TECHNICAL MEMORANDUM

DATE February 29, 2024 **Project No.** 1655070

TO Lafarge Canada Inc.
6509 Airport Road, Mississauga ON L4N 1S7

CC Mal Wensierski, Land Manager
Lafarge Canada Inc

FROM Sean McFarland, Hayley Wallace **EMAIL sean.mcfarland@wsp.com**

PROPOSED LAFARGE PIT NO. 3 EXTENSION: MAXIMUM PREDICTED WATER TABLE ELEVATION

1.0 INTRODUCTION

WSP Canada Inc (WSP) is pleased to provide Lafarge Canada Inc. (Lafarge) with this technical memorandum outlining the "maximum predicted water table" in support of a, Class A aggregate licensing application for the proposed Lafarge Pit No. 3 Extension lands (the Site). The Site is located at 17923 Shaw's Creek Road, Town of Caledon, Ontario (Figure 1). The Site is located immediately west of the existing Lafarge Pit No. 3 and is intended to be an extension of that active operation.

The following sections outline the groundwater field monitoring program conducted at the Site, as it relates to the identification of the maximum predicted water table elevation. Additional details and results from the field monitoring program are summarized in *Proposed Lafarge Pit No. 3 Extension Level 1 and 2 Hydrogeology and Hydrology Report* (WSP, 2023).

2.0 FIELD PROGRAM

A Site field program was initiated in 2016 with the objectives of characterizing hydrogeologic conditions at the Site, including: geologic units, water levels, groundwater temperature, groundwater chemistry and hydraulic conductivity. The monitoring network includes the following stations (Figure 1):

- Seven monitoring wells (07-DH-154, 07-DH-160, 07-DH-169, MW16-01A/B (nest), MW16-02, and an inactive domestic well north of the Site on Lafarge property ("House Well");
- An on-Site wetland piezometer (UW3); and
- Four off-Site surface water monitors equipped with staff gauges (UW1, UW2A, UW2B, EW1).

The following subsections describe the methodology and results of the field program in detail.

2.1 Borehole Drilling and Monitoring Well Installation

The following is noted with respect to Site boreholes and monitoring wells:

Well Location. The wells were strategically placed around and within the Site to establish Site-wide water level patterns. The well locations and elevations were surveyed by a professional land surveyor. The UW3 monitor was surveyed by Golder field staff.

Completion Date. The 07-series monitoring wells were installed in 2007. Well 07-DH-154 is located in Lafarge lands north of the Site whereas Well 07-DH-160 and 07-DH-169 are located within the Site. The 16-series monitoring wells were installed in 2016 to provide Site-wide coverage. The UW3 piezometer was installed on May 15, 2019. The House Well, a historic former domestic supply well on Lafarge property, is now used as a monitoring well.

Screened Interval. Wells 07-DH-154, 07-DH-160, 07-DH-169, MW16-1A, MW16-2 and UW3 are completed in the unconfined aquifer. MW16-1B, located adjacent to its nest partner MW16-1A, is completed underneath the unconfined aquifer in the silt and clay aquitard for the purpose of measuring vertical gradients between the two units. The House Well is completed within bedrock.

Geology. The borehole logs support the conceptual hydrostratigraphy of 1) an unconfined sand and gravel aquifer, overlying: 2) a silt and clay aquitard, overlying: 3) a bedrock aquifer. The following descriptions summarize the borehole log observations:

- **Unconfined Sand and Gravel Aquifer:** The unconfined aquifer consists largely of brown fine to coarse sand, often silty, with varying proportions of gravel and cobbles. The observed thickness of this unit ranges from 7.62 m to 14.33 m.
- **Silt and Clay Aquitard**: The transition from the unconfined aquifer to the underling aquitard varies from abrupt to gradual. Typically, the transition to aquitard is denoted by the predominance of grey-brown to grey silt. The presence of clay appears more common at greater depths. Well record 4908398, just off-Site, suggests that the aquitard is present down to top of bedrock with a thickness of approximately 26 m.
- **Bedrock Aquifer:** Well record 4908398 indicates that bedrock near the Site is approximately 39 m below ground surface. The log reports grey shale underlain by grey dolostone underlain by grey sandstone. The dolostone reported in the log is the Goat Island-Gasport (Amabel) Formation.

2.2 Water Level Measurements

Water level monitoring at the Site began in 2016 with quarterly frequency but was increased to monthly frequency after June 2017. The period of record for baseline groundwater level monitoring at the Site spans from June 2016 to December 2020. Monitoring wells 16-2 and 07-DH-169 continue to be monitored to present as part of the monthly monitoring program for the existing Lafarge Pit No. 3. Monitoring events included both manual readings at wells using a water level probe and taking staff gauge readings at surface water stations.

Water levels are listed in Table 1. Hydrographs for groundwater and surface water monitors are shown on Figures 3A and 3B. Lastly, an inferred high water table map for the unconfined sand and gravel aquifer is provided on Figure 4. The following trends are noted:

- The unconfined aquifer groundwater levels vary between +/- 1 m or less annually (Figure 3A). The hydrographs indicate that the highest groundwater elevations typically occur during late spring / early summer and the lowest groundwater elevation typically occur during late fall /early winter. These patterns are consistent with a fairly deep unconfined system that receives the bulk of its recharge after the freshet. The highest groundwater elevations across the Site, were recorded during May 2019 after a particularly wet spring / early summer. Although the water level measurement at UW3 was also relatively high in March 2020, the conditions recorded in May 2019 represent the most comprehensive data set for an estimate of the highest groundwater elevation across the entire Site.
- Depending on the well and time of year, depth to water at wells within the Site can vary from 4.4 m to 13.5 m below ground surface (Table 1).
- The wetlands north of the Site, when ponded, exhibit water level patterns similar to, but greater in elevation, than those of on-Site wells (Figure 3A). Well 07-DH-154, which lies north of UW1, further confirms that water levels are greater north of the Site. As such, the wetlands are considered upgradient of the Site. The wetlands exhibit a typical hydroperiod response: water levels rise during the spring freshet and slowly decline into late summer; thereafter the wetlands are largely dry for the remainder of the year. The 2017 data share a somewhat similar pattern although the extent of the wet hydroperiod is dominated by an unusually wet June.
- UW3 water level measurements are limited to wet periods during 2019. Access to the wetland during summer was prevented as a result of wild (poison) parsnip overgrowth surrounding the feature. When measured, the groundwater level was consistently below ground surface (within 0.13 to 0.54 m) but raised relative to the groundwater elevation at surrounding wells. This would suggest that the UW3 area, which is in effect a drainage “bowl”, may be an area of increased infiltration resulting in slightly localized water table mounding.
- The difference in water level between unconfined sand and gravel aquifer (MW16-1A) and the underlying silt aquitard (MW16-1B) varies within 0.5 m (Figure 3B). Vertical gradient direction is most frequently observed as downwards; however, upward gradients are observed during late summer into early winter.
- Bedrock water levels are at least 3 m lower than those in the overburden (Figure 3B). Furthermore, the bedrock hydrograph is subdued relative to the seasonal behaviour observed in the overburden system.

2.3 Maximum Predicted Water Table Elevation

An inferred high-water table map was developed using water levels measured during the May 31, 2019 monitoring event (Figure 4). Consistent with other monitoring events, the on-Site flow pattern during this period is from roughly northwest to southeast. On-Site, the high-water table ranges from approximately 390.4 masl in the northwest to 389 masl in the eastern corner. The pit floor elevation will be graded in a generally southerly direction with a maximum elevation of 390.4 metres above sea level (masl) in the north to a minimum elevation of 389 masl in the south (consistent with the established groundwater table elevation). Rehabilitation of the pit will restore the Site to pre-existing grades.

