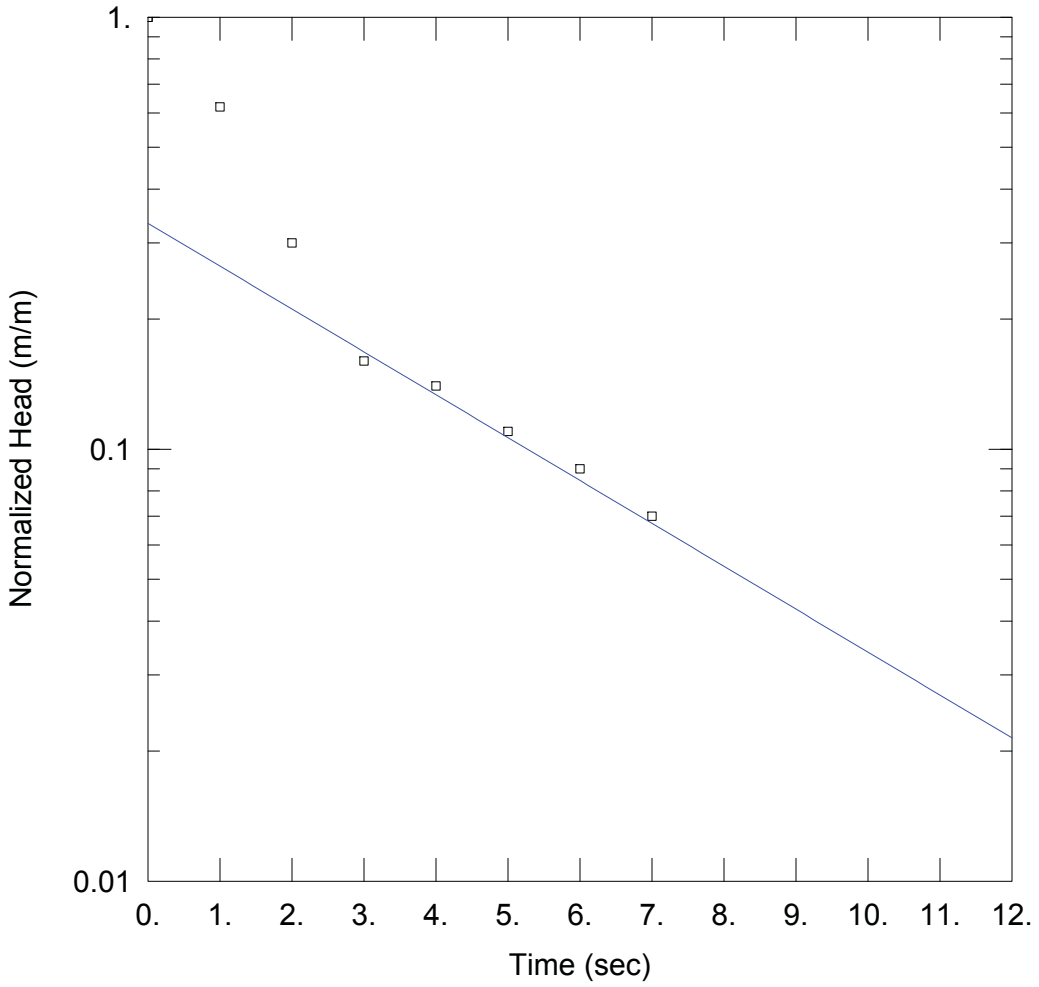
WELL DATA (MW1-D)

Initial Displacement: 0.309 m
Static Water Column Height: 14.66 m
Total Well Penetration Depth: 14.66 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW1-S Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00021 m/sec y0 = 0.1 m

AQUIFER DATA

Saturated Thickness: 8.06 m Anisotropy Ratio (Kz/Kr): 1.

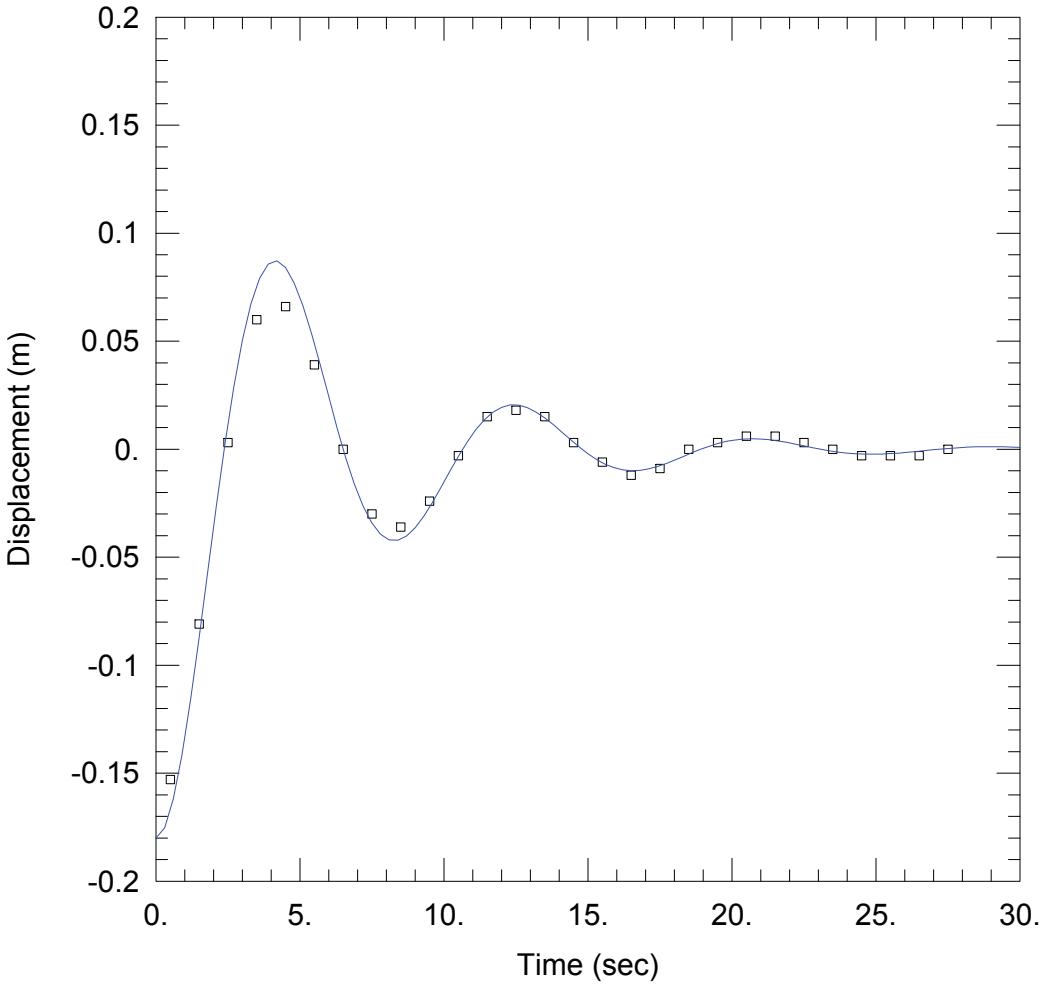
WELL DATA (MW1-S)

Initial Displacement: 0.3 m
Static Water Column Height: 8.06 m
Total Well Penetration Depth: 8.06 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW2-D Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 0.0015 m/sec Le = 16.17 m

AQUIFER DATA

Saturated Thickness: 19.36 m Anisotropy Ratio (Kz/Kr): 1.

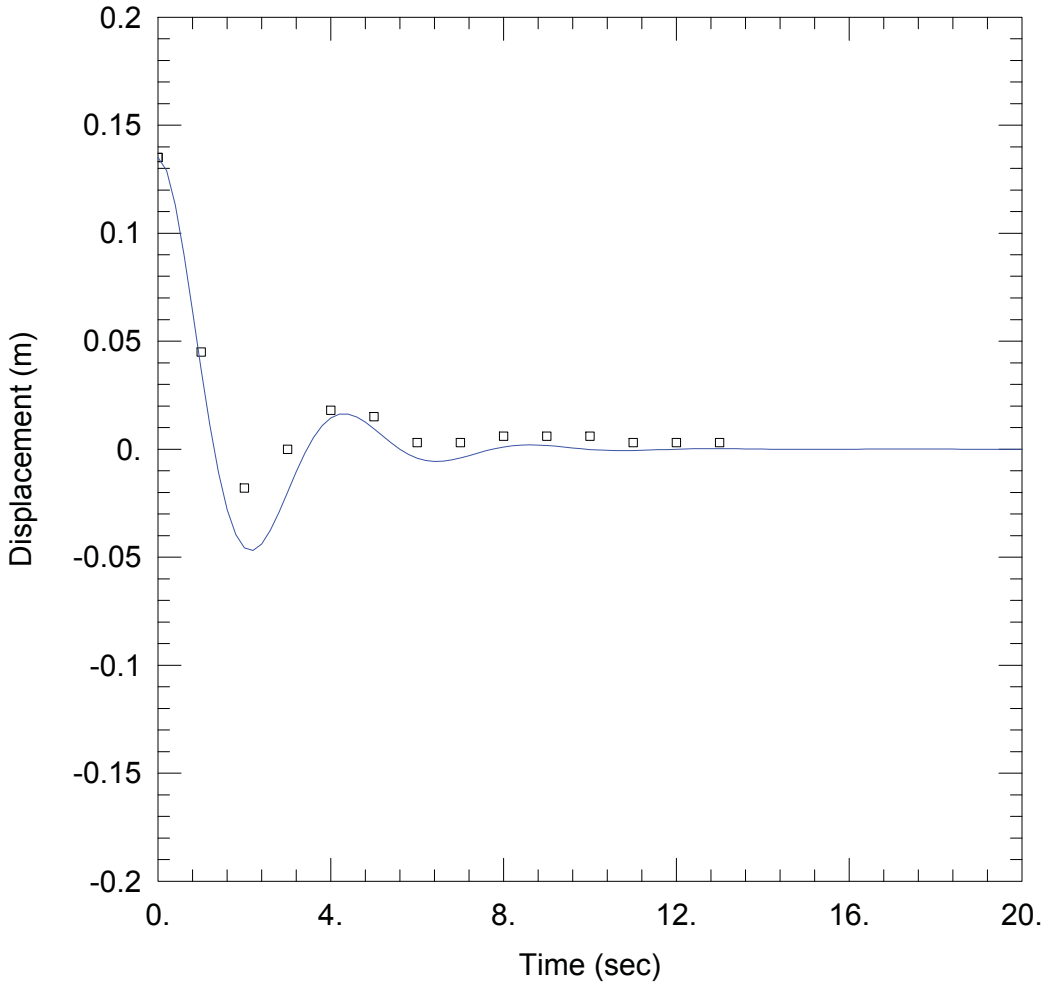
WELL DATA (MW2-D)

Initial Displacement: -0.18 m
Static Water Column Height: 16.93 m
Total Well Penetration Depth: 16.93 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW2-S Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: Springer-Gelhar

K = 0.0021 m/sec Le = 4.13 m

AQUIFER DATA

Saturated Thickness: 4.89 m Anisotropy Ratio (Kz/Kr): 1.

