DATE October 3, 2012 **PROJECT No.** 12-1127-0062/4000

TO Frank Cairo
Richmond Village (South) Limited

CC Mike Green
Mattamy (Jock River) Limited

FROM Brian Byerley, P.Eng. **EMAIL** bbyerley@golder.com

UPDATED ASSESSMENT OF SUBSURFACE DRAINAGE AND ANALYSIS OF 100 YEAR FLOOD EVENT PROPOSED VILLAGE OF RICHMOND DEVELOPMENT OTTAWA, ONTARIO

Golder Associates Ltd. (Golder) was retained by Richmond Village (South) Limited (RVSL) to assess the hydrogeological effects of subsurface drainage for the proposed development by RVSL and Mattamy (Jock River) Limited (Mattamy) in the Village of Richmond, in Ottawa, Ontario. The development site extends northwesterly from the Jock River, on the west side of Richmond, for a distance of about 2.5 km. The overall objective of this work was to evaluate the suitability of the proposed drainage plan for the development (completed by David Schaeffer Engineering Ltd. (DSEL)) with respect to the hydrogeological conditions encountered at the site.

The current assessment was undertaken in order to estimate:

■ The average long term groundwater conditions based on the proposed site drainage plan;

■ The time to achieve the long term groundwater conditions;

■ groundwater levels and groundwater inflows to the foundation drains during the 100 year storm event superimposed on the spring freshet; and,

■ The maximum expected sump pump pumping rate (including snow melt and roof discharge).

The tasks involved in this assessment included a review of the available drainage plans, hydrogeological data, and previous work completed at the site. This technical memorandum includes a summary of the information that was reviewed and summarizes the results of the groundwater modelling analyses completed for this assessment.

Data Sources

Available data that was reviewed as a part of this study is summarized as follows:

■ DSEL design drawings relating to the Richmond Village storm water management ponds (DSEL project 11-486, Figures 12 and 13), surface grading plan (DSEL project 11-486, Figure 3), storm servicing plan (DSEL project 11-486, Figure 4), and storm trunk profiles (DSEL project 11-486, Figures 5, 6, and 7);

■ DSEL Storm Water Management Report (DSEL Project 11-486) dated April 2012 (DSEL, 2012);

■ Borehole logs (Golder 2010a) and test pit logs (Jacques-Whitford, 2007);

- Monthly groundwater elevations collected from site piezometers between April 2010 and April 2011, as summarized in Golder's August 11, 2011 technical memorandum to Susan Murphy (Golder, 2011);

- Results of hydraulic testing of the overburden and bedrock across the site, as summarized in Golder's July 16, 2010 memo to Susan Murphy (Golder, 2010a); and,

- Results of a previous modelling assessment of groundwater inflow to building foundations (Golder, 2010b).

In addition to the above, supplementary groundwater elevation data and hydraulic response testing data were collected in May 2012. Groundwater elevation data are included in Table 1 and shown in Figure 2, attached. Hydraulic response testing date are presented in the following section of this technical memorandum.

Hydraulic Testing

Single well response tests were conducted in on-site monitoring wells on May 3, 2010 as part of a previous hydrogeological investigation. Additional hydraulic testing was carried out on a subset of these monitoring wells on May 1, 2012 to confirm hydraulic conductivity (K) estimates of the overburden and shallow bedrock material within the study area. Static groundwater levels were established prior to testing. The rate of water level recovery in the monitoring well was measured following the addition (falling head test) or removal (rising head test) of a slug, displacing the water column by a known amount. Water level recovery in each monitoring well was measured manually and continuously (0.5 to 2 second interval) with a pressure transducer.

The data collected were then analyzed by using the Hvorslev Method (Hvorslev, 1951). The hydraulic conductivities estimated from the 2012 in-situ hydraulic testing are consistent with the results of the 2010 hydrogeological investigation, as summarized in the table below.

Summary of In-Situ Hydraulic Conductivity Estimates (Hvorslev Analysis)

Well ID	May 3, 2010 K (m/s)	May 1, 2012 K (m/s)	Stratigraphy at Well Screen
MW10-1A	5×10^{-6}	5×10^{-6}	Grey silty Clay
MW10-1B	8×10^{-6}	6×10^{-6}	Grey Brown silty Clay (Weathered Crust)
MW10-2	1×10^{-6}	--	Grey Brown silty fine Sand
MW10-3A	2×10^{-5}	1×10^{-5}	fresh Grey Dolomite
MW10-3B	4×10^{-6}	--	Grey Brown silty Clay (Weathered Crust)
MW10-4A	3×10^{-6}	--	Grey Brown fine sandy Silt
MW10-4B	1×10^{-5}	1×10^{-5}	Grey Brown silty Clay (Weathered Crust)
MW10-5A	5×10^{-6}	--	Grey sandy silt some gravel trace clay (Glacial Till)
MW10-5B	2×10^{-6}	--	Grey Brown silty fine Sand
MW10-6A	4×10^{-6}	5×10^{-6}	fresh Grey Dolomite
MW10-6B	7×10^{-6}	--	Grey Brown silty Sand trace Clay
MW10-7	3×10^{-6}	--	Grey Brown silty fine Sand
MW10-8	*	1×10^{-4}	Weathered to fresh Grey Dolomite

Notes: * Water level recovery too fast to measure manually, K value could not be estimated.
        -- In-situ hydraulic conductivity was not completed at the monitoring well on May 1, 2012

Golder Associates

Site Drainage Plan

Based on a review of the site drainage plan, it is Golder's understanding that the initial groundwater drainage of the site will occur through the granular backfill material within service trenches, which are completed along the roadway centre lines. Groundwater collected by the service trenches will discharge at ground surface near surface water control features (storm water management ponds). The foundation drains of each dwelling will be connected to sumps. Sump pumps, connected to the storm sewer, are a component of the proposed servicing plan; however, granular material will not be used as backfill around service connections to the dwellings (i.e. the granular material will not connect service trenches to foundation drains). Because of the open connection between the service trench backfill and the surface water bodies proposed under the current drainage plan, it was assumed that groundwater elevations in the service trench backfill will be controlled by surface water elevations at the trench discharge point.

Model Construction

Two numerical groundwater flow (MODFLOW) models were developed to complete the hydrogeological assessment. The construction of these models was based on previously constructed models that provided estimates of groundwater inflow to basement foundation drains (Golder, 2010b). Details regarding the previous model construction and parameterization can be found in the March 2010 Technical Memorandum (Golder, 2010b). As a part of the current assessment, one model, representative of a large portion of the proposed development, was used to predict the long-term groundwater levels at the Site based on the proposed drainage plan. This model is referred to herein as the "Long-Term Drainage Model". A second model, representative of a single lot, was used to evaluate the short-term sump pump response to the 100 year storm and the spring freshet. This model is referred to herein as the "100 year Storm Event Model".

Parameterization of both models is summarized as follows:

■   The representative horizontal hydraulic conductivity of the overburden, weathered bedrock, and competent bedrock were 5×10^{-6} m/s, 5×10^{-5} m/s, and 5×10^{-7} m/s, respectively. The representative horizontal hydraulic conductivity of the overburden was increased from 1×10^{-6} m/s in the original analysis to 5×10^{-6} m/s based on the results of hydraulic testing (described above). A horizontal to vertical anisotropy ratio of 10:1 was maintained for each hydrostratigraphic unit; and,

■   The specific yield of the overburden material was 0.2. The specific storage of the overburden and rock units was 1×10^{-5} m^{-1}. These values are considered representative of the materials encountered during subsurface investigations at the site, and are not based on results of hydraulic testing.

Long-Term Drainage Model

The following assumptions were used in the construction of the long-term drainage model:

■   The model domain was defined based on the centre portion of the proposed development, bounded on the east by Strachan Street and on the west by Perth Street (Shown in Figure 1). This domain was chosen to represent the "worst case" conditions for the construction of the first houses (approximately 150 houses);

■   Overburden thickness varied linearly from 6 metres (m) at the Perth St. Boundary to 3 m at the Ottawa Street Boundary based on test pit logs by Jacques Whitford (2007);

■   Groundwater was assumed to flow to the north-east towards the Arbuckle Municipal Drain. Constant head boundaries were specified through all model layers to create an average horizontal hydraulic gradient of 0.002 m/m and an average groundwater elevation of 94.2 masl (value in the centre of the modelled portion

of the development). These values correspond to groundwater elevations measured at the Site in April 2011, which were the highest recorded groundwater elevations observed during the monthly monitoring summarized in the August 2011 Technical Memorandum (Golder, 2011);

■ Recharge of 25 mm/year was applied over the entire model domain. The value was adjusted to limit mounding of groundwater;

■ Storm sewer invert elevations were assigned based on drawings provided to Golder by DSEL. Drain boundary elevations were specified at an elevation of 0.05 m above the storm sewer invert elevation to represent the potential flowing water depth in the sewer;

■ Storm Water Management Pond 1 was specified as a constant head boundary at an elevation of 92.35 m, which represents the normal operating level of the pond (based on information provided by DSEL);

■ No backyard ditches or sump pumps were included in the simulation;

■ Infiltration to the groundwater table from surface recharge was assumed to be consistent with current conditions (i.e., reduction in recharge following placement of hard surfaces – roofs, pavement, etc. – was not considered); and,

■ It was assumed that no short circuiting of flow between the service trench fill and the storm sewer pipe would occur. Equivalent porous media assumptions apply at this interface.

