

# APPENDIX D

## Sensitivity Analysis Results

## MEMORANDUM

**TO:** Project Team, Guelph/Guelph-Eramosa Water Quantity Policy Development Study

**FROM:** David Van Vliet and Jeff Melchin, Matrix Solutions Inc.

**SUBJECT:** Memo #4 – Sensitivity Analysis of Non-Municipal Permitted Pumping Rates  
Guelph/Guelph-Eramosa WHPA-Q1 Risk Management Measures Evaluation Process

**DATE:** June 14, 2018

### 1 INTRODUCTION

Matrix Solutions Inc. (Matrix) previously conducted a series of Risk Management Measure (RMM) scenarios as part of the Risk Management Measures Evaluation Process (RMMEP). The purpose of these scenarios was to evaluate the potential for RMMs to mitigate the water quantity threats and reduce the water quantity risk level identified through the City of Guelph and Township of Guelph/Eramosa Tier Three Water Budget and Local Area Risk Assessment (Tier Three Assessment, Matrix 2017). These scenarios were based on RMMs selected from the RMMs Catalogue (TRCA 2014) and the results of the Threats Ranking, as reported in several earlier memorandums.

A final sensitivity analysis was developed to test the overall sensitivity of drawdown at municipal water supply wells to increased non-municipal, non-dewatering permitted water takings within the WHPA-Q1-A under average climate and drought conditions. This scenario tested the possible implications if RMMs for non-municipal permits to take water (PTTWs) were not implemented (e.g., no implementation of industrial, commercial, or institutional efficiency strategies) and non-municipal permitted pumping progressively increased from their current (2016) rates to their maximum permitted consumptive rates.

### 2 DESCRIPTION OF SENSITIVITY ANALYSIS

The sensitivity analysis was designed to examine the potential impacts of future increases in pumping from existing non-municipal, non-dewatering permits in WHPA-Q1-A. The scenario provided insight into the sensitivity of water levels in municipal wells relative to increases in non-municipal demands. The inherent assumption in this scenario is that non-municipal water taking may increase corresponding to population and economic growth within the WHPA-Q1-A area. It is recognized that it is difficult to identify where any increase in non-municipal water taking may occur; therefore, the sensitivity analysis uses increases to existing non-municipal takings as a surrogate for overall non-municipal growth. The sensitivity analysis should not be construed as implying there will be increases to existing non-municipal water takings' reporting pumping.

This scenario incorporates the municipal pumping distribution considered for RMMEP Scenario 6, which assumes the lower demand of at least 69,872 m<sup>3</sup>/d during average and drought conditions corresponding to the Water Supply Master Plan Update (WSMPU) future demand for 2038 (AECOM and

Golder 2014). This reduced demand projection includes well optimization as well as conservation measures already achieved but not guaranteed into the future. Scenario 6 represents the reference condition for the sensitivity analysis. The analysis considers 10 different sets of pumping rates, starting initially with the Scenario 6 rate, then incrementally increasing each of the permitted demands by 10% of the remaining capacity between the initial rate and the maximum permitted consumptive water demand. This scenario does not include similar increases in dewatering from the Dolime Quarry. The 10 sensitivity model runs are designed to identify the increased non-municipal water demand that will result in municipal wells being unable to pump their future Allocated rates under the RMMs of RMMEP Scenario 6 considering either average annual or drought conditions. The design of this sensitivity analysis assumes that increases in permitted demand will occur at existing well locations, and although this assumption is not realistic, the goal of the analysis is to evaluate the response of the aquifer system to increased water use that follows current geographic trends. New permits or significant increases for individual existing permitted takings may result in a different effect on municipal wells. Similarly, if this sensitivity analysis was conducted with a different starting condition other than RMMEP Scenario 6 (e.g., using higher Tier Three Assessment Allocated rates) the simulation results would vary.

### 3 RESULTS

The analysis discussed above is evaluated under both long-term average (steady-state) and drought conditions. As summarized below in Table 1, the modelling results show that municipal pumping wells can maintain their Allocated rates under average annual conditions, with non-municipal, non-dewatering pumping rates increasing up to the current maximum permitted consumptive demand.

**TABLE 1 Results of Non-Municipal Pumping Sensitivity Analysis (Average Annual Conditions)**

Sensitivity Run (% of difference between Scenario 6 and maximum permitted consumptive demand)	Total Non-municipal, Non-dewatering PTTW Demand in WHPA-Q1-A (m <sup>3</sup> /d)	Municipal Wells Unable to Meet Allocated Rate
100 (maximum permitted consumptive demand)	41,909	None
90	38,462	None
80	35,015	None
70	31,568	None
60	28,121	None
50	24,674	None
40	21,227	None
30	17,780	None
20	14,333	None
10	10,887	None
0 (demand from RMMEP Scenario 6)	7,440	None

As summarized below in Table 2, the modelling results show that municipal pumping wells are not able to maintain their Allocated rates under drought conditions, with non-municipal, non-dewatering pumping rates increasing up to the current maximum permitted consumptive demand. At approximately 60% to 70% of the difference between the Scenario 6 rates and the maximum consumptive rate, drawdown at the Burke Well increases below its safe threshold (Safe Additional

Available Drawdown). At 100% of the maximum consumptive permitted rate, drawdown at the Park and Carter wells also increase below their safe thresholds.

**TABLE 2 Results of Non-Municipal Pumping Sensitivity Analysis (Drought Conditions)**

Sensitivity Run (% of difference between Scenario 6 and maximum permitted consumptive demand)	Total Non-municipal, Non-dewatering PTTW Demand in WHPA-Q1-A (m <sup>3</sup> /d)	Municipal Wells Unable to Meet Allocated Rate
100 (maximum permitted consumptive demand)	41,909	Burke, Park 1/2, Carter (Arkell 8 within 4 cm, Water St. within 2 cm of threshold)
70	31,568	Burke
60	28,121	None (Burke within 3 cm of threshold)
50	24,674	None
20	14,333	None
0 (demand from RMMEP Scenario 6)	7,440	None

Under the assumption of the sensitivity analysis, the modelling results imply that non-municipal, non-dewatering permitted pumping rates could increase to as much as 300% of their current rates providing that the rate of increased demands is scaled up consistently across the WHPA-Q and that the RMMs of Scenario 6 are achieved. Figure 1, 2 and 3 illustrate the timing of drawdown at the Burke, Park and Carter wells falling below the threshold under drought conditions. The modelling results also indicate that the groundwater system cannot support the full permitted, non-municipal water takings under the future Allocated rate and considering drought conditions.

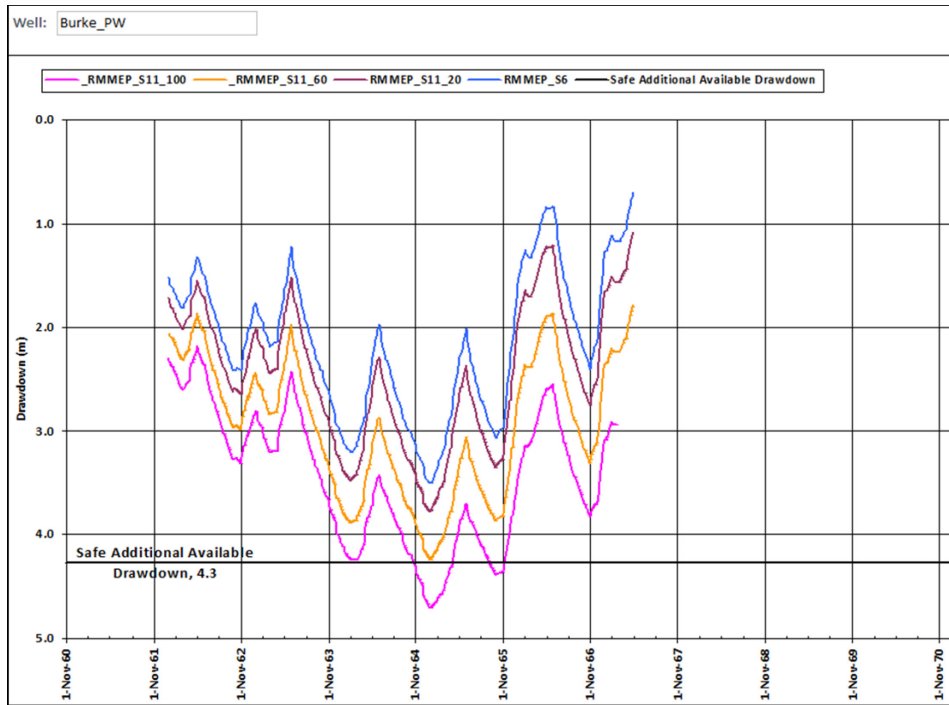


FIGURE 1 Drawdown at Burke Well (Drought Conditions)