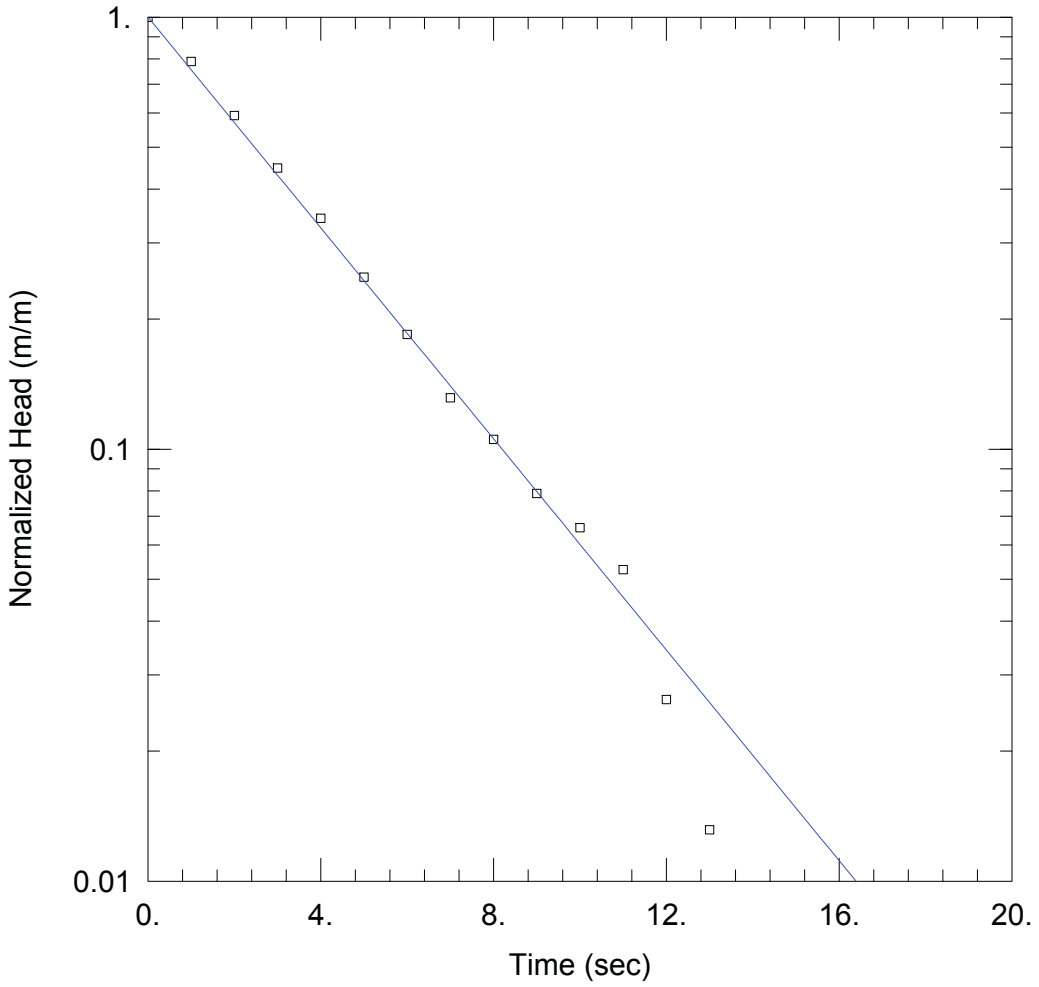
WELL DATA (MW2-S)

Initial Displacement: 0.135 m
Static Water Column Height: 4.89 m
Total Well Penetration Depth: 4.89 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW3-D Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00028 m/sec y0 = -0.228 m

AQUIFER DATA

Saturated Thickness: 15.09 m Anisotropy Ratio (Kz/Kr): 1.

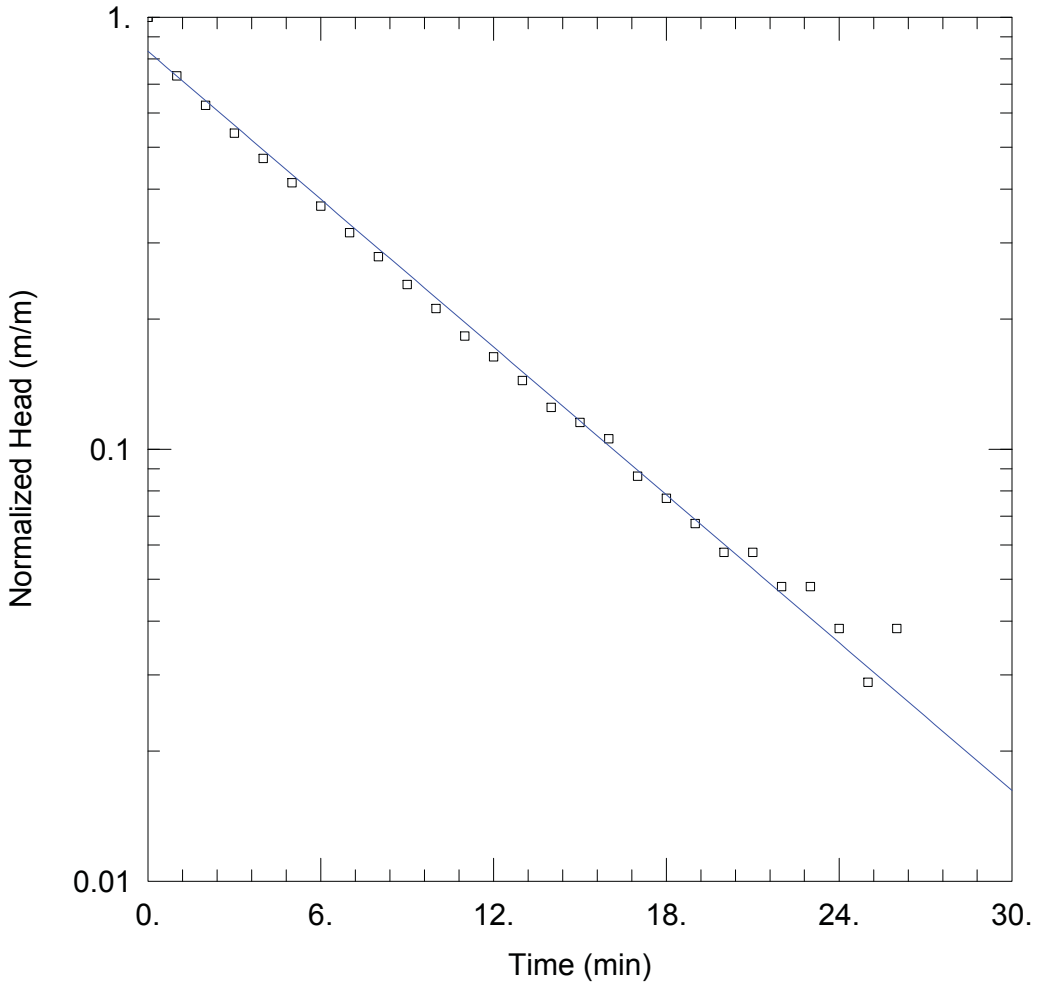
WELL DATA (MW3-D)

Initial Displacement: -0.228 m
Static Water Column Height: 15.09 m
Total Well Penetration Depth: 15.09 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW4-D Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 2.15E-6 m/sec y0 = 0.26 m

AQUIFER DATA

Saturated Thickness: 13.38 m Anisotropy Ratio (Kz/Kr): 1.

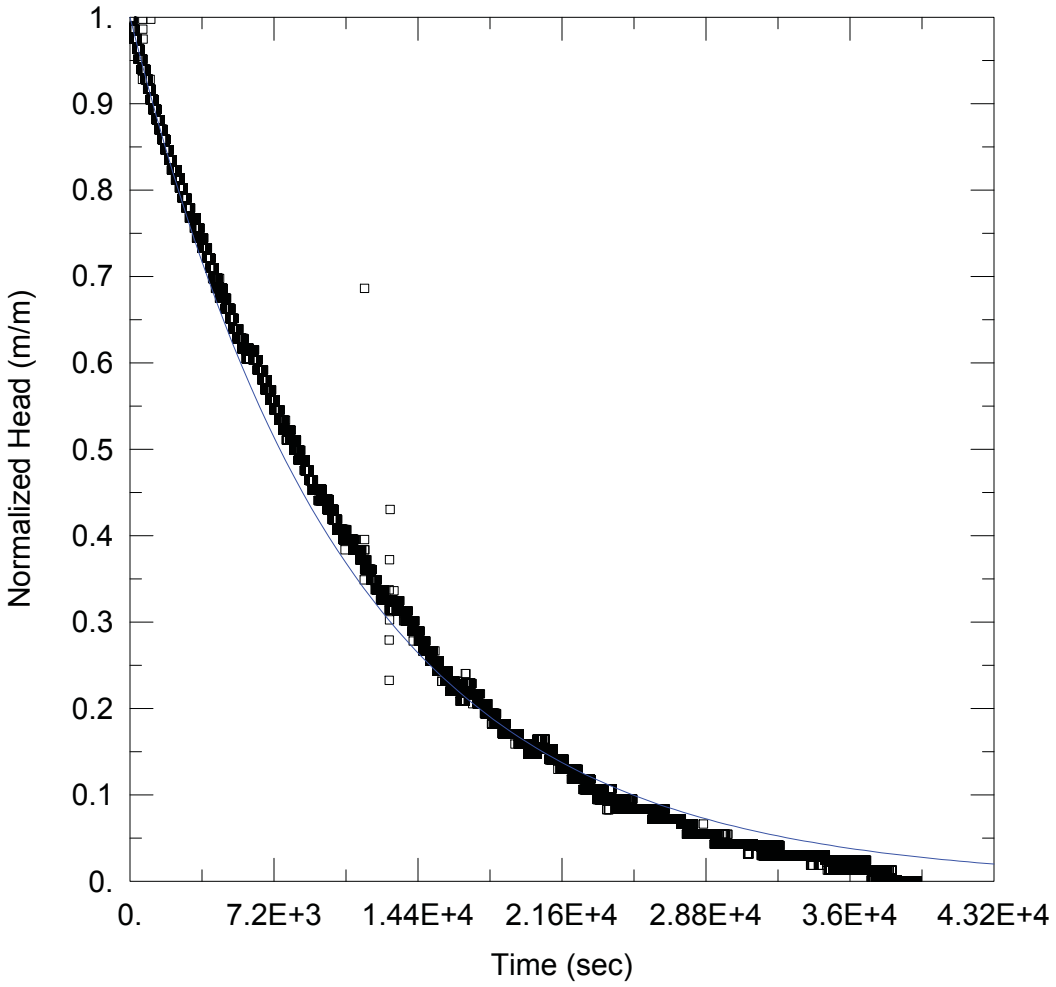
WELL DATA (MW4-D)

Initial Displacement: 0.312 m
Static Water Column Height: 13.38 m
Total Well Penetration Depth: 13.38 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW4-S Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 8.2E-8 m/sec Ss = 1.0E-10 m^{-1}
Kz/Kr = 1.