The Long-Term Drainage Model was initially run without using the drain boundaries that represent the service trenches and Storm Water Management Pond 1, to establish an initial groundwater condition approximating conditions observed in April 2011. The drain boundaries were then 'switched-on', and transiently allowed to drain the site.

100 Year Storm Event Model

The following assumptions were used in the construction of the long-term drainage model:

■ The ground surface at the road centre line (post-grading) elevation was assigned as 95.15 m, and the elevation of the top of rock was assigned as 89.95 masl. These values correspond to the area (see Figure 1) identified as the "worst case" in terms of the 100 year storm event given the difference between the proposed underside of footing (USF; i.e. foundation drain) elevations (93.08 m) and the expected surface water level during the 100 year storm event (94.11 m);

■ The foundation drain elevation (93.08 masl) was assigned at 2.07 m below the graded road elevation. This assumes a 3% surface grade across the lot, an 11 m set-back from the centreline of the road, and a 2.4 m depth from ground surface to the foundation drain elevation;

■ The Storm sewer elevation (92.98 masl) was assigned using a constant head boundary set to an elevation of 0.1 m below the foundation drain elevation. This is representative of a 0.15 m separation between the storm sewer invert and the foundation drain elevations (DSEL, 2012), and assumes 0.05 m depth of water in the sewer;

■ A service stub was specified using a constant head boundary from the storm sewer to towards the house. The stub was terminated at a distance of 3 m from the house. A 2 m width was assumed for the stub trench. The constant head boundary was assigned at the same elevation as the storm sewer trench;

- It was assumed that the portions of the storm sewer and foundation drain specified in the model only draw water from areas located within the model domain (i.e. it is assumed that the sump pumps, and service stubs will generate groundwater flow divides at each property boundary);

- No backyard ditches or basement drains were included in the simulation; and,

- It was assumed that no short circuiting of flow between the service trench fill and the storm sewer pipe would occur. Equivalent porous media assumptions apply at this interface.

In order to establish an initial groundwater condition, the model recharge was adjusted until the simulated groundwater elevation was directly beneath the foundation drains (which occurred at a recharge rate of 90 mm/yr). Using this initial condition, the 100 year storm was simulated transiently over a 24 hour period, during which time groundwater elevations in the storm sewer trench and service stub were increased from 92.98 masl to 94.11 masl. Water levels were assumed to increase instantaneously at the onset of the storm. To simulate the additional impact of the 100 year storm occurring concurrently with the spring freshet, the recharge was increased to 2000 mm/year during the same 24 hour period. This value of recharge resulted in an average head throughout the model domain that approximated the 100 year storm water level. The magnitude and duration of the spring freshet used for the modelling were assumed values; however, the selected parameters are considered to be conservative.

Following the storm event, groundwater elevations in the storm sewer and service stub were lowered to 92.98 m, and the recharge was reduced to 90 mm/year. Groundwater elevations within the service trenches were assumed to decrease instantaneously 24 hours after the start of the storm based on information provided by DSEL. The instantaneous rise and fall of groundwater elevations is expected to generate more inflow to the foundation drains than would be generated by the expected gradual changes that are more likely to occur within the same 24 hour time period.

Results

Long Term Drainage Model

The simulated average long-term (steady-state) groundwater elevation within the proposed development was 93.15 masl. Simulated groundwater elevations varied from 93.91 masl in the southeastern corner of the site to 92.35 masl along the edge of Storm Water Management Pond 1. These conditions were achieved approximately 475 days following the initiation of drainage by the storm sewer network. It is noted that at steady state, simulated groundwater elevations in a small area in the south-western corner of the modelled portion of the development (see Figure 1) were 0.05 to 0.20 m above the proposed USF elevation. In all other areas, the long term drainage model predicts groundwater elevations to be below the proposed USF elevations. Given the period of time required to achieve the steady-state groundwater elevations it is likely that short term dewatering activities will be required during construction.