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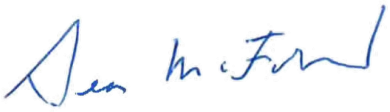

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Attachments: Table 1: Water Levels
Figure 1: Site Plan
Figure 2: Site Section
Figure 3A: Unconfined Aquifer Hydrographs
Figure 3B: Vertical Gradients
Figure 4: Inferred High Water Table
Curriculum Vitae

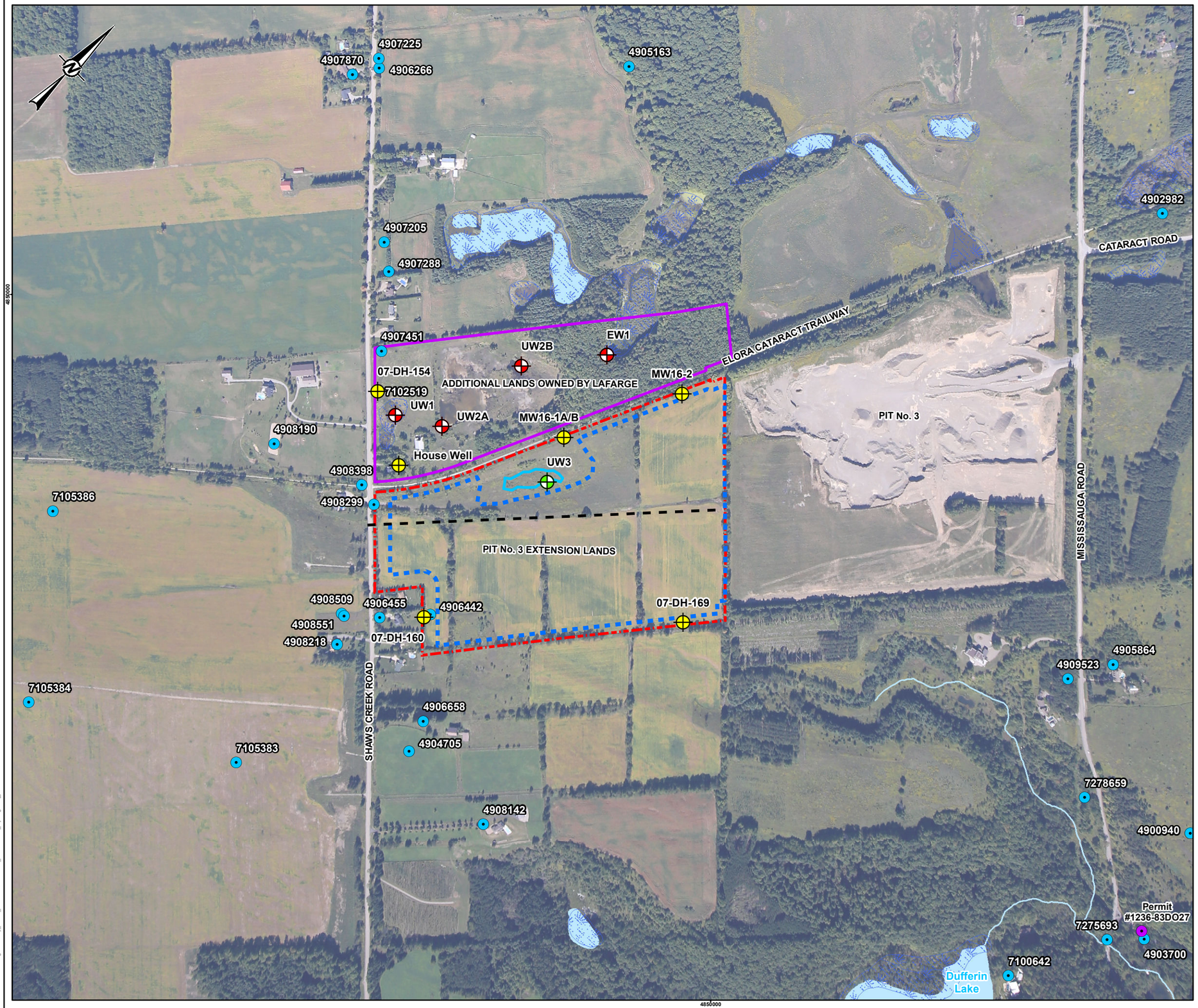
https://golderassociates.sharepoint.com/sites/19026g/report/06b_feb 2024 high water table memo/1655070 final memo max water table 29feb2024_rev0.docx

3.0 REFERENCES

WSP, 2024. *Proposed Lafarge Pit No. 3 Extension Level 1 and 2 Hydrogeology and Hydrology.* Submitted to Lafarge Canada Inc. 1655070 (15001). February 2024.