AQUIFER DATA

Saturated Thickness: 6.91 m

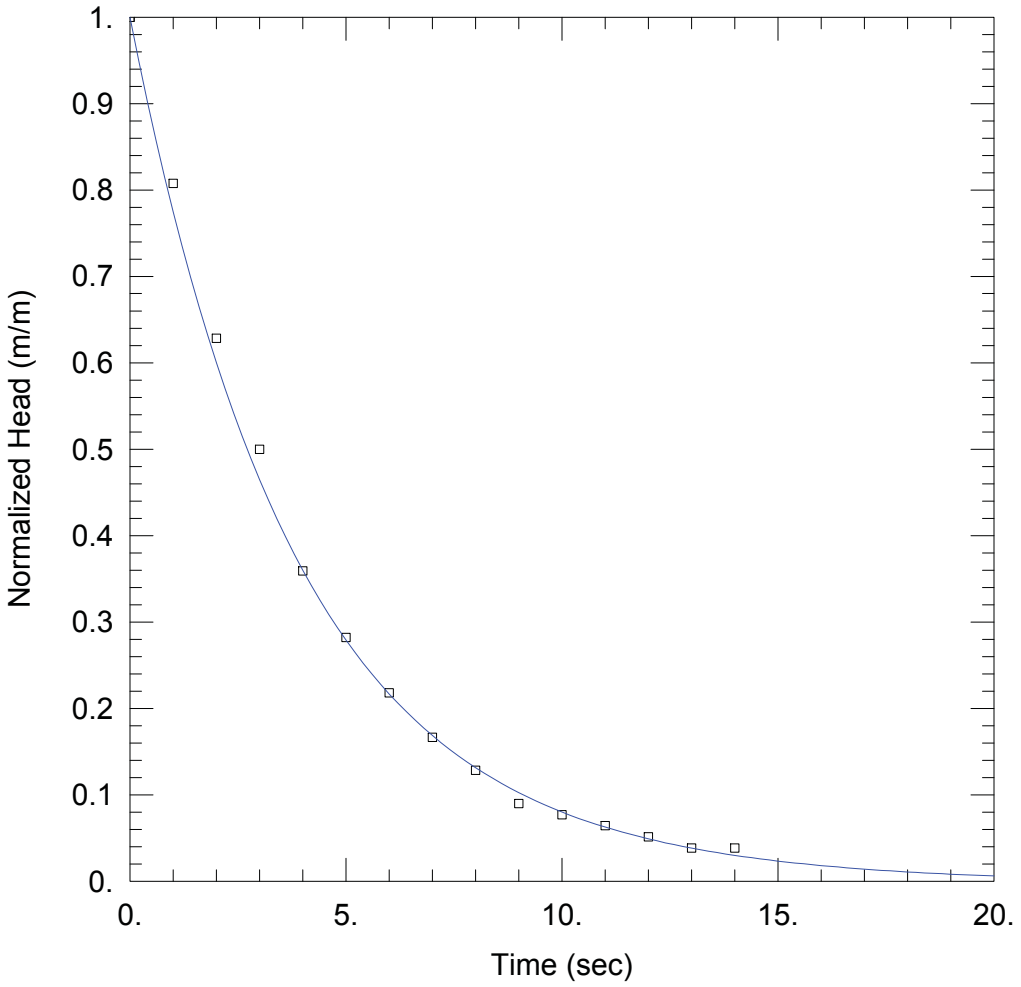
WELL DATA (MW4-S)

Initial Displacement: 0.258 m
Static Water Column Height: 6.91 m
Total Well Penetration Depth: 6.51 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW5-D Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00025 m/sec Ss = 1.4E-11 m^{-1}
Kz/Kr = 1.

AQUIFER DATA

Saturated Thickness: 18.45 m

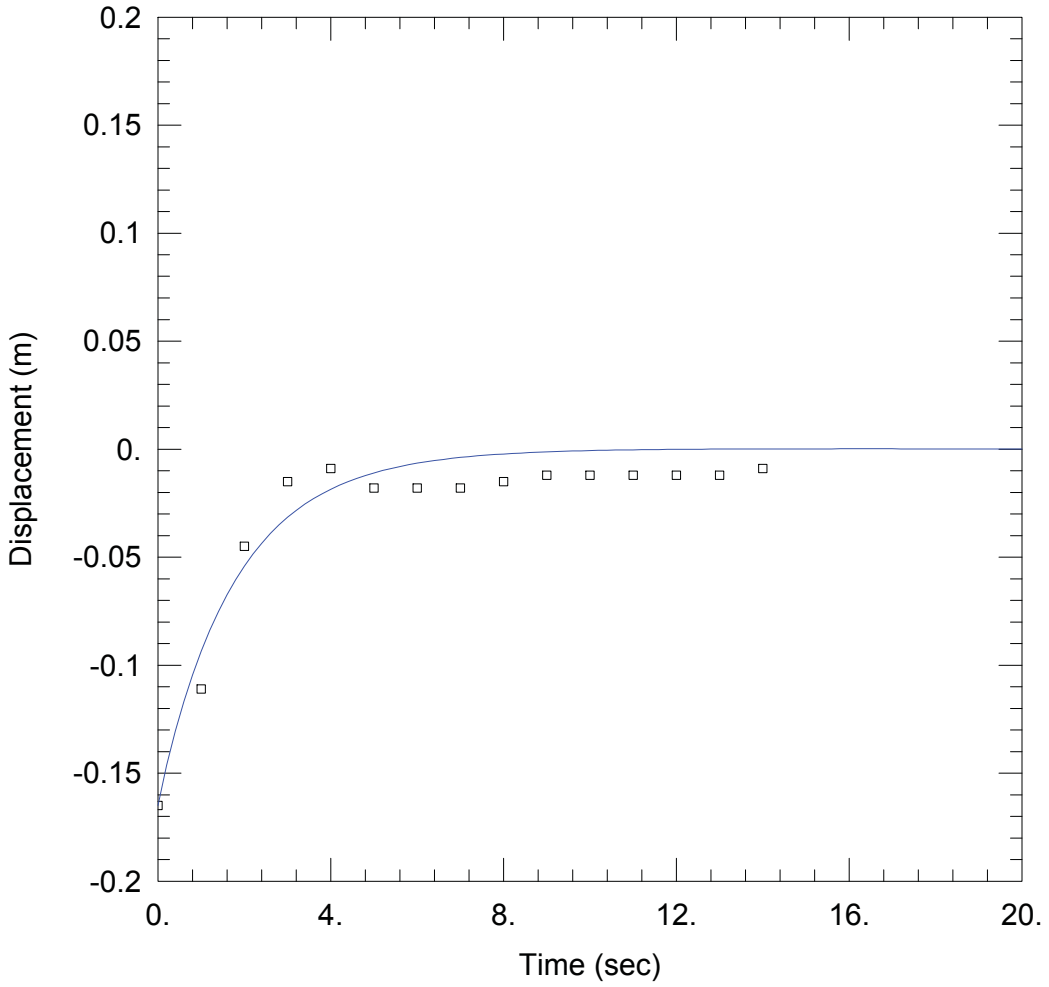
WELL DATA (MW5-D)

Initial Displacement: 0.234 m
Static Water Column Height: 18.45 m
Total Well Penetration Depth: 18.45 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW5-S Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00054 m/sec Ss = 1.0E-5 m^{-1}
Kz/Kr = 1.

AQUIFER DATA

Saturated Thickness: 11.59 m

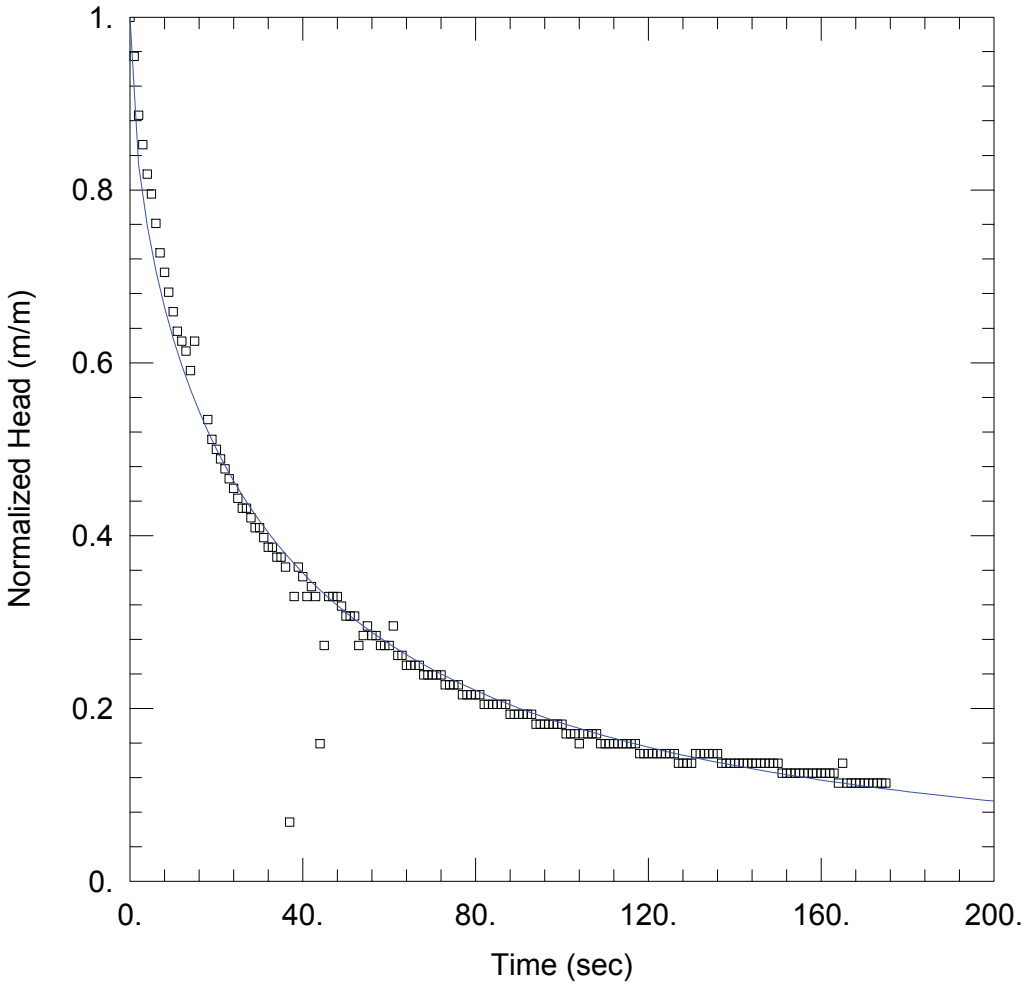
WELL DATA (MW5-S)

Initial Displacement: -0.165 m
Static Water Column Height: 11.59 m
Total Well Penetration Depth: 11.59 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW6-D Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 7.6E-6 m/sec Ss = 0.1 m^{-1}
Kz/Kr = 1.