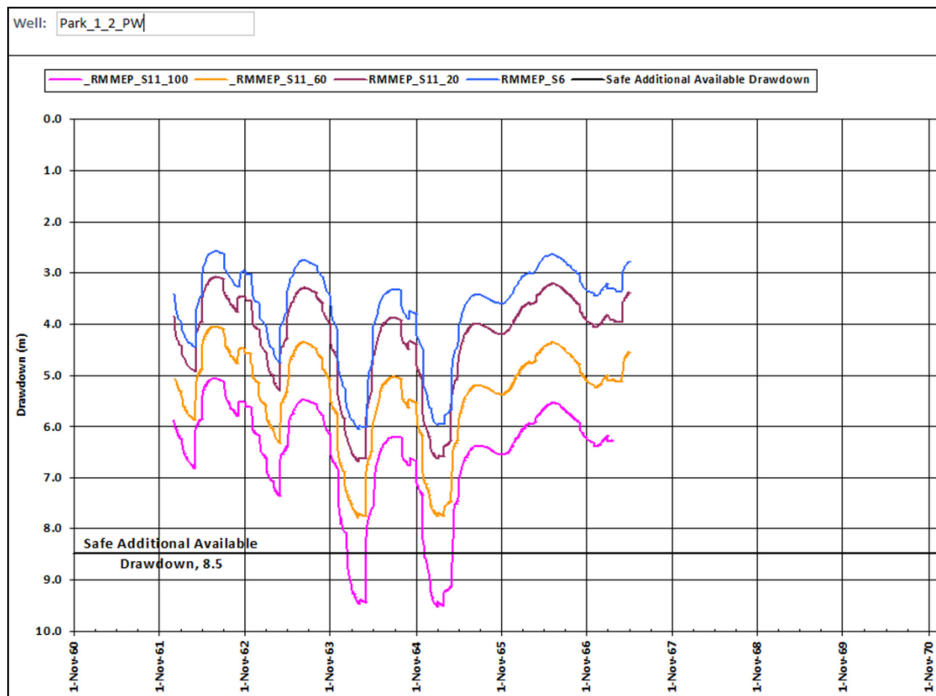
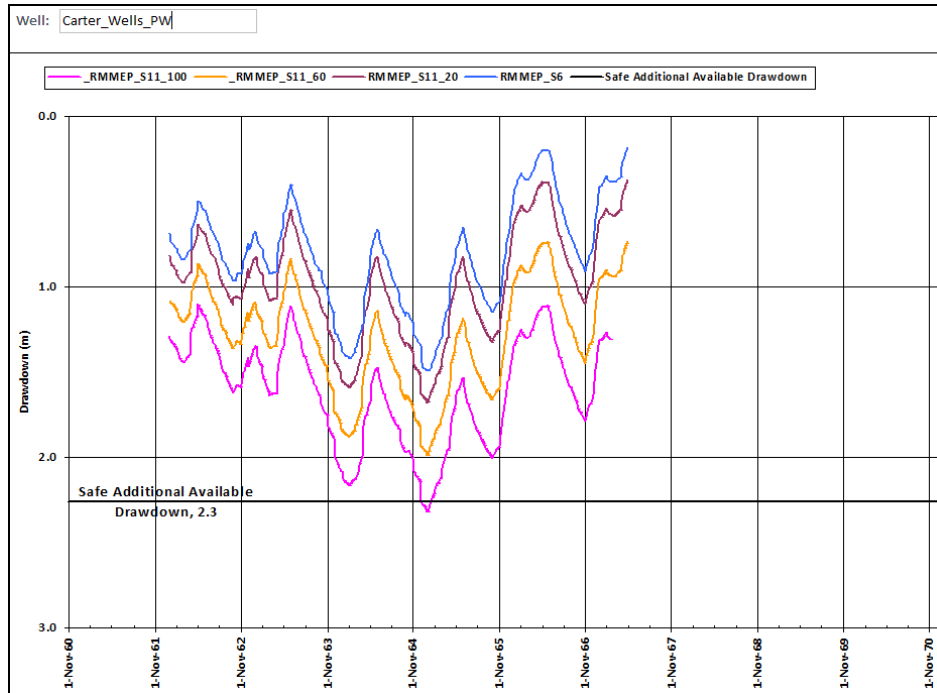


FIGURE 2 Drawdown at Park Wells (Drought Conditions)



**FIGURE 3 Drawdown at Carter Wells (Drought Conditions)**

#### 4 CONCLUSION

A sensitivity analysis was run to test impacts at municipal wells if non-municipal, non-dewatering permitted pumping was progressively increased from current rates to maximum permitted consumptive rates. This scenario did not increase pumping from existing dewatering permits. The modelling results show that municipal pumping wells can maintain their Allocated rates under average annual conditions, with non-municipal, non-dewatering pumping rates increasing up to the current maximum permitted consumptive demand. The results of the sensitivity analysis revealed that if the future WSMPU rates were achievable for the municipal wells, then, within the assumptions of the scenario, the current non-municipal, non-dewatering permitted takings may be able to increase by approximately three times their current amount before impacts are predicted at municipal wells under drought conditions.

These results suggest that there may be capacity within the WHPA-Q1-A for increased water takings. If future water demand targets that include additional conservation and efficiency efforts are not met, there will be reduced capacity for increased takings within the WHPA-Q1-A. The modelling results also show that the groundwater system cannot support the maximum, permitted pumping rates in the WHPA-Q1-A under drought conditions.

Yours truly,

**MATRIX SOLUTIONS INC.**



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**REFERENCES**

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