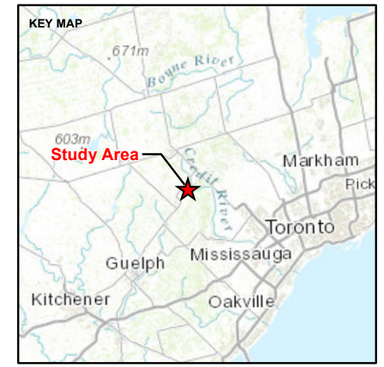
TABLE 1: WATER LEVELS

Well ID:	07-DH-154		07-DH-160		07-DH-169		MW16-1A		MW16-1B		MW16-2		House Well		UW1		UW2A		UW2B		UW3		EW1	
East83/North83:	577370	4850375	577748	4850129	578113	4850482	577691	4850571	577691	4850568	577793	4850796	577502	4850303	577428	######	577507	######	577533	######	577730	######	577635	######
Depth (mbgs):	7.62		12.19		15.85		8.69		21.34		12.96		54.60		0		0		0		0.58		0	
Ground (masl):	392.09		394.89		398.67		395.76		395.72		399.71		395.41		389.40		389.44		389.38		390.86		389.55	
Pipe Elev. (masl):	392.90		395.77		399.52		396.62		396.62		400.64		395.92		390.62		390.63		390.74		391.78		390.79	
Date	Water Depth (mbtop)	Water Elev. (masl)	Water Depth (mbtop)	Water Elev. (masl)	Water Depth (mbtop)	Water Elev. (masl)	Water Depth (mbtop)	Water Elev. (masl)	Water Depth (mbtop)	Water Elev. (masl)	Water Depth (mbtop)	Water Elev. (masl)	Water Depth (mbtop)	Water Elev. (masl)	Water Height (m)	Water Elev. (masl)	Water Height (m)	Water Elev. (masl)	Water Height (m)	Water Elev. (masl)	Water Height (m)	Water Elev. (masl)	Water Height (m)	Water Elev. (masl)
28/30-Jun-16	3.10	389.80	7.45	388.32	11.64	387.88	7.05	389.57	7.28	389.34	11.11	389.53	12.34	383.58	0.35	389.75	0.445	389.88	0.465	389.85	-	-	0.36	389.91
26-Jul-16	3.27	389.64	7.57	388.20	11.74	387.78	7.25	389.37	7.38	389.24	11.32	389.32	11.03	384.89	-	-	-	-	-	-	-	-	-	-
30-Sep-16	3.84	389.06	7.98	387.79	12.165	387.36	7.78	388.84	7.58	389.04	11.84	388.80	11.08	384.84	-	-	-	-	-	-	-	-	-	-
24-Oct-16	4.04	388.86	8.13	387.64	12.33	387.19	7.99	388.63	7.68	388.94	12.03	388.61	11.14	384.78	-	-	-	-	-	-	-	-	-	-
05-Dec-16	4.37	388.53	8.43	387.35	12.65	386.87	8.32	388.30	7.84	388.78	12.35	388.29	11.12	384.80	Dry		Dry		Dry		-	-	Dry	
12-Jan-17	4.42	388.48	8.65	387.12	12.93	386.60	8.485	388.14	8.88	387.75	12.53	388.11	-	-	-	-	-	-	-	-	-	-	-	-
30-Mar-17	3.516	389.39	8.06	387.71	12.45	387.07	7.49	389.13	7.95	388.67	11.52	389.12	11.45	384.47	Dry		Dry		Dry		-	-	Dry	
27-Jun-17	2.695	390.21	7.07	388.70	11.26	388.26	6.625	390.00	6.88	389.74	10.73	389.91	10.87	385.05	0.70	390.09	0.81	390.25	0.85	390.23	-	-	0.70	390.25
30-Aug-17	2.90	390.01	7.08	388.69	11.21	388.32	6.85	389.78	6.84	389.78	10.95	389.68	10.82	385.10	0.51	389.91	0.61	390.05	0.63	390.01	-	-	0.55	390.11
22-Sep-17	3.07	389.84	7.23	388.55	11.35	388.18	7.03	389.60	6.96	389.66	11.11	389.53	10.96	384.96	0.39	389.78	0.44	389.88	0.46	389.84	-	-	0.41	389.96
27-Oct-17	3.32	389.59	7.47	388.30	11.59	387.93	7.30	389.33	7.19	389.44	11.37	389.26	10.83	385.09	0.17	389.57	0.18	389.62	0.21	389.60	-	-	0.24	389.80
30-Nov-17	3.55	389.35	7.67	388.10	11.83	387.70	7.51	389.11	7.40	389.22	11.57	389.06	10.79	385.13	Dry		Dry		Dry		-	-	Dry	
11-Dec-17	3.63	389.28	7.75	388.02	11.92	387.61	7.59	389.04	7.48	389.14	11.64	389.00	10.98	384.94	Dry		Dry		Dry		-	-	Dry	
29-Jan-18	3.66	389.24	7.84	387.94	12.07	387.46	7.62	389.01	7.71	388.91	11.68	388.96	10.97	384.95	Frozen/Dry		Dry		Frozen/Dry		-	-	Dry	
26-Feb-18	3.33	389.57	7.51	388.27	11.88	387.64	7.26	389.37	7.65	388.97	11.37	389.27	10.85	385.07	0.26	389.66	0.18	389.62	0.21	389.60	-	-	Dry	389.56
28-Mar-18	3.36	389.54	7.66	388.11	11.92	387.61	7.34	389.28	7.51	389.11	11.39	389.24	10.89	385.03	0.14	389.53	0.16	389.59	0.20	389.58	-	-	Dry	389.56
30-Apr-18	2.91	389.99	7.23	388.55	11.53	388.00	6.87	389.76	7.34	389.29	10.93	389.73	10.89	385.03	0.47	389.87	0.59	390.02	0.61	389.99	-	-	0.28	389.83
31-May-18	2.87	390.04	7.11	388.66	11.24	388.29	6.82	389.81	7.06	389.57	10.91	389.73	11.42	384.50	0.49	389.89	0.65	390.09	0.67	390.05	-	-	0.44	389.99
22-Jun-18	2.96	389.95	7.19	388.59	11.32	388.20	6.92	389.70	7.02	389.60	11.01	389.63	11.08	384.84	0.43	389.83	0.56	390.00	0.58	389.97	-	-	0.40	389.96
27-Jul-18	3.13	389.77	7.37	388.41	11.50	388.02	7.13	389.50	7.11	389.51	11.20	389.44	10.96	384.96	0.31	389.70	0.11	389.55	0.10	389.48	-	-	0.29	389.85
24-Aug-18	3.33	389.57	7.52	388.25	11.83	387.69	7.32	389.30	7.25	389.37	11.38	389.25	11.04	384.88	0.12	389.52	0.21	389.64	0.18	389.57	-	-	0.15	389.70
02-Oct-18	3.64	389.26	7.78	388.00	11.93	387.59	7.63	389.00	7.49	389.14	11.68	388.95	10.94	384.98	Dry		Dry		Dry		-	-	Dry	
31-Oct-18	3.84	389.07	7.95	387.82	12.13	387.39	7.81	388.81	7.68	388.94	11.87	388.76	11.02	384.90	Dry		Dry		Dry		-	-	Dry	
29-Nov-18	3.82	389.09	7.96	387.81	12.16	387.36	7.77	388.86	7.87	388.75	11.83	388.80	10.90	385.02	Dry		Dry		Dry		-	-	Dry	
17-Dec-18	3.72	389.19	7.85	387.93	12.01	387.52	7.67	388.95	7.82	388.80	11.73	388.90	10.88	385.04	Dry		Dry		Dry		-	-	Dry	
28-Jan-19	3.45	389.45	7.69	388.09	12.00	387.53	7.43	389.19	7.69	388.93	11.48	389.16	10.81	385.11	Frozen/Dry		Dry		Dry		-	-	Dry	
26-Feb-19	3.33	389.58	7.49	388.29	11.82	387.71	7.25	389.38	7.53	389.09	11.32	389.32	10.81	385.11	Frozen/Dry		Frozen/Dry		Frozen/Dry		-	-	Frozen/Dry	
28-Mar-18	3.36	389.54	7.66	388.11	11.92	387.61	7.34	389.28	7.51	389.11	11.39	389.24	10.89	385.03	0.14	389.53	0.16	389.59	0.20	389.58	-	-	Dry	
30-Apr-18	2.91	389.99	7.23	388.55	11.53	388.00	6.87	389.76	7.34	389.29	10.93	389.71	10.89	385.03	0.47	389.87	0.59	390.02	0.61	389.99	-	-	0.28	389.83
31-May-18	2.87	390.04	7.11	388.66	11.24	388.29	6.82	389.81	7.06	389.57	10.91	389.73	11.42	384.50	0.49	389.89	0.65	390.09	0.67	390.05	-	-	0.44	389.99
22-Jun-18	2.96	389.95	7.19	388.59	11.32	388.20	6.92	389.70	7.02	389.60	11.01	389.63	11.08	384.84	0.43	389.83	0.56	390.00	0.58	389.97	-	-	0.40	389.96