AQUIFER DATA

Saturated Thickness: 19.9 m

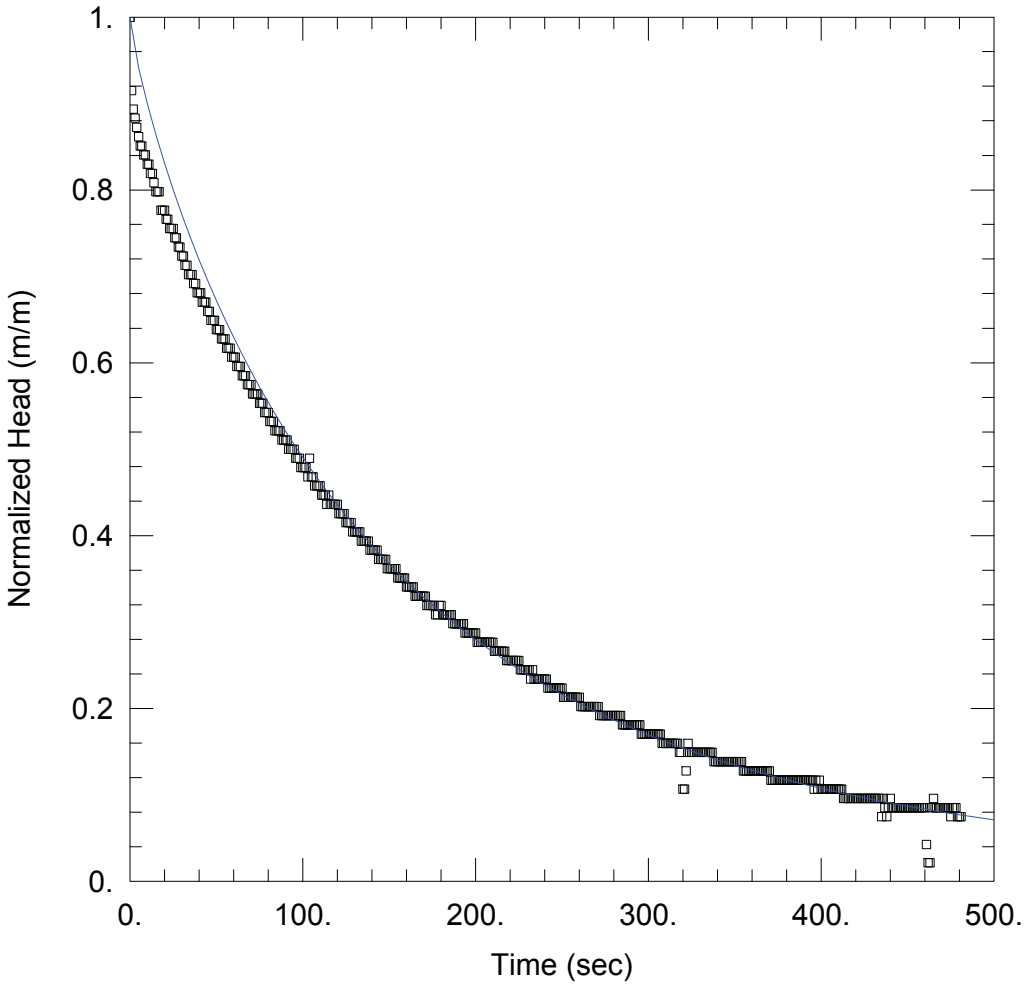
WELL DATA (MW6-D)

Initial Displacement: -0.264 m
Static Water Column Height: 19.9 m
Total Well Penetration Depth: 19.9 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW6-S Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 5.4E-6 m/sec Ss = 0.00077 m^{-1}
Kz/Kr = 1.

AQUIFER DATA

Saturated Thickness: 5.195 m

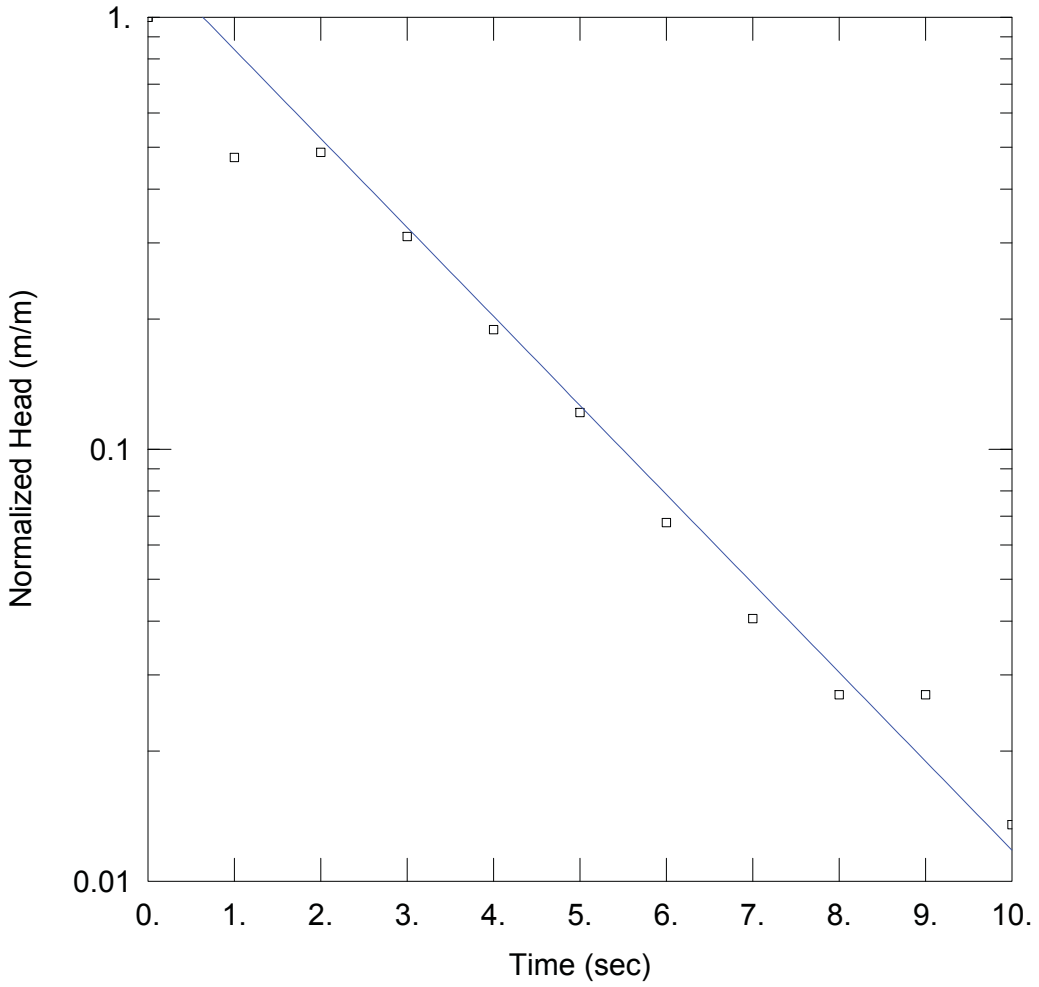
WELL DATA (MW6-S)

Initial Displacement: 0.282 m
Static Water Column Height: 5.195 m
Total Well Penetration Depth: 5.195 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW7-D Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.00048 m/sec y0 = 0.3 m

AQUIFER DATA

Saturated Thickness: 17.21 m Anisotropy Ratio (Kz/Kr): 1.

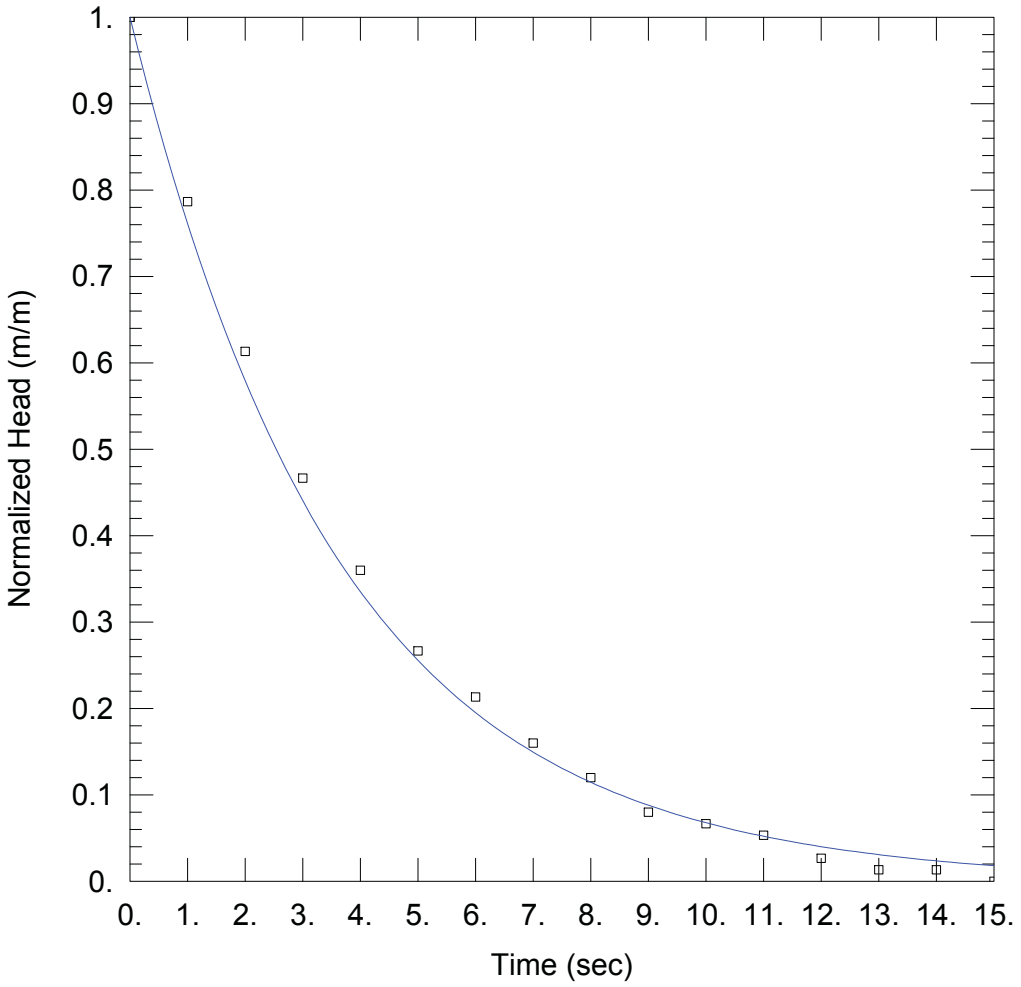
WELL DATA (MW7-D)

Initial Displacement: 0.222 m
Static Water Column Height: 17.21 m
Total Well Penetration Depth: 17.21 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW8-D Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00023 m/sec Ss = 1.0E-10 m^{-1}
Kz/Kr = 1.