100 Year Storm Event Model

Using the 100 Year Storm Event Model, the simulated peak inflow to the foundation drain during the 100 year storm event was 1.07 m^3/day. This value represents the maximum expected sump pump pumping rate. It is noted that a small portion of the flow out of the model domain was through the sewer trenches (0.37 m^3/day), due to the high level of recharge applied to simulate freshet conditions. The simulated peak groundwater elevation in the model cell adjacent to the foundation drains (0.1 m from the drains) was 0.09 m above the USF elevation, and was 0.48 m above the USF elevation at 1 m from the drains. Following the storm event, flow to the foundation drains ended instantly as gradients were reversed towards the storm sewer. Simulated groundwater elevations fell below the USF elevation within 1 hour after the end of the storm event.

Summary and Conclusion

The results of the modelling assessment indicate the following:

- The simulated long-term (steady-state) groundwater elevations were below the USF elevations, with the exception a small area in the south-western corner of the modelled portion of the development. The constant head boundaries were selected to approximate groundwater elevations observed in April 2011 (the highest groundwater elevations measured on-site). Based on the groundwater level monitoring data (see Figure 2), lower groundwater elevations occur during dryer times of year;

- It is expected that sump pumps would be required to operate during a 100 year storm event; however, the duration of operation would not be expected to extend beyond the duration of the 100 year storm event. Sump pump operation may also be required during the spring freshet, or during any period of high recharge, as is typical for dwellings designed for sump pumps. Based on the results of the groundwater modelling, the expected volume of water that would be pumped at each dwelling would be easily handled by standard commercially available residential-type sump pumps;

- Based on the site's subsurface conditions and the results of the groundwater modelling, it is expected that the amount of groundwater lowering that would occur through the granular backfill material within the service trenches and the storm water management ponds would not adversely affect base flow to adjacent water courses, water levels in water supply wells, or existing and future residential foundations; and,

- The modelling assumed that groundwater drainage of the site will occur through the granular backfill material within service trenches, and groundwater collected by the service trenches will discharge at ground surface near the storm water management pond. The modeling also assumed that the granular material within the service trenches will not directly connect to foundation drains. Inspection during construction, to ensure implementation of this design, is recommended.

Limitations

This report was prepared for the use of Richmond Village (South) Limited and Mattamy (Jock River) Limited. The report, which specifically includes all tables, figures and appendices, is based on data gathered by Golder Associates Ltd., and information provided to Golder Associates Ltd. by others. The information provided by others has not been independently verified or otherwise examined by Golder Associates Ltd. to determine the accuracy or completeness. Golder Associates Ltd. has relied in good faith on this information and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the information as a result of omissions, misinterpretation or fraudulent acts.

The assessment of environmental conditions and possible hazards at this site has been made using the results of physical measurements from a number of locations. The site conditions between testing locations have been inferred based on conditions observed at the testing locations. Actual conditions may deviate from the inferred values.

Hydrogeological investigations and groundwater modelling are dynamic and inexact sciences. They are dynamic in the sense that the state of any hydrological system is changing with time, and in the sense that the science is continually developing new techniques to evaluate these systems. They are inexact in the sense that groundwater systems are complicated beyond human capability to evaluate them comprehensively in detail, and we invariably do not have sufficient data to do so. A groundwater model uses the laws of science and mathematics to draw together the available data into a mathematical or computer-based representation of the essential features of an existing hydrogeological system. While the model itself obviously lacks the detailed reality of the existing

hydrogeological system, the behaviour of a valid groundwater model reasonably approximates that of the real system. The validity and accuracy of the model depends on the amount of data available relative to the degree of complexity of the geologic formations and on the quality and degree of accuracy of the data entered. Therefore, every groundwater model is a simplification of a reality and the model described in this report is not an exception.

The professional groundwater modelling services performed as described in this report were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practising under similar conditions, subject to the quality and quality of available data, the time limits and financial and physical constraints applicable to the services. Unless otherwise specified, the results of previous or simultaneous work provided by sources other than Golder Associates Ltd. and quoted and/or used herein are considered as having been obtained according to recognized and accepted professional rules and practices, and therefore deemed valid. This model provides a predictive scientific tool to evaluate the impacts on a real groundwater system of specified hydrological stresses and/or to compare various scenarios in a decision-making process. However and despite the professional care taken during the construction of the model and in conducting the simulations, its accuracy is bound to the normal uncertainty associated to groundwater modelling and no warranty, express or implied, is made.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made, or actions taken based on this report.