27-Jul-18	3.13	389.77	7.37	388.41	11.50	388.02	7.13	389.50	7.11	389.51	11.20	389.44	10.96	384.96	0.31	389.70	0.11	389.55	0.10	389.48	-	-	0.29	389.85
24-Aug-18	3.33	389.57	7.52	388.25	11.83	387.69	7.32	389.30	7.25	389.37	11.38	389.25	11.04	384.88	0.12	389.52	0.21	389.64	0.18	389.57	-	-	0.15	389.70
02-Oct-18	3.64	389.26	7.78	388.00	11.93	387.59	7.63	389.00	7.49	389.14	11.68	388.95	10.94	384.98	Dry		Dry		Dry		-	-	Dry	
31-Oct-18	3.84	389.07	7.95	387.82	12.13	387.39	7.81	388.81	7.68	388.94	11.87	388.76	11.02	384.90	Dry		Dry		Dry		-	-	Dry	
29-Nov-18	3.82	389.09	7.96	387.81	12.16	387.36	7.77	388.86	7.87	388.75	11.83	388.80	10.90	385.02	Dry		Dry		Dry		-	-	Dry	
17-Dec-18	3.72	389.19	7.85	387.93	12.01	387.52	7.67	388.95	7.82	388.80	11.73	388.90	10.88	385.04	Dry		Dry		Dry		-	-	Dry	
28-Jan-19	3.45	389.45	7.69	388.09	12.00	387.53	7.43	389.19	7.69	388.93	11.48	389.16	10.81	385.11	Frozen		Dry		Dry		-	-	Dry	
26-Feb-19	3.33	389.58	7.49	388.29	11.82	387.71	7.25	389.38	7.53	389.09	11.32	389.32	10.81	385.11	Frozen		Frozen		Frozen		-	-	Frozen	
25-Mar-19	2.98	389.92	7.10	388.68	11.48	388.05	6.92	389.70	7.34	389.29	11.05	389.59	10.58	385.34	0.47	389.87	0.53	389.96	0.54	389.92	-	-	0.20	389.76
26-Apr-19	2.68	390.23	6.85	388.93	11.12	388.41	6.62	390.00	7.03	389.59	10.74	389.90	10.38	385.54	0.69	390.09	0.82	390.25	0.85	390.23	-	-	0.52	390.07
15-May-19	2.53	390.37	6.62	389.15	10.78	388.74	6.44	390.19	6.82	389.80	10.46	390.18	10.43	385.49	-	-	-	-	-	-	1.06	390.73	-	-
31-May-19	2.50	390.41	6.52	389.25	10.66	388.87	6.40	390.22	6.69	389.94	10.56	390.08	10.40	385.52	Flooded		Flooded		Flooded		1.20	390.58	0.76	390.31
27-Jun-19	2.59	390.32	6.60	389.17	10.75	388.77	6.50	390.13	6.61	390.02	10.65	389.98	10.18	385.74	0.80	390.19	0.93	390.36	0.96	390.34	1.46	390.32	0.69	390.25
29-Jul-19	2.82	390.09	6.82	388.96	10.95	388.57	6.92	389.70	6.98	389.64	10.88	389.76	10.38	385.54	0.56	389.96	0.70	390.14	0.72	390.10	-	-	0.50	390.05
22-Aug-19	3.02	389.89	7.02	388.75	11.16	388.36	-	-	-	-	11.09	389.55	10.57	385.35	0.41	389.80	0.51	389.94	0.52	389.90	-	-	0.32	389.87
28-Oct-19	3.61	389.29	7.60	388.18	11.75	387.77	7.59	389.03	7.37	389.25	11.66	388.98	10.85	385.07	Dry		Dry		Dry		1.34	390.45	Dry	
28-Nov-19	3.85	389.05	7.84	387.93	12.02	387.50	7.79	388.83	7.61	389.01	11.87	388.77	10.80	385.12	Dry		Dry		Dry		1.40	390.38	Dry	
13-Dec-19	3.92	388.98	7.94	387.84	12.15	387.37	7.87	388.76	7.73	388.90	11.93	388.71	11.00	384.92	Dry		Dry		Dry		1.12	390.66	Dry	
24-Feb-20	3.41	389.50	7.62	388.16	11.91	387.62	7.38	389.24	7.65	388.97	11.43	389.21	10.77	385.15	Dry		Dry		Dry		1.27	390.51	Dry	
24-Mar-20	3.06	389.84	-	-	11.61	387.91	7.04	389.59	7.48	389.14	11.11	389.53	10.86	385.05	0.34	389.74	0.45	389.85	0.46	389.97	1.13	390.66	0.13	389.69
30-Apr-20	2.91	390.00	-	-	-	-	-	-	-	-	10.95	389.69	10.57	385.35	Dry		Dry		Dry		-	-	Dry	
19-May-20	2.92	389.98	-	-	-	-	-	-	-	-	10.98	389.66	10.63	385.29	Dry		Dry		Dry		-	-	Dry	
29-Jun-20	-	-	-	-	11.32	388.21	-	-	-	-	11.14	389.50	-	-	Dry		Dry		Dry		-	-	Dry	
31-Jul-20	3.34	389.56	-	-	-	-	-	-	-	-	11.37	389.27	-	-	Dry		Dry		Dry		-	-	Dry	
24-Aug-20	-	-	-	-	11.75	387.77	-	-	-	-	11.54	389.10	-	-	Dry		Dry		Dry		-	-	Dry	
24-Sep-20	-	-	-	-	12.00	387.52	-	-	-	-	11.80	388.84	-	-	Dry		Dry		Dry		-	-	Dry	
28-Oct-20	4.07	388.84	-	-	12.00	387.52	-	-	-	-	12.07	388.57	-	-	Dry		Dry		Dry		-	-	Dry	
11-Nov-20	-	-	-	-	12.53	386.99	8.25	388.37	8.05	388.57	12.30	388.34	-	-	Dry		Dry		Dry		-	-	Dry	
11-Dec-20	-	-	-	-	12.62	386.90	-	-	-	-	12.33	388.31	-	-	Dry		Dry		Dry		-	-	Dry	
08-Feb-21	-	-	-	-	13.04	386.48	-	-	-	-	12.68	387.96	-	-	-	-	-	-	-	-	-	-	-	-
22-Feb-21	-	-	-	-	13.09	386.43	-	-	-	-	12.74	387.90	-	-	-	-	-	-	-	-	-	-	-	-
23-Mar-21	-	-	-	-	13.10	386.42	-	-	-	-	12.59	388.05	-	-	-	-	-	-	-	-	-	-	-	-
20-Apr-21	-	-	-	-	13.17	386.36	-	-	-	-	12.35	388.29	-	-	-	-	-	-	-	-	-	-	-	-
21-May-21	-	-	-	-	13.21	386.32	-	-	-	-	12.14	388.50	-	-	-	-	-	-	-	-	-	-	-	-
15-Jun-21	-	-	-	-	13.24	386.28	-	-	-	-	12.11	388.53	-	-	-	-	-	-	-	-	-	-	-	-
07-Jul-21	-	-	-	-	13.28	386.25	-	-	-	-	12.11	388.53	-	-	-	-	-	-	-	-	-	-	-	-
20-Aug-21	-	-	-	-	13.34	386.19	-	-	-	-	12.38	388.26	-	-	-	-	-	-	-	-	-	-	-	-
16-Sep-21	-	-	-	-	13.41	386.12	-	-	-	-	12.52	388.12	-	-	-	-	-	-	-	-	-	-	-	-
15-Oct-21	-	-	-	-	13.49	386.04	-	-	-	-	12.61	388.03	-	-	-	-	-	-	-	-	-	-	-	-
26-Nov-21	-	-	-	-	13.36	386.16	-	-	-	-	12.59	388.05	-	-	-	-	-	-	-	-	-	-	-	-
09-Dec-21	-	-	-	-	13.39	386.13	-	-	-	-	12.54	388.10	-	-	-	-	-	-	-	-	-	-	-	-
26-Jan-22	-	-	-	-	13.17	386.35	-	-	-	-	12.15	388.49	-	-	-	-	-	-	-	-	-	-	-	-
01-Mar-22	-	-	-	-	12.99	386.53	-	-	-	-	11.73	388.91	-	-	-	-	-	-	-	-	-	-	-	-
22-Mar-22	-	-	-	-	12.57	386.95	-	-	-	-	11.31	389.33	-	-	-	-	-	-	-	-	-	-	-	-
29-Apr-22	-	-	-	-	12.10	387.42	-	-	-	-	11.08	389.56	-	-	-	-	-	-	-	-	-	-	-	-
26-May-22	-	-	-	-	11.92	387.60	-	-	-	-	11.07	389.57	-	-	-	-	-	-	-	-	-	-	-	-
10-Jun-22	-	-	-	-	11.86	387.66	-	-	-	-	11.11	389.53	-	-	-	-	-	-	-	-	-	-	-	-
28-Jul-22	-	-	-	-	11.93	387.59	-	-	-	-	11.41	389.23	-	-	-	-	-	-	-	-	-	-	-	-
25-Aug-22	-	-	-	-	12.06	387.46	-	-	-	-	11.60	389.04	-	-	-	-	-	-	-	-	-	-	-	-
21-Oct-22	-	-	-	-	12.40	387.13	-	-	-	-	12.07	388.57	-	-	-	-	-	-	-	-	-	-	-	-
25-Nov-22	-	-	-	-	12.58	386.95	-	-	-	-	12.38	388.26	-	-	-	-	-	-	-	-	-	-	-	-
31-Dec-22	-	-	-	-	12.82	386.70	-	-	-	-	12.52	388.12	-	-	-	-	-	-	-	-	-	-	-	-



LEGEND

- Piezometer
- Surface Water Monitors
- Groundwater Monitoring Wells
- MECP Well Record
- MECP Permit To Take Water
- Cross-Section
- Watercourse
- Waterbody
- Wetland
- Unevaluated Wetland
- Additional Lands Owned by Lafarge
- Limit of Extraction
- Proposed Licence Boundary



0 200 400

1:7,500 METRES

REFERENCE(S)
1. IMAGERY: PROVIDED BY MHBC 2019
2. BASE DATA: LIO MNRF 2019
3. PROJECTION: TRANSVERSE MERCATOR NAD 1983 UTM ZONE 17N

CLIENT
LAFARGE CANADA INC.

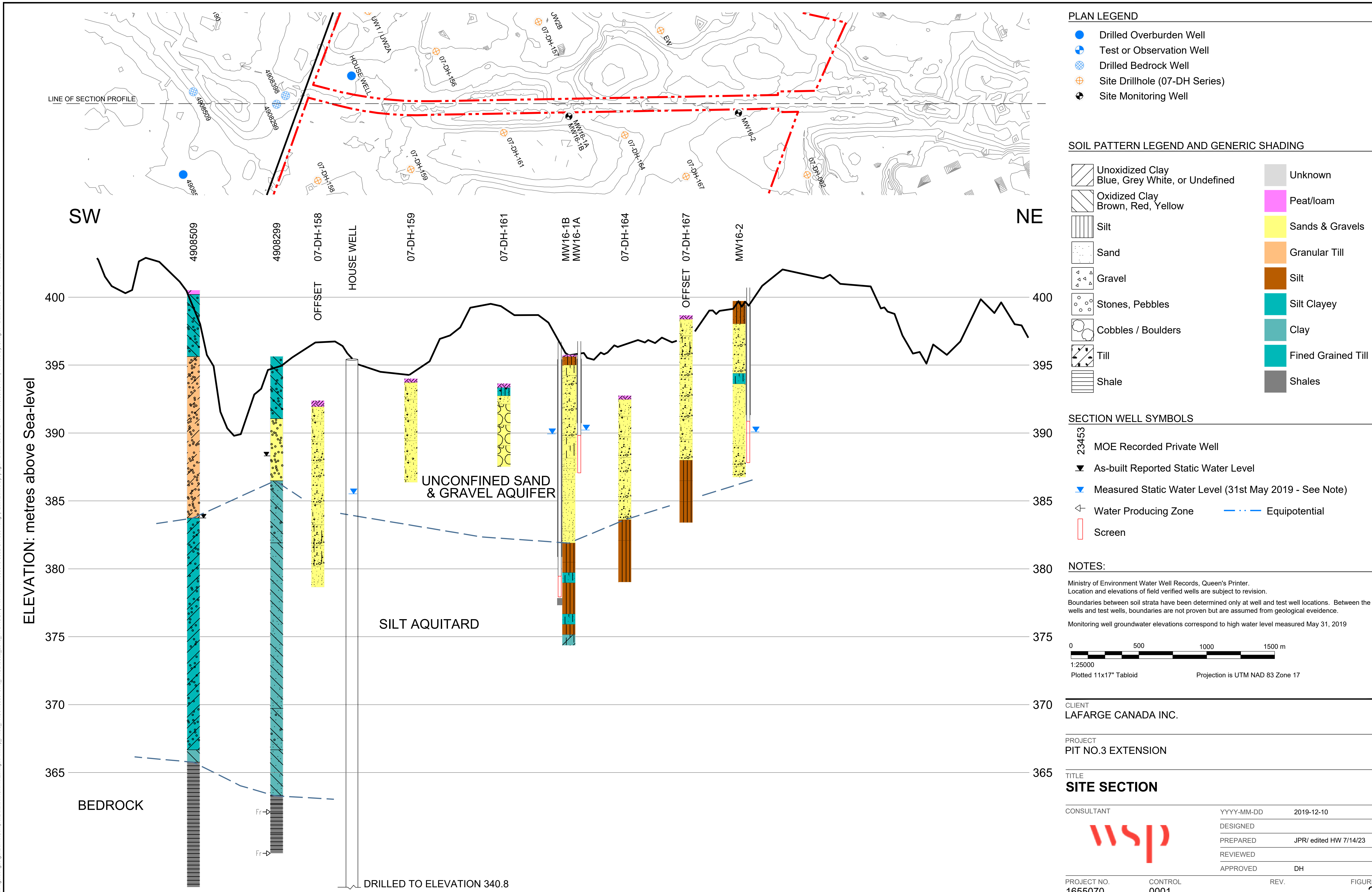
PROJECT
PIT NO.3 EXTENSION

TITLE
SITE PLAN

CONSULTANT

YYYY-MM-DD	2020-02-11
DESIGNED	SO
PREPARED	SO
REVIEWED	DH
APPROVED	DH

PROJECT NO.	CONTROL	REV.	FIGURE
21453896	0001	-	1


PLAN LEGEND
Drilled Overburden Well
Test or Observation Well
Drilled Bedrock Well
Site Drillhole (07-DH Series)
Site Monitoring Well
LINE OF SECTION PROFILE
HOUSE WELL
SOIL PATTERN LEGEND AND GENERIC SHADING
Unoxidized Clay Blue, Grey White, or Undefined
Oxidized Clay Brown, Red, Yellow
Silt
Sand
Gravel
Stones, Pebbles
Cobbles / Boulders
Till
Shale
Unknown
Peat/loam
Sands & Gravels
Granular Till
Silt
Silt Clayey
Clay
Fined Grained Till
Shales
SECTION WELL SYMBOLS
23453 MOE Recorded Private Well
As-built Reported Static Water Level
Measured Static Water Level (31st May 2019 - See Note)
Water Producing Zone
Equipotential
Screen
SW
NE
4908509
4908299
07-DH-158
OFFSET
HOUSE WELL
07-DH-159
07-DH-161
MW16-1B
MW16-1A
07-DH-164
OFFSET
07-DH-167
MW16-2
ELEVATION: metres above Sea-level
400
395
390
385
380
375
370
365
UNCONFINED SAND & GRAVEL AQUIFER
SILT AQUITARD
BEDROCK
DRILLED TO ELEVATION 340.8
Fr
0
500
1000
1500 m
1:25000
Plotted 11x17" Tabloid
Projection is UTM NAD 83 Zone 17

NOTES:

Ministry of Environment Water Well Records, Queen's Printer.
Location and elevations of field verified wells are subject to revision.

Boundaries between soil strata have been determined only at well and test well locations. Between the wells and test wells, boundaries are not proven but are assumed from geological eveidence.

Monitoring well groundwater elevations correspond to high water level measured May 31, 2019

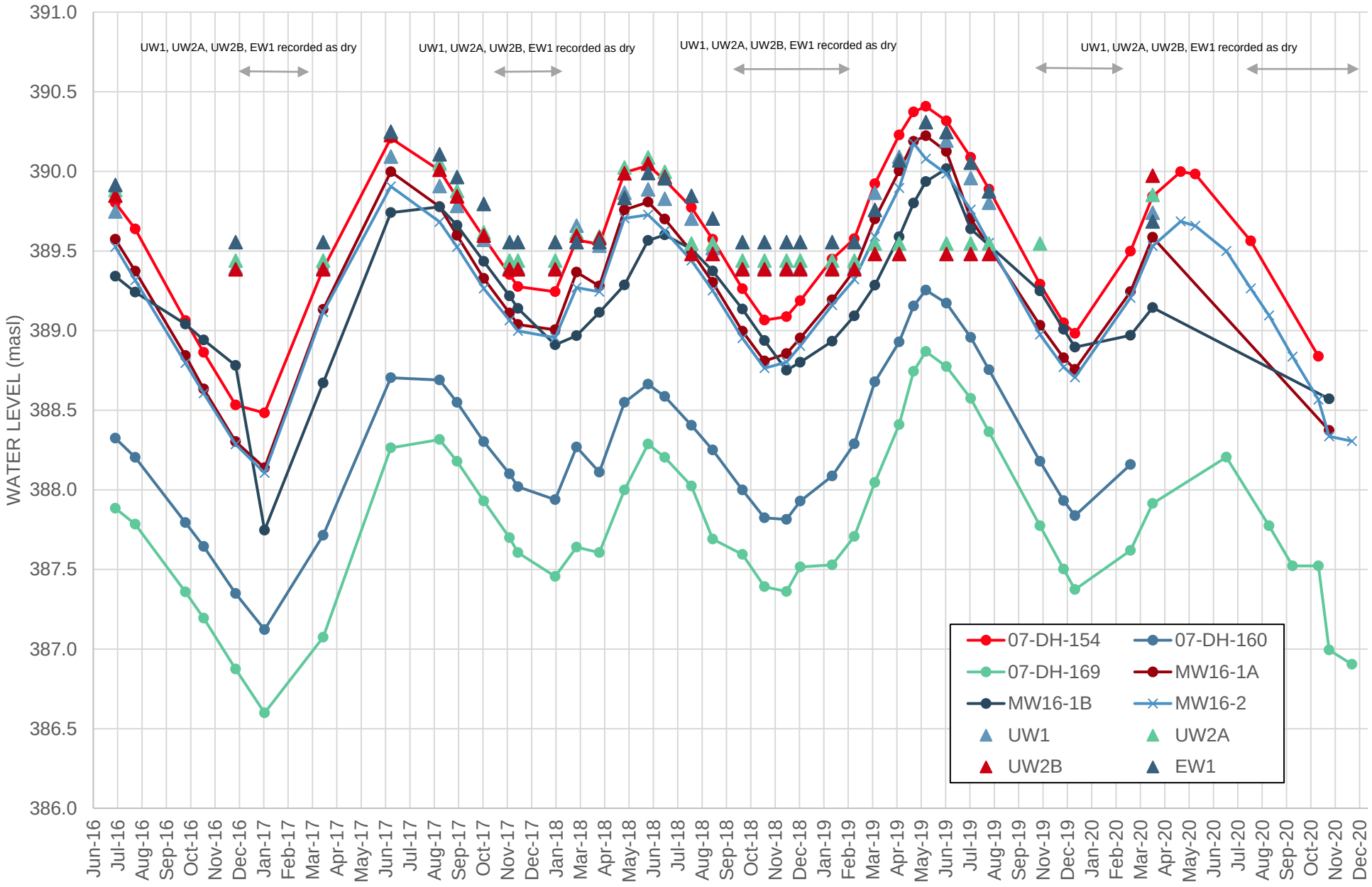
CLIENT
LAFARGE CANADA INC.

PROJECT
PIT NO.3 EXTENSION

TITLE
SITE SECTION

CONSULTANT		
wsp	YYYY-MM-DD	2019-12-10
	DESIGNED	
	PREPARED	JPR/ edited HW 7/14/23
	REVIEWED	
	APPROVED	DH

PROJECT NO.	CONTROL	REV.	FIGURE
1655070	0001	----	2



NOTES

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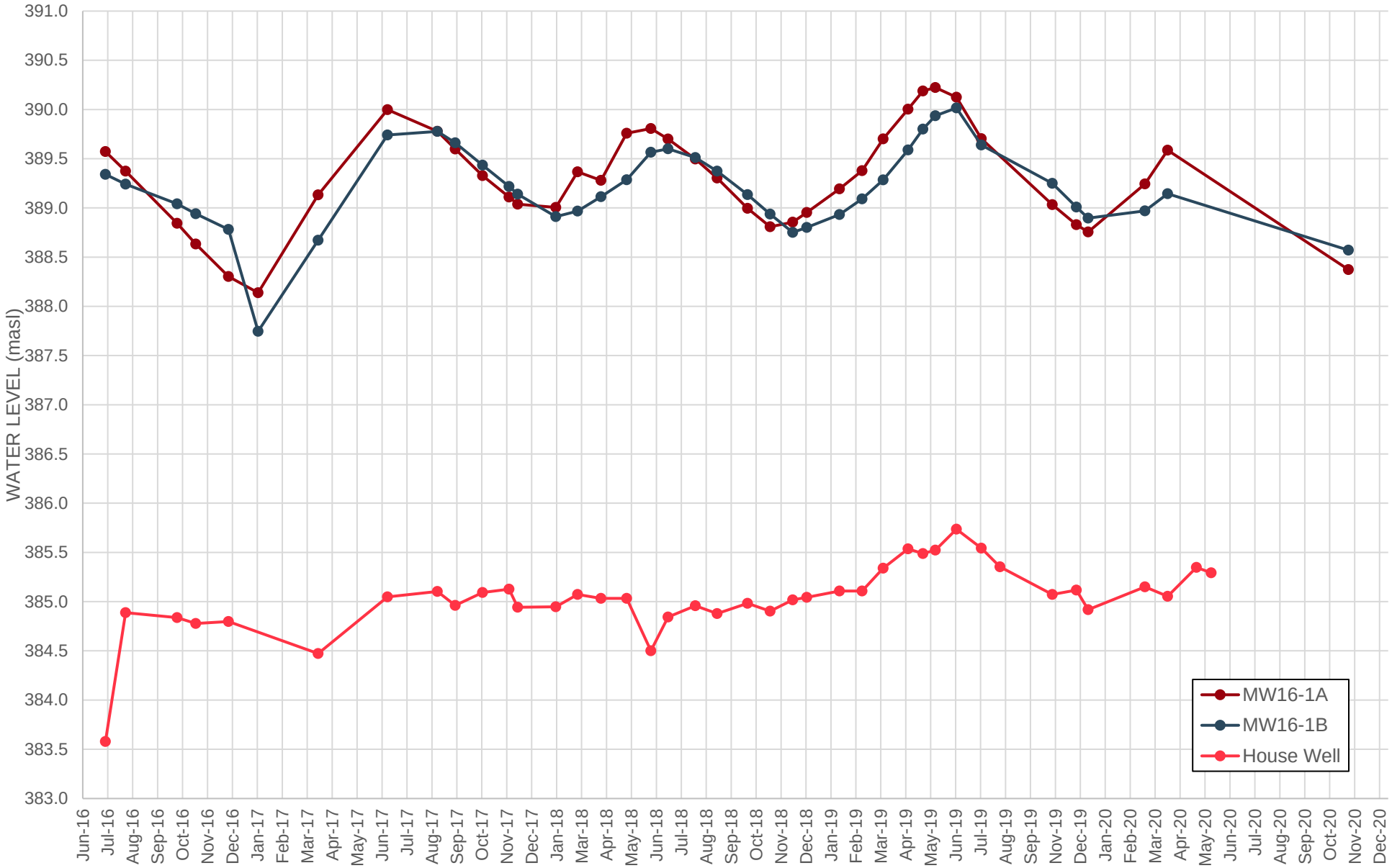
LAFARGE CANADA INC: PIT NO.3 EXTENSION

UNCONFINED AQUIFER HYDROGRAPHS

JULY 2023	PROJECT: 1655070	FIGURE: 3A

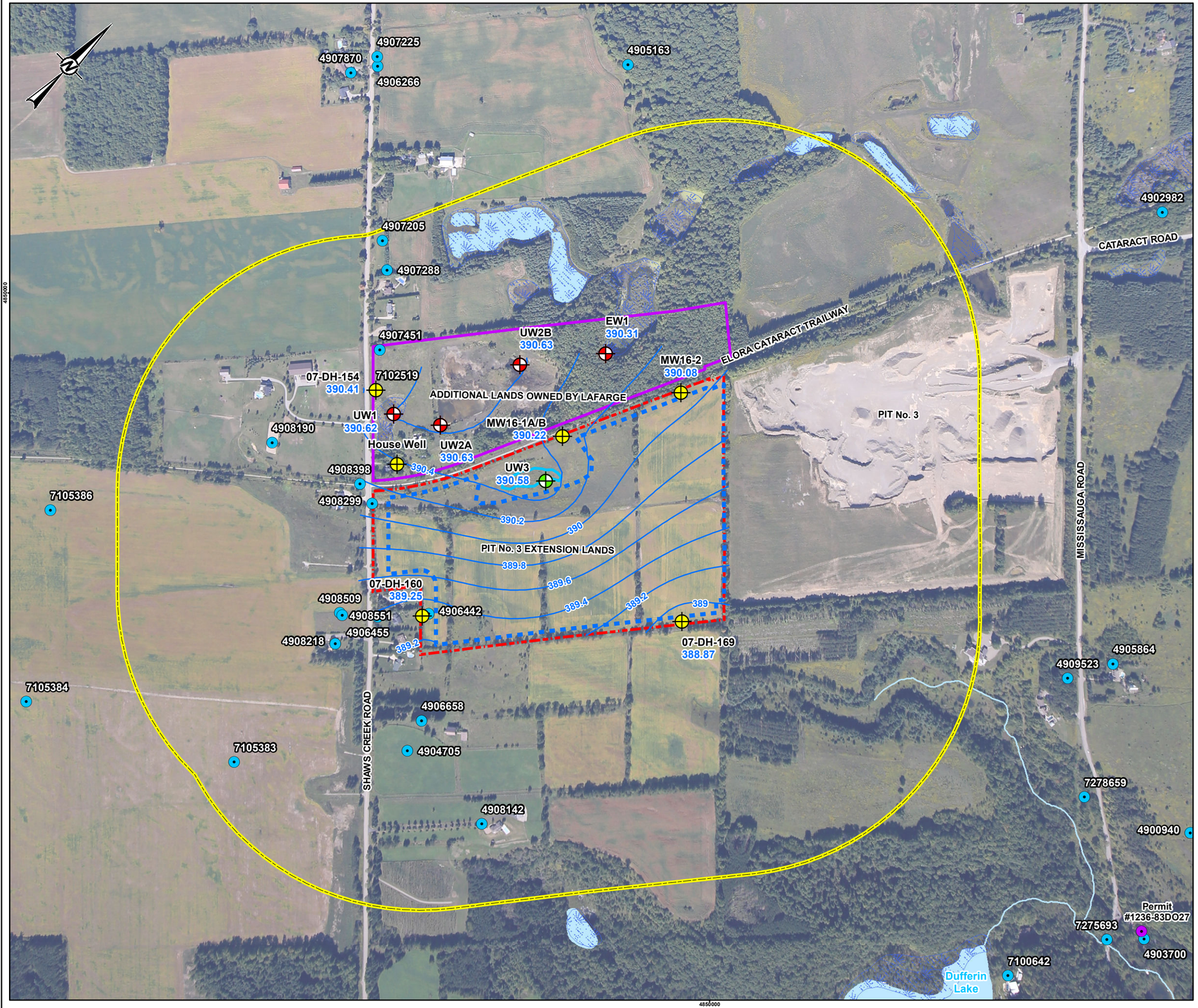


NOTES

LAFARGE CANADA INC: PIT NO.3 EXTENSION

VERTICAL GRADIENTS

July 2023	PROJECT: 1655070	FIGURE: 3B



LEGEND

- Piezometer
- Surface Water Monitors
- Groundwater Monitoring Wells
- MECP Well Record
- MECP Permit To Take Water
- Water Table Contours in masl
- Watercourse
- Waterbody
- Wetland
- Unevaluated Wetland
- Additional Lands Owned by Lafarge
- Limit of Extraction
- Proposed Licence Boundary
- 500 m Buffer

0 200 400

1:7,500 METRES

NOTE(S)

1. INFERRED HIGH WATER TABLE BASED ON WATER LEVELS MEASURED ON MAY 31, 2019.
2. UW1 AND UW2A/B MONITORS FLOODED SLIGHTLY ABOVE STAFF GAUGE DURING HIGH WATER TABLE EVENT AND THUS COULD NOT BE PRECISELY MEASURED. FOR CONTOURING PURPOSES THE WATER LEVEL AT THESE LOCATIONS IS ASSUMED TO COINCIDE WITH THE TOP OF THE STAFF GAUGE ELEVATION.

REFERENCE(S)

1. IMAGERY: PROVIDED BY MHBC 2019
2. BASE DATA: LIO MNRF 2019
3. PROJECTION: TRANSVERSE MERCATOR NAD 1983 UTM ZONE 17N

CLIENT
LAFARGE CANADA INC.

PROJECT
PIT NO.3 EXTENSION

TITLE
ESTABLISHED WATER TABLE

CONSULTANT

wsp

YYYY-MM-DD	2019-12-17
DESIGNED	SO
PREPARED	SO
REVIEWED	DH
APPROVED	DH

PROJECT NO.	CONTROL	REV.	FIGURE
21453896	0001	-	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm

0

PATH: S:\Clients\Lafarge\Pinkney_Pit\99_PRO\21453896-40_PRO\0001_Hydrogeology\21453896-0001-CH-0006.mxd PRINTED ON: 2024-02-29 AT: 11:54:14 PM

Curriculum Vitae

DR. SEAN MCFARLAND

Senior Hydrogeologist, Senior Principal/Fellow, Geotech & Water

Areas of practice

Hydrogeology and Geology

Languages

English

PROFILE

As a Senior Hydrogeologist and Geologist, Dr. McFarland has more than 35 years of professional experience and a broad background in conducting, managing and directing hydrogeological and geological work programs for nuclear, aggregate, waste management, mining, power, oil and gas, and ground water management and protection, municipal, and land development projects. He has served as expert witness hydrogeologist for an Ontario Municipal Board (OMB) and Environmental Assessment (EA) hearings.

Sean's experience in nuclear facilities including his current role leading the hydrogeological work program for the ongoing new build at the Bruce nuclear site. He conducted a hydrogeological and geological component of the hydrogeological work programs for Low Level Radioactive Waste Management (LLRWM facility concepts) for the federal government. This involved as a senior hydrogeologist and project manager for in Port Hope for a hydrogeological assessment in support of potential siting of a deep cavern for disposal of low-level radioactive waste in limestone bedrock beneath or adjacent to Lake Ontario, involving the drilling, geophysical logging, and packer testing of a deep geological borehole. Sean was the senior hydrogeologist and project manager for a hydrogeological assessment for the federal government at the Chalk River nuclear laboratory for the potential siting of a deep cavern disposal facility for disposal of low-level radioactive waste which involved geological mapping, identification of fault zones and fracturing and the drilling, geophysical logging, hydrogeophysical logging and packer testing of a deep angled borehole drilled through a fault zone. He also conducted a geological terrain analysis for siting of nuclear waste in northern Ontario. He also acted as an executive client sponsor for the Bruce Nuclear and OPG nuclear sites.

Sean acted as the senior hydrogeologist and project manager for numerous proposed aggregate, landfill and where he conducted hydrogeological investigations extended periods, engaged in public consultation and provided expert witness testimony at an OMB and EA hearings. He has been involved in extensive contaminated site investigations including legal disputes. He was the senior hydrogeologist and project manager for the extensive Adams Mine landfill project, which involved the successful permitting of a 20 million tonne hydraulic containment engineered landfill facility, within a 200 m deep former open pit iron mine in low permeability bedrock, following hydrogeological investigations collected over a 10-year period. He served as an expert witness at the Environmental Assessment (EA) and OMB hearings for successful approval of the landfill facility.

He also was the senior hydrogeologist and project manager for large scale provincially funded municipal groundwater studies including for the City of Kawartha Lakes and the City of Stratford as well as extensive work in contaminated site assessments.

EDUCATION

PhD, Osgoode Hall Law School, York University	2013
LLM, Osgoode Hall Law School, York University	2005
MBA, Athabasca University	2001
M.Sc. Earth Sciences, Brock University	1997
H.B.Sc. Geological Sciences (Honours), University of Toronto	1985

DR. SEAN MCFARLAND

Senior Hydrogeologist, Senior Principal/Fellow, Geotech & Water

AWARDS

Master's Thesis Award, Ontario Petroleum Institute (OPI)	1997

PROFESSIONAL ASSOCIATIONS

Professional Geoscientist, Ontario,	P.Geo.
Project Management Professional	PMP

CAREER

Senior Hydrogeologist and Senior Principal/Fellow, WSP	2022 – Present
Senior Hydrogeologist and Principal, Golder Associated Ltd., Ontario (WSP Acquisition)	1987 – 2022
Hydrogeologist then Senior Hydrogeologist, Golder Associated Ltd., Ontario (WSP Acquisition)	1987 – Present
Managing Principal, Vice President, Canada	2005 – 2014
Geologist and Hydrogeologist Regina Associates Ltd., Kingston, Ontario	1983 – 1987

PROFESSIONAL EXPERIENCE

Nuclear

- Bruce Power New Build, Kincardine, Ontario (2022/23): Hydrogeologist. Sean is currently the senior hydrogeologist and geologist and lead for the ongoing hydrogeological assessment of the new build at Bruce Nuclear. This includes a hydrogeological assessment based on existing information and a field investigation based on a gap analysis of existing data that includes borehole drilling, monitoring well installations, hydraulic conductivity sampling, groundwater sampling and data analysis and reporting. He is also responsible for leading a hazard assessment that includes a senior impact assessment including retaining outside experts in the field. Client: Bruce Nuclear
- Hydrogeological Investigation for LLRWM, Port Hope, Ontario: Hydrogeologist and project manager for a hydrogeological assessment at Port Hope for the low level radioactive (LLRWM) facility concepts as part of regulatory approvals for the Canadian federal government for the Siting Task Force Secretariat (STFS). This involved the potential siting of a deep cavern for disposal of low-level radioactive waste in limestone bedrock beneath or adjacent to Lake Ontario, involving the drilling, geophysical logging, and packer testing of a deep geological borehole to assess the subsurface hydrogeological conditions at the site. Client: Federal Government - STFS (LLRWM).
- Hydrogeological Investigation for LLRWM, Chalk River Ontario: Senior hydrogeologist and project manager for a hydrogeological assessment for the federal government, for the Siting Task Force Secretariat (STFS), at the Chalk River nuclear laboratory for the potential siting of a deep cavern disposal facility for disposal of low-level radioactive waste which involved geological mapping, identification of fault zones and fracturing and the drilling, geophysical logging, hydrogeophysical borehole logging and packer testing of a deep angled borehole drilled through a fault zone. Conducted groundwater quality using a flow through cell. The result of the

work program were used to assess the suitability of the site for disposal of low level radioactive waste. Client: Federal Government -STFS (LLRWM).

- Nuclear Waste Site Selection Northern Ontario: Geologist. Geologist for assessment of geological and terrain analysis of areas in northern Ontario as part of a project to identify potential suitable candidate sites for siting of a low level radioactive waste disposal facility. Client: Federal Government.

Aggregate Industry

- Aggregate Resource Evaluation, Regional Municipality of Peel, Ontario: Project Manager and geologist for evaluation of sand and gravel and bedrock resources in the Regional Municipality of Peel, Ontario for the provincial Ministry of Municipal Affairs and Housing (MMAH). The project was carried out as part of the development of the official plan for the Region. Client: Regional Municipality of Peel.
- Aggregate Resource Inventory Paper, Regional Municipality of Peel, Ontario: Technical advisor for ARIP (Aggregate Resource Inventory Paper) report for the Regional Municipality of Peel. The project involves and evaluation of shale and gravel, limestone and shale resources in the Region and was submitted to the Ontario Geological Survey for publication as a government document ARIP Paper. Client: Regional Municipality of Peel.
- Navan Quarry, Navan, Ontario: Project Manager and geologist for evaluation of sand and gravel and bedrock resources in the Regional Municipality of Peel, Ontario for the provincial Ministry of Municipal Affairs and Housing (MMAH). The project was carried out as part of the development of the official plan for the Region.
- Brockville Quarry, Brockville, Ontario: Project Manager and hydrogeologist for hydrogeological evaluation of the Permanent Lafarge Brockville Quarry. The results of the evaluation were used to negotiate the liability of the quarry to alleged water well interference associated with quarry expansion with the Ontario Ministry of the Environment.
- Dufferin Aggregates, Ontario: Project Director and senior hydrogeologist for numerous aggregate projects at quarries and sand and gravel pits within Ontario including resource evaluations, hydrogeological investigations and environmental assessments.
- Due Diligence Studies, Southern Ontario: Project Manager and senior hydrogeologist for due diligence studies as part of the potential purchase of aggregate companies and operating pits and quarries in Ontario.
- Site Selection Studies, Southern Ontario: Project Director for site selection studies for development of quarries and sand and gravel operations in Ontario.
- North Quarry, Flamborough, Ontario: Role on Project Director for hydrogeological program at the Lafarge (formerly Redland) Quarry Operations in Flamborough, Ontario, to meet the regulatory requirements of the Ontario Ministry of the Environment. Client: Lafarge Canada Inc.
- Proposed Halminen Quarry, Buckhorn, Ontario: Project Manager for a private application for a license for a proposed limestone quarry near Buckhorn, Ontario. The project involved management of multi-disciplinary project team public meetings, and application for a Class A licence under the Aggregate Resources Act.
- Bowmanville, Ontario: Project Director for the development of a limestone/dolostone mine under Lake Ontario. The work programs involve drilling

and testing of a 275m deep borehole under the lake, development of an underground mine plan, preparation of an EA document for regulatory approvals and public participation programs. Client: Votorantim Cimentos.

- Milton Limestone Quarry Peer Review, Milton, Ontario: Project Director for the peer review of the hydrogeological and adaptive management plan report for the proposed Dufferin Aggregates Milton Quarry expansion. The work program involved meetings with the hydrogeological consultant and legal counsel and attendance at Ontario Municipal Board hearings.
- SAROS Study, Greater Golder Horseshoe, Ontario: Evaluation of supply and demand of aggregate resources in the Greater Golden Horseshoe for the MMNR (Ministry of Natural Resources and Forestry). The project includes resource estimates for 25 quarries and 120 pits and unlicensed sand and gravel resources in the study area.. Ministry of Natural Resources and Forestry.
- Nelson Quarry Expansion, Burlington, Ontario (year): Project Director for the proposed Nelson Quarry extension including extensive borehole drilling and monitoring well installations, water quality sampling, a surface water program, groundwater flow modeling, impact assessments, preparation of an Adaptive Management Plan (AMP), reporting and acting as an expert witness at an Ontario Municipal Board hearing.
- Lafarge South Quarry Expansion, Dundas, Ontario: Project Director for a hydrogeological and hydrological work programs in support of a license application for the expansion of the Lafarge South Quarry near Dundas, Ontario (ongoing). The work program involves borehole drilling and monitoring well installations, geophysical borehole logging, water quality sampling and analyses, hydrological analyses of streams and wetlands, a karst assessment, a water well survey, geological and hydrogeological interpretation, groundwater flow modeling, agency interaction and attendance at public meetings. Client: Lafarge Canada Inc.
- Lafarge Fonthill Pit PTTW Renewal, Fonthill, Ontario: Project Director for a hydrogeological work program in support of a Permit to Take Water (PTTW) application for the Lafarge, The work program included interpretation of pumping wells records, evaluation of drawdown in water wells related to pumping, water quality analyses and preparation and submission of a report in support of the permit application. Client: Lafarge Canada Inc.
- Lafarge North Quarry Expansion, Dundas, Ontario: Project Director for a hydrogeological work program conducted in support of a license application for the expansion of the Lafarge North Quarry. The work program involved borehole drilling and monitoring well installations, pumping tests, groundwater flow modelling, a water well survey, an impact assessment of potential effects on water wells and an adjacent provincially significant wetland, agency interaction and preparation of a report submitted in support of the license application. The application was approved with an Ontario Municipal Board hearing. Client: Lafarge Canada Inc.
- Lafarge PTTW Monitoring Programs, Ontario: Project Director for hydrogeological monitoring programs for a portfolio of more than 50 pits and quarries in Ontario. The programs involved water level and water quality monitoring, evaluation of pumping records, effects assessments and preparation and submission of monitoring reports for compliance with the permits. Client: Lafarge Canada Inc.
- RW Tomlinson Quarry License Application, Brechin, Ontario: Project Co-director for the hydrogeological work program for a hydrogeological work program

performed in support of a license application for a dolostone quarry in the Carden Plain. The work program involved borehole drilling and monitoring well installation, geophysical borehole logging, packer testing, well response testing, pump testing, water quality sampling, groundwater flow monitoring, an impact assessment including potential effects on surrounding water wells and an adjacent wetland, development of a monitoring program preparation of a report in support of the application and agency interaction. Client: R. W Tomlinson Limited.

- Proposed Lafarge Glen Morris Pit, Ontario: Project Director and senior hydrogeologist for the hydrogeological work program in support of a license application for the proposed Glen Morris Pit. The work program included borehole drilling, monitoring well installations, groundwater level monitoring and the provision of data and preparation of a hydrogeological report. Client: Lafarge Canada Inc.
- Lafarge Wellington Quarry PTTW and ECA Renewal, Ontario: Project Director and senior hydrogeologist for the Lafarge Wellington Quarry Renewal. The field program involved borehole drilling, packer testing, monitoring well installations, groundwater level monitoring, a field pumping test, development of a water budget and groundwater quality sampling. A hydrogeological impact assessment was developed to assess the potential impacts of quarry groundwater level drawdown related to quarry dewatering activities on surrounding private water wells and municipal wells. The work program included the modification of the regional source water protection to incorporate site data to assess the potential affects on the Guelph municipal wells. Client: Lafarge Canada Inc.
- Lafarge Regan Resource Drilling, Ontario: Role on Project. Project Manager and senior geoscientist for resource drilling at the Lafarge Regan site using some drilling techniques. The results of the work program were provided to Lafarge for their resource assessment. Client: Lafarge Canada Inc.
- Lafarge Hagersville Quarry, Hagersville, Ontario: Senior Hydrogeologist for the assessment of quarry dewatering and pumping for the Lafarge Hagersville Quarry as part of the PTTW monitoring program. Client: Lafarge Canada Inc.
- Arbour Farms License Application, Ontario: Senior Hydrogeologist for the Arbour Farms license application for a pit below water. The work program included borehole drilling, installation of monitoring wells, groundwater level monitoring and assessment of potential affects on an adjacent water course. Three-dimensional groundwater flow and heat transport modeling was completed to assess the potential thermal impacts on the surrounding surface water courses. Client: Arbour Farms.
- Port Colborne Quarry Extension, Port Colborne, Ontario: Project Director for a multi-disciplinary work program for a license application for an extension of the Port Colborne Quarry. The work program involved hydrogeological, hydrological, blasting, noise, air, natural environment, planning, agricultural and archaeological studies and a resource estimate. Senior Hydrogeologist for the hydrogeological work program that involved borehole drilling, monitoring well installations, groundwater quality sampling and analysis, an impact assessment and a monitoring and response program for potential impacts on surrounding water wells. Client: Rankin Construction Inc.
- Lafarge Goodwood Pit Extension, Goodwood, Ontario: Project Director and senior hydrogeologist for a license application for the Lafarge Goodwood Pit extension, for a Category 1 Class EA pit below water. The objective of the work program was to characterize the existing hydrogeological and hydrological conditions in the vicinity

of the site, including the depth and elevation of the water table and assess potential affects of the operational and rehabilitation scenarios. The work program involved borehole drilling, monitoring well installations, groundwater level monitoring, development of a water budget and a hydrogeological impact assