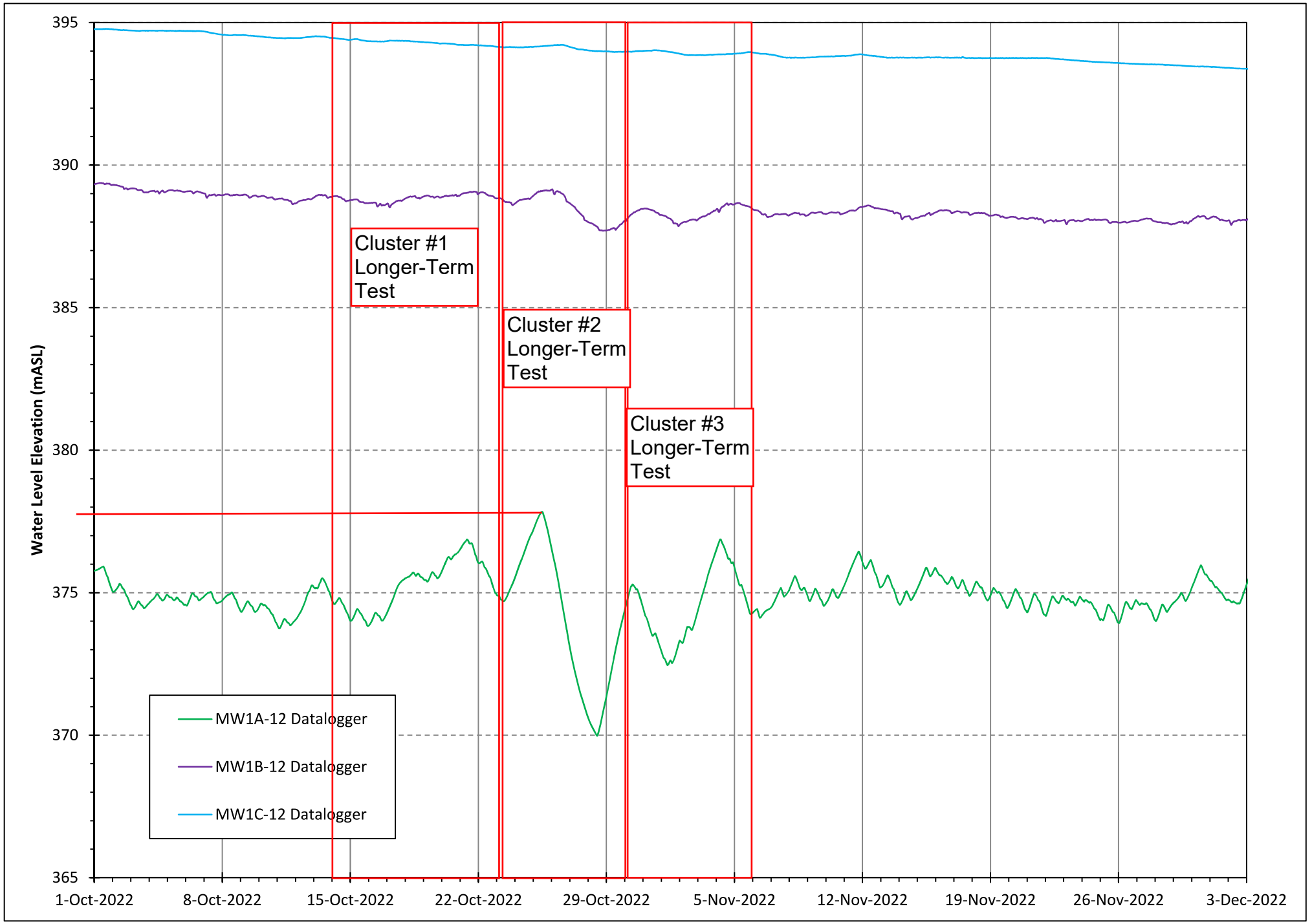
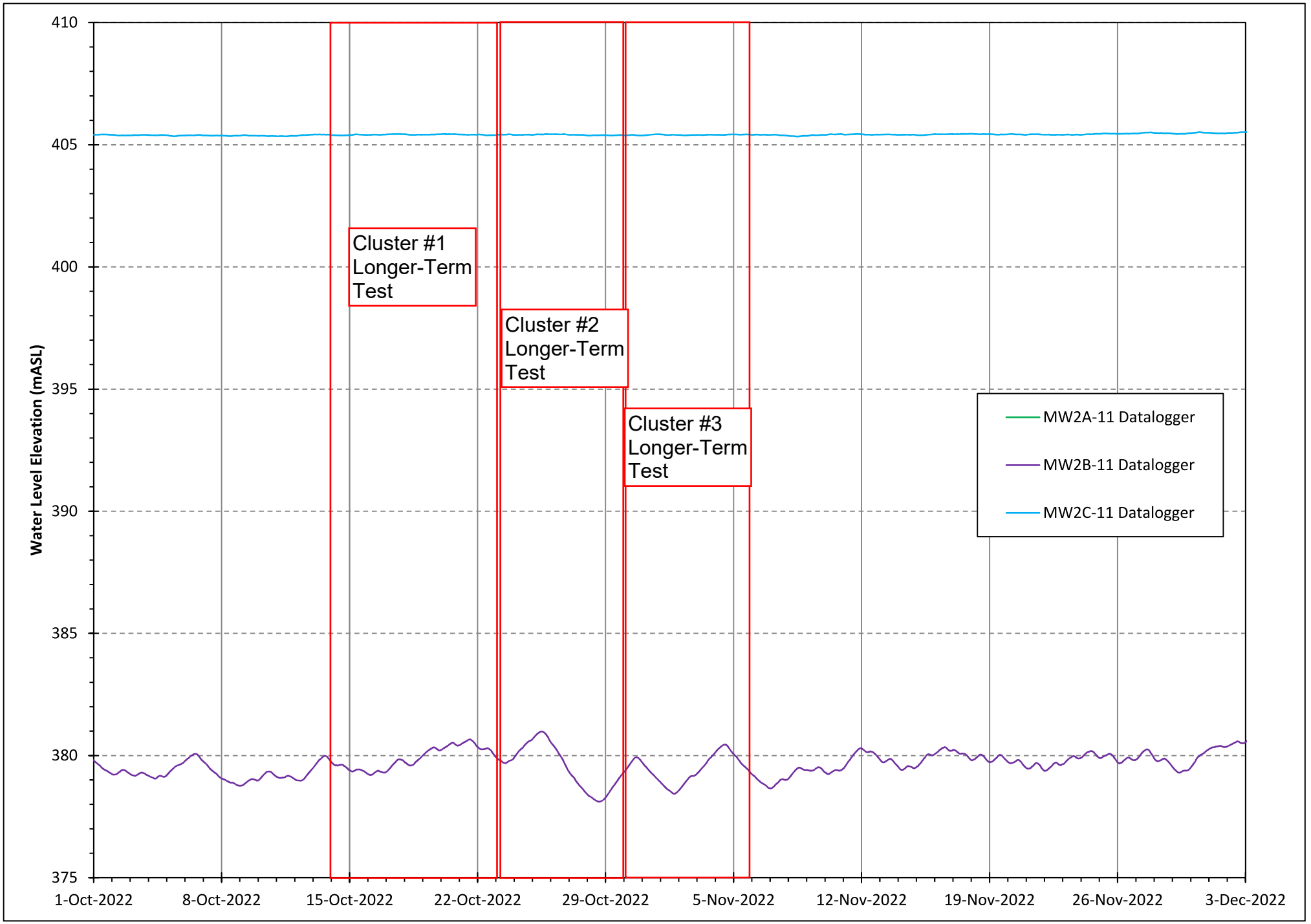
Appendix F. Groundwater Science Corp. Hydrographs


Water Level Elevation (mASL)
395
390
385
380
375
370
365
1-Oct-2022
8-Oct-2022
15-Oct-2022
22-Oct-2022
29-Oct-2022
5-Nov-2022
12-Nov-2022
19-Nov-2022
26-Nov-2022
3-Dec-2022
Cluster #1 Longer-Term Test
Cluster #2 Longer-Term Test
Cluster #3 Longer-Term Test
MW1A-12 Datalogger
MW1B-12 Datalogger
MW1C-12 Datalogger


Water Level Elevation (mASL)
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405
400
395
390
385
380
375
1-Oct-2022
8-Oct-2022
15-Oct-2022
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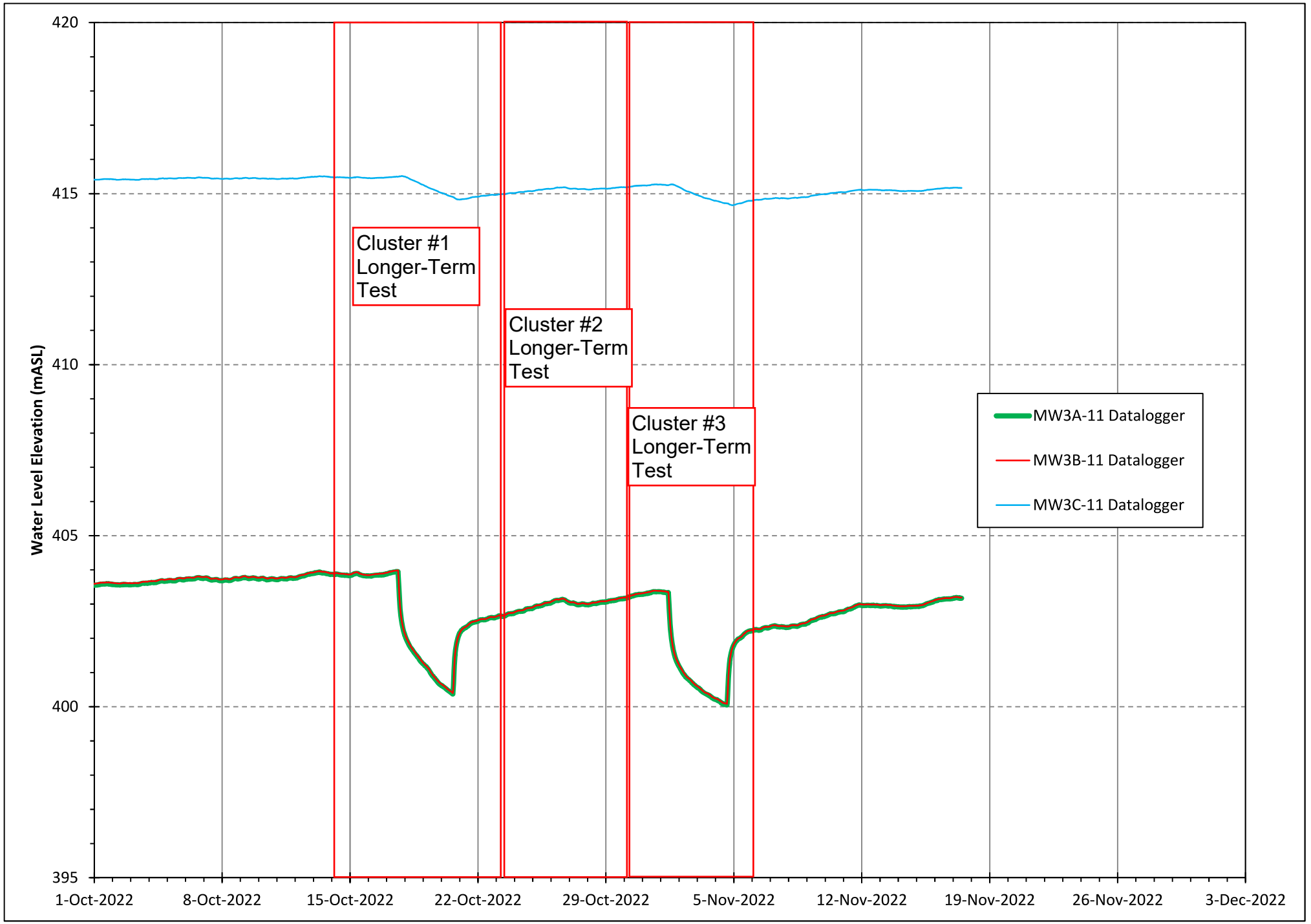
29-Oct-2022
5-Nov-2022
12-Nov-2022
19-Nov-2022
26-Nov-2022
3-Dec-2022
Cluster #1 Longer-Term Test
Cluster #2 Longer-Term Test
Cluster #3 Longer-Term Test
MW2A-11 Datalogger
MW2B-11 Datalogger
MW2C-11 Datalogger


Water Level Elevation (mASL)
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415
410
405
400
395
1-Oct-2022
8-Oct-2022
15-Oct-2022
22-Oct-2022
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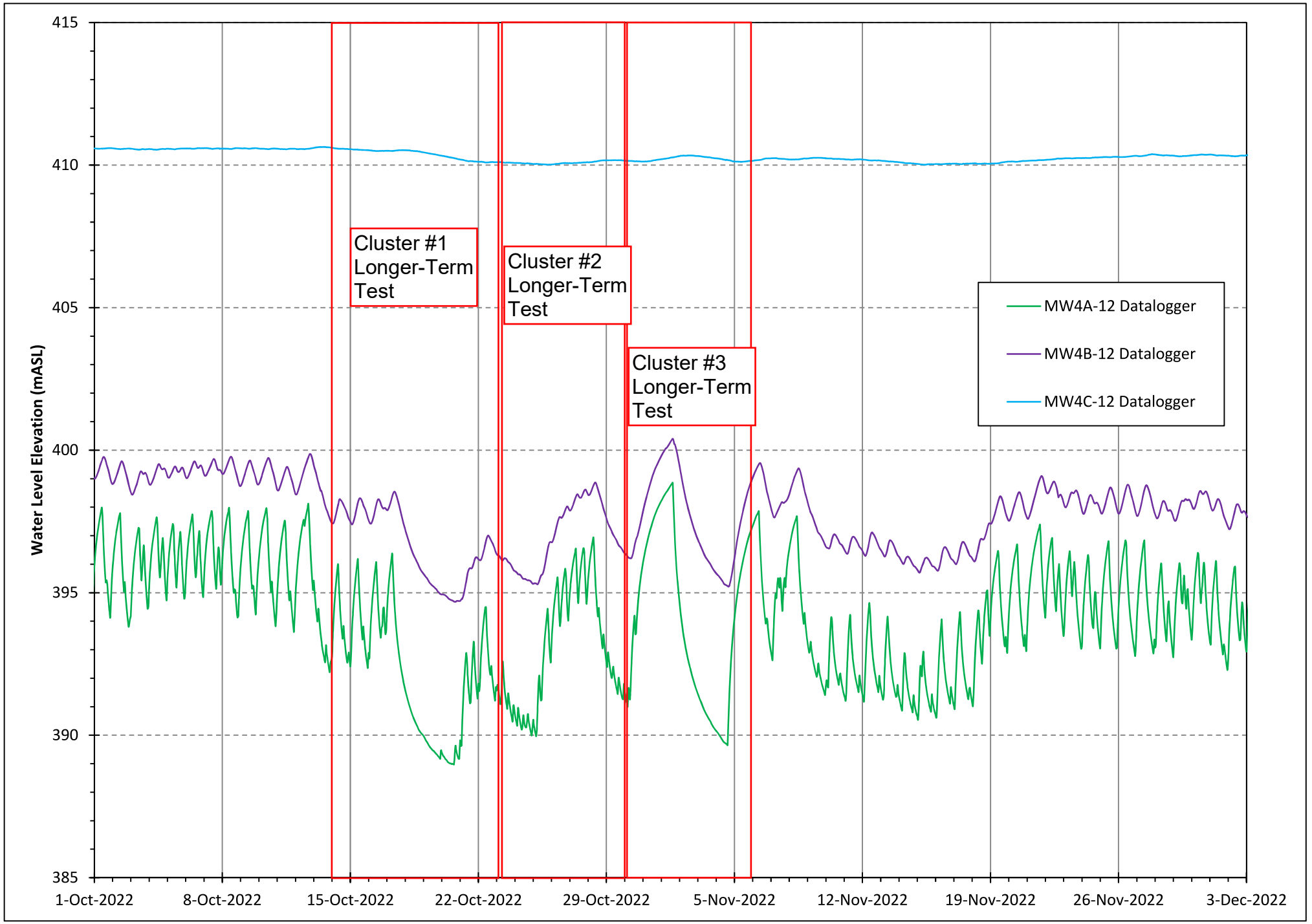
5-Nov-2022
12-Nov-2022
19-Nov-2022
26-Nov-2022
3-Dec-2022
Cluster #1 Longer-Term Test
Cluster #2 Longer-Term Test
Cluster #3 Longer-Term Test
MW3A-11 Datalogger
MW3B-11 Datalogger
MW3C-11 Datalogger


Water Level Elevation (mASL)
415
410
405
400
395
390
385
1-Oct-2022
8-Oct-2022
15-Oct-2022
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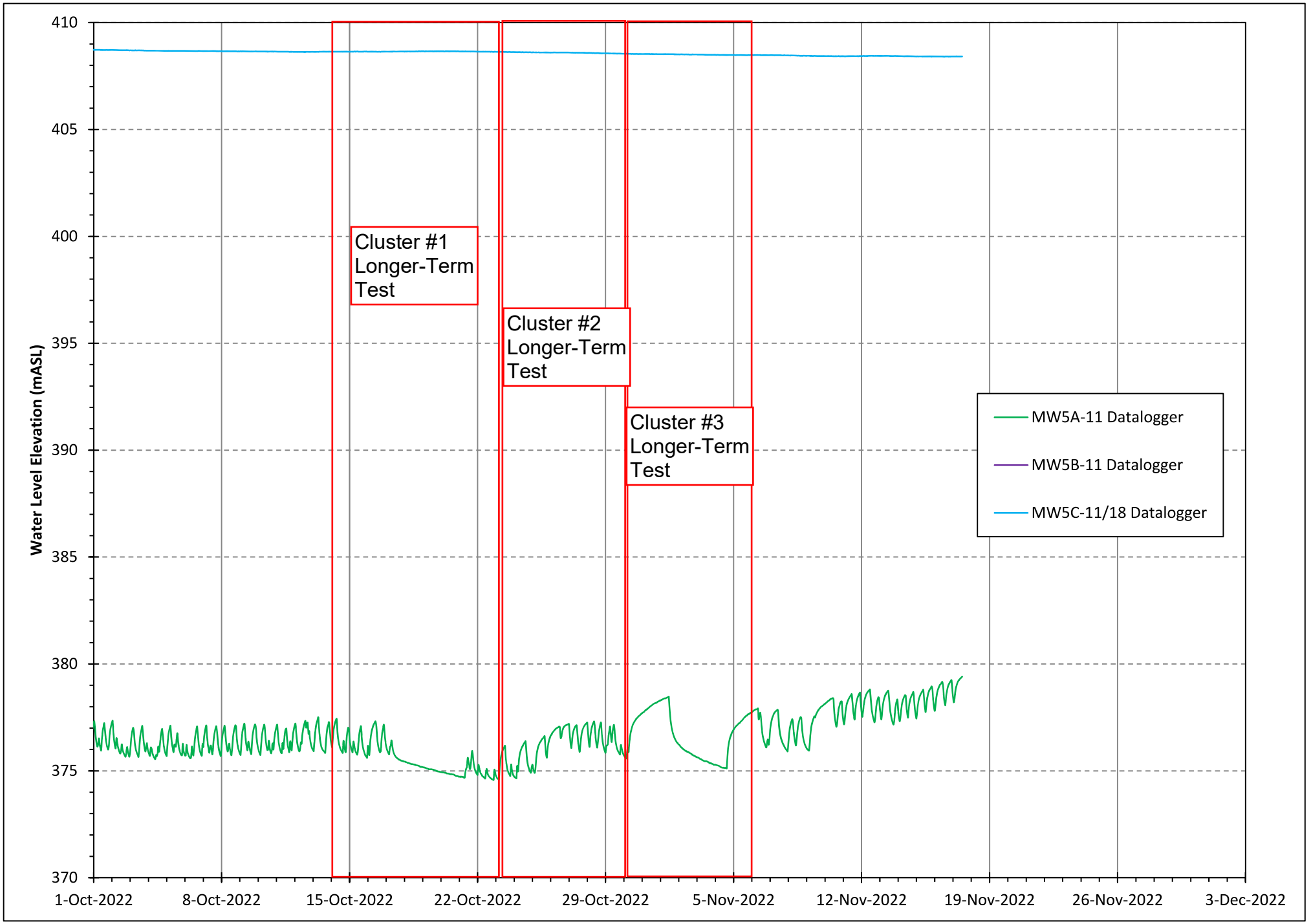
29-Oct-2022
5-Nov-2022
12-Nov-2022
19-Nov-2022
26-Nov-2022
3-Dec-2022
Cluster #1 Longer-Term Test
Cluster #2 Longer-Term Test
Cluster #3 Longer-Term Test
MW4A-12 Datalogger
MW4B-12 Datalogger
MW4C-12 Datalogger


Water Level Elevation (mASL)
410
405
400
395
390
385
380
375
370
1-Oct-2022
8-Oct-2022
15-Oct-2022
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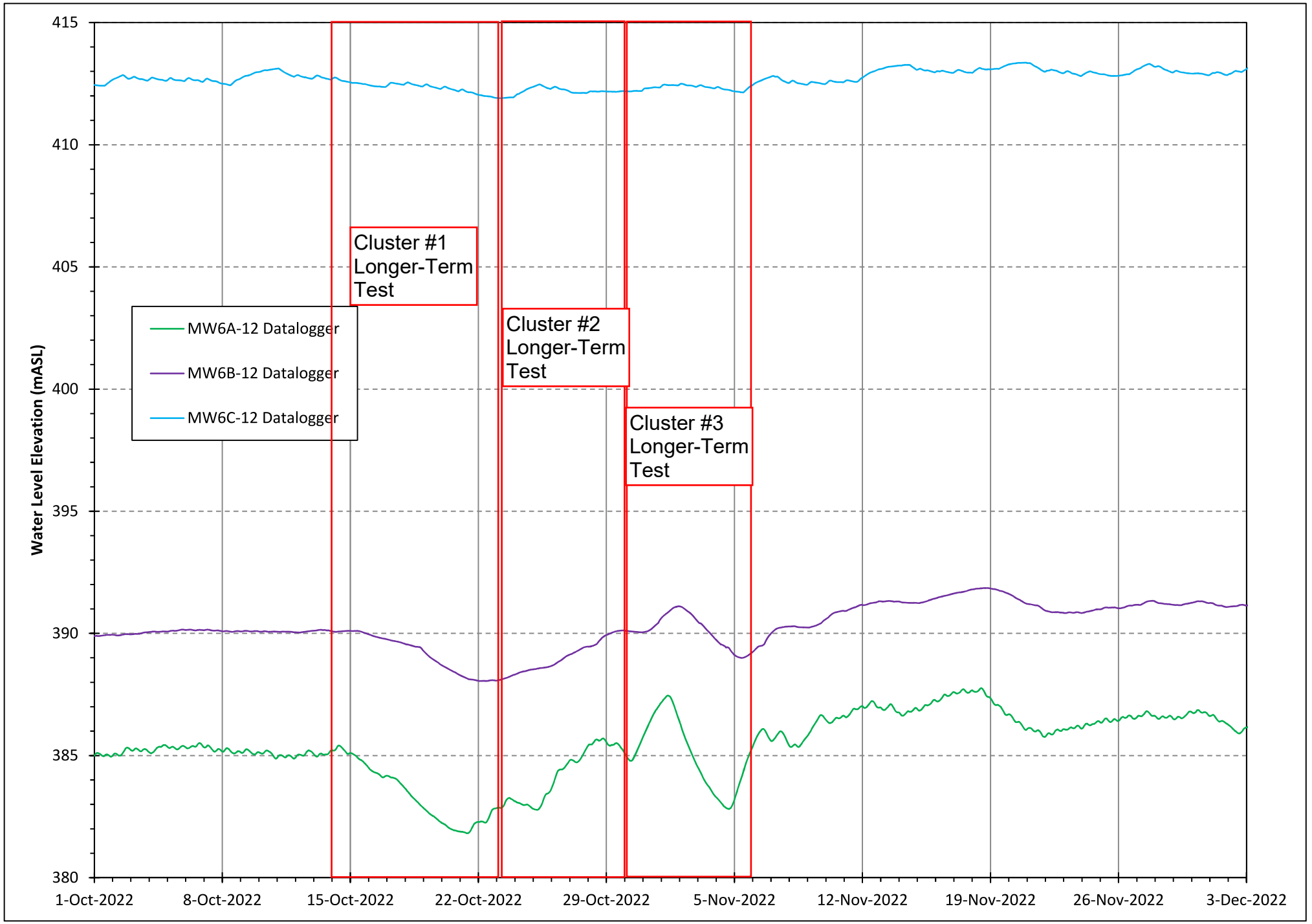
29-Oct-2022
5-Nov-2022
12-Nov-2022
19-Nov-2022
26-Nov-2022
3-Dec-2022
Cluster #1 Longer-Term Test
Cluster #2 Longer-Term Test
Cluster #3 Longer-Term Test
MW5A-11 Datalogger
MW5B-11 Datalogger
MW5C-11/18 Datalogger


Water Level Elevation (mASL)
415
410
405
400
395
390
385
380
1-Oct-2022
8-Oct-2022
15-Oct-2022
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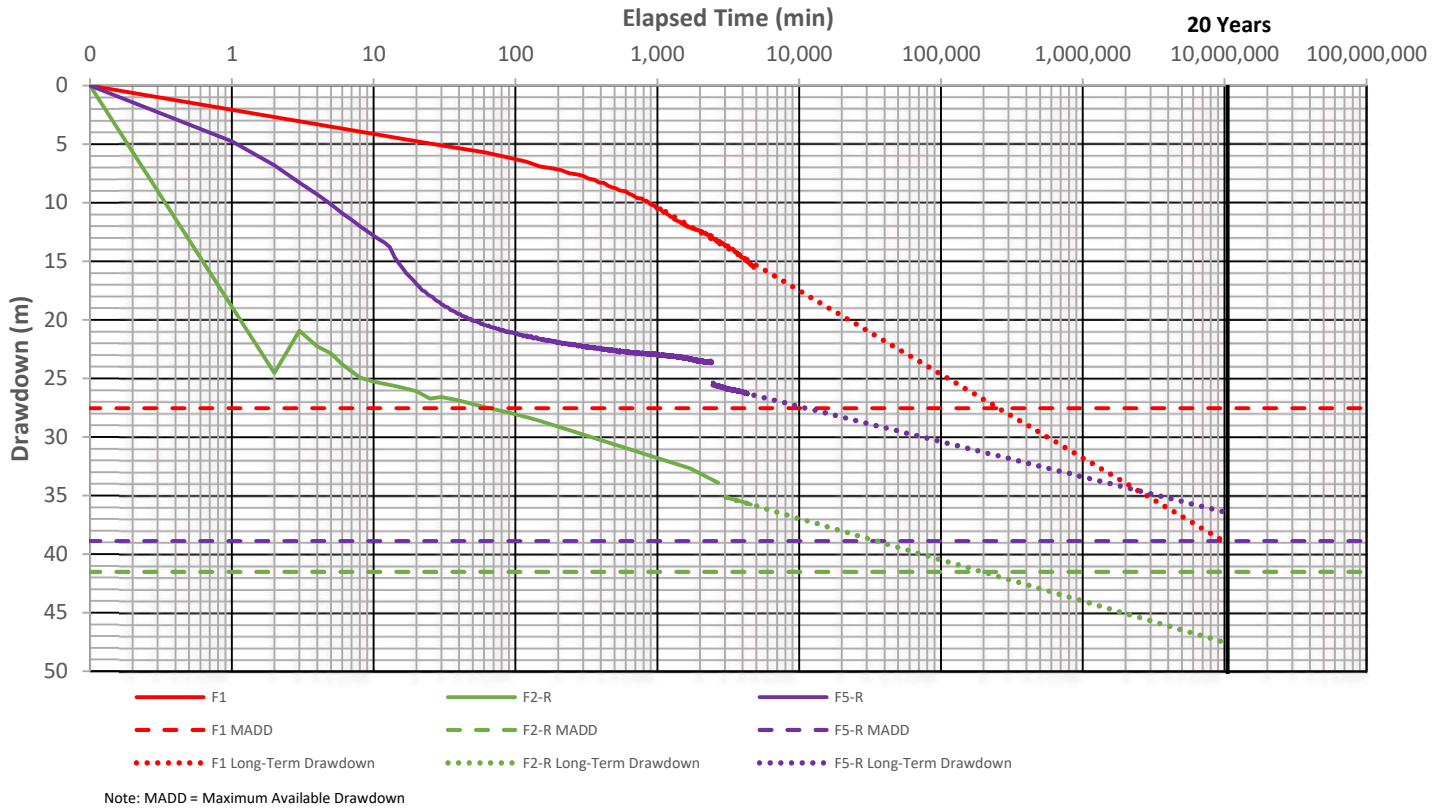
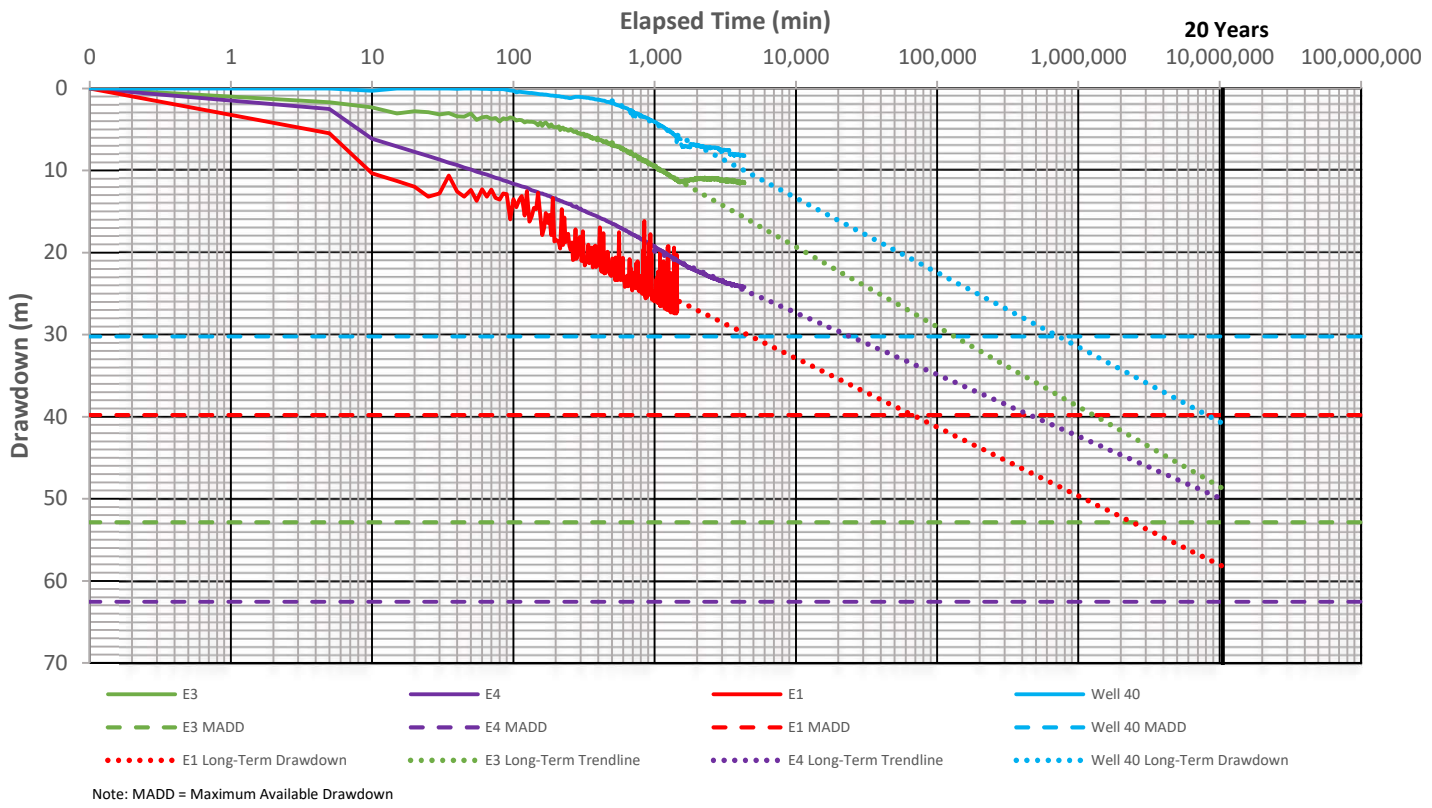
29-Oct-2022
5-Nov-2022
12-Nov-2022
19-Nov-2022
26-Nov-2022
3-Dec-2022
MW6A-12 Datalogger
MW6B-12 Datalogger
MW6C-12 Datalogger
Cluster #1 Longer-Term Test
Cluster #2 Longer-Term Test
Cluster #3 Longer-Term Test

Appendix G. Extended Drawdown Plots



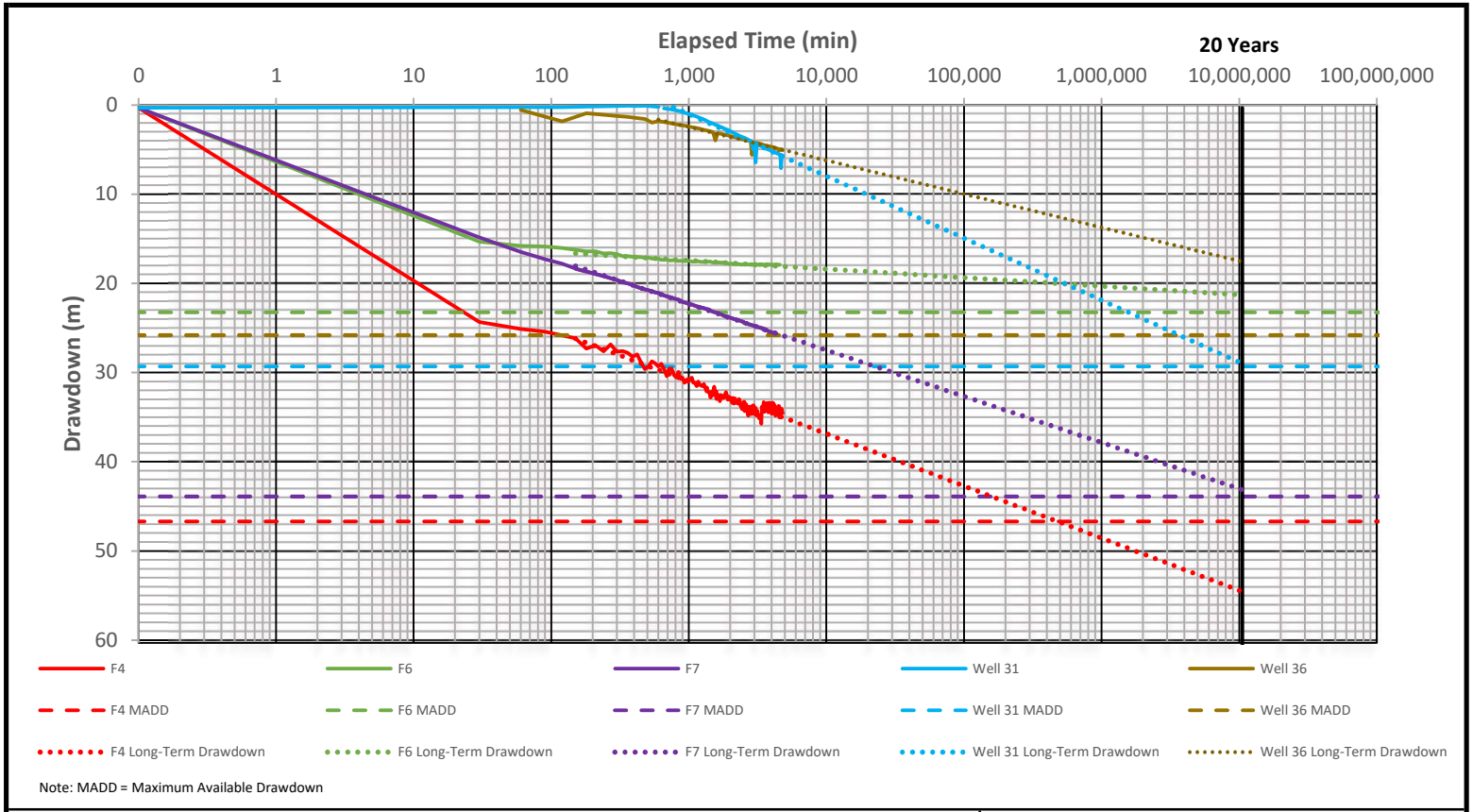
Note: MADD = Maximum Available Drawdown

Cluster #1 - Elapsed Time vs Drawdown			AECOM Imagine it. Delivered.
Centre Wellington Wellfield Capacity Assessment			**Date: June 2023**
Project: 60692210	**Drawn: PM**	**Approved: MA**	**Figure G-1**



Note: MADD = Maximum Available Drawdown

Cluster #2 - Elapsed Time vs Drawdown			AECOM Imagine it. Delivered.
Centre Wellington Wellfield Capacity Assessment			**Date: June 2023**
Project: 60692210	**Drawn: PM**	**Approved: MA**	**Figure G-2**



Note: MADD = Maximum Available Drawdown

Cluster #3 - Elapsed Time vs Drawdown			AECOM Imagine it. Delivered.
Centre Wellington Wellfield Capacity Assessment			**Date: June 2023**
Project: 60692210	**Drawn: PM**	**Approved: MA**	**Figure G-3**

Appendix H. Modelling Analysis Technical Memorandum

Matrix Solutions Inc.
A Montrose Environmental Company

GROUNDWATER FLOW MODELLING TO SUPPORT THE TOWNSHIP OF CENTRE WELLINGTON WELL CAPACITY ASSESSMENT

Prepared for:
AECOM CANADA LTD.

Prepared by:
MATRIX SOLUTIONS INC., A MONTROSE ENVIRONMENTAL COMPANY

Version 1.0
December 2023
Guelph, Ontario

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GROUNDWATER FLOW MODELLING TO SUPPORT THE TOWNSHIP OF CENTRE WELLINGTON WELL CAPACITY ASSESSMENT

Prepared for AECOM Canada Ltd., December, 2023

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DISCLAIMER

Matrix Solutions Inc. certifies that this report is accurate and complete and accords with the information available during the project. Information obtained during the project or provided by third parties is believed to be accurate but is not guaranteed. Matrix Solutions Inc. has exercised reasonable skill, care, and diligence in assessing the information obtained during the preparation of this report.

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VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	14-Nov-2023	Draft	23876-527 CW-Well Capacity LR 2023-11-14 draft V0.1.docx	Issued to client for review
V1.0	08-Dec-2023	Final	23876-527 CW-Well Capacity LR 2023-12-08 final V1.0.docx	Issued to client

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IN-TEXT TABLES

FIGURES

1 INTRODUCTION

Matrix Solutions Inc, a Montrose Environmental company, was subcontracted by AECOM Canada Limited to complete an impact evaluation in support of the Township of Centre Wellington's (the Township) municipal water supply well capacity assessment. The scope of work included updating and applying the existing three-dimensional groundwater flow model to simulate groundwater withdrawals under projected average daily demands and maximum daily demands. Matrix previously developed and calibrated the groundwater flow model used in this work for the Township of Centre Wellington (the Township) Scoped Tier Three Water Budget and Local Area Risk Assessment (Tier Three Assessment; Matrix 2018) and was also applied in support of the Township's Water Supply Master Plan (WSMP). As part of the current work, the following key tasks were completed:

- Review of the existing model and new data, including pumping test results completed at the replacement pumping wells F2-R and F5-R and long-term pumping tests at nine municipal water supply wells (grouped into Clusters 1, 2, and 3).

- Simulation of the short-term pumping tests at F2-R and F5-R and long-term pumping tests at nine municipal water supply wells using the existing FEFLOW model. This task included incorporating the data collected during the completion of the replacement pumping wells F2-R and F5-R and achieving an acceptable match between simulated and observed drawdown data. The goal of matching drawdown at the pumping wells was achieved by applying small changes to local-scale hydrogeological properties in the existing FEFLOW model.

- Water supply capacity assessment simulations, consisting of scenarios of groundwater withdrawals based on projected average daily and maximum daily demands. Model results were used to assess incremental drawdown at private supply wells and changes to groundwater discharge to streams and wetlands.

This report provides a summary of the simulation results of the pumping test simulations at the water supply wells and of capacity assessment simulations for average daily and maximum daily demands.

2 PUMPING TEST SIMULATIONS

Matrix applied the existing model to replicate short-term pumping tests at replacement wells F2-R and F5-R wells and long-term tests at well Clusters 1, 2, and 3 completed in Fall 2022 and additional tests at Cluster 2 completed in Spring 2023. Groundwater level monitoring data at water supply wells and monitoring wells were used for assessment of model fit. The 44 monitoring locations used for this assessment included municipal monitoring wells and private well locations. For the 12 segments of the municipal monitoring well nests at MW3-11, MW4-11, MW5-11, and MW6-12, Matrix received only figures with monitoring data (instead of digital data records) which could not directly be used for this

assessment. However, this monitoring data was not considered a critical piece of information since the emphasis for this part of evaluation was on matching drawdown and the Tier Three model calibration had included data for these wells.

A good match between simulated and observed drawdown during the pumping tests was achieved by applying the following small adjustments to local-scale hydrogeological properties in the existing FEFLOW model:

- Hydraulic conductivity zones extent near F5-R and F2-R to match the drawdown during the short-term tests and long-term tests in Fall 2022.
- Hydraulic conductivity zones extent near F1 to match the drawdown during for Cluster 1 long-term test data in Fall 2022.
- Hydraulic conductivity values and zones extent near E3 and E4 to match the drawdown during long-term tests at Cluster 2 in Spring 2023.

The priority in making these local adjustments was to match simulated and observed drawdown in the water supply wells. Matrix evaluated the match of relative head change response throughout the duration of the pumping testing (Figure 1) and the match of magnitude of drawdown at the water supply wells during the long-term testing corresponding to each of the water supply wells' constant rate test period (Table 1, Figure 2). The simulated drawdown at seven out of nine production wells was less than ±10% of the observed value, with E3 still showing a similarly good match at just over 10%. While the deviation of simulated from observed drawdown at F4 in the long-term testing was higher (16%), Figure 1 shows that the simulated response in F4 generally follows the observed data. Given F4 had undergone well rehabilitation, additional model refinement around this well beyond the scope of this study might yield an even better match. The normalized root mean squared error (NRMSE) was below 10%. The assessment of model fit concluded that the model is fit for purpose for the subsequent well capacity assessment.

TABLE 1 Observed and Simulated Drawdown at Production Wells

Well	Observed Drawdown (m)	Simulated Drawdown (m)	Simulated - Observed Drawdown Difference (m)	Simulated - Observed Drawdown Difference (%)
F1	15.6	14.8	-0.8	-5%
F2-R	35.7	34.4	-1.4	-4%
F5-R	26.3	24.0	-2.4	-9%
F4	34.1	39.5	5.4	16%
F6	17.6	16.5	-1.0	-6%
F7	25.3	25.0	-0.3	-1%
E1	27.2	29.2	2.0	7%
E3	11.5	12.8	1.3	11%
E4	24.1	25.4	1.3	5%

RMSE = 2.2 m
NRMSE = 9%

3 WELL CAPACITY ASSESSMENT – SIMULATION SCENARIOS

Matrix simulated two scenarios to assess the Township's municipal water supply future capacity. Table 2 shows the proposed average daily and maximum daily pumping scenarios provided by AECOM. Table 2 also includes a revised estimate of safe aquifer elevation, or setpoint, based on current understanding of each well; in particular, setpoints for F2-R and F5-R have been updated based on provided as-constructed well details. Details on how pumping rates and updated setpoint were developed can be found in AECOM (2023).

The average pumping scenario is designed to represent increased average annual pumping rates. The maximum pumping scenario is designed to represent short-term increased pumping in response to irregular, higher demands (e.g., short daily peaks, hot weather conditions, etc.). These maximum rates take into account the current maximum rates provided in the Permit-to-Take-Water (PTTW), estimated future water demands in the community, rates recommended in the well replacement project (F2-R and F5-R), and professional judgement.

TABLE 2 Well Capacity Assessment - Proposed Scenarios

Well Name	Safe Elevation "Setpoint" (m asl)	Delta* (m)	Scenario 1: Average Pumping		Scenario 2: Maximum Pumping	
			Pumping Rate (m^3/d)	Pumping Rate (L/s)	Pumping Rate (L/s)	Pumping Rate (L/s)
E1	338	0	1,500	17	1,728	20
E3	323	25	900	10	1,339	16
E4	314	11	1,400	16	1,901	22
Subtotal			**3,800**	**44**	**4,968**	**58**
F1	345	0	1,300	15	1,728	20
F2-R	350	20	1,600	19	1,728	20
F4	344	8	1,300	15	1,987	23
F5-R	365	-15	500	6	1,728	20
F6	353	25	1,000	12	1,987	23
F7	355	0	1,600	19	1,987	23
Subtotal			**7,300**	**84**	**11,145**	**129**
Total			**11,100**	**128**	**16,113**	**187**

*As compared to the WSMP setpoints.
ASL - above sea level

The simulation results were reviewed to compare the simulated heads at municipal water supply wells against the established setpoints, provided in Table 2, to confirm that water levels remain above their setpoint elevations. For Scenario 2, the simulation results were reviewed to confirm that the water levels remain above setpoints for the duration of time need to maintain maximum pumping rates.

The emphasis of the local calibration refinement (Section 2) was to match relative drawdown in the observation wells, rather than absolute head elevation. The comparison of simulated head data to setpoint elevation was completed using simulated hydraulic heads adjusted by an offset between simulated and observed head at the time presumed to reach "static level" at each of the water supply wells. An example of such adjustment is shown in Figure 3.

To evaluate potential impacts on existing domestic water takings (represented as clusters of wells in the model; Matrix 2020, 2018), the simulated heads at 18 representative surrogate locations (Figure 4)were reviewed to confirm that their simulated water levels remain above the base of these wells.

The change in groundwater interactions (i.e., groundwater recharge and groundwater discharge) with local streams and wetlands was calculated to evaluate potential impacts from increased pumping on surface water features. To assess potential impacts, groundwater interactions under the proposed scenarios was compared against those simulated under current (i.e., 2020 and 2021) average pumping rates at the at existing municipal wells (Groundwater Science Corp. 2022). Coldwater streams in the vicinity of Elora and Fergus include portions of the Grand River, Irvine Creek, and Swan Creek with its tributaries. Wetlands in the broader vicinity of Elora and Fergus include the Creek Bank Valley Wetland, Irvine Creek Wetland Complex, and Salem South Wetland Complex; classified as Provincially Significant Wetlands, the Living Springs Wetland Complex, North Cumnock Wetland Complex, Alma Wetland Complex, Inverhaugh Valley Wetland Complex, North Woolwich Swamp, and parts of the Speed-Lutteral-Swan Creek Wetland Complex. Groundwater discharge to these streams and wetlands was simulated for each pumping scenario to evaluate potential changes (positive or negative) in groundwater discharge.

4 WELL CAPACITY ASSESSMENT – SIMULATION RESULTS

4.1 Scenario 1: Average Pumping Conditions

Table 3 summarizes the Scenario 1 simulation results including simulated heads under steady state conditions and available head above the setpoint, calculated as difference between setpoint elevation and simulated head. For all wells except Well F5-R, the simulated head remains above the setpoint elevation. At Well F5-R, the water level is simulated to fall approximately 0.4 m below the setpoint elevation. However, in discussion with AECOM it was agreed that, given the model uncertainty and precision associated with simulated heads and the assumptions made for this scenario, this value is still within an acceptable range. The results indicate that the prescribed pumping rates can be likely achieved under average, or steady state condition.

TABLE 3 Scenario 1 (Average Pumping Conditions) – Set-up, Simulated Heads, and Resulting Remaining Head above Setpoint

Well Name	Safe Elevation "Setpoint" (m asl)	Boundary Condition Type	Assigned Pumping Rate (m^3/d)	Simulated Head* (m asl)	Available Head above Setpoint (m)
E1	338	Specified Pumping	1,500	337.6	10.2
E3	323	Specified Pumping	900	362.2	3.2
E4	314	Specified Pumping	1,400	347.9	10.2
Subtotal			**3,800**		
F1	345	Specified Pumping	1,300	355.2	24.3
F2-R	350	Specified Pumping	1,600	353.2	6.0
F4	344	Specified Pumping	1,300	354.2	15.4
F5-R	365	Specified Pumping	500	389.3	**-0.4**
F6	353	Specified Pumping	1,000	359.0	39.2
F7	355	Specified Pumping	1,600	370.4	33.9
Subtotal			**7,300**		
Total			**11,100**		

*Adjusted head as described in Section 3
ASL - above sea level

Water levels at private water takings were reviewed to assess whether the proposed pumping rate in this scenario would adversely impact private wells. Rather than evaluate water levels at all 1,000+ domestic well locations, water levels were evaluated at 18 surrogate locations (Figure 4) designed to represent clusters of domestic wells. As shown in Table 4, water levels at all wells were simulated to remain between 19.8 and 78.4 m above the bottom elevation of the wells, indicating that the proposed pumping in this scenario would not impede the ability of private well users to sustain domestic pumping.

Simulated groundwater interactions with surface water features were reviewed along stream reaches and wetlands to assess the effects of proposed pumping at existing municipal wells on the recharge/discharge at selected surface water features. In Scenario 1, stream and wetland discharge is simulated to be reduced, but only as a small proportion of current rates. The reduction of groundwater discharge to Swan Creek and its riparian wetland areas is estimated to be relatively low (3% reduction). The total reduction in discharge along the Grand River below Shand Dam is larger, but will remain as a relatively small proportion (<2%) compared to low flows in the river which are controlled by the dam. Groundwater/surface water exchange was calculated for the wetlands listed in Section 3 and the change in groundwater exchange was relatively minor (<5%) for most wetlands. The changes in Irvine Creek Wetland Complex were more prominent (25%), but appear reasonable due to relatively low simulated discharge rates at the wetland complex (280 m^3/d) and low magnitude of the flow rate change (70 m^3/d) when compared to the increased pumping (1830 m^3/d) at the Cluster 3 municipal wells in their vicinity of the wetland complex. Overall, the enhanced pumping is not estimated to result in significant or measurable effects on local surface water features.

TABLE 4 Scenario 1 (Average Pumping Conditions) – Impact on Domestic Water Takings

Well Cluster Name/ID	Bottom Elevation of Well (m asl)	Simulated Head (m asl)	Remaining Head above Bottom of Well (m)
Grand River South of E4	325.0	344.8	19.8
Belwood Lake Northeast	395.0	428.0	33.0
Belwood Lake East	356.0	424.4	68.4
Grand River East Fergus	385.0	405.1	20.1
101	316.5	375.1	58.6
102	328.9	369.4	40.5
103	329.5	396.6	67.1
104	320.3	381.5	61.2
105	330.5	380.9	50.4
106	331.2	378.0	46.8
201	333.0	384.8	51.8
202	331.5	382.4	50.9
203	338.1	392.9	54.8
204	329.8	399.3	69.5
205	324.3	402.7	78.4
206	340.0	394.2	54.2
207	342.2	394.2	52.0
208	334.2	384.5	50.3

ASL - above sea level

4.2 Scenario 2: Maximum Pumping Conditions

Scenario 2 simulates maximum pumping conditions and was designed to represent short-term increased pumping in response to irregular, higher demands (e.g., maximum day demand). These rates consider the current maximum rates provided in the PTTW, estimated future water demands in the community, rates recommended in the well replacement project (F2-R and F5-R), and insights on potential pumping rates and neighbouring private wells from the well capacity assessment. Table 5 summarizes the safe drawdown elevations (setpoints), assigned boundary condition type, and applied pumping rates. Pumping rates were specified as boundary conditions for all wells.

The simulation results presented in Table 5 include the simulated heads after 14 days of transient conditions (adjusted as described in Section 3) and the remaining head above the setpoint, calculated as difference between setpoint elevation and simulated head at that time. For all wells except wells E1, F4, and F6, the simulated heads after 14 days remain above the setpoint elevation, indicating that the prescribed pumping rates could be achieved. At wells E1, F4, and F6, water levels were simulated to fall approximately 4.1 m, 7.6 m, and 5.7 m below the setpoint elevation, after five, one, and two days of pumping, respectively. Additionally, water level at F2-R decreased below the setpoint elevation after 93 days of pumping.

Due to simulated water levels failing to stay above setpoint elevations at multiple wells, no further analysis of this scenario was completed. Instead, an additional Scenario 2A was simulated (Section 4.3) and

presents an alternative maximum pumping scenario designed to estimate the maximum short-term capacity of the water supply with the proposed set of wells.

TABLE 5 Scenario 2 (Maximum Pumping Conditions) – Set-up, Simulated Heads, and Resulting Remaining Head above Setpoint

Well Name	Safe DD Elevation "Setpoint" (m asl)	Boundary Condition Type	Assigned Pumping Rate (m^3/d)	Simulated Head* (m asl)	Remaining Head above Setpoint** (m)	Time to Reach Setpoint (d)
E1	338	Specified Pumping	1,728	333.9	**-4.1**	**5**
E3	323	Specified Pumping	1,339	359.1	36.1	--
E4	314	Specified Pumping	1,901	342.0	28.0	--
Subtotal			**4,968**			
F1	345	Specified Pumping	1,728	354.1	9.1	--
F2-R	350	Specified Pumping	1,728	352.3	2.3	93
F4	344	Specified Pumping	1,987	336.4	**-7.6**	**1**
F5-R	365	Specified Pumping	1,728	371.6	6.6	--
F6	353	Specified Pumping	1,987	347.3	**-5.7**	**2**
F7	355	Specified Pumping	1,987	365.0	10.0	--
Subtotal			**11,145**			
Total			**16,113**			

*Adjusted head as described in Section 3, at 14 days simulation
**At 14 days simulation time
ASL - above sea level
DD - drawdown

4.3 Scenario 2a: Alternative Maximum pumping conditions

Scenario 2a was developed in consultation with AECOM to estimate the maximum short-term capacity. The scenario simulated steady state pumping at the municipal wells by using specified head (rather than specified rate) boundary conditions with setpoint elevations assigned as the boundary condition values. The application of specified head boundary conditions forces the water level in the well to the setpoint elevation and simulates the resulting water volume withdrawn from the well at that minimum threshold limit. Pumping rates at wells E3 and E4 were assigned as specified rate boundaries using the maximum rates defined for Scenario 2, to constrain the maximum pumping rate to address concerns of higher rates negatively impacting neighbouring private wells as identified during the long-term pumping test at these locations.

Table 6 summarizes the safe drawdown elevations (setpoints), assigned boundary condition type, simulated achieved pumping rates, and simulated resulting heads. Since pumping rates at wells E3 and E4 were constrained to their maximum proposed rates, their simulated rates are equal to their proposed pumping; resulting head elevations (above their setpoint elevations) are shown as the simulated results. Since the setpoint elevations were specified as boundary conditions for the remaining wells, their

simulated heads are equal to those thresholds; resulting pumping rates are shown as the simulated results.

Scenario 2A result in a total estimated pumping rate of 15,448 m3/d , which is 665 m3/d less than the proposed total pumping volume of 16,113 m3/d for Scenario 2. These rates are based on results from a steady state simulation and represent longer-term equilibrium conditions. Short-term, higher pumping rates are expected to be achievable during the dewatering phase from head levels under average conditions until a new equilibrium is reached. Further, the resulting pumping rates should be considered as totals, rather than on a per well basis. The Tier Three groundwater model is a regional model that was calibrated to represent conditions within the hydrostratigraphic units at this scale and there is variability in the precision of results at the scale of each production well.

TABLE 6 Scenario 2a (Alternative Maximum Pumping Conditions) – Set-up, Simulated Pumping Rates, and Simulated Heads

Well Name	Safe Elevation "Setpoint" (m asl)	Boundary Condition Type	Simulated Pumping Rate (m^3/d)	Simulated Head* (m asl)
E1	338	Specified Head	**1,398**	338.0
E3	323	Specified Pumping	1,339	**355.3**
E4	314	Specified Pumping	1,901	**338.4**
Subtotal			**4,638**	
F1	345	Specified Head	**2,205**	345.0
F2-R	350	Specified Head	**1,480**	350.0
F4	344	Specified Head	**1,572**	344.0
F5-R	365	Specified Head	**1,965**	365.0
F6	353	Specified Head	**1,180**	353.0
F7	355	Specified Head	**2,408**	355.0
Subtotal			**10,810**	
Total			**15,448**	

*Adjusted head as described in Section 3
ASL - above sea level

Water levels at private water takings at 18 surrogate locations (Figure 4) were reviewed to estimate whether the proposed pumping rate in this scenario would adversely impact private wells. As shown in Table 7, water levels at all wells were simulated to remain between 19.7 and 75.4 m above the bottom elevation of the wells, indicating that the proposed pumping in this scenario would not impede the ability of private well users to sustain domestic pumping.

Groundwater interactions with surface water features are not evaluated for maximum pumping conditions. Maximum rates will be in place only for short durations, and the estimated impacts associated with average pumping rates are more representative of impacts to surface water features.

TABLE 7 Scenario 2a (Alternative Maximum Pumping Conditions Scenario) – Impact on Domestic Water Takings

Well Cluster Name/ID	Bottom Elevation of Well (m asl)	Simulated Head (m asl)	Remaining Head above Bottom of Well (m)
Grand River South of E4	325.0	344.7	19.7
Belwood Lake Northeast	395.0	428.0	33.0
Belwood Lake East	356.0	424.3	68.3
Grand River East Fergus	385.0	404.7	19.7
101	316.5	371.7	55.2
102	328.9	367.8	38.9
103	329.5	396.2	66.7
104	320.3	381.4	61.1
105	330.5	380.6	50.1
106	331.2	376.5	45.3
201	333.0	384.2	51.2
202	331.5	382.0	50.5
203	338.1	389.9	51.8
204	329.8	397.4	67.6
205	324.3	399.7	75.4
206	340.0	391.9	51.9
207	342.2	391.5	49.3
208	334.2	383.6	49.4

ASL - above sea level

5 SUMMARY AND RECOMMENDATIONS

To support a municipal water supply well capacity assessment, a three-dimensional groundwater flow model previously developed for the Scoped Tier Three Water Budget and Local Area Risk Assessment and the Township's Water Supply Master Plan was applied to simulate groundwater withdrawals under projected average daily demands and maximum daily demands (Matrix 2020, 2018). The local refinements of groundwater flow model properties were completed to incorporate the data collected during completion of replacement wells F2-R and F5-R wells, short-term pumping tests at F2-R and F5-R and long-term tests at well Clusters 1, 2, and 3. The assessment of model fit concluded that the model is fit for purpose for the subsequent well capacity assessment.

A well capacity assessment included simulation of three scenarios. The scenarios incorporated pumping rates under average (Scenario 1) and maximum daily pumping conditions (Scenario 2 and Scenario 2A). The simulation results were evaluated with respect to potential impacts on existing municipal wells, existing domestic water takings, and groundwater exchange with surface water features (streams and wetlands). The scenario results are as follows:

- The proposed average pumping rates in Scenario 1 can be achieved meeting an average day demand of 11,100 m3/day without impacting domestic wells or surface water features.

- The proposed maximum pumping rates in Scenario 2 cannot be achieved without water levels at multiple pumping wells falling below their setpoints.

- Scenario 2A illustrates that a maximum day demand of 15,448 m3/day can likely be achieved using the wells and setpoints considered.

The assessment of maximum pumping conditions was completed in steady state and represent longer-term pumping equilibrium conditions. Under the transient conditions, short-term pumping rates may be higher under transient dewatering conditions present until the long-term equilibrium has been reached. Further, the resulting pumping rates should be considered as totals, rather than on a per well basis. The Tier Three groundwater model is a regional model that was calibrated to represent conditions within the hydrostratigraphic units at this scale and there is variability in the precision of results at the scale of each production well.

As the Township continues to refine and finalize plans to increase groundwater takings from the local aquifer system by either increasing pumping rates at existing wells or bringing additional wells online, it is recommended to keep using the model as a powerful tool to test and optimise proposed well and pumping rate configurations.

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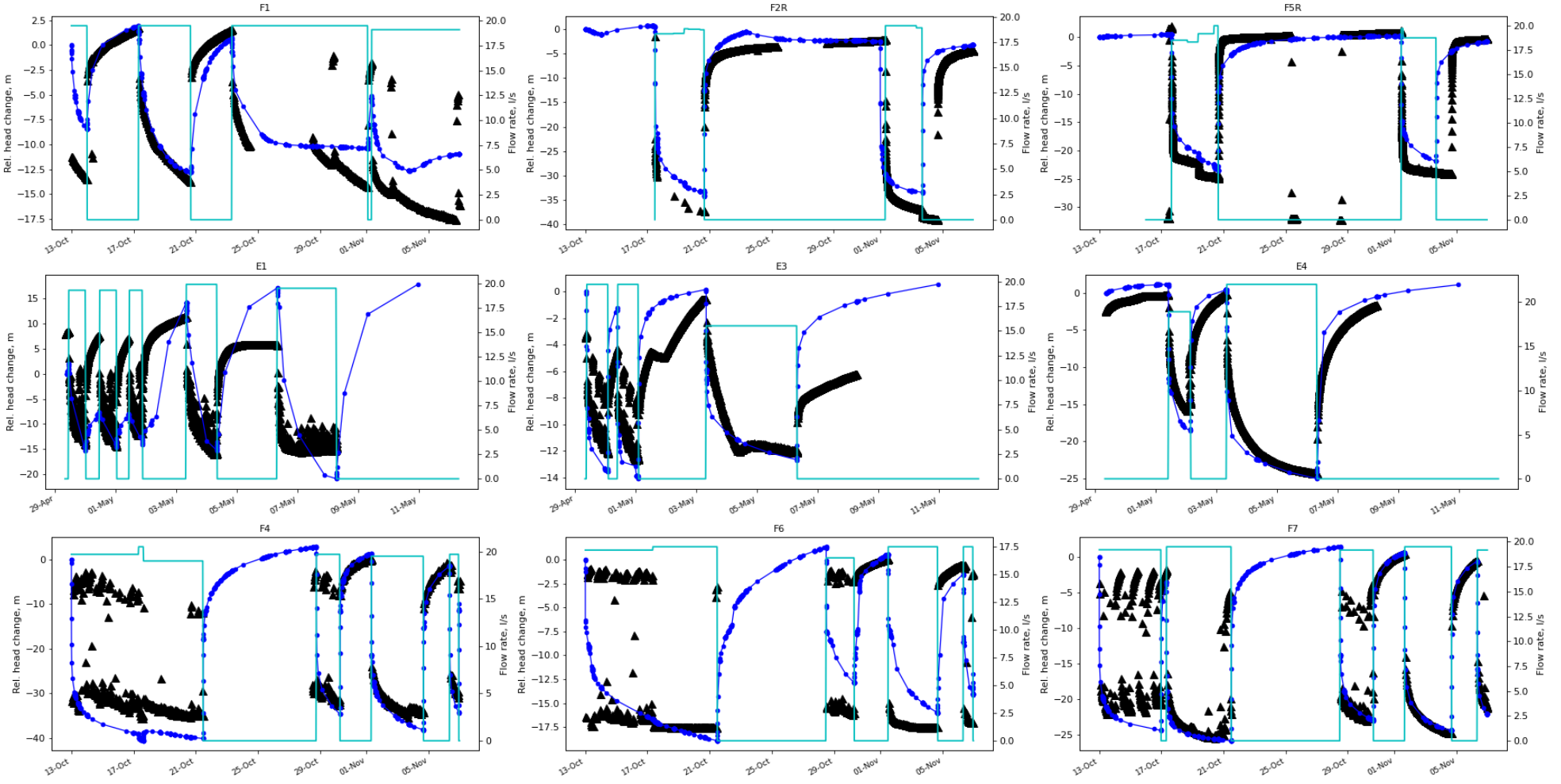


▲ Observed Relative Head Change

Simulated Relative Head Change

Pumping Rate

Matrix Solutions Inc.
A Montrose Environmental Company

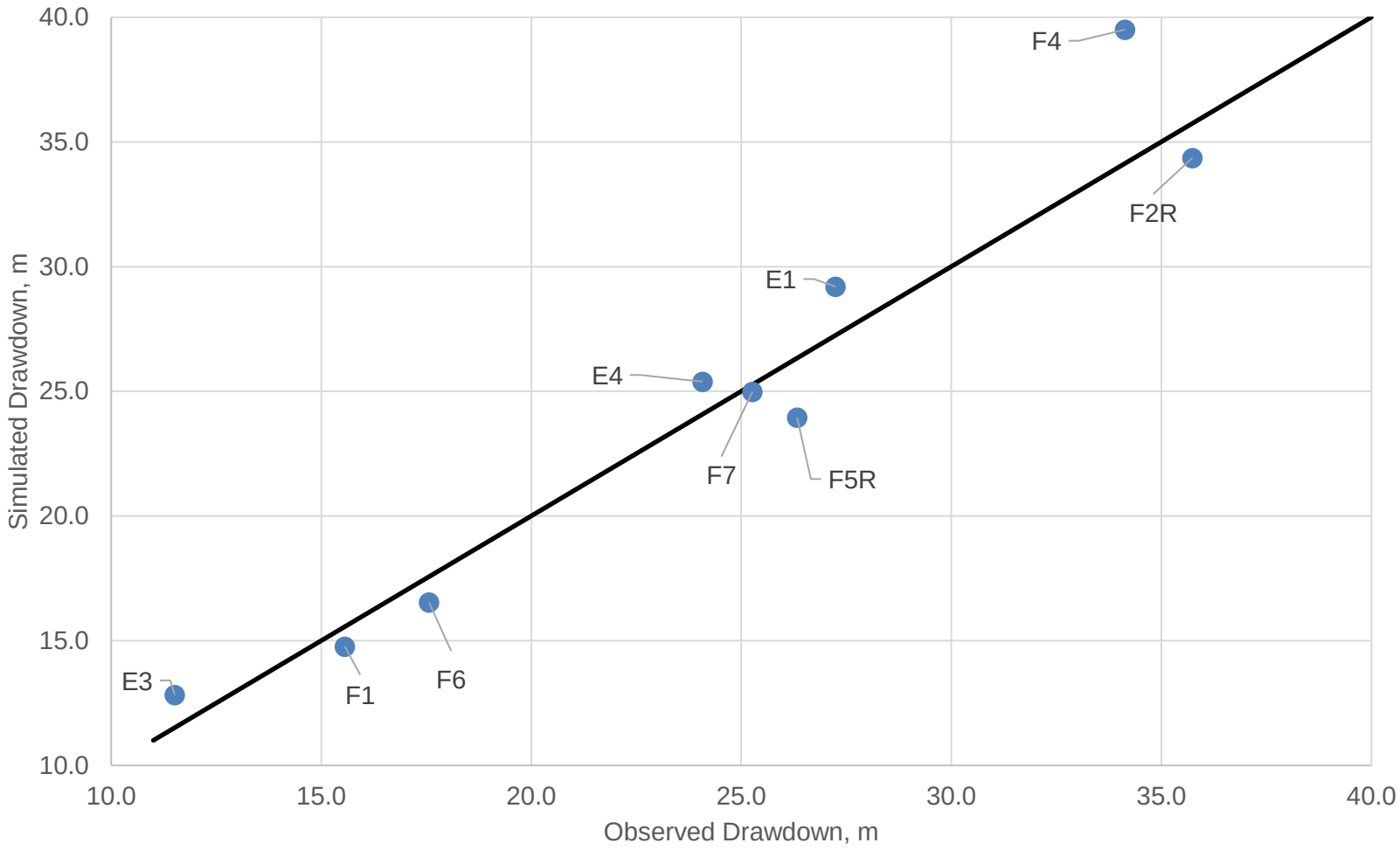
Township of Centre Wellington
Well Capacity Assessment

Simulated and Observed Production Well Hydrographs

Date:	Project:	Submitter:	Reviewer:
August 2023	23876	P.Abdrakhimova	D. Van Vliet

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

Figure 1



Matrix Solutions Inc.
A Montrose Environmental Company

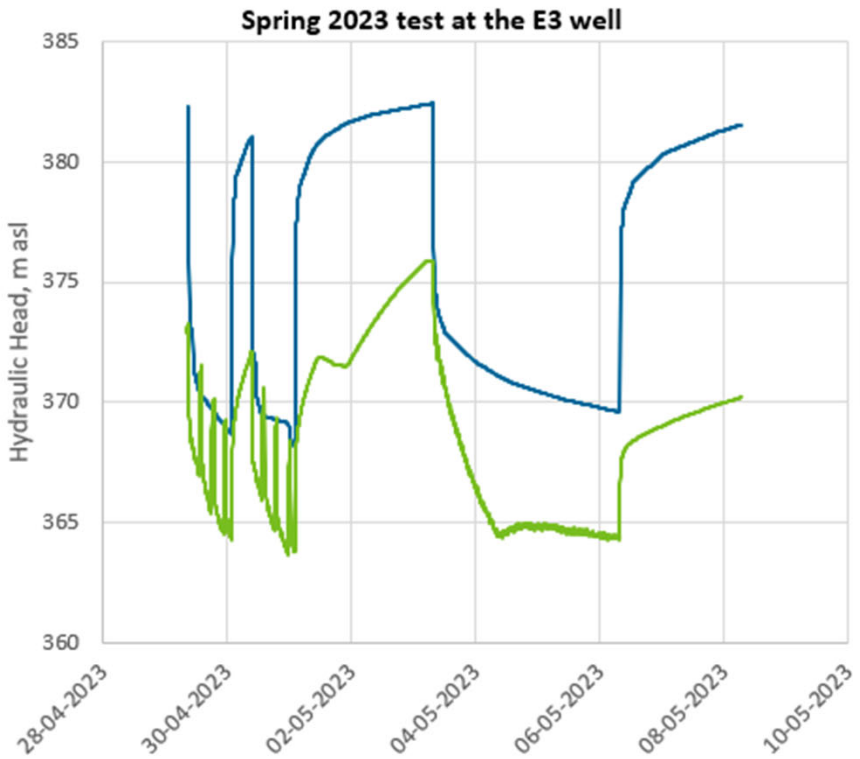
Township of Centre Wellington
Well Capacity Assessment

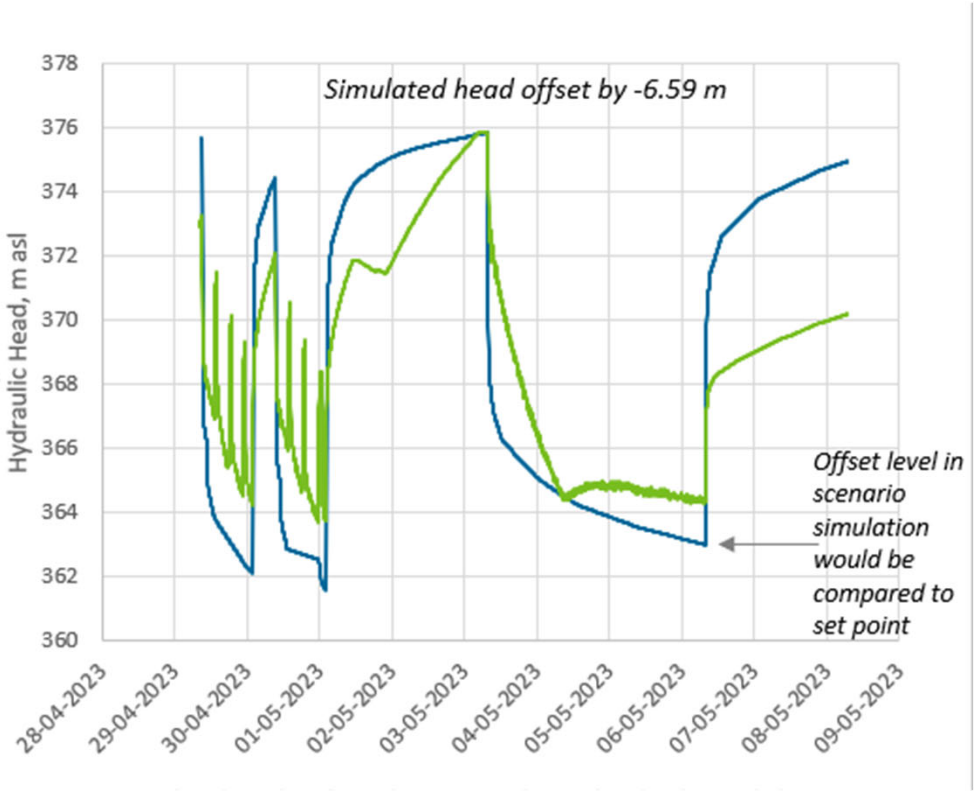
Scatter Plot of Simulated and Observed Drawdown

Date:	Project:	Submitter:	Reviewer:
August 2023	23876	P.Abdrakhimova	D. Van Vliet

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

Figure 2





Simulated Head

Observed Hydraulic Head Elevation

Matrix Solutions Inc.
A Montrose Environmental Company

Township of Centre Wellington
Well Capacity Assessment

Simulated Head Value Setpoint Comparison Demonstration

Date:	Project:	Submitter:	Reviewer:
August 2023	23876	P.Abdrakhimova	D. Van Vliet

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

Figure 3

Easting (m)

540000 544000 548000 552000 556000 560000

Northing (m)

4848000 4844000 4840000 4836000 4832000

Sideroad 12
Wellington 16 Road
Irvine Creek
Grand River
10 Sideroad
9th Line
Belwood Lake Northeast
Sideroad 20
Sideroad 15
16th Line
Belwood Reservoir
6th Line
Townline Erin Garafraxa
Wellington 26 Road
Porter Creek
2nd Line
Belwood Lake East
Sideroad 18
Sideroad 5
Alma
12th Line
Grand River East Fergus
7th Line
F6
F4
A7
205
Sideroad 10
F2
206
207
F7
F1
F5
A5
204
Fergus
Townline Erin Garafraxa
Sideroad 30
Windo'er Lake
203
201
103
104
105
Salem
102
E1
208
202
4th Line
Sideroad 15 West
A8
106
Elora
Luther Creek
E3
A2
Carroll Creek
Wellington 29 Road
101
Wellington 7 Road
A3
Middlebrook
E4
Sideroad 6 North
Swan Creek
Speed River
Sideroad 4
Grand River South of E4
Cox Creek
Sideroad 10
8th Line
Sideroad 6 South
Grand River
Grand River

17 6 18 22 21

Model Boundary
Wetland
Water Body
Watercourse
Highway
Road
Railroad Trail

Municipal and Non-Municipal Wells

- Municipal Well
- Well Representing a Cluster of Domestic Wells
- Middlebrook Well

1:84,304

Kilometres

0.75 0 0.75 1.5

NAD 1983 UTM Zone 17N

Reference: Data obtained from Grand River Conservation Authority (2017) and GeoBase® used under license. Municipal boundaries obtained from Ontario Ministry of Municipal Affairs and Housing. Contains information licensed under the Open Government Licence – Ontario.

Matrix Solutions Inc.
A Montrose Environmental Company

Township of Centre Wellington
Well Capacity Assessment

Municipal and Non-Municipal Wells

Date:	Project:	Submitter:	Reviewer:
Dec 2023	23876	P.Abdrakhimova	C.Gabriel

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Figure 4

T:\23876_CW-WellCapacityAssessment\GIS\Report_Figures\Figure-4-Municipal and Non-Municipal Wells.mxd - Tabbed_L - 08-Dec-23, 12:08 PM - pabdrakhimova - TID005

Appendix I. Wellfield Capacity Assessment Work Plan

Technical Memorandum – Proposed Well Field Capacity Assessment Work Plan to Address Condition 4.2 of Permit to Take Water No. 4856-9KBH5A

AECOM Imagine it. Delivered.

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Township of Centre Wellington

CC:

Project ref:
60565830

From:
Jason Murchison, P.Geo., Matt Alexander, P.Geo.

Date:
June 22, 2020

Technical Memorandum

Subject: Proposed Well Field Capacity Assessment Work Plan to Address Condition 4.2 of Permit to Take Water No. 4856-9KBH5A

1. Introduction

The Township of Centre Wellington (the 'Township') presently operates a series of nine (9) municipal groundwater supply wells under the authorization of Permit to Take Water (PTTW) No. 4856-9KBH5A, dated June 23rd, 2014. Condition 4.2 of the PTTW requires that the Township submit a detailed scope of work for a well field capacity assessment to MECP within a calendar year following exceedance of 50% of the PTTW maximum combined water-taking volume of 15,031,080 L/day. As the Township has not exceeded this threshold, they are proceeding with submission of the work plan by the June 30th, 2020 date specified in the PTTW as an alternate deadline. The purpose of this memorandum is to provide a scope of work for the well field capacity assessment to address Condition 4.2 of the PTTW. Aspects of this memorandum related to numerical groundwater modelling were developed by Dave Van Vliet of Matrix Solutions Inc.

2. Centre Wellington Groundwater Supply Wells

The Township's groundwater supply system presently is comprised of six (6) bedrock supply wells in Fergus and three (3) bedrock supply wells in Elora (location map included as **Figure 1**). The Fergus municipal wells are referred to as F1, F2, F4, F5, F6 and F7, while the Elora municipal wells are referred to as E1, E3 and E4. Pumping from the municipal supply well network is governed by the aforementioned PTTW, which expires June 30th, 2024. This PTTW allows for a total water-taking of 15,031,080 L/day, with a specified maximum allowable taking (both instantaneous and daily) for each well. Condition 3.3 in the PTTW restricts the total combined taking from all wells, such that the daily volume pumped from the entire well field (on an annual average basis) shall not exceed 9,018,648 L/day (approximately 60% of the total permitted taking for the individual wells) until such time as the well field capacity assessment has been completed by the Township and approved by MECP.

3. Centre Wellington Water Supply Master Plan

The Township completed a Water Supply Master Plan (WSMP) in 2019 to evaluate and forecast their water supply requirements to 2041. The WSMP identified a deficit between the current capacity of the Township's municipal well supply and the 2041

projected water demand of 2,044 and 7,023 m^3/day on an average and maximum day basis, respectively. To address this deficit, the WSMP recommended the projects listed below, including the noted implementation timeline (projects not relevant to the time frame of the current PTTW are omitted, dates have been updated to reflect current timelines):

- Replacement of well F5 implemented in 2021/2022, field work commencing in 2020;
- Replacement of well F2 implemented in 2021/2022, field work commencing in 2020;
- New supply well in Area #3 (location map included in **Attachment A**) implemented in 2026, field work commencing in 2020;
- New supply well in Area #5 implemented in 2031, field work commencing in 2020; and,
- New supply well in Area #8 implemented in 2036/2037, field work commencing in 2020.

All of the projects above will require amendments to the PTTW and/or additional PTTW to permit taking from the new/replacement wells. **Section 4** of this memorandum provides detail with respect to how the Township proposes to incorporate these projects into the well field capacity assessment work plan.

4. Proposed Well Field Capacity Assessment

4.1 Overview of Proposed Pumping Tests

This section provides an overview of the proposed well field capacity assessment work plan. Integral to the work plan is achieving pumping rates at the F2 and F5 wells as close to the current approved maximum allocation within the PTTW as possible. The F2 well has been out of service since 2003 and is not currently operational. The F5 well is currently operated significantly below its permitted maximum due to water quality concerns (turbidity) produced at higher pumping rates. For context, in 2017 the average annual daily taking from F5 was 310 m^3, or 16% of the PTTW maximum. To address these deficiencies, the Township plans to replace both of these wells via a well construction program on the existing F2 and F5 properties. These replacement wells are proposed to be integrated into the well field capacity assessment program, as noted below. The new water supply well program described in **Section 3** for Areas 3, 5 and 8, will occur separately from the well field assessment program; however, any relevant data collected from this program will be integrated into the well field capacity assessment, particularly from the perspective of revising the current characterization of the hydrogeological system.

Similar to the 2013 well field capacity assessment program, the Township proposes to segment the testing program by separating the pumping between Fergus and Elora. Testing in Fergus is proposed to be further segmented, as indicated in **Table 1**. The segmentation in Fergus is an operational strategy that will assist the Township with maintaining the requirements for delivery of on-going supply to the community and management of the water generated during testing. Previous testing data from the Fergus wells supports this testing strategy, in terms of minimal observed mutual interference between the six (6) Fergus production wells. As documented in the 2013 well field capacity assessment report (Golder, 2013), the Fergus wells were not observed to cause mutual interference drawdown, with the exception of mutual interference observed at F4 during preliminary testing. Previous analysis indicated that F6 may cause of minor interference drawdown at F4 (Golder, 2013). During the proposed testing, groundwater level monitoring will occur at the locations identified in **Section 4.4**, and at all supply wells (existing and replacement), during each of the three (3) tests outlined in **Table 1**. Therefore, the proposed testing will provide further insight into any interference drawdown that may occur between the supply well clusters and within monitored private wells.

The proposed testing strategy will be subject to the results of individual testing conducted during the F2 and F5 replacement program, whereby the replacement wells will be pumped independently from the existing supply wells and interference drawdown caused by pumping the replacement wells (and vice versa) will be assessed.

Table 1: Proposed Well Field Capacity Testing Strategy

Test Number*	Production Well	Target Pumping Rate (L/s)
1	F1	19
	F2 (replacement)^	19
	F5 (replacement)^	30
2	E1	19
	E3	20
	E4	20
3	F4	20
	F6	19
	F7	19

Notes: ****Test number is for illustrative purposes, actual order of tests is subject to future operational considerations.***
^Pumping of the replacement F2 and F5 wells will be completed under a separate PTTW.

Short-term testing at each individual existing supply well will be conducted in advance of the long-term pumping tests to confirm the ability of each well to achieve the target rate specified in **Table 1** and project the sustainability of the rate over the duration of the test. The form of the short-term testing will be based on a review of the available performance testing data and may comprise of a stepped rate performance test or single rate test at the target rate. Typical pumping duration will be one to four hours. Pre-testing of the replacement wells will be more comprehensive than at the existing wells (i.e. step and constant rate 24-hour pumping tests) as the sustainability of pumping these wells at the target rate(s) is an unknown that must be proven prior to the full scale well field testing program.

The proposed constant rate well field capacity tests (**Table 1**) will be staged such that one of the Fergus clusters is tested first, following a shutdown period to allow for aquifer recovery within the cluster to the extent that is operationally possible (min. 2 to 3 days). During this period, pumping within the other Fergus cluster will be minimized. Following completion of testing at the first Fergus cluster, the Elora wells will be tested, following a shutdown period at these wells. Finally, testing will be conducted at the second Fergus cluster, following a shutdown period at these wells.

The duration of long-term testing at each well cluster will be a function of aquifer response. The minimum duration will be 72 hours. The tests will continue until, in the opinion of the Qualified Professional overseeing the testing, that the sustainability of the taking and potential impacts related to the taking, have been adequately assessed.

It is anticipated that the well field capacity testing program will not occur during the high demand period (late spring/summer) in order to maximize the length of time that the system can be shut down prior to initiating constant rate testing.

The outlined testing strategy is subject to progress with the replacement well program. The Township is currently planning to complete replacement well construction and testing for F5 and F2 in 2021/2022. If delays are experienced in this program, the well field capacity assessment for wells E1, E3 and E4 may be advanced prior to completion of the replacement well program in order to maintain the overall testing schedule by the December 31st, 2024 deadline. MECP will be given advanced notice if such a deviation is contemplated by the Township.

4.2 Permitting

Testing of the existing well field will occur under the current PTTW. In order to complete continuous testing, the Township requests that MECP provides a short-term exception from the restriction limiting daily pumping of E4 to a maximum of 15 hours. This is consistent with the well field capacity testing that occurred in 2012/2013 when this well was pumped for more than 3 days continuously.

Pumping of the F2 and F5 replacement wells for the well field capacity testing will occur under a Category 3 PTTW that the Township will apply to MECP for as part of the well replacement program.

4.3 Discharge of Pumped Water

Where at all possible, water pumped during the testing will be treated and distributed to satisfy local demand requirements. At the locations where pumping exceeds demand requirements and storage capacity, water will be pumped to waste in accordance with the respective existing site configurations. All discharge activities will be completed in accordance with existing Environmental Compliance Approvals (ECAs), Township By-Laws, and Grand River Conservation Authority (GRCA) requirements.

4.4 Groundwater Monitoring Locations

Monitoring of aquifer response to the testing program outlined in **Section 4.1** will be conducted within the production wells using the Township's existing SCADA system and within the existing multi-level monitoring wells listed in **Table 2** and shown in **Figure 1**. The F2 well replacement field program will include the installation of a multi-level monitoring well located approximately mid-way between the F1 and F2 properties. This monitoring well will be established to monitor the hydraulics within the target zone (Gasport/Goat Island Formations), and groundwater levels within the Guelph Formation and the overburden (subject to sufficient overburden being encountered at the drilling location).

Also included in **Table 2** are monitoring wells owned by the Township or GRCA and private wells that have been previously monitored by the Township[1]. The private wells are included to indicate the distribution of monitoring wells that the Township will attempt to monitor; however, data collection at these locations is subject to access permission being granted by each well owner. Previous testing has shown all of these wells to be hydraulically connected to the target aquifer with the exception of Wells 20 and 30. The well depth information presented in **Table 2** for these wells indicates that all are likely completed within bedrock. After receipt of access permissions for private well monitoring locations and review of the overall distribution of monitoring locations, the Township will evaluate the presence of data gaps. If present, the data gaps will be address through the installation of additional monitoring wells at the identified locations.

Table 2: Proposed Well Field Capacity Assessment Groundwater Monitoring Locations

Well Name	Well Type	Associated Production Well	Completion Formation	Top of Screen (mbgs)	Bottom of Screen or Well Depth (mbgs)	Proposed Monitoring Frequency
MW1-12A	Municipal Monitoring Well	E3	Goat Island (Ancaster/Niagara Falls member)	125.9	131.98	Hourly
MW1-12B			Guelph	40.84	46.94	Hourly
MW1-12C			Overburden (gravelly CLAY)	14.36	17.41	Hourly
MW2-11A	Municipal Monitoring Well	E1	Goat Island (Niagara Falls member)	123.70	128.66	Hourly
MW2-11B			Guelph	29.91	36.01	Hourly
MW2-11C			Overburden (silty SAND)	8.53	11.58	Hourly

[1] The exception is Well 34. This deep bedrock well was completed in 2015, after the previous testing was completed.

Well Name	Well Type	Associated Production Well	Completion Formation	Top of Screen (mbgs)	Bottom of Screen or Well Depth (mbgs)	Proposed Monitoring Frequency
MW3-11A	Municipal Monitoring Well	F5	Goat Island (Niagara Falls member)	115.80	121.92	Hourly
MW3-11B			Guelph	42.98	49.07	Hourly
MW3-11C			Overburden (sandy SILT)	21.18	24.23	Hourly
MW4-12A	Municipal Monitoring Well	F7	Goat Island (Ancaster member)	113.10	119.15	Hourly
MW4-12B			Guelph	32.00	38.10	Hourly
MW4-12C			Overburden (silty SAND)	12.19	15.24	Hourly
MW5-11A	Municipal Monitoring Well	F6	Gasport	122.50	128.63	Hourly
MW5-11B			Guelph	39.93	46.03	Hourly
MW5-11C			Overburden (sandy SILT)	16.76	19.18	Hourly
MW6-12A	Municipal Monitoring Well	F4, F6	Goat Island (Ancaster member)	104.20	110.30	Hourly
MW6-12B			Guelph	38.98	45.08	Hourly
MW6-12C			Overburden (silty SAND)	21.34	22.86	Hourly
MW7-20A*	Proposed Municipal Monitoring Well	F1, F2	Gasport	115†	120†	Hourly
MW7-20B*			Guelph	35†	40†	Hourly
MW7-20C*			Overburden (if present)	10†	15†	Hourly
Well 1	Private Well	F4, F6	Unknown	-	54.9 (est. depth)^	Hourly
Well 4	Municipal Monitoring Well	F1	Unknown	-	38.3^	Hourly
Well 14	Private Well	E3	Unknown	-	36.6 (est. depth)^	Hourly
Well 15	Municipal Monitoring Well	E3, E4	Unknown	-	44.8^	Hourly

Well Name	Well Type	Associated Production Well	Completion Formation	Top of Screen (mbgs)	Bottom of Screen or Well Depth (mbgs)	Proposed Monitoring Frequency
Well 17	Municipal Monitoring Well	E4	Unknown	-	61.0^	Hourly
Well 19	GRCA Monitoring Well	E4	Unknown	-	97.5^	Hourly
Well 20	Private Well	Background	Unknown	Unknown	Unknown	Hourly
Well 21	Private Well	E1	Unknown	-	78.0 (est. depth)^	Hourly
Well 28	Private Well	F5	Unknown	-	>61 (est. depth)^	Hourly
Well 29	Private Well	F2, F5	Unknown	-	54.9 (est. depth)^	Hourly
Well 30	Private Well	F6	Unknown	-	51.8 (est. depth)^	Hourly
Well 31	Private Well	F4, F6, F7	Unknown	-	>50 (est. depth)^	Hourly
Well 32	Private Well	F7	Unknown	Unknown	Unknown	Hourly
Well 33	Private Well	F2	Unknown	Unknown	69 (est. depth)^	Hourly
Well 34	Private Well	E1	Multiple[Ω]	Unknown	158.5[‡]	Hourly

Notes: ****Future/proposed multi-level monitoring well.***
[†]Screen depths are preliminary and will be based on drilling results.
^Well depth or estimated well depth.
[Ω]Open hole bedrock well likely open to Goat Island/Gasport FMs based on depth and Bedrock Materials described on well record.
[‡]Well depth as shown on MECP well record.

4.4.1 Private Water Well Survey and Monitoring Program

Field work required for the F2 and F5 replacement well program will include an inventory of private supply wells within a radial distance of 500 m from these sites (the 'water well survey area') and the inclusion of private wells in the field monitoring program, where access permission is granted. These groundwater monitoring points will be in addition to those listed in **Table 2**.

The purpose of the survey will be to obtain background information on the use of local aquifers as a water supply (both potable and non-potable) and to assess baseline groundwater levels prior to initiation of the well drilling and testing program.

The private water well monitoring program will consist of the following general components:

- Desktop review of available information regarding the local hydrogeologic setting and location of private water wells within each 500 m survey radius that may utilize the local overburden or bedrock aquifers for their water supply;
- Hand delivery of a water well survey package to all properties within each water well survey area. The survey package will be designed to collect information on well construction, water quality/quantity characteristics, and location of potential

nearby activities (i.e., septic systems, fuel storage, etc.) that may pose a possible threat to the quality or quantity of the groundwater supply;

- Site visit to each survey respondent, where access permission has been obtained in writing, to provide assistance with survey completion and/or collection of completed surveys. Site visits will include the measurement of static groundwater levels and collection of a raw (untreated) water quality sample for analysis of bacteriological parameters, general chemistry, major ions and total metals analysis, in the wells where permission is granted. The survey completed for the F2 site will also include analysis of a VOC suite; and,
- Installation of electronic pressure transducers outfitted with dataloggers within select private wells within each water well survey area accompanied by the periodic collection of manual groundwater level measurements during water quantity (pump) testing.

Private well monitoring locations identified through this program will be in addition to the potential monitoring locations identified in **Table 2**.

4.5 Surface Water Assessment

In advance of the pumping tests proposed for the well field capacity assessment, the Township will conduct a reconnaissance level survey and background data review in the area around the Fergus and Elora wells, including Irvine River, Swan Creek and the Grand River to document stream conditions and baseflows, where feasible.

The Township production wells are deep bedrock installations that have been observed to induce little, if any, water level drawdown within the overburden. Further, there is no history of surface water impacts related to pumping of the existing supply wells. This historical information will be investigated during the well field capacity assessment through monitoring of the existing and newly installed shallow monitoring wells at the frequency indicated in **Table 2**. In addition, a series of mini-piezometers will be installed within the Irvine River and Swan Creek if/where locations of potential groundwater upwelling are identified. These installations will be monitored prior to and during the well field capacity assessment to evaluate potential water level fluctuations associated with municipal pumping.

An assessment of potential impacts to surface water features related to the pumping of the Township supply wells will be completed based on the collected groundwater level data.

4.6 Capacity Testing Contingency Plan

The communities of Fergus and Elora have a relatively high density of operating private wells within the urban envelope and in some cases there are private wells in very close proximity to the municipal supply wells. During the proposed well field capacity assessment testing, aquifer drawdown will be monitored as described in **Section 4.4**. If a private well interference complaint is received during testing, the complainant will be provided with a short-term supply of drinking water and the Township will commence an immediate assessment of whether the received complaint is related to the testing. If this assessment determines that the test has caused interference and that the private well cannot provide the required supply, the test will be stopped. If, within 24 hours of the complaint being received, the interference assessment is inconclusive, the test will be stopped. Finally, if the assessment determines that the private well can continue to operate as required, or that the testing *has not* caused interference to the supply, the test will continue according to the planned schedule and duration. In accordance with the existing PTTW, the Township will immediately notify the local MECP District Office of any complaint received during the testing and the proposed action to assess and mitigate the complaint. Subsequently, the Township will notify MECP of the complaint resolution.

5. Data Analysis and Reporting

Data collected during the well field capacity assessment, as described in **Section 4**, will be compiled and analyzed to determine the sustainable capacity of the Fergus and Elora water supply systems. This will include an assessment of available historical data, drawdown curves observed during the capacity assessment (both pumping and monitored locations), anticipated steady-state pumping elevations, potential long-term drawdown over extended pumping periods and

typical drawdown under average municipal pumping conditions. An impact assessment will be completed to evaluate the Zone of Influence (horizontal), vertical propagation of drawdown within the various key hydrostratigraphic layers, the magnitude of interference drawdown that occurred between pumping wells, the observed/potential for municipal supply wells to interfere with private supply wells, and potential impacts on local surface water features. Additional geologic and hydrogeologic data collection completed for the replacement well program and/or for the development of new well sites and multi-level monitoring wells, such as borehole drilling and down-hole geophysics will be utilized to update the existing conceptual model and aquifer characterization.

An aspect of the analysis and impact assessment will include use of the Centre Wellington Tier Three groundwater flow model. Initially, the conceptual model and the calibrated numerical model will be compared to pumping test results completed in support of the replacement wells and the well field capacity assessment. Where necessary, the numerical groundwater flow model will be refined to match this new information. Once calibrated, the model will be applied to evaluate what cannot be understood directly from the field results, including; incremental drawdown contours in overburden, shallow bedrock and deep bedrock under average and peak pumping conditions.

The groundwater flow model will also be applied to estimate incremental drawdown at the location and depth of all known private supply wells under average or peak pumping rates. The results of this analysis will inform the Township's Contingency and Mitigation strategy employed for addressing well complaints.

Finally, the groundwater flow model will be applied to estimate changes to the water budget for new/replacement municipal supply wells, as compared to existing conditions. Water budget parameters will include groundwater discharge to streams and vertical leakage between shallow and deeper aquifers.

The results of the above described analysis and impact assessment, along with all collected field data will be documented in a well field capacity assessment report that will be submitted to the MECP Director, as per Condition 4.2 of the PTTW. The following is a general summary of the analysis and information that will be included in this report:

- Site map showing the location of all wells drilled, tested and monitored;
- A summary of the regional physiography, geologic and hydrogeologic setting, including appropriate maps and drawings;
- A summary of the water well survey results;
- Borehole logs;
- Geophysical logs;
- Geologic cross-sections;
- Hydrographs of monitoring data;
- Pumping and non-pumping groundwater contour maps;
- Aquifer hydrogeologic properties within the ZOI of each replacement well;
- Analysis of pumping test and recovery data;
- Copies of MECP Water Well Records;
- The proven well field production capacity;
- Potential pumping impacts to:
    - other groundwater users (private wells);
    - groundwater dependant ecological features;
    - existing municipal wells; and,
    - aquifer water quality.
- Detailed summary of the completed groundwater modelling task, including:
    - Model update/refinements and calibration;
    - Modelling methodology;
    - Scenario results, including graphical output; and,
    - Discussion and recommendations.

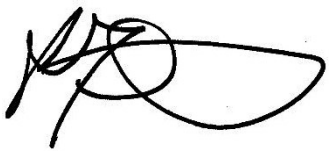
- Summarize the impact assessment detailed above and provide potential mitigation methods, as required; and,
- Recommendations as to the maximum pumping rate for the Fergus and Elora well fields and the details of any Conditions recommended to be included within the new well field PTTW.

Through discussion with MECP during the well field capacity assessment work plan pre-consultation process, it is understood that MECP would consider issuing separate PTTWs for the Fergus and Elora well fields. At this time, the Township is planning to complete the assessment testing consecutively as outlined in this document and submit a single well field capacity report to MECP. If delays are experienced in the well replacement program that will cause a corresponding delay in submission of the well field assessment report, the Township will contact MECP to discuss the option of separating the two (2) testing programs and requesting that the current PTTW be split into separate Fergus and Elora PTTWs.

6. Closing

This memorandum was prepared to provide the detail associated with the Township's proposed well field capacity assessment work plan, as required by Condition 4.2 of PTTW No. 4856-9KBH5A. This document should be submitted to MECP by June 30th, 2020 to meet this Condition. Should you have any questions please do not hesitate to contact the undersigned.

Sincerely,
AECOM Canada Ltd.



Matthew Alexander, M.Sc., P.Geo.
Manager, Hydrogeology
Environment
Matthew.Alexander@aecom.com

Jason Murchison, P.Geo., QP(ESA O.Reg.153)
Director, Geosciences (Hydrogeology/ Geotechnical Engineering)
Environment
Jason.Murchison@aecom.com

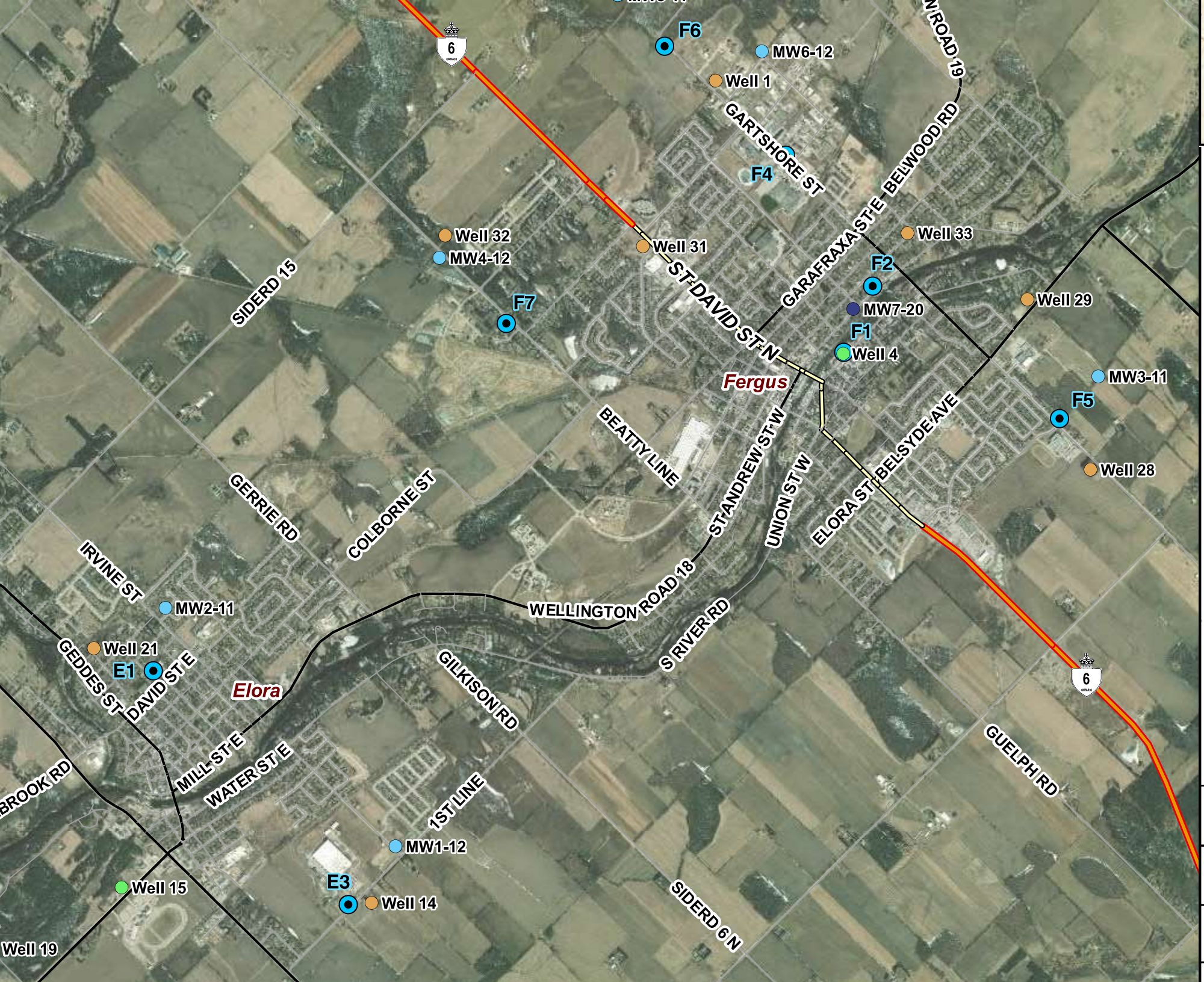
7. References

AECOM, 2019. Township of Centre Wellington Water Supply Master Plan (Draft).

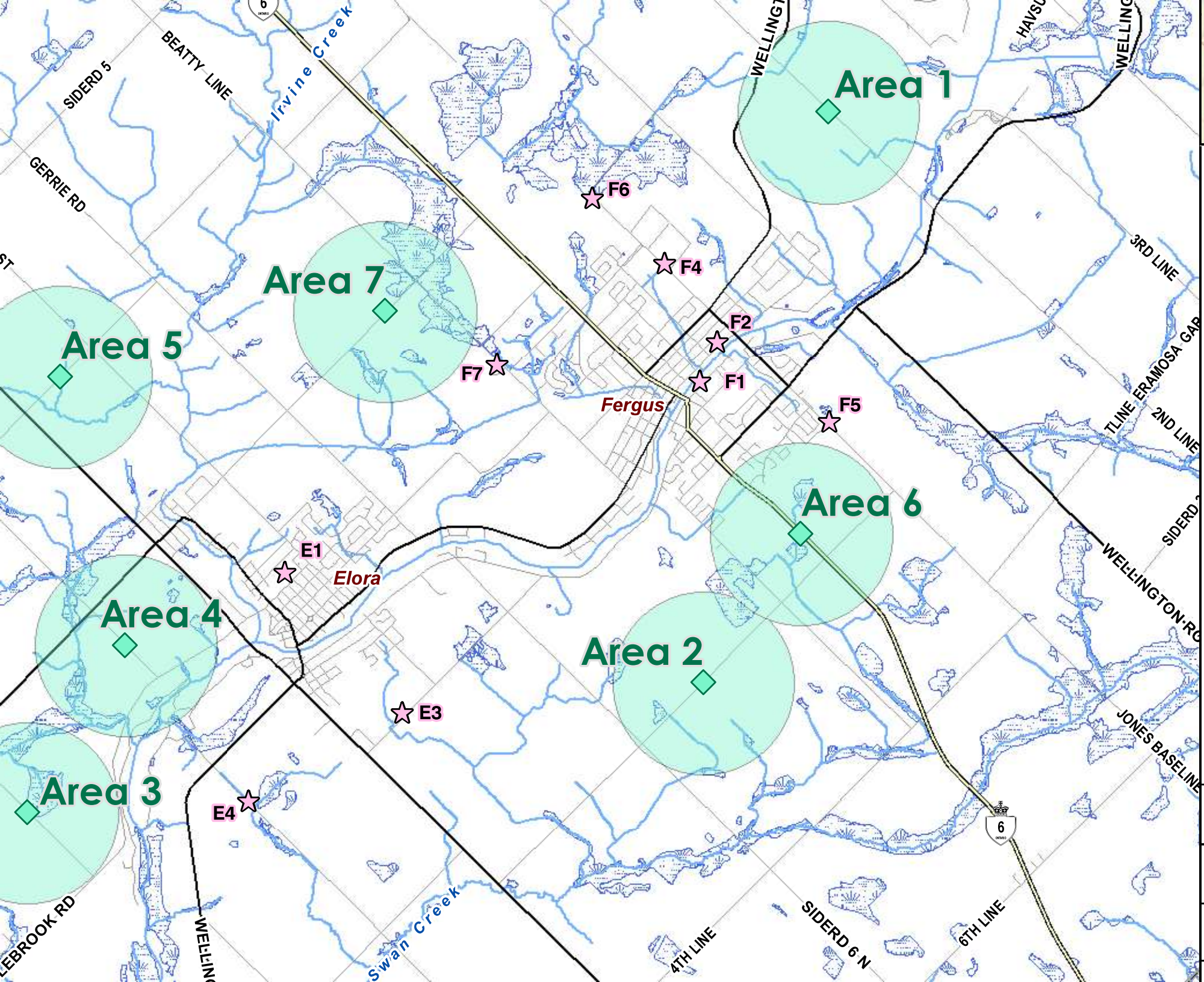
AECOM, 2020. Pre-Consultation Meeting Minutes. Meeting Date: May 26th, 2020.

Golder Associates Ltd. (Golder), 2013. Township of Centre Wellington: Well Field Capacity Assessment. Prepared for the Township of Centre Wellington. Elora, Ontario.

Figure 1: Well Location Map


F6
MW6-12
Well 1
GARTSHORE ST
F4
Well 32
MW4-12
Well 31
ST DAVID ST N
GARAFRAXA ST E
BELWOOD RD
Well 33
F2
MW7-20
Well 29
SIDERD 15
F7
F1
Well 4
Fergus
MW3-11
F5
BEATTY LINE
ST ANDREW ST W
UNION ST W
ELORA ST
BELSYDE AVE
Well 28
GERRIE RD
COLBORNE ST
IRVINE ST
MW2-11
WELLINGTON ROAD 18
S RIVER RD
Well 21
E1
GEDDES ST
DAVID ST E
Elora
GILKISON RD
MILL ST E
WATER ST E
GUELPH RD
1ST LINE
MW1-12
E3
Well 15
Well 14
SIDERD 6 N
Well 19
Legen
General
Aerial Imager
Keymap Base
0
June, 202

Attachment A: WSMP Figure – Existing Municipal Wells and Potential Exploration Areas


Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7
F1
F2
F4
F5
F6
F7
E1
E3
E4
Fergus
Elora
Irvine Creek
Swan Creek
BEATTY LINE
SIDERD 5
GERRIE RD
3RD LINE
2ND LINE
ERAMOSA GAP
WELLINGTON RD
JONES BASELINE
4TH LINE
SIDERD 6 N
6TH LINE
6

Township of Centre Wellington Wellfield Capacity Work Plan Comments

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March 5, 2021

Our Reference
60565830

Gregory Meek
Director, s. 34.1, OWRA
Permit to Take Water Unit
Environmental Permissions Branch
Ontario Ministry of the Environment,
Conservation and Parks
135 St. Clair Ave W
Toronto, Ontario
M4V 1P5

Township of Centre Wellington Wellfield Capacity Work Plan Comments

Dear Mr. Meek

AECOM was retained by the Township of Centre Wellington ('the Township') to prepare a detailed work plan for a well field capacity assessment to address Condition 4.2 of Permit to Take Water (PTTW) No. 4856-9KBH5A, dated June 23rd, 2014. This work plan was submitted to the Ministry of the Environment, Conservation and Parks (MECP) on June 26th, 2020, and MECP provided work plan review comments on October 30th, 2020. These comments were compiled in two (2) separate documents, as described below:

- Document #1 (**Attachment A**):
  - File name: GW-Well Field Capacity Assessment Work Plan-Centre Wellington Municipal System-October-23-2020
  - Author: Abdul Quyum
  - Topic: Hydrogeological review comments
- Document #2 (**Attachment B**):
  - File name: Centre of Wellington PTTW 4856-9KBH5A Well Field Capacity Plan SW Comments
  - Author: Michael Spencer
  - Topic: Hydrologic review comments

Subsequently, additional comments were received from Abdul Quyum in two emails, included in **Attachment C** (Document #3). The purpose of this letter is to provide a response to the review comments received; including recommendations for revisions to the work plan to address these comments. For clarity, this letter is organized with separate responses to each of the documents referenced above. The review comments have not been reproduced herein; rather, the review comment numbering utilized within the respective review documents has been maintained for clarity (where applicable).

Hydrogeological Review Comments (Document #1)

1. Section 3, Centre Wellington Water Supply Master Plan

- As was discussed during the MECP pre-consultation meeting on May 26th, 2020, and stated in the work plan, existing wells F2 and F5 cannot currently operate at the PTTW Table A maximum rate(s), and therefore the incorporation of replacement wells at each location is considered to be a required element to permit testing of the complete well field identified within the Permit and referenced by Condition 4.2.

- The approach described in the bullet above is consistent with the reviewer's comment that the "well field capacity assessment is applicable to the sources (wells) listed in Table A of the Permit" and that it is to "demonstrate that the permitted taking of 15,031,080 litre per day from 9 permitted wells in Elora and Fergus is sustainable". Thus, unless replacement wells F2 and F5 are included in the program, the intent of testing all of the 9 sources listed in the Permit cannot be achieved. As the ongoing operational issues with existing Wells F2 and F5 are unrelated to local aquifer conditions, it is our opinion that the proposed approach to include replacement Wells F2 and F5 reasonable and justified.
- In January 2014, MECP provided review comments on the Centre Wellington 2013 well field capacity assessment, which included an opinion that the assessment showed that the well field was sustainable at pumping rates of up to 50% of the permitted rates. As outlined in the previous bullet, replacement of the identified wells is required to test the well field at its maximum permitted capacity and address this issue highlighted previously by MECP.
- It is anticipated that the work plan will be reviewed by multiple parties at MECP, some of whom are not familiar with details of the Centre Wellington Water Supply Master Plan (WSMP) and related population and employment growth planned in Centre Wellington. As such, the context provided serves as important background information that justifies the proposed approach of including the F2 and F5 replacement wells in the well field capacity assessment.

2. *Section 4.1, Overview of Proposed Pumping Tests*

- The reviewer states that the proposed work plan does not specify whether the wells will be shut-down prior to the initiation of testing. Section 4.1 of the work plan indicates that a minimum 2 to 3 day shut-down period will occur prior to the testing of each cluster. Additional detail will be added to the work plan to clarify this point, as follows:
  - Prior to the initiation of each well cluster test, the elevated water storage tanks and reservoirs serviced by each cluster will be filled to capacity and the wells will be shut down for period of 2 to 3 days, subject to operational or demand constraints. This process will be followed in advance of the testing within each well cluster.

Item a)

- The response to this review comment, originally provided to MECP on December 16th, 2020, has been superseded by a response to the additional review comments contained within Document #3 (**Attachment C**). This final response is provided on Page 7 of this letter.

Item b)

- With respect to whether the testing will be implemented using a simultaneous versus staggered start, it is proposed that the additional text below forms a component of the work plan:
  - Following the shut down period, the wells within each cluster will be turned on in a staggered fashion, with a four (4) hour gap occurring between each well being activated. Following each cluster test, the wells will be turned off simultaneously.
- As stated in Section 4.1 of the proposed work plan: "The minimum testing duration for each well cluster will be 72 hours. The testing will continue until, in the opinion of the Qualified Professional overseeing the testing, the sustainability of the taking and potential impacts related to the taking, have been adequately assessed."
- The value of mimicking the full 2012/13 testing program is unclear as the Township already has this data available for review/analysis. Rather, we see value in implementing the recommended program with an option to extend the duration of testing based on review and interpretation of monitoring data collected throughout the testing period.

Item c)

- **Table 1a** below, is a revision to Table 1 in the submitted work plan. It is proposed that this table replace work plan Table 1 to address the reviewer's comment about target pumping rates versus existing PTTW rates:

Table 1a: Proposed Well Field Capacity Testing Strategy

Test Number*	Production Well	Target Pumping Rate (L/s)	Target Pumping Rate (L/min)
1	F1	21.2	1,273
	F2 (replacement)^	19.0	1,137
	F5 (replacement)^	30.3	1,818
2	E1	20.2	1,209
	E3	22.7	1,364
	E4	22.7	1,364
3	F4	22.7	1,364
	F6	22.7	1,364
	F7	22.7	1,364

Notes: ****Test number is for illustrative purposes, actual order of tests is subject to future operational considerations.***
^Pumping of the replacement F2 and F5 wells will be completed under a separate PTTW.

3. *Section 4.2. Permitting*

- We agree with the reviewer that temporary relief from the PTTW limitations on daily pumping duration for F2 (6 hours) and E4 (15 hours) will be required to facilitate the proposed well field testing program. In the case of an F2 replacement well, this will be requested in the PTTW application for the well replacement program. In the case of well E4, we respectfully request clarification on the process that the Township should follow to receive permission from the Director to seek relief from the identified PTTW condition.

4. *Section 4.4. Groundwater Monitoring Locations*

- The reviewer states that the proposed work plan includes a door-to-door water well survey within 500 m of the **municipal wells**. It should be noted that the work plan includes a door-to-door water well survey within 500 m of the **F2 and F5 well sites**.
- Within Table 2 of the submitted work plan, the 'Completion Formation' for the Private Wells and some of the Municipal Monitoring Wells is described as 'Unknown'. This indicates wells that do not have sufficient available background information to reliably identify the bedrock formations encountered by the wells. However, most of the listed wells were selected based on previous testing results that showed that these wells are connected to the bedrock formations targeted by the municipal wells. Well 20 was selected as a background well and the depth of this well will be verified during the well field capacity assessment to the extent possible. Well 34 was not previously monitored by the Township and was selected for this program as it is a known very deep well (158.5 m) that is anticipated to be hydraulically connected to the target bedrock formations (**Attachment D**).
- The Township has identified a series of additional wells for inclusion in the monitoring program, as outlined in **Table 2a** below, and shown in the attached **Figure 1**. These wells represent monitoring points that are most relevant to Elora wells E3 and E4, and Fergus wells F1 and F7. The wells identified as "Research Monitoring Wells" will be installed by the G360 Institute for Groundwater Research from the University of Guelph. If requested, the borehole logs generated for these wells will be provided to MECP when they are available. The Township has consulted with A.O. Smith and received permission to monitor the bedrock wells identified in **Table 2a**. With the monitoring wells identified in **Table 2a** added to the program, the Township has identified a monitoring network that provides coverage throughout Elora and Fergus, and to the north, south, east and west

of the community. In addition, the monitoring network includes both shallow and deep monitors that will provide information on vertical gradients present within the groundwater system and determine whether a hydraulic connection exists between the deep bedrock aquifer targeted by the Township production wells and the shallow bedrock and overburden.

Table 2a: Proposed Additional Well Field Capacity Assessment Groundwater Monitoring Locations

Well Name	Well Type	Associated Production Well	Completion Formation	Top of Screen or Open Interval (mbgs)	Bottom of Screen or Well Depth (mbgs)	Proposed Monitoring Frequency	Notes
Well 35	Private Well	E3, E4	TBD	TBD	TBD	Hourly	Private bedrock well on or near Hill St. to be identified prior to testing program
North Bedrock Well 1	Research Monitoring Well	E3	TBD	TBD	TBD	Hourly	Field program currently being completed by University of Guelph. Bedrock well details to be determined.
North Bedrock Well 2	Research Monitoring Well	E3	TBD	TBD	TBD	Hourly	Field program currently being completed by University of Guelph. Bedrock well details to be determined.
North Overburden Well 1	Research Monitoring Well	E3	TBD	TBD	TBD	Hourly	Field program currently being completed by University of Guelph. Overburden well details to be determined.
North Overburden Well 2	Research Monitoring Well	E3	TBD	TBD	TBD	Hourly	Field program currently being completed by University of Guelph. Overburden well details to be determined.

Well Name	Well Type	Associated Production Well	Completion Formation	Top of Screen or Open Interval (mbgs)	Bottom of Screen or Well Depth (mbgs)	Proposed Monitoring Frequency	Notes
South Bedrock Well 1	Research Monitoring Well	E3, E4	TBD	TBD	120.4*	Hourly	Field program currently being completed by University of Guelph. Bedrock well details to be determined.
South Bedrock Well 2	Research Monitoring Well	E3, E4	TBD	TBD	125.6*	Hourly	Field program currently being completed by University of Guelph. Bedrock well details to be determined.
South Overburden Well 1	Research Monitoring Well	E3, E4	TBD	TBD	27.5*	Hourly	Field program currently being completed by University of Guelph. Overburden well details to be determined.
South Overburden Well 2	Research Monitoring Well	E3, E4	TBD	TBD	57.5*	Hourly	Field program currently being completed by University of Guelph. Overburden well details to be determined.
MS24A-94S	A.O. Smith Monitoring Well	F1, F7	Guelph	36.7	39.6	Hourly	
MS46A-00S	A.O. Smith Monitoring Well	F1, F7	Guelph	29.3	32.3	Hourly	
MS46A-00I	A.O. Smith	F1, F7	Guelph	46.7	49.7	Hourly	

Well Name	Well Type	Associated Production Well	Completion Formation	Top of Screen or Open Interval (mbgs)	Bottom of Screen or Well Depth (mbgs)	Proposed Monitoring Frequency	Notes
	Monitoring Well						
MS47A-01S	A.O. Smith Monitoring Well	F1, F7	Guelph	32.0	35.1	Hourly	
MS47A-01I	A.O. Smith Monitoring Well	F1, F7	Guelph	48.8	51.9	Hourly	
DDH5-09	Ontario Geological Survey Well	E1, E4	Guelph, Goat Island	25 38.5 82 123 137.5	26.5 41.5 83.5 124.5 139	Hourly	Flute liner with multiple ports installed in borehole

Notes: ****Preliminary drilling results based on communication with University of Guelph G360 Institute.***

- With respect to the MECP recommendation that a door-to-door survey be conducted within the anticipated zone of influence of the well field pumping, rather than within 500 m of the F2 and F5 wells, it is our opinion that the proposed approach for monitoring private wells is consistent with the MECP *Technical Guidance Document for Hydrogeological Studies in Support of Category 3 Applications for Permit to Take Water* (April, 2008), as follows (pg. 9):

  "Where there are a relatively large number of existing wells, a representative subset of wells can be assessed if the qualified person clearly identifies the criteria used to select the wells and that all wells at higher risk of experiencing unacceptable interference are included. At a minimum, reasonable effort should be made to obtain static water level readings in the wells closest to the production well that are screened in the same aquifer."

5. *Section 5, Data Analysis and Reporting*

- Section 5 of the work plan will be updated to reference an assessment of 20 years of continuous pumping at a constant maximum rate.
- The response to this review comment, originally provided to MECP on December 16th, 2020, has been superseded by a response to the additional review comments contained within Document #3 (**Attachment C**). This final response is provided on Page 8 of this letter.

Hydrologic Review Comments (Document #2)

1. Section 4.5, Surface Water Assessment

- We are in agreement with the reviewer's comment. The work plan will be updated to state that the proposed mini-piezometer locations will be submitted to MECP for review following completion of the reconnaissance survey/background review and prior to installation.

Additional Hydrogeological Review Comments (Document #3)

Document #3 includes various emails exchanged between Matthew Alexander (AECOM) and Abdul Quyum (MECP) between February 3rd, 2021 and February 15th, 2021. Through the course of this correspondence, some of the initial comments raised by MECP were resolved and did not require any revisions to the work plan. The issues that did result in work plan revisions are discussed below.

1. *Comment in email dated February 3rd, 2021: What would be the status of wells in first cluster while testing the 2nd cluster in [Elora] and Fergus well field? How to incorporate the impact of operating wells in one cluster while testing wells in 2nd cluster? The wells in 1st cluster, in our opinion, should be fully operational at full capacity before and during testing of wells in the 2nd cluster.*

- The above comment was subsequently discussed with the MECP reviewer via a telephone conversation. The response provided herein only includes the final agreed upon details regarding well cluster testing.

  The Elora well cluster (E1/E3/E4) will be operated independently of the two (2) Fergus well clusters (**Table 3a**). The Fergus well clusters will be operated simultaneously at maximum capacity, as outlined in **Table 3a**. Township Operations Staff were consulted with respect to the possibility that all six (6) Fergus wells be shut-down for a minimum 2 to 3 day period in advance of testing all Fergus wells concurrently. It was determined that this shut-down could not be accommodated while still meeting community supply demands anticipated during the testing period. Therefore, the two cluster tests in Fergus include a minimum 2 to 3 day shut-down period for the three primary wells being tested in each cluster test, while the three wells in the non-primary cluster will not undergo a shut-down, as illustrated in **Table 3a**.

Table 3a: Proposed Well Cluster Operation During Well Field Capacity Testing

Test/Cluster Number*	Production Well	Status of Cluster 1	Status of Cluster 2	Status of Cluster 3
1	F1	Operating at Max. Capacity following shut-down period	Operating to Meet Demand	Operating at Max. Capacity **with no shut down period**
	F2 (replacement)			
	F5 (replacement)			
2	E1	Operating to Meet Demand	Operating at Max. Capacity following shut-down period	Operating to Meet Demand
	E3			
	E4			
3	F4	Operating at Max. Capacity **with no shut down period**	Operating to Meet Demand	Operating at Max. Capacity following shut-down period
	F6			
	F7			

Notes: ****Test number is for illustrative purposes, actual order of tests is subject to future operational considerations.***

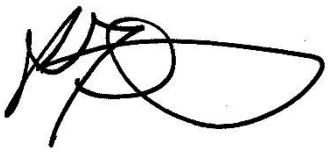
2. *Comment in email dated February 3rd, 2021: With respect to the application of Alberta guideline for assessing sustainability of the aquifer, MECP requires assessment of the sustainability of aquifer for a period of 20 years of taking at full permitted capacity but it does not provide any specific guidance on how to evaluate/demonstrate that. In the absence of a specific guidance from MECP on this or other regulatory matters, it is not uncommon to follow a guidance/practice from other Canadian or US regulatory bodies. An alternative to this is to graphically demonstrate the aquifer sustainability by providing the following information on figures for each production and a near by bedrock monitoring well completed in the municipal bedrock aquifer:*

    - *Top of bedrock elevation*
    - *Static water elevation prior to pumping*
    - *Water level elevation at the end of pumping*
    - *Extrapolated groundwater elevation after 20 years of continuous pumping at pumping rate at which well was tested.*

- This comment suggests a method for preparing figures that pertain to each production well and a nearby bedrock monitoring well completed in the target aquifer. We agree with this suggestion, including the data listed in the four bullets.

Closing

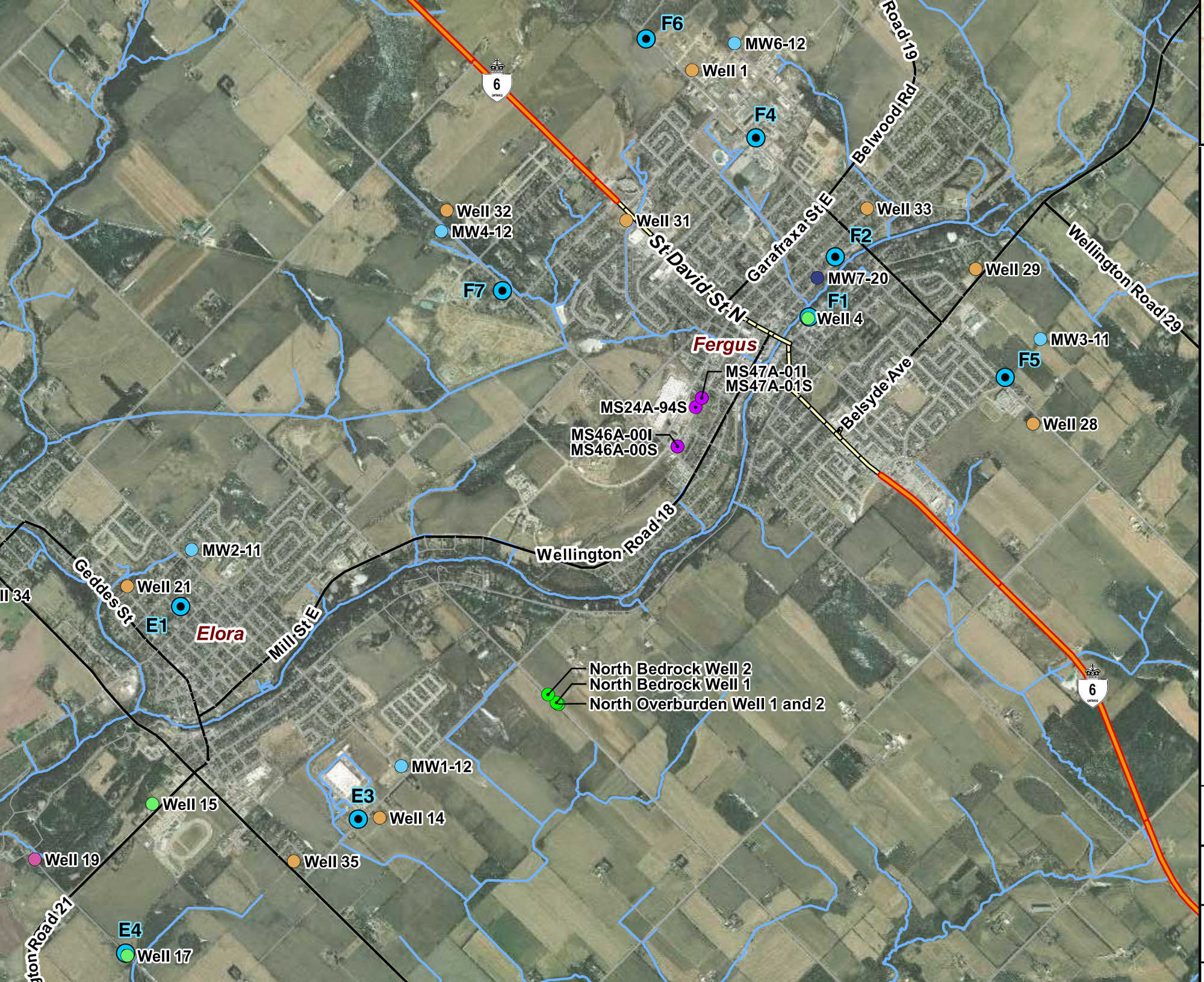
We trust that the response to MECP technical review comments and edits/additions to the work plan provided herein are sufficient. Please do not hesitate to contact the undersigned for discussion or clarification of any of the topics addressed in this letter.



Jason Murchison, P.Geo.
AECOM Canada Ltd.

Matthew Alexander, P.Geo.
AECOM Canada Ltd.

cc: Colin Baker, Township of Centre Wellington
Adam Gilmore, Township of Centre Wellington


F6
MW6-12
Well 1
6
F4
Belwood Rd
Road 19
Well 32
MW4-12
Well 31
St David St N
Garafraxa St E
Well 33
F2
Wellington Road 29
F7
MW7-20
Well 29
F1
Well 4
Fergus
MW3-11
F5
MS47A-01I
MS47A-01S
Belsyde Ave
MS24A-94S
Well 28
MS46A-00I
MS46A-00S
MW2-11
Wellington Road 18
Geddes St
Well 21
E1
Elora
Mill St E
North Bedrock Well 2
North Bedrock Well 1
North Overburden Well 1 and 2
6
MW1-12
E3
Well 15
Well 14
Well 19
Well 35
E4
Well 17
Legen
Feature
Aerial Imager
Keymap Base
0
December, 2

AECOM Imagine it. Delivered.

Attachment A

MECP Hydrogeological Review Comments (received via memorandum)

Ministry of the Environment, Conservation and Parks
Drinking Water and Environmental Compliance Division
West Central Region

119 King Street West, 12th Floor
Hamilton, Ontario L8P 4Y7
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Fax: 905 521-7820

Ministère de l'Environnement de la Protection de la nature et des Parcs
Division de la conformité en matière d'eau potable et d'environnement
Direction régionale du Centre-Ouest

119 rue King Ouest, 12e étage
Hamilton (Ontario) L8P 4Y7
Tél.: 905 521-7640
Téléc.: 905 521-7820

Ontario

Memorandum

Date: October 23, 2020

To: Gregory Meek, Director, s. 34.1, Ontario Water Resources Act (OWRA)

From: Abdul Quyum, Hydrogeologist, Water Resources Unit, TSS

Re: Well Field Capacity Assessment Work Plan
Township of Centre Wellington, Wellington County, Ontario

As requested, I have reviewed the following technical submission for groundwater issues:

- *Technical Memorandum, Proposed Well Field Capacity Assessment Work Plan to Address Condition 4.2 of Permit to Take Water No.: 4856-9KBH5A (Permit), AECOM Canada Ltd., June 22, 2020.*

Comments:

The review comments are outlined below:

1. Section 3, Centre Wellington Water Supply Master Plan:

   The work plan required by Condition 4.2 of the Permit for undertaking a well field capacity assessment is applicable to the sources (wells) listed in Table A of the Permit. The purpose of the well field capacity assessment was and is to assess the viability of the groundwater taking from each individual municipal well at the current permitted rate of taking for each source and to demonstrate that the permitted taking of 15,031,080 litre per day from 9 permitted municipal wells in Elora and Fergus is sustainable on a long-term basis (20 years of continuous taking at full permitted capacity). The information provided about future municipal wells as well as replacement wells are not relevant in the context of the municipal sources listed in Table A and total taking permitted in Condition 3.2 of the Permit. This input is consistent with the staff feedback provided to the Township of Centre Wellington during the pre-consultation meeting on May 26th, 2020. Since a formal technical input on the Centre Wellington's water supply master plan has been provided (GW-TSS memorandum dated August 20th, 2019), further commentary on the water supply master plan is not warranted.

2. Section 4.1, Overview of Proposed Pumping Tests:

   It is indicated that the well testing program will be conducted in three clusters and each cluster will include a maximum of three wells. The proposal does not specify whether the wells will be shut-down prior to the initiation of the testing for establishing baseline steady state hydraulic conditions both in the production and monitoring wells. We have issues with the proposed well testing strategy outlined in this section:

a) As indicated during the pre-consultation meeting of May 26th, 2020 and reiterated in Section 5 of the document, the Township may or could consider applying for two separate well field permits, Elora well field and Fergus well field. The testing strategy, testing wells in three clusters, is not consistent with the well field approach. In our opinion, all municipal wells (6) within the Fergus well field should be tested at the same time. Similarly, all three municipal wells in the Elora well field should be tested together at the same time. The current proposed testing approach is deemed not reasonable and should be revised.

b) It is not clear from the proposal whether all wells within each well field will undergo a staggered or simultaneous start. In the case of a staggered start, the duration of testing for each well before the next well will be brought online during the staggered start should be provided. The duration of the combined testing at a constant rate involving all wells in each well field should also be provided. The combined testing involving all wells in each well field should be of sufficient duration in order to assess the cumulative impact of groundwater extraction from all wells on the municipal aquifer as well as mutual well interference. In our opinion, the proposed well testing program should be revised as per Section 6.1 & Table 6 (Fergus well field) and Section 6.3 & Table 9 (Elora well field) of the "*Well Field Capacity Assessment, Golder Associates Ltd., September 2013"*, to mimic the well testing program implemented in 2012/2013 with an improved/enhanced monitoring network or propose and implement a testing strategy which is more comprehensive than what had been implemented in 2012-13.

c) The proposed and permitted rate for each individual permitted well and combined pumping rate for the Fergus and Elora well fields are summarized below (see tables). The proposed combined pumping rate from the Fergus well field (6 wells) is about 9% less than the permitted rate in Table A. Similarly, the proposed combined pumping rate from the Elora well field (3 wells) is about 10% less than the approved permitted rate in Table A of the Permit. It is also noted that the proposed pumping rate outlined in Table 1 does not appear to be final and are subject to change depending on the operational constraints. The reduced proposed combined pumping rate will have a negative implication for a future long-term permit, i.e. currently approved capacity will have to be revised downward as per the combined pumping rate at which each well field is subjected to during testing.

Fergus Well Field		
Well ID	Proposed Rate (L/M)	Permitted Rate (L/M)
F1	1,140	1,273
F2	1,140	1,137
F4	1,200	1,364
F5	1,800	1,818
F6	1,140	1,364
F7	1,140	1,364
Combined Total	7,560	8,320

Elora Well Field		
Well ID	Proposed Rate (L/M)	Permitted Rate (L/M)
E1	1,140	1,209
E3	1,200	1,364
E4	1,200	1,364
Combined Total	3,540	3,937

3. Section 4.2, Permitting:

   The current permit (Table A) does not allow operation of F2 for more than 6 hours and E4 for more than 15 hours a day. In order to complete a well testing program involving continuous pumping of all permitted wells in Table A for 72 hours or more, a temporary approval providing relief from meeting the requirements of Table A for Maximum Number of Hours Taken per Day will be needed and the PTTW Director should consider providing this relief via a letter notification instead of a formal permit amendment.

4. Section 4.4, Groundwater Monitoring Locations:

   It is stated that additional monitoring wells installation will depend on the availability and/or access restrictions to existing private wells. A door to door survey will be conducted within 500 m of the municipal wells to confirm available private wells and their construction details as well as access issues. In addition, it is indicated that a single multi-level monitoring well nest will be installed as part of the F2 municipal well replacement well testing program. The monitoring program outlined in Table 2 does not provide any information as to the relevance of the private wells production zone (elevations) with the municipal well production zones. In fact, the production zone (bedrock formation) in which the private water supply wells are completed and are selected for hydraulic monitoring are not known. More importantly, the consultant has not definitively confirmed that the proposed monitoring locations will provide adequate spatial coverage, both in lateral and vertical direction, for the assessment of the a) extent of the zone of influence at maximum induced hydraulic stress, b) evaluation of hydraulic connectivity of the production zone with the overlying aquifers/hydrostratigraphic units and mutual well hydraulic interference, and c) assessment and quantification of groundwater / surface water interactions (impact on the shallow and near surface functions of the ecosystem). In this regard, a water well door to door survey within the anticipated zone of influence of the municipal wells, instead of the proposed 500 m radius of the municipal wells, should be conducted first before the selection of private wells as monitoring locations with the goal of selecting only those private wells whose production zones are comparable to the municipal wells production zone for assessing the induced hydraulic decline in the municipal aquifer water level due to municipal pumping. The monitoring program should be revised to confirm it will provide an adequate hydraulic dataset to evaluate the technical issues noted above.

5. Section 5, Data Analysis and Reporting:

   The permit program requires the assessment of source sustainability/viability by predicting the impact of 20 years of continuous taking at a constant maximum rate instead of an impact assessment under average municipal pumping conditions as indicated in this section. With respect to the application of the Tier III source water model for assessing/interpreting the pumping test data, WCR GW staff, through the Tier III working group, outlined a number of technical concerns with the model development (lack of additional data collected since the Golder 2013 report on local geology and hydrogeology to confirm lateral and vertical variability in geologic sequence and hydraulic characteristics within the model domain), calibration (target wells were concentrated within 15-20% of the model domain area) and its application (limitations for assessing the extent of the zone of influence and predicted drawdown further away from the municipal wells). That said, we are not requiring or making any suggestion as to the application of the Tier III model for predicting the sustainability of the municipal aquifer even though we believe the model's predicted results are expected to be a scientific guess and likely unreliable. Since the Ministry's PTTW program does not provide specific guidance for assessing sustainability of taking from individual wells and a municipal aquifer, guidance provided in Section 2.3 of the "*Guide to Groundwater Authorization, Alberta Environment, March 2011*" should be followed. It is stated that the model will be used to predict a maximum pumping rate from the Elora

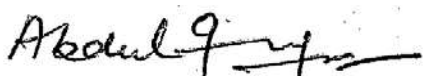
and Fergus well fields. The Ministry does not consider permit approval for pumping rates higher than the physical pumping rates (combined pumping rate in case of well field) for which municipal wells are tested.

Conclusions:

The proposed testing approach/strategy is found to be not consistent with the well field approach and should be revised as per the testing approach implemented in 2012/2013. The proposed monitoring program should be revised as per technical input provided above to ensure that the monitoring plan is appropriate in providing adequate spatial lateral and vertical coverage for the assessment of the extent of the zone of influence and induced changes in the vertical hydraulic gradients and quantification of the groundwater / surface water interactions. An updated work plan with the required information/details should be resubmitted for approval to the Director, s. 34.1, of the OWRA.

Statement of Limitations:

The purpose of the preceding review is to provide advice to the Ministry of the Environment regarding subsurface conditions based on a review of the information provided in the above referenced document and data gathered in the investigation undertaken by the ministry. The conclusions, opinions and recommendations of the reviewer are based on information provided by others. The Ministry cannot guarantee that the information that has been provided by others is accurate or complete. A lack of specific comment by the reviewer is not to be construed as endorsing the content or views expressed in the reviewed material.



Abdul Quyum, P.Eng., P.Geo. (AB)
Hydrogeologist

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Attachment B

MECP Hydrological Review Comments

Ministry of the Environment, Conservation and Parks
Drinking Water and Environmental Compliance Division
West Central Region

119 King Street West, 12th Floor
Hamilton, Ontario L8P 4Y7
Tel.: 905 521-7640
Fax: 905 521-7820

Ministère de l'Environnement de la Protection de la nature et des Parcs
Division de la conformité en matière d'eau potable et d'environnement
Direction régionale du Centre-Ouest

119 rue King Ouest, 12e étage
Hamilton (Ontario) L8P 4Y7
Tél.: 905 521-7640
Téléc.: 905 521-7820

Ontario

October 23, 2020

MEMORANDUM

To: Gregory Meek
Director, Section 34
Ontario Water Resources Act, R.S.O. 1990

From: Michael Spencer
Surface Water Group Leader
Technical Support Section

RE: Centre of Wellington
Elora and Fergus Well Field Capacity Assessment
Permit to Take Water No. 4856-9KBH5A Condition No. 4.2

As requested, I have reviewed the following document for surface water issues:

> Technical Memorandum, Proposed Well Field Capacity Assessment Work Plan to Address Condition 4.2 of Permit to Take Water No. 4856-9KBH5A, AECOM Canada Ltd., June 22, 2020.

Background

The Centre of Wellington was issued PTTW No. 4856-9KBH5A for the taking of water from the Elora (E1, E3, E4) and Fergus (F1, F2, F4, F5, F6, F7) municipal wells. PTTW Condition No 4.2 requires a detailed scope of work for a well field capacity assessment to be submitted to the Director by June 30, 2020. As such, the Technical Memorandum (AECOM, June 2020) was submitted to address PTTW No. Condition No. 4.2.

The Groundwater review of the Technical Memorandum (AECOM, June 2020) was completed by Abdul Quyum, Hydrogeologist in an October 23, 2020 memorandum.

Comments

Based on my review of the Centre of Wellington Technical Memorandum (AECOM, June 2020), I have the following comment:

1. Section 4.5 Surface Water Assessment in the Centre of Wellington Technical Memorandum (AECOM, June 2020) proposed assessment of potential impacts to surface water features. A reconnaissance level survey and background data review was proposed including Irvine River, Swan Creek and the Grand River to document stream conditions and baseflows. In addition to monitoring existing and newly installed shallow monitoring wells, mini-piezometers were proposed to be installed within Irvine River and Swan Creek where locations of potential groundwater upwellings are identified. The proposed surface wter assessment in Section 4.5 is acceptable. However, I recommend that the details of the reconnaissance level survey and background data review, and the proposed locations of the mini-piezometer installations be provided to the Ministry for review and comment before commencement.

Michael Spencer
Surface Water Group Leader
Technical Support Section

cc: M. Prusinski, B. Slattery, EAPD
A. Quyum, TSS

IDS Ref. No.
File

Limitations: The purpose of the preceding review is to provide advice to the Ministry of the Environment, Conservation and Parks regarding surface water impacts based on a review of the information provided in the above referenced documents. The conclusions, opinions and recommendations of the reviewer are based on information provided by others, except where otherwise noted. The Ministry cannot guarantee that the information that is provided by others is accurate or complete. A lack of specific comment by the reviewer is not to be construed as endorsing the content or views expressed in the reviewed material.

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Attachment C

MECP Hydrogeological Review Comments (received via email)

Alexander, Matthew (Guelph)

From: Quyum, Abdul (MECP) <Abdul.Quyum@ontario.ca>
Sent: Monday, February 15, 2021 8:42 PM
To: Alexander, Matthew (Guelph)
Cc: Colin Baker; Murchison, Jason
Subject: [EXTERNAL] RE: Center Wellington - Well field Capacity Assessment

Follow Up Flag: Follow up
Flag Status: Completed

Hi Matt,
With respect to Fergus, the revised Table below meets our concerns. I have no further comment on this.
The next question is are you plan on updating the December 2020 response letter by incorporating the changes you and I have recently discussed for Fergus well cluster testing and guidance provided on assessing the sustainability of the source either using Alberta Environment approach or MECP guidance (graphical depiction) ? That would be my preference. I am open to alternative suggestion from you .

With respect to pumping rate for individual well or well clusters, the current Table A is not based on a comprehensive system wide well testing program and that is the reason why the Township is undertaking well field capacity assessment to assess the aquifer/system capacity based on current municipal well infrastructure. We do not consider capacity approval higher than the rate at which individual well or well cluster has been subjected to during well testing program. This is precisely the purpose of this testing. If the Township believes they can take more water out of the system than their current max. permitted rate in their existing permit, feel free to pump at higher rates during cluster testing and for that you probably will require pumping test permit. If existing infrastructure is not capable of pumping more or meeting the current permitted rate in Table A, this information will be helpful for future municipal well infrastructure planning. The system wide pumping test will need to demonstrate the current municipal well infrastructure is capable of producing what has been approved in the permit and is sustainable on a long-term basis from a source perspective.
Regards,

Abdul

From: Alexander, Matthew (Guelph) <Matthew.Alexander@aecom.com>
Sent: February 12, 2021 5:46 PM
To: Quyum, Abdul (MECP) <Abdul.Quyum@ontario.ca>
Cc: Colin Baker <CBaker@centrewellington.ca>; Murchison, Jason <Jason.Murchison@aecom.com>
Subject: RE: Center Wellington - Well field Capacity Assessment

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Hi Abdul,

We communicated with the Township this week, in response to the discussion you and I had by telephone last Friday (Feb 5th). They have confirmed that the approach you requested whereby all of the Fergus wells are simultaneously pumped at maximum can be achieved from an operational perspective. I wanted to reiterate that there is a constraint related to a full shut down in advance of this maximum pumping, so the shut-down period will be conducted by well cluster. I have adjusted the table below to reflect this revision to the plan.

Regarding the brief discussion that we had about the test rates for individual wells, I noted your comment that MECP's approach for an amended PTTW, issued after the testing would be to include maximum Table A rates for each well that aligned with the maximum test rates (and not higher). We wanted to raise a concern related to this statement as it

pertains to de-rating wells that may currently be permitted for rates above those achieved in the well field testing. As the Township generally operates all of their wells below the current Table A PTTW rates, it is possible that wells may not be able to achieve the maximum permitted rates at the time of testing. This could be related to performance decline of the wells due to fouling, well efficiency, well pumping configuration/equipment, etc. and unrelated to the capacity of the aquifer local to the well. For the sake of argument, let's assume that a given well pumps below the current PTTW rate during the testing, but aquifer water level data indicates that the aquifer has additional capacity to support increased pumping. If MECP was the de-rate the well in an amended permit, the Township would then have to obtain an additional, short term PTTW to implement a rehabilitation or replacement program to address the well performance and would then have to complete a Class EA to increase the system capacity above the amended PTTW rate(s). This introduces administrative barriers and associated costs that could be avoided, in our opinion, if through technical review, MECP agrees that a pumping result below the current PTTW maximum for a given well is unrelated to an aquifer limitation.

The scenario outlined above illustrates a situation that could potentially occur but obviously all of the associated variables and issues cannot be identified at this planning stage. Therefore, I don't think that we need to reach an agreement as to how all of the potential outcomes would be handled, rather, we would appreciate MECP acknowledging that a well(s) would not necessarily be de-rated in an amended permit based solely on the Township not achieving the maximum rates in the current PTTW, at each well during the well field testing. Consideration should also be paid to the County of Wellington being designated as a growth area under the Provincial Growth Plan and the water supply requirements associated with meeting this plan.

We are happy to discuss the topic of well de-rating or the edits to the work plan with you further as required.

Test/Cluster Number	Production Well	Status of Cluster 1	Status of Cluster 2	Status of Cluster 3
1	F1	Operating at Max. Capacity following shut-down period	Operating to Meet Demand	Operating at Max. Capacity with no shut down period
	F2 (replacement)^			
	F5 (replacement)^			
2	E1	Operating to Meet Demand	Operating at Max. Capacity following shut-down period	Operating to Meet Demand
	E3			
	E4			
3	F4	Operating at Max. Capacity with no shut down period	Operating to Meet Demand	Operating at Max. Capacity following shut-down period
	F6			
	F7			

Have a good weekend,
Matt

Matthew Alexander, M.Sc., P.Geo.
Manager, Hydrogeology
DCS Americas, Canada Region (Ontario)
Environment
M +1-226-821-4906
matthew.alexander@aecom.com

From: Quyum, Abdul (MECP) <Abdul.Quyum@ontario.ca>
Sent: Friday, February 5, 2021 3:07 PM
To: Alexander, Matthew (Guelph) <Matthew.Alexander@aecom.com>
Cc: Colin Baker <CBaker@centrewellington.ca>
Subject: [EXTERNAL] RE: Center Wellington - Well field Capacity Assessment

Hi Matt,
I still have questions with regard to new proposed pumping schedule under Item 1 and let me know when we can discuss this further.
Abdul

From: Alexander, Matthew (Guelph) <Matthew.Alexander@aecom.com>
Sent: February 5, 2021 3:01 PM
To: Quyum, Abdul (MECP) <Abdul.Quyum@ontario.ca>
Cc: Colin Baker <CBaker@centrewellington.ca>
Subject: RE: Center Wellington - Well field Capacity Assessment

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Hi Abdul,

Thanks very much for providing these additional questions/comments for discussion. I have provided additional information below, numbered 1 to 3, to align with the three bullets in your email.

1. Below is a modified version of the table from our response letter that provides the proposed status of each well cluster for each of the three proposed tests. I think this should clarify how we are proposing that the Township would operate the clusters that are not being tested during each of the three tests. Regarding your question of how the impacts of the 2nd cluster would be assessed while testing the 1st cluster, we reviewed the previous reporting during preparation of the work plan, to understand the propagation of drawdown in the aquifer between Fergus and Elora. This reporting (Golder, 2013) concluded that no influence of Elora pumping was observed in Fergus and vice versa. This conclusion will be re-assessed under this work plan through the analysis of water level data collected at the monitoring wells positioned between the Fergus and Elora clusters (MW1-12, MW2-11, new research monitoring wells, AO Smith wells – see Figure 1 in our response letter).

Test/Cluster Number	Production Well	Status of Cluster 1	Status of Cluster 2	Status of Cluster 3
1	F1	Operating at Max. Capacity	Operating to Meet Demand	Operating to Meet Demand
	F2 (replacement)^			
	F5 (replacement)^			
2	E1			

Test/Cluster Number	Production Well	Status of Cluster 1	Status of Cluster 2	Status of Cluster 3
	E3	Operating to Meet Demand	Operating at Max. Capacity	Operating to Meet Demand
	E4			
3	F4	Operating to Meet Demand	Operating to Meet Demand	Operating at Max. Capacity
	F6			
	F7			

2. Regarding the E1 target rate of 1,406 L/min vs. 1,209 L/min, the Township shared the 2009 PTTW with us (first screen shot below) and I have also included a second screen shot of the current PTTW (4856-9KBH5A; expiry of June 30, 2024). It seems that the discrepancy in values is related to a change in the max. per minute values between the previous and current PTTW. We propose to keep the 1,209 L/min value in the work plan.

3. Water Takings Authorized by This Permit

3.1 Expiry

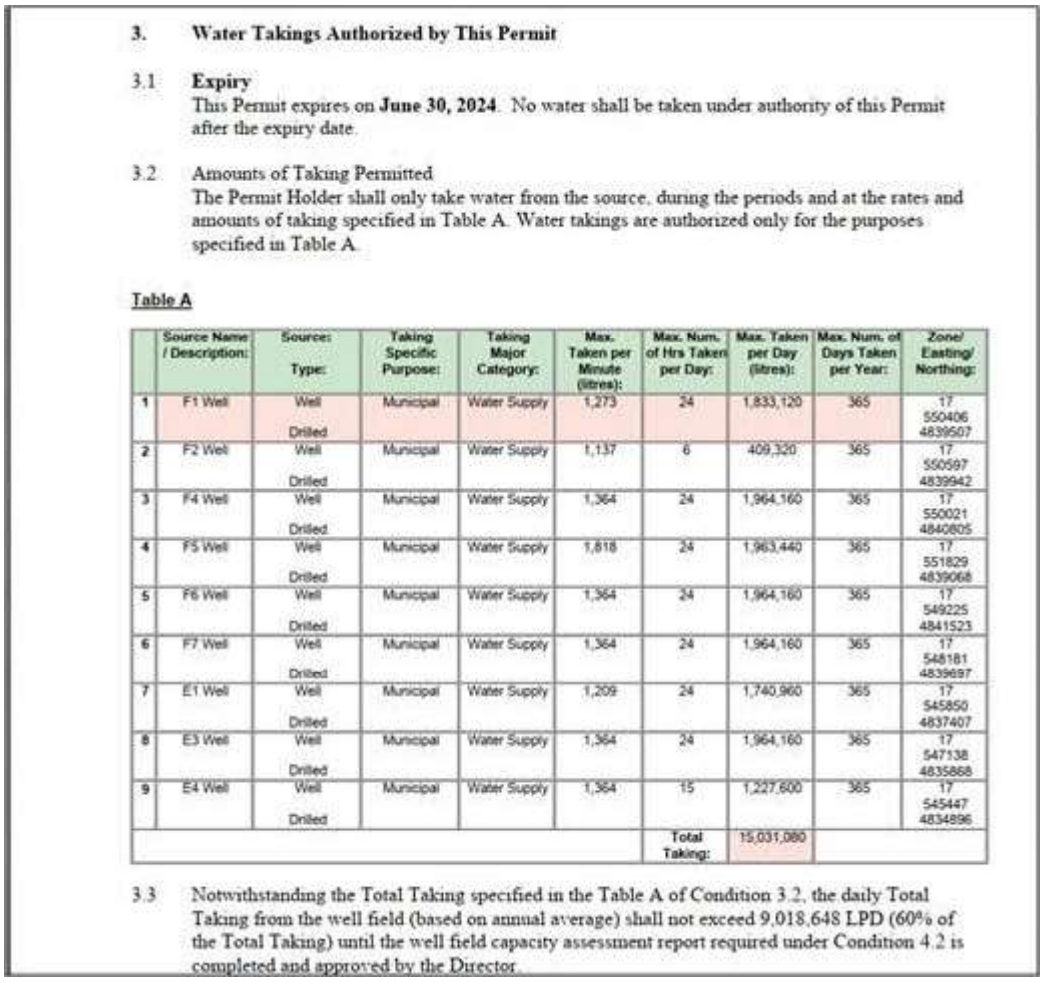
This Permit expires on **June 30, 2011**. No water shall be taken under authority of this Permit after the expiry date.

3.2 Amounts of Taking Permitted

The Permit Holder shall only take water from the source, during the periods and at the rates and amounts of taking specified in Table A. Water takings are authorized only for the purposes specified in Table A.

Table A

	Source Name / Description:	Source: Type:	Taking Specific Purpose:	Taking Major Category:	Max. Taken per Minute (litres):	Max. Num. of Hrs Taken per Day:	Max. Taken per Day (litres):	Max. Num. of Days Taken per Year:	Zone/ Easting/ Northing:
1	F1	Well Drilled	Municipal	Water Supply	1,273	24	1,832,947	365	17 550400 4839505
2	F2	Well Drilled	Municipal	Water Supply	1,137	6	490,140	365	17 550655 4839970
3	F4	Well Drilled	Municipal	Water Supply	1,364	24	1,963,911	365	17 550015 4840615
4	F5	Well Drilled	Municipal	Water Supply	1,818	24	1,963,872	365	17 551825 4839070
5	F6	Well Drilled	Municipal	Water Supply	1,363	24	1,963,872	365	17 549220 4841520
6	F7	Well Drilled	Municipal	Water Supply	1,362	24	1,962,000	365	17 548175 4839700
7	E1	Well Drilled	Municipal	Water Supply	1,460	24	1,740,960	365	17 540845 4837400
8	E3	Well Drilled	Municipal	Water Supply	1,363	24	1,963,000	365	17 547145 4835875
9	E4	Well Drilled	Municipal	Water Supply	1,363	15	1,227,000	365	17 545395 4834920
						Total Taking:	15,107,702		



3. **Water Takings Authorized by This Permit**

3.1 **Expiry**
This Permit expires on **June 30, 2024**. No water shall be taken under authority of this Permit after the expiry date.

3.2 Amounts of Taking Permitted
The Permit Holder shall only take water from the source, during the periods and at the rates and amounts of taking specified in Table A. Water takings are authorized only for the purposes specified in Table A.

Table A

	Source Name / Description:	Source: Type:	Taking Specific Purpose:	Taking Major Category:	Max. Taken per Minute (litres):	Max. Num. of Hrs Taken per Day:	Max. Taken per Day (litres):	Max. Num. of Days Taken per Year:	Zone/ Easting/ Northing:
1	F1 Well	Well Drilled	Municipal	Water Supply	1,273	24	1,833,120	365	17 550406 4839507
2	F2 Well	Well Drilled	Municipal	Water Supply	1,137	6	409,320	365	17 550597 4839942
3	F4 Well	Well Drilled	Municipal	Water Supply	1,364	24	1,964,160	365	17 550021 4840805
4	F5 Well	Well Drilled	Municipal	Water Supply	1,818	24	1,963,440	365	17 551829 4839068
5	F6 Well	Well Drilled	Municipal	Water Supply	1,364	24	1,964,160	365	17 549225 4841523
6	F7 Well	Well Drilled	Municipal	Water Supply	1,364	24	1,964,160	365	17 548181 4839697
7	E1 Well	Well Drilled	Municipal	Water Supply	1,209	24	1,740,960	365	17 545850 4837407
8	E3 Well	Well Drilled	Municipal	Water Supply	1,364	24	1,964,160	365	17 547138 4835868
9	E4 Well	Well Drilled	Municipal	Water Supply	1,364	15	1,227,600	365	17 545447 4834896
						Total Taking:	15,031,080		

3.3 Notwithstanding the Total Taking specified in the Table A of Condition 3.2, the daily Total Taking from the well field (based on annual average) shall not exceed 9,018,648 LPD (60% of the Total Taking) until the well field capacity assessment report required under Condition 4.2 is completed and approved by the Director.

3. Your third point suggests a method for preparing figures that pertain to each production well and a nearby bedrock monitoring well completed in the target aquifer. We agree with this suggestion, including the data listed in the four bullets.

Please do not hesitate to contact me by email or phone to discuss this response.

Thanks,
Matt

Matthew Alexander, M.Sc., P.Geo.
Manager, Hydrogeology
DCS Americas, Canada Region (Ontario)
Environment
M +1-226-821-4906
matthew.alexander@aecom.com

From: Quyum, Abdul (MECP) <Abdul.Quyum@ontario.ca>
Sent: Wednesday, February 3, 2021 9:01 AM
To: Alexander, Matthew (Guelph) <Matthew.Alexander@aecom.com>
Cc: Colin Baker <CBaker@centrewellington.ca>
Subject: [EXTERNAL] Center Wellington - Well field Capacity Assessment

Hi Matt,
Further to my voice message to you earlier today, I want to discuss the following issues:

- What would be the status of wells in first cluster while testing the 2nd cluster in Erin and Fergus well field? How to incorporate the impact of operating wells in one cluster while testing wells in 2nd cluster? The wells in 1st cluster, in our opinion, should be fully operational at full capacity before and during testing of wells in the 2nd cluster.
- Table 1, Item c: E1 target rate of 1,209 l/m is inconsistent with Table A permitted rate of 1,460 l/m, just want to ensure this is not an error.
- With respect to the application of Alberta guideline for assessing sustainability of the aquifer, MECP requires assessment of the sustainability of aquifer for a period of 20 years of taking at full permitted capacity but it does not provide any specific guidance on how to evaluate/demonstrate that. In the absence of a specific guidance from MECP on this or other regulatory matters, it is not uncommon to follow a guidance/practice from other Canadian or US regulatory bodies. An alternative to this is to graphically demonstrate the aquifer sustainability by providing the following information on figures for each production and a near by bedrock monitoring well completed in the municipal bedrock aquifer:
    - Top of bedrock elevation
    - Static water elevation prior to pumping
    - Water level elevation at the end of pumping
    - Extrapolated groundwater elevation after 20 years of continuous pumping at pumping rate at which well was tested.

Regards,
Abdul

Abdul Quyum, P.Eng., P.Geo.(AB)
Hydrogeologist

Ministry of the Environment, Conservation and Parks | 119 King Street W., 12th Floor, Hamilton, ON, L8P 4Y7
Tel: 289-659-4007 (Cell) | Fax: 905-521-7820 | abdul.quyum@ontario.ca

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Attachment D

Well 34 MECP Water Well Record

Mailing Address (Street Number/Name)	Municipality	Province	Postal Code	Telephone No. (inc. area code)
7461 WELLINGTON ROAD 18	ELORA	ON	N0B 1S0	5198468289

Well Location

Address of Well Location (Street Number/Name)	Township	Lot	Concession
7461 WELLINGTON ROAD 18	PILKINGTON	1	A

County/District/Municipality	City/Town/Village	Province	Postal Code
WELLINGTON	ELORA	Ontario	N0B 1S0

UTM Coordinates	Zone	Easting	Northing	Municipal Plan and Sublot Number	Other
NAD 83	17	544326	4837525		

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

General Colour	Most Common Material	Other Materials	General Description	Depth (m/ft) From	To
	PREVIOUSLY DRILLED			0	128.0
WHITE	LIMESTONE			128.0	144.2
GREY	LIMESTONE			144.2	155.8
BROWN/GREY	LIMESTONE		INTERMIXED	155.8	156.4
GREEN	SHALE	GREY LIMESTONE		156.4	158.5

Annular Space

Depth Set at (m/ft) From	To	Type of Sealant Used (Material and Type)	Volume Placed (m³/ft³)

Method of Construction

- ☐ Cable Tool
- ☒ Rotary (Conventional)
- ☐ Rotary (Reverse)
- ☐ Boring
- ☐ Air percussion
- ☐ Diamond
- ☐ Jetting
- ☐ Driving
- ☐ Digging
- ☐ Other, specify

Well Use

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

Construction Record - Casing

Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft) From	To

Construction Record - Screen

Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft) From	To

Status of Well

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

Water Details

Water found at Depth	Kind of Water	
-156 (m/ft)	☐ Gas	☐ Fresh ☒ Untested ☐ Other, specify
(m/ft)	☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify
(m/ft)	☐ Gas	☐ Fresh ☐ Untested ☐ Other, specify

Hole Diameter

Depth (m/ft) From	To	Diameter (cm/in)
128.0	158.5	15.6

Results of Well Yield Testing

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

If pumping discontinued, give reason:

Pump intake set at (m/ft): 36.6m

Pumping rate (l/min / GPM): 341

Duration of pumping: 1 hrs + 0 min

Final water level end of pumping (m/ft): 28.83

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

Recommended pump depth (m/ft): 36.6

Recommended pump rate (l/min / GPM): 341

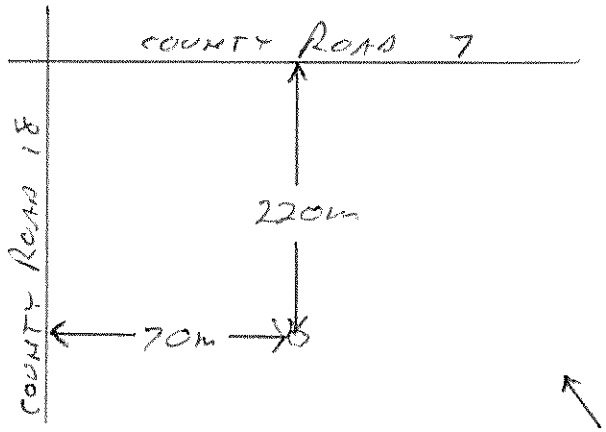
Well production (l/min / GPM):

Disinfected? ☒ Yes ☐ No

	Draw Down Time (min)	Draw Down Water Level (m/ft)	Recovery Time (min)	Recovery Water Level (m/ft)
Static Level		14.36		28.83
1	1	23.77	1	18.97
2	2	24.07	2	18.20
3	3	24.60	3	17.76
4	4	24.96	4	17.50
5	5	25.31	5	17.26
10	10	26.22	10	16.62
15	15	26.82	15	16.29
20	20	27.16	20	16.08
25	25	27.59	25	15.95
30	30	27.82	30	15.78
40	40	28.26	40	15.58
50	50	28.56	50	15.42
60	60	28.83	60	15.25

Map of Well Location

Please provide a map below following instructions on the back.



Comments:

Well Contractor and Well Technician Information

Business Name of Well Contractor	Well Contractor's Licence No.
WELL INITIATIVES	7221

Business Address (Street Number/Name)	Municipality
15 TRAFALGAR	BRANTFORD

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