Closure
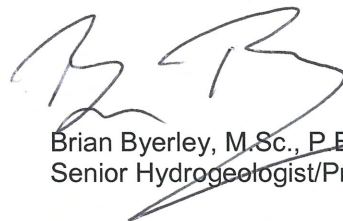
We trust that this memo is adequate for your current needs. Please contact the undersigned if you have any questions.

Yours truly,

GOLDER ASSOCIATES LTD.

Melissa Bunn, Ph.D.
Environmental Consultant

Brian Byerley, M.Sc., P.Eng.
Senior Hydrogeologist/Principal
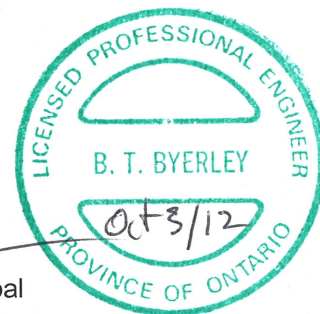
MIB/BTB/SRW/sg
n:\active\2012\1127 - geosciences\12-1127-0062 richmond village drainage and sump design\reporting\phase 4000 reporting\12-1127-0062 tech memo 3oct2012 phase 4000 100 yr flood modelling.docx

Attachments: Table 1 – Groundwater Monitoring Data
              Figure 1 – Site Plan
              Figure 2 – Observed Groundwater Levels

References

Golder Associates Ltd., 2011. Groundwater Monitoring Program Proposed Mattamy Homes Development, Richmond (Ottawa), Ontario. Technical Memorandum No. 08-1122-0078/9600, August 2011.

Golder Associates Ltd., 2010a. Hydrogeological Investigation Proposed Mattamy Homes Development, Richmond (Ottawa), Ontario. Technical Memorandum No. 08-1122-0078/9600, July 2010.

Golder Associates Ltd., 2010b. Draft Preliminary Groundwater Modelling Assessment of Potential Shallow Groundwater Inflow to Building Foundations. Technical Memorandum No. 08-1122-0078/9500, March 2010.

Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Groundwater Observations. U.S. Army Corps Engrs. Water ways Exp. Sta. Bull. 36, Vicksburg, Miss.

Jacques Whitford Limited., 2007. Preliminary Geotechnical Investigation Proposed Residential Subdivision, Perth and Ottawa Streets, Richmond Area Ottawa, Ontario. Report No. 1026929, June 2007.

Table 1: Groundwater Monitoring Data

Well ID	Ground Surface Elevation (geodetic)	Screen depth (middle of screen) (mbgs)	Soil/rock at depth of well screen	Groundwater Level (mbgs)														
				Apr.29 & 30, 2010	May 14, 2010	Jun.16, 2010	Jul. 15, 2010	Aug. 20, 2010	Sept. 16, 2010	Oct. 1, 2010	Oct 18, 2010	Nov. 19, 2010	Dec. 15, 2010	Jan. 18, 2011	Feb. 14, 2011	Mar. 15, 2011	Apr. 15, 2011	May 1, 2012
MW10-1A	94.55	1.11	Grey silty Clay	0.73	0.78	0.80	0.81	0.78	0.81	0.61	0.77	0.72	0.78	1.00	1.21	0.89	0.64	0.83
MW10-1B	94.55	1.21	Grey brown silty Clay (weathered crust)	0.74	0.77	0.80	0.79	0.79	0.81	0.62	0.75	0.72	0.78	0.97	1.17	0.90	0.66	0.83
MW10-2	94.90	2.12	Grey brown silty find Sand	0.73	0.67	0.86	0.66	0.96	0.94	0.17	0.59	0.34	0.55	0.78	0.89	0.56	0.13	--[4]
MW10-3A	94.0	4.55	Fresh grey Dolomite	0.22	0.26	0.58	0.28	0.23	0.25	-0.09[1]	0.08	-0.06[1]	--[3]	--[3]	--[3]	--[3]	-0.21[1]	0.25
MW10-3B	94.0	2.12	Grey brown silty Clay (weathered crust)/grey brown fine sandy Silt	0.82	0.81	0.87	0.79	0.87	0.85	0.44	0.72	0.56	0.73	0.90	0.77	0.69	0.29	0.95
MW10-4A	94.34	3.03	Grey brown fine sandy Silt	0.48	0.47	0.56	0.49	0.64	0.62	0.11	0.47	0.27	0.44	0.53	0.64	0.41	0.21	--[4]
MW10-4B	94.34	1.21	Grey brown silty Clay (weathered crust)	0.47	0.49	0.56	0.49	0.64	0.62	0.08	0.46	0.25	0.44	0.56	0.65	--[3]	0.26	0.78
MW10-5A	95.65	3.03	Glacial Till	0.82	0.79	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[4]
MW10-5B	95.65	1.21	Grey brown silty find Sand	0.89	0.88	1.33	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[2]	--[4]
MW10-6A	95.67	4.24	Fresh grey Dolomite	1.38	1.38	1.98	1.34	1.31	1.52	0.66	0.84	0.67	0.68	1.22	1.44	0.56	0.46	1.21
MW10-6B	95.67	1.52	Grey brown silty Sand trace Clay	1.29	1.28	1.84	1.59	1.12	1.55	0.31	0.62	0.26	0.50	1.16	1.42	--[3]	0.05	1.15
MW10-7	95.36	2.42	Grey brown silty fine Sand	0.51	0.49	1.09	0.98	0.38	0.47	0.03	0.06	0.04	0.03	--[3]	--[3]	--[3]	0.02	--[4]
MW10-8	93.32	2.42	Weathered to fresh grey Dolomite	1.02	1.15	1.52	1.39	1.24	1.29	0.23	0.31	0.26	0.27	0.80	0.81	--[3]	0.19	0.74