AQUIFER DATA

Saturated Thickness: 16.08 m

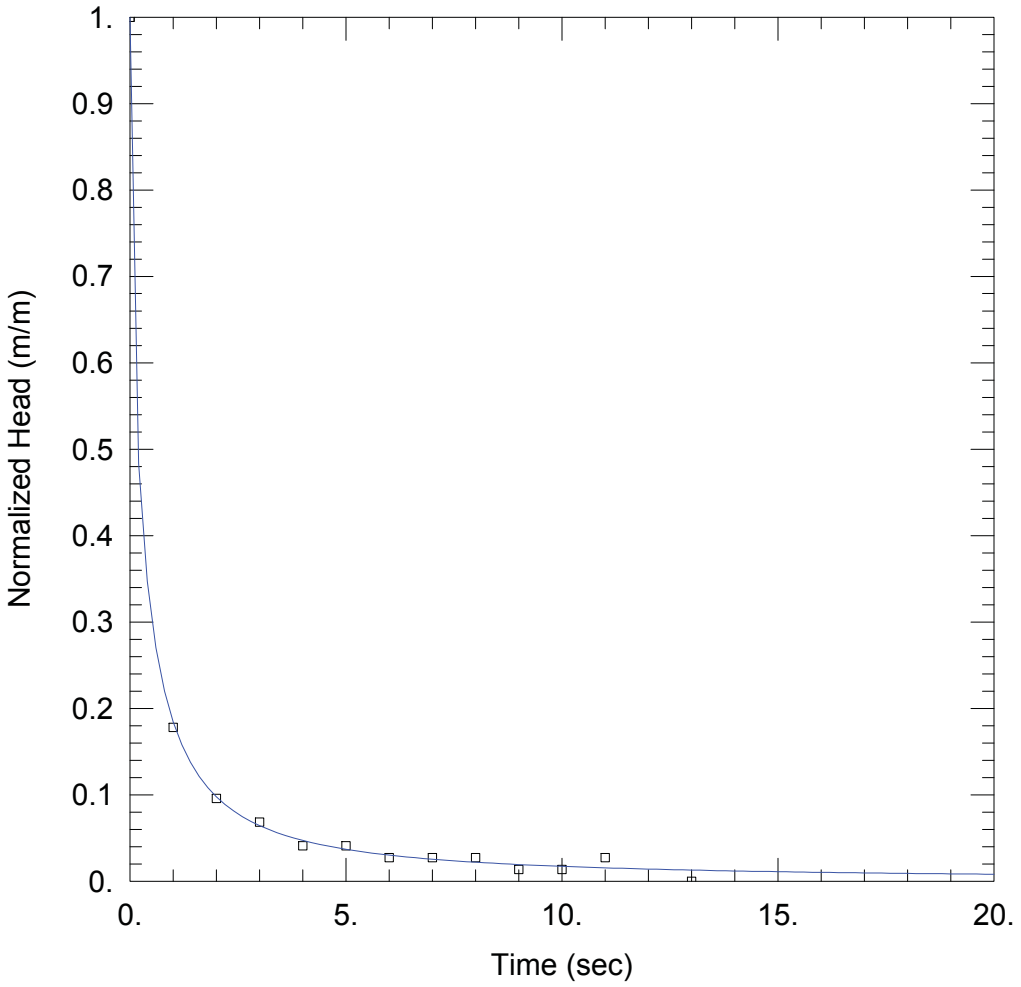
WELL DATA (MW8-D)

Initial Displacement: 0.225 m
Static Water Column Height: 11.66 m
Total Well Penetration Depth: 11.66 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW8-S Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00066 m/sec Ss = 0.16 m^{-1}
Kz/Kr = 1.

AQUIFER DATA

Saturated Thickness: 3.25 m

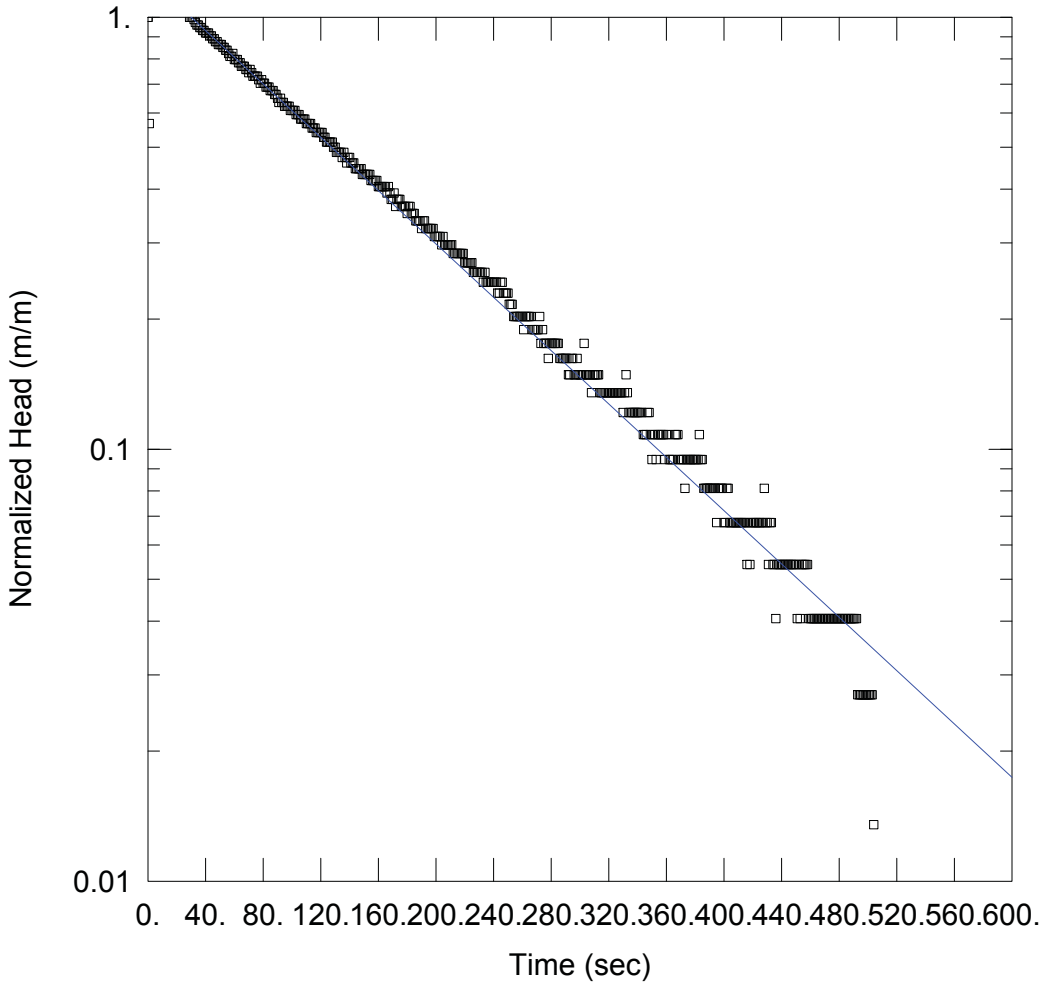
WELL DATA (MW8-S)

Initial Displacement: 0.219 m
Static Water Column Height: 3.25 m
Total Well Penetration Depth: 3.25 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW9-D Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 7.2E-6 m/sec y0 = 0.2745 m

AQUIFER DATA

Saturated Thickness: 17.25 m Anisotropy Ratio (Kz/Kr): 1.

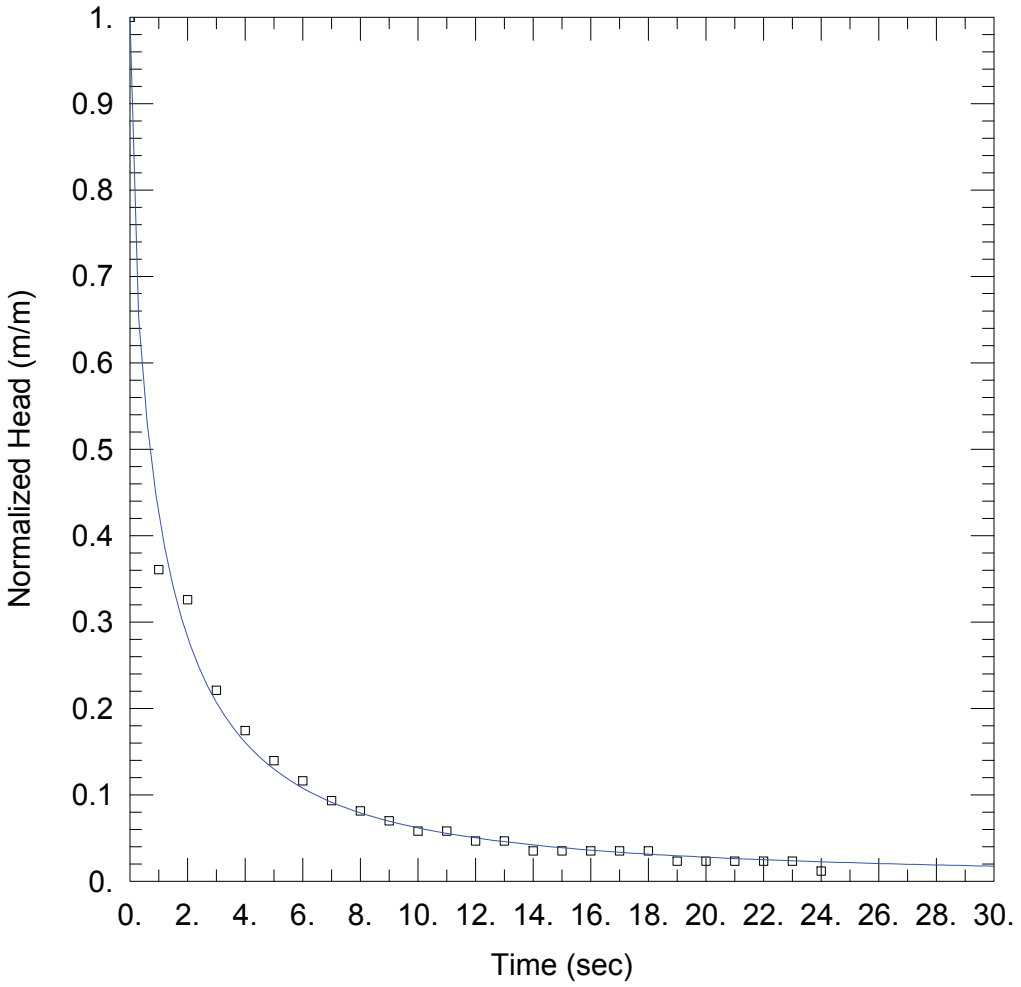
WELL DATA (MW9-D)

Initial Displacement: 0.222 m
Static Water Column Height: 17.25 m
Total Well Penetration Depth: 17.25 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

MW9-S Hydraulic Conductivity Test

Prepared By:	Prepared For:
Matrix Solutions Inc	City of Guelph
Project:	**Location:**
23089-528	Clair-Maltby



SOLUTION

Aquifer Model: Unconfined
Solution Method: KGS Model

Kr = 0.00022 m/sec Ss = 0.1 m^{-1}
Kz/Kr = 1.

AQUIFER DATA

Saturated Thickness: 3.795 m

WELL DATA (MW9-S)

Initial Displacement: 0.258 m
Static Water Column Height: 3.795 m
Total Well Penetration Depth: 3.795 m
Screen Length: 1.52 m
Casing Radius: 0.026 m
Well Radius: 0.026 m

Matrix Solutions Inc.

Appendix B-Tables
Tables B1-B7

TABLE B1

Monitoring Well Summary

City of Guelph

Clair - Maltby Master Environmental Servicing Plan (MESP) and Secondary Plan (SP)

Monitoring Well	UTM NAD83 Zone 17N		Elevation[1] (masl)					Depth (mbgs)					Hydraulic Conductivity (m/s)	Method	Stratigraphy of Screened Interval
	Northing	Easting	Ground Surface	Top of Casing	Oct. 2016 Ground Water	Dec. 2016 Ground Water	Jan. 2017 Ground Water	Top of Screen	Base of Screen	Oct. 2016 Water	Dec. 2016 Water	Jan. 2017 Water			
MW01-D	4817765	566644	337.27	337.85	331.52	331.26	332.02	19.6	21.1	5.75	6.01	5.25	5.8E-07	BR	Clayey Silt (Till)
MW01-S	4817763	566642	337.20	337.71	331.72	331.51	332.25	11.9	13.4	5.48	5.69	4.95	2.1E-04	BR	Sand, Gravel
MW02-D	4817419	566681	335.29	336.11	331.32	331.12	331.93	18.9	20.4	3.98	4.17	3.37	1.5E-03	SG	Gravely Sand
MW02-S	4817425	566682	335.40	336.36	332.00	331.80	332.55	6.7	8.2	3.40	3.60	2.85	2.1E-03	SG	Sandy Gravel
MW03-D	4816950	568080	350.05	350.80	330.89	330.58	330.51	32.6	34.1	19.17	19.48	19.55	2.8E-04	BR	Sand, Gravel
MW03-S	4816949	568083	349.95	350.70	331.17	330.80	330.68	21.6	23.2	18.78	19.15	19.27	NA	SG	Sand
MW04-D	4816485	566169	349.60	350.47	334.60	334.43	334.89	26.8	28.3	15.00	15.17	14.71	2.2E-06	BR	Sandy Silt
MW04-S	4816488	566171	349.63	350.54	336.01	335.80	336.06	19.4	20.9	13.63	13.83	13.58	8.2E-08	KGS	Silt (Till)
MW05-D	4816337	567001	340.17	341.10	334.66	334.46	334.85	22.6	24.1	5.51	5.71	5.32	2.5E-04	KGS	Sand, Gravel
MW05-S	4816335	566999	340.16	341.11	335.07	334.86	335.30	15.2	16.8	5.09	5.31	4.86	5.4E-04	KGS	Sand, Gravel
MW06-D	4816250	567400	352.38	353.20	334.40	334.14	334.29	35.1	36.6	17.98	18.24	18.09	7.6E-06	KGS	Silty Sand
MW06-S	4816247	567401	352.41	353.34	334.71	334.42	334.42	21.4	22.9	17.69	17.99	17.98	5.4E-06	KGS	Silt and Sand
MW07-D	4815512	565479	347.04	347.89	329.61	329.31	329.44	33.1	34.6	17.43	17.73	17.60	4.8E-04	BR	Sand, Gravel
MW08-D	4815489	566248	338.48	339.45	330.90	330.57	330.52	17.7	19.2	7.58	7.91	7.96	2.3E-04	KGS	Sand, Gravel
MW08-S	4815494	566250	338.48	339.40	334.08	333.81	334.39	6.1	7.6	4.40	4.67	4.09	6.6E-04	KGS	Sand, Gravel
MW09-D	4815295	566970	350.51	351.15	331.14	330.81	330.74	32.0	33.5	19.37	19.69	19.77	7.2E-06	BR	Sandy Silt
MW09-S	4815292	566972	350.46	350.98	331.02	330.74	330.64	21.6	23.2	19.44	19.72	19.82	2.2E-04	KGS	Sand, Gravel
MW1-11*	4816210	565410	346.40	347.32	329.85	329.62	329.94	15.3[AB]	18.3[AB]	16.55	16.77	16.46	--	--	--
MW2-11*	4816026	565434	343.36	344.37	329.91	329.67	329.89	12.0[AB]	15.0[AB]	13.45	13.69	13.47	--	--	--
MW3-11*	4815829	565622	349.03	349.90	331.41	331.48	331.48	11.6[AB]	17.8[AB]	17.62	17.56	17.55	--	---	--

Notes:

[1] - elevations are geodetic
[AB] - As reported by Aquifer Beach Ltd. (2012)
* - Pre-existing monitoring well at 132 Clair Road
masl - metres above sea level
NA - not available
BR - Bouwer and Rice method (1976)
KGS - Hyder et al method (1994)
SG - Springer-Gelhar (1991)
- Indicates an upward flow gradient at the well

Notes:

Water levels were recorded on the following dates:
October 19, 20, 21, 2016
December 13, 2016
January 26, 2017

TABLE B2

Mini Piezometer Summary

City of Guelph

Clair - Maltby Master Environmental Servicing Plan (MESP) and Secondary Plan (SP)

Monitoring Well	UTM NAD83 Zone 17N		Elevation[1] (masl)								Depth (mbgs)
					Oct. 2016		Dec. 2016		Jan. 2017		
	Northing	Easting	Ground Surface	Top of Casing	Surface Water	Ground Water	Surface Water	Ground Water	Surface Water	Ground Water	Ground Surface to Screen Base
MP01-D	4816236	565484	341.95	342.86	dry	340.64	dry	340.77	342.11	341.30	1.99
MP01-S	4816236	565484	341.95	342.78	dry	dry	dry	dry	342.12	341.83	1.15
MP02	4816113	565844	345.90	347.16	dry	dry	dry	dry	346.18	345.58	1.04
MP03	4816332	566274	347.42	348.28	dry	347.09	dry	347.23	347.55	347.52	1.44
MP04	4816622	566419	339.30	340.33	dry	339.09	dry	339.25	339.67	339.66	1.27
MP05	4815925	566681	337.70	338.36	dry	337.49	dry	337.64	338.13	338.13	1.64
MP06	4816131	566973	337.39	338.24	dry	337.00	dry	337.02	337.73	337.69	1.45
MP07-D	4816369	567115	337.26	338.37	dry	336.45	dry	336.75	337.43	336.82	2.42
MP07-S	4816369	567115	337.29	338.22	dry	336.97	dry	336.96	337.38	337.32	1.37
MP08	4816745	566739	337.40	338.72	337.38	337.28	337.40	337.29	337.68	337.67	0.98
MP09-D	4817378	566708	333.14	334.00	dry	331.63	dry	331.92	332.99	332.26	2.04
MP09-S	4817379	566707	333.14	334.30	dry	332.47	dry	332.45	332.99	332.33	1.14
MP10	4815366	565340	330.11	331.58	NA	NA	dry	329.95	330.13	330.10	0.97
MP11	4814531	566385	333.03	334.04	dry	332.98	333.19	333.16	333.33	333.33	1.29
MP12	4816079	567796	334.34	335.61	NA	NA	dry	334.16	334.38	334.33	1.47
MP13-D	4816631	568562	334.03	335.21	dry	333.29	333.99	333.38	334.30	333.99	2.17
MP13-S	4816631	568563	334.07	335.04	dry	333.51	333.99	333.74	334.28	333.83	1.16
MP14	4815633	568626	326.80	327.54	326.90	326.56	326.90	326.85	326.96	327.11	0.86

Notes:

[1] - elevations are geodetic

masl - metres above sea level

NA - not available

- Indicates an upward flow gradient in the GW system

- Indicates groundwater discharge to surface water

Notes:

Water levels were recorded on the following dates:

October 20 and 21, 2016

December 13, 2016

January 26, 2017

TABLE B3

Groundwater Quality Results - Field and Routine Parameters

City of Guelph

Clair - Maltby Master Environmental Servicing Plan (MESP) and Secondary Plan (SP)

Sample Point		MW01-D	MW01-S	MW02-D	MW02-S	MW03-D	MW03-S	MW04-D	MW04-S	MW05-D	MW05-S	MW06-D	MW06-S	Ontario Drinking Water Quality Standards[+]
Sample Date		20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	19-Oct-16	19-Oct-16	19-Oct-16	19-Oct-16	
MSI Sample Number		23089161020003	23089161020004	23089161020002	23089161020001	23089161020005	23089161020006	23089161020008	23089161020007	23089161019007	23089161019006	23089161019004	23089161019005	
Field Parameters														
Field EC[25]	µS/cm	439	975	753	880	547	676	504	598	683	790	474	616	**NS**
Field DO[%]	% Saturation	71.3	70.1	15.4	19.1	22	54.2	23.1	45.6	15.1	22.2	25.3	33.3	**NS**
Field pH		7.2	7.5	7.3	7	8.1	7.7	8.2	8.3	7.4	7.3	8.1	8.2	**6.5 - 8.5** [OG]
Field Temp	°C	10.4	11.4	10.5	12.4	8.4	8.8	8.7	9.3	9.9	9.8	10.4	10.8	**15**[AO]
Turbidity	NTU	***269.2***	***224.1***	***136.7***	***122.6***	***449.7***	---	---	---	***856.7***	***478***	***185.8***	***973.5***	**5**[AO]
Routine Potability														
Bicarbonate	mg/L	188	291	354	375	248	317	239	227	366	327	229	282	**NS**
Calcium	mg/L	20.7	87.8	97	98.3	57.9	80.5	41.9	53.2	94.3	105	50.9	69.2	**NS**
Carbonate	mg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**NS**
Chloride	mg/L	13.2	106	18.4	61.3	12.6	28.6	9.95	26.8	11.9	10	4.32	9.21	**250**[AO]
Lab EC	µS/cm	411	947	723	862	517	680	484	568	663	750	460	602	**NS**
Hydroxide	mg/L	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	**NS**
Ion Balance	%	104	100	106	101	103	106	103	102	101	112	112	108	**NS**
Iron	mg/L	<0.010	<0.010	***0.452***	***1.27***	0.222	<0.010	0.288	<0.010	***2.25***	***0.346***	0.067	0.012	**0.3**[AO]
Magnesium	mg/L	19.3	29	26.7	25.1	25.4	28	26.6	25.4	27	35.8	20.8	29.7	**NS**
Manganese	mg/L	0.0157	0.00157	***0.157***	***0.459***	0.0174	0.013	0.0135	***0.0575***	***0.0829***	***0.159***	0.0154	0.0453	**0.05**[AO]
Nitrate-N	mg/L	<0.10	2.12	<0.020	<0.020	<0.020	1.65	<0.020	<0.020	<0.020	0.429	<0.020	<0.020	**10**[MAC]
Nitrite-N	mg/L	<0.050	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.028	<0.010	0.056	<0.010	<0.010	**1**[MAC]
Lab pH		7.96	7.2	7.15	6.85	7.54	7.38	7.76	7.66	7.17	7.17	7.64	7.53	**6.5 - 8.5** [OG]
Potassium	mg/L	0.798	1.65	1.01	0.868	0.986	1.62	1.48	2.8	0.837	1.63	1.28	2.2	**NS**
Sodium	mg/L	33.7	49	8.9	32.8	4.38	13.7	13.5	18.5	4.71	5.53	15.1	13	**200**[AO,Na]
Sulphate	mg/L	23.4	49.3	34.9	20.2	27.7	20.4	25.7	48.8	36	89.4	24.7	55.6	**500**[AO]
Temperature of sample upon receipt by lab	°C	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	8.7	8.7	8.7	8.7	**NS**
Total Alkalinity	mg/L	188	291	354	375	248	317	239	227	366	327	229	282	**30 - 500** [OG]
Total Dissolved Solids	mg/L	246	***550***	416	495	293	385	278	323	396	430	259	351	**500**[AO]
Total Hardness	mg/L	***131***	***339***	***352***	***349***	***249***	***316***	***214***	***237***	***347***	***410***	***213***	***295***	**80 - 100** [OG]
Total Kjeldahl Nitrogen	mg/L	0.67	0.43	0.44	0.48	0.23	<1.5	0.18	5	4.1	0.62	0.19	0.28	**NS**

Notes:

--- - not analyzed

NS - not specified

[25] - field EC corrected to 25°C

[AO] - aesthetic objective

[OG] - operational guidelines

[MAC] - maximum acceptable concentration

NTU - nephelometric turbidity units

[Na] - the local Medical Officer or Health should be notified when sodium concentrations exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets

Italics - values do not meet applicable guidelines

TABLE B3

Groundwater Quality Results - Field and Routine Parameters

City of Guelph

Clair - Maltby Master Environmental Servicing Plan (MESP) and Secondary Plan (SP)

Sample Point		MW07-D	MW08-D	MW08-S	MW09-D	MW09-S	Ontario Drinking Water Quality Standards[+]
Sample Date		19-Oct-16	19-Oct-16	19-Oct-16	21-Oct-16	21-Oct-16	
MSI Sample Number		23089161019001	23089161019002	23089161019003	23089161021001	23089161021002	
Field Parameters							
Field EC[25]	µS/cm	709	1188	597	486	635	**NS**
Field DO[%]	% Saturation	42.7	35	22.6	30	69.1	**NS**
Field pH		7.4	7	7.3	8.4	7.8	**6.5 - 8.5** [OG]
Field Temp	°C	10.1	10.3	11.9	8.5	8.4	**15**[AO]
Turbidity	NTU	***428***	***>1100***	***727.8***	---	---	**5**[AO]
Routine Potability							
Bicarbonate	mg/L	276	336	288	237	260	**NS**
Calcium	mg/L	79.3	105	77.7	54.4	89.3	**NS**
Carbonate	mg/L	<10	<10	<10	<10	<10	**NS**
Chloride	mg/L	39.6	189	14.4	2.79	14.1	**250**[AO]
Lab EC	µS/cm	696	1180	569	445	583	**NS**
Hydroxide	mg/L	<10	<10	<10	<10	<10	**NS**
Ion Balance	%	109	101	112	123	121	**NS**
Iron	mg/L	0.024	<0.010	<0.010	0.024	<0.010	**0.3**[AO]
Magnesium	mg/L	30.7	30.5	22.8	22.3	23.4	**NS**
Manganese	mg/L	***0.0787***	0.0434	0.00707	0.0367	0.00469	**0.05**[AO]
Nitrate-N	mg/L	0.318	1.49	1.04	<0.020	7	**10**[MAC]
Nitrite-N	mg/L	0.028	<0.050	<0.010	<0.010	<0.010	**1**[MAC]
Lab pH		7.44	7.23	7.25	7.56	7.28	**6.5 - 8.5** [OG]
Potassium	mg/L	1.55	3.18	1.29	1.08	3.34	**NS**
Sodium	mg/L	17.1	88.3	4.17	12.1	4.69	**200**[AO,Na]
Sulphate	mg/L	47.4	32	4.79	7.88	16.9	**500**[AO]
Temperature of sample upon receipt by lab	°C	8.7	8.7	8.7	12	12	**NS**
Total Alkalinity	mg/L	276	336	288	237	260	**30 - 500** [OG]
Total Dissolved Solids	mg/L	386	***639***	295	272	346	**500**[AO]
Total Hardness	mg/L	***325***	***388***	***288***	***228***	***319***	**80 - 100** [OG]
Total Kjeldahl Nitrogen	mg/L	<0.15	0.51	0.76	0.48	1.91	**NS**

Notes:

--- - not analyzed

NS - not specified

[25] - field EC corrected to 25°C

[AO] - aesthetic objective

[OG] - operational guidelines

[MAC] - maximum acceptable concentration

NTU - nephelometric turbidity units

[Na] - the local Medical Officer or Health should be notified when sodium concentrations exceeds 20 mg/L so that this information may be communicated to local physicians for their use with patients on sodium restricted diets

Italics - values do not meet applicable guidelines

TABLE B4

Groundwater Quality Results - Dissolved Metals

City of Guelph

Clair - Maltby Master Environmental Servicing Plan (MESP) and Secondary Plan (SP)

Sample Point		MW01-D	MW01-S	MW02-D	MW02-S	MW03-D	MW03-S	MW04-D	MW04-S	MW05-D	MW05-S	MW06-D	MW06-S	Ontario Drinking Water Quality Standards[+]
Sample Date		20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	20-Oct-16	19-Oct-16	19-Oct-16	19-Oct-16	19-Oct-16	
MSI Sample Number		23089161020003	23089161020004	23089161020002	23089161020001	23089161020005	23089161020006	23089161020008	23089161020007	23089161019007	23089161019006	23089161019004	23089161019005	
Silver (Ag)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	**NS**
Aluminum (Al)	mg/L	0.007	<0.0050	<0.0050	0.0064	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	**0.1[OG]**
Arsenic (As)	mg/L	0.00763	0.00012	0.0104	0.023	0.00238	0.00019	0.00812	0.0003	0.0008	0.00333	0.00166	0.00104	**0.025[IMAC]**
Boron (B)	mg/L	0.078	0.021	0.015	0.028	<0.010	0.011	0.015	0.018	<0.010	<0.010	0.012	0.014	**5[IMAC]**
Barium (Ba)	mg/L	0.0345	0.0573	0.0901	0.0647	0.0806	0.0832	0.0637	0.0793	0.145	0.126	0.121	0.124	**1[MAC]**
Beryllium (Be)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	**NS**
Bismuth (Bi)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	**NS**
Cadmium (Cd)	mg/L	<0.000010	0.000195	<0.000010	<0.000010	<0.000010	0.000064	<0.000010	<0.000010	<0.000010	0.000019	<0.000010	<0.000010	**0.005[MAC]**
Cesium (Cs)	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000011	<0.000010	<0.000010	<0.000010	**NS**
Cobalt (Co)	mg/L	0.00022	<0.00010	0.00137	0.003	0.00013	<0.00010	<0.00010	0.00023	0.00011	0.00092	0.00013	0.0002	**NS**
Chromium (Cr)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	**0.05[MAC]**
Copper (Cu)	mg/L	0.00059	0.00129	0.00056	0.00056	0.00032	0.00081	0.00033	0.00037	<0.00020	0.00046	0.00037	0.00046	**1[AO]**
Lithium (Li)	mg/L	0.0016	0.0016	0.0017	0.0014	0.0023	<0.0010	0.0029	<0.0010	0.0018	0.0043	0.0027	0.0017	**NS**
Molybdenum (Mo)	mg/L	0.00453	0.000284	0.00136	0.00192	0.000905	0.000447	0.00315	0.0066	0.000176	0.0235	0.0023	0.00323	**NS**
Nickel (Ni)	mg/L	0.00152	0.00082	0.00619	0.0126	<0.00050	0.00083	<0.00050	0.00647	0.0009	0.00372	<0.00050	<0.00050	**NS**
Phosphorus (P)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	**NS**
Lead (Pb)	mg/L	<0.000050	0.00018	0.000163	0.000266	<0.000050	0.000158	<0.000050	<0.000050	<0.000050	0.000154	<0.000050	<0.000050	**0.01[MAC,Pb]**
Rubidium (Rb)	mg/L	0.00082	0.0026	0.00129	0.00182	0.00056	0.00205	0.00062	0.00208	0.00075	0.0024	0.00075	0.00159	**NS**
Sulfur (S)	mg/L	7.99	16.5	11.2	6.4	8.95	6.67	8.32	15.5	11.6	31	8.63	18.1	**NS**
Antimony (Sb)	mg/L	0.00024	<0.00010	0.00046	0.00049	<0.00010	<0.00010	<0.00010	0.0004	<0.00010	0.00041	<0.00010	0.0003	**0.006[IMAC]**
Selenium (Se)	mg/L	<0.000050	0.000229	<0.000050	0.000151	<0.000050	0.000258	<0.000050	0.000206	<0.000050	0.000167	<0.000050	0.000053	**0.01[MAC]**
Silicon (Si)	mg/L	4.6	4	5.6	3.84	6.41	5.02	8.69	5.85	9.08	4.01	6.43	4.2	**NS**
Tin (Sn)	mg/L	0.00014	<0.00010	<0.00010	<0.00010	0.00012	<0.00010	0.00013	0.0007	<0.00010	<0.00010	0.00016	0.00061	**NS**
Strontium (Sr)	mg/L	0.314	0.326	0.142	0.144	0.109	0.11	0.158	0.256	0.135	0.143	0.123	0.256	**NS**
Tellurium (Te)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	**NS**
Thorium (Th)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	**NS**
Titanium (Ti)	mg/L	<0.00030	<0.00030	<0.00030	<0.00040	<0.00030	<0.00030	<0.00030	<0.00030	0.00038	<0.00030	<0.00030	<0.00030	**NS**
Thallium (Tl)	mg/L	<0.000010	0.000021	<0.000010	<0.000010	<0.000010	0.000024	<0.000010	0.000014	<0.000010	0.00002	<0.000010	<0.000010	**NS**
Uranium (U)	mg/L	0.00232	0.000809	0.00489	0.00961	0.00149	0.00102	0.00112	0.00248	0.000113	***0.024***	0.00202	0.00545	**0.02[MAC]**
Vanadium (V)	mg/L	0.001	<0.00050	<0.00050	0.00128	<0.00050	<0.00050	<0.00050	<0.00050	0.00062	<0.00050	<0.00050	<0.00050	**NS**
Tungsten (W)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	**NS**
Zinc (Zn)	mg/L	0.0042	0.111	0.0404	0.183	0.0053	0.0648	0.0272	0.0039	0.0019	0.0276	0.0038	0.0509	**5[AO]**
Zirconium (Zr)	mg/L	<0.00030	<0.00030	<0.00030	0.00053	<0.00030	<0.00030	<0.00030	<0.00030	0.00051	<0.00030	<0.00030	<0.00030	**NS**

Notes:

--- - not analyzed

NS - not specified

AO - aesthetic objective from Guidelines for Canadian Drinking Water Quality-Summary Table (Health Canada 2017)

OG - operational guidelines

MAC - maximum acceptable concentration from Guidelines for Canadian Drinking Water Quality-Summary Table (Health Canada 2017)

IMAC - interim maximum acceptable concentration

Pb - standard applies to water at the point of consumption. Since lead is a component in some plumbing systems,

\+ - *Technical Support Document for Ontario Drinking Water Quality Standards, Objectives and Guidelines* (MOE 2006)

Italics - values do not meet applicable guidelines

TABLE B4

Groundwater Quality Results - Dissolved Metals

City of Guelph

Clair - Maltby Master Environmental Servicing Plan (MESP) and Secondary Plan (SP)

Sample Point		MW07-D	MW08-D	MW08-S	MW09-D	MW09-S	Ontario Drinking Water Quality Standards[+]
Sample Date		19-Oct-16	19-Oct-16	19-Oct-16	21-Oct-16	21-Oct-16	
MSI Sample Number		23089161019001	23089161019002	23089161019003	23089161021001	23089161021002	
Silver (Ag)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	**NS**
Aluminum (Al)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	**0.1**[OG]
Arsenic (As)	mg/L	0.00037	<0.00010	0.00028	0.0039	0.00012	**0.025**[IMAC]
Boron (B)	mg/L	<0.010	0.013	0.011	0.017	0.012	**5**[IMAC]
Barium (Ba)	mg/L	0.127	0.144	0.0167	0.0908	0.0869	**1**[MAC]
Beryllium (Be)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	**NS**
Bismuth (Bi)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	**NS**
Cadmium (Cd)	mg/L	0.000015	0.000067	0.000043	0.000019	0.000036	**0.005**[MAC]
Cesium (Cs)	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	**NS**
Cobalt (Co)	mg/L	0.00062	0.00085	0.00018	0.00023	<0.00010	**NS**
Chromium (Cr)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	**0.05**[MAC]
Copper (Cu)	mg/L	0.00103	0.00201	0.00158	0.00054	0.00112	**1**[AO]
Lithium (Li)	mg/L	0.0032	0.0034	<0.0010	0.0027	<0.0010	**NS**
Molybdenum (Mo)	mg/L	0.00118	0.000662	0.000655	0.00634	0.000203	**NS**
Nickel (Ni)	mg/L	0.00174	0.0031	0.00945	0.00068	<0.00050	**NS**
Phosphorus (P)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	**NS**
Lead (Pb)	mg/L	0.000155	0.000614	0.000051	0.000113	0.00006	**0.01**[MAC,Pb]
Rubidium (Rb)	mg/L	0.00127	0.00225	0.00069	0.00167	0.00047	**NS**
Sulfur (S)	mg/L	15.5	10.9	1.48	2.24	5.6	**NS**
Antimony (Sb)	mg/L	0.00017	0.00012	0.00036	0.00013	<0.00010	**0.006**[IMAC]
Selenium (Se)	mg/L	0.000098	0.000251	0.000132	<0.000050	0.000314	**0.01**[MAC]
Silicon (Si)	mg/L	6.12	5.51	3.66	7.26	4.43	**NS**
Tin (Sn)	mg/L	0.00055	<0.00010	0.00123	0.00027	0.00027	**NS**
Strontium (Sr)	mg/L	0.114	0.18	0.115	0.166	0.0948	**NS**
Tellurium (Te)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	**NS**
Thorium (Th)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	**NS**
Titanium (Ti)	mg/L	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	**NS**
Thallium (Tl)	mg/L	0.000018	0.000048	<0.000010	0.00002	<0.000010	**NS**
Uranium (U)	mg/L	0.00148	0.000649	0.000231	0.00104	0.000262	**0.02**[MAC]
Vanadium (V)	mg/L	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	**NS**
Tungsten (W)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	**NS**
Zinc (Zn)	mg/L	0.0149	0.192	0.0101	0.0146	0.0604	**5**[AO]
Zirconium (Zr)	mg/L	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	**NS**

Notes:

--- - not analyzed

NS - not specified

AO - aesthetic objective from Guidelines for Canadian Drinking Water Quality-Summary Table (Health Canada 2017)

OG - operational guidelines

MAC - maximum acceptable concentration from Guidelines for Canadian Drinking Water Quality-Summary Table (Health Canada 2017)

IMAC - interim maximum acceptable concentration

Pb - standard applies to water at the point of consumption. Since lead is a component in some plumbing systems,

\+ - *Technical Support Document for Ontario Drinking Water Quality Standards, Objectives and Guidelines* (MOE 2006)

Italics - values do not meet applicable guidelines

TABLE B5

Groundwater Quality Results - Enriched Tritium

City of Guelph

Clair - Maltby Master Environmental Servicing Plan (MESP) and Secondary Plan (SP)

Sample Point	Sample Date	MSI Sample Number	^{3}H Tritium TU
MW03-S	28-Oct-16	23089161028003	13.10
MW05-S	28-Oct-16	23089161028001	10.90
MW05-D	28-Oct-16	23089161028002	10.10
MW07-D	28-Oct-16	23089161028004	6.40
Minimal Detection Limit**			**0.80**

Notes:

1TU = 0.11919 Becquerels/L per IAEA, 2000 Report.

TABLE B6

Guelph Permeameter Testing Results

City of Guelph

Clair - Maltby Master Environmental Servicing Plan (MESP) and Secondary Plan (SP)

Location ID	Adjacent MW Nest	Date	Soil Interval		Soil Description*	Field Saturated Soil Hydraulic Conductivity (m/s)
			Top (mbgs)	Bottom (mbgs)		
GP01	MW01	2-Nov-16	0.00	0.19	Clayey Silt, some gravel to cobbles, trace sand	3.7E-06
GP02	MW02	2-Nov-16	0.00	0.22	Silty Clay, trace sand and gravel	4.4E-08
			0.22	0.41	Clayey Silt, some sand, trace gravel	
GP03	MW03	2-Nov-16	0.00	0.22	Clayey Silt, organics	1.6E-06
			0.22	0.34	Very Fine Sand, some silt	
GP04	MW04	1-Nov-16	0.00	0.19	Clayey Silt, trace sand and gravel	3.4E-07
			0.19	0.30	Fine Sandy Silt, trace clay and gravel	
GP05	MW05	1-Nov-16	0.00	0.20	Silty Sand	2.7E-07
			0.20	0.35	Silty Sand, trace gravel	
GP06	MW06	1-Nov-16	0.00	0.10	Silty Clay, organics	2.6E-07
			0.10	0.20	Clayey Silt, trace sand	
			0.20	0.33	Silty Clay, trace sand	
GP07	MW07	1-Nov-16	0.00	0.20	Silty Sand, trace gravel, organics	1.6E-06
			0.20	0.30	Fine Sand, trace silt	
GP08	MW08	2-Nov-16	0.00	0.33	Clayey Silt, trace sand	6.9E-08
GP09	MW09	2-Nov-16	0.00	0.28	Clayey Silt, trace sand and gravel, organics, worms	1.2E-05

Notes:

* - Soil description of hand-augered, near surface soil

TABLE B7

Surface Water Spot Flow Results

City of Guelph

Clair - Maltby Master Environmental Servicing Plan (MESP) and Secondary Plan (SP)

Spot Flow Location	Subwatershed	UTM NAD83 Zone 17N		Spot Flows											
				Summer 2016							Fall 2016				
				Aug. 30		Aug. 31		Sep. 1			Nov. 9		Nov. 10		
		Northing	Easting	Flow (L/s)	SW Temp °C	Flow (L/s)	SW Temp °C	Flow (L/s)	SW Temp °C	Flow Method	Flow (L/s)	SW Temp °C	Flow (L/s)	SW Temp °C	Flow Method
HC-HR1	Hanlon Creek	4817074	562217			63.3	18.1			FT			59.9	6.3	FT
HC-HR2	Hanlon Creek	4816810	562558			0.0	---			V			0.0	---	V
HC-HR3	Hanlon Creek	4816866	562652					2.1	---	L			2.6	10.2	FT
HC-T1	Hanlon Creek	4816367	562118					14.0	17	FT			11.6	6.3	FT
LSR-D2	Hanlon Creek	4814794	562355					0.0	---	V			0.0	---	V
LSR-L1	Lower Speed River	4815033	561481			0.0	---			V			0.0	---	V
LSR-P1	Lower Speed River	4815726	560821					0.1	---	B			0.1	---	B
LSR-P2	Lower Speed River	4816066	560757					0.0	---	V			0.0	---	V
LSR-P3	Lower Speed River	4816551	560703					0.1	---	V			0.3	---	B
MC-C71	Mill Creek	4812339	566992			0.0	---			V	0.0	---			V
MC-C72	Mill Creek	4812723	566606			0.0	---			V	0.8	---			L
MC-G1	Mill Creek	4813575	569960	36.9	15.2					FT	43.4	7.6			FT
MC-GN1	Mill Creek	4814253	568042	1.9	21.5					FT	4.7	8.3			FT
MC-GN2	Mill Creek	4814342	567968	1.9	---					B	2.4	---			B
MC-GN3	Mill Creek	4813648	568576			73.8	16.9			FT	58.2	8.4			FT
MC-GN4	Mill Creek	4813263	569173			105.7	23.9			FT	111.4	8.7			FT
MC-M2	Mill Creek	4818016	569639	---	---	---	---	---	---	---			0.0	---	V
MC-M3	Mill Creek	4814352	566152			0.0	---			V	0.0	---			V
MC-SR1	Mill Creek	4811552	567674			174.3	21.9			FT	187.2	8.1			FT
MC-V1	Mill Creek	4813756	571458	16.5	16.4					FT	12.0	7.4			FT
MC-V2	Mill Creek	4815732	569467	11.2	20.9					FT	5.8	8.0			FT
MC-W2	Mill Creek	4817137	571205	8.3	---					FT			5.6	6.3	FT
MC-WL3	Mill Creek	4813824	568493	76.9	17.9					FT	65.8	8.0			FT
MC-WL4	Mill Creek	4813565	568249			8.4	18.8			FT	13.5	8.1			FT
TC-C1	Torrance Creek	4820979	565613	---	---	---	---	---	---	---			0.0	---	V
TC-V1	Torrance Creek	4820265	564884	---	---	---	---	---	---	---			4.0	3.4	FT
TC-V2	Torrance Creek	4820648	564494	---	---	---	---	---	---	---			0.0	---	V

Notes:

--- - not recorded
FT - Son-Tek FlowTracker
L - Measured leaf velocity and multiplied by simplified cross-sectional area to estimate discharge
B - Discharge collected in a bucket over a measured amount of time
V - Visual estimate