Notes:

[1] Artesian conditions exist. Groundwater level above ground surface.

[2] Monitoring well MW 10-5 A and B vandalized and groundwater levels not available after May 14, 2010.

[3] Groundwater in monitoring well frozen. Depth to groundwater level could not be measured.

[4] Only select wells were monitored in May 2012 as a component of a hydraulic response testing program

Golder Associates
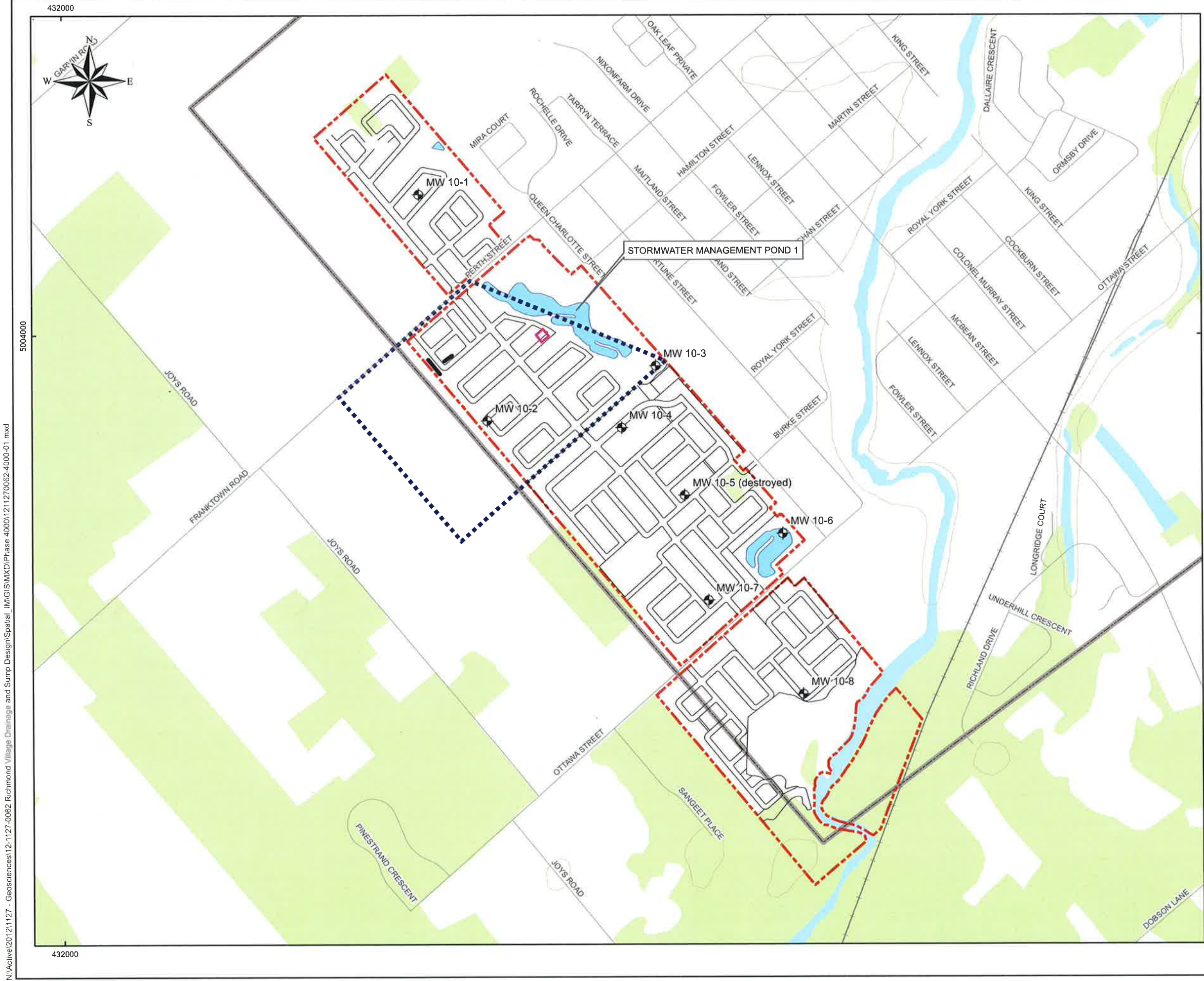
LEGEND

- ◈ MONITORING WELL LOCATION
- — PROPOSED ROAD
- ⊢ RAILWAY
- — ROAD
- — TOPOGRAPHIC CONTOUR (m)
- ▨ PROPOSED STORMWATER MANAGEMENT POND
- ⬚ RICHMOND VILLAGE/MATTAMY RICHMOND LANDS
- ▭ RICHMOND VILLAGE BOUNDARY
- ▨ WATERBODY
- ▨ VEGETATION
- ▰▰▰ APPROXIMATE BOUNDARY OF LONG-TERM DRAINAGE MODEL DOMAIN
- ▭ 100 YEAR STORM EVENT MODEL DOMAIN
- ▬ APPROXIMATE AREA WHERE ESTIMATED STEADY - STATE GROUNDWATER ELEVATIONS EXCEED USF ELEVATION

Map labels:
432000
5004000
MW 10-1
MW 10-2
MW 10-3
MW 10-4
MW 10-5 (destroyed)
MW 10-6
MW 10-7
MW 10-8
STORMWATER MANAGEMENT POND 1

Street names: GARVIN RD, OAK LEAF PRIVATE, KING STREET, DALLAIRE CRESCENT, ORMSBY DRIVE, NIXONFARM DRIVE, MARTIN STREET, ROCHELLE DRIVE, TARRYN TERRACE, HAMILTON STREET, LENNOX STREET, ROYAL YORK STREET, KING STREET, MIRA COURT, MAITLAND STREET, FOWLER STREET, COLONEL MURRAY STREET, COCKBURN STREET, OTTAWA STREET, QUEEN CHARLOTTE STREET, PERTH STREET, FORTUNE STREET, MCBEAN STREET, LENNOX STREET, ROYAL YORK STREET, JOYS ROAD, BURKE STREET, FOWLER STREET, FRANKTOWN ROAD, LONGRIDGE COURT, UNDERHILL CRESCENT, RICHLAND DRIVE, OTTAWA STREET, SANGEET PLACE, PINESTRAND CRESCENT, JOYS ROAD, DOBSON LANE

NOTE

THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LIMITED REPORT NO. 12-1127-0062 PHASE 4000

REFERENCE

BASE DATA - CANVEC PROVIDED BY HER MAJESTY THE QUEEN IN RIGHT OF CANADA, DEPARTMENT OF NATURAL RESOURCES
PROJECTION: TRANSVERSE MERCATOR   DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18

480   240   0   480

Meters
1:12,000

PROJECT
RICHMOND VILLAGE
ASSESSMENT OF SUBSURFACE DRAINAGE

TITLE
SITE PLAN

Golder Associates
Ottawa, Ontario

PROJECT No. 12-1127-0062		SCALE AS SHOWN	REV. 0.0
DESIGN	NB	May 2012	
GIS	ABD	July 2012	
CHECK			**FIGURE 1**
REVIEW			

Water Elevation (masl)

96.0
95.5
95.0
94.5
94.0
93.5
93.0
92.5
92.0
91.5

Note: No water level monitoring was completed between April 2011 and April 2012

Date (dd/mm/yy)

19/04/10 18/06/10 17/08/10 16/10/10 15/12/10 13/02/11 14/04/11 13/06/11 12/08/11 11/10/11 10/12/11 08/02/12 08/04/12

Legend:
- MW10-1A
- MW10-1B
- MW10-2
- MW10-3A
- MW10-3B
- MW10-4A
- MW10-4B
- MW10-5A
- MW10-5B
- MW10-6A
- MW10-6B
- MW10-7
- MW10-8
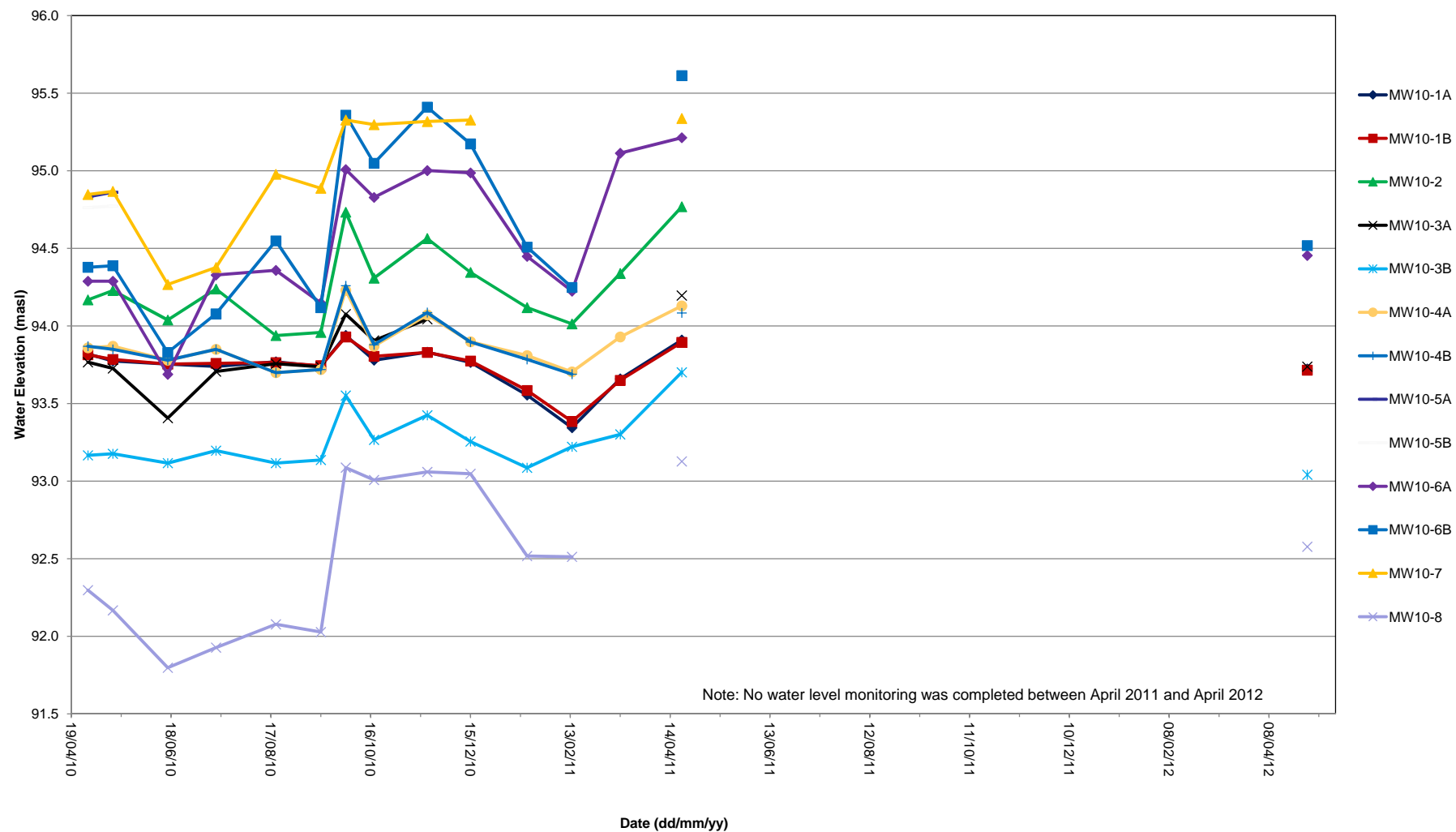
Golder Associates Ltd.

RICHMOND VILLAGE ASSESSMENT OF SUBSURFACE DRAINAGE

OBSERVED GROUNDWATER ELEVATIONS

| OCTOBER 2012 | PROJECT: 12-1127-0062 | FIGURE 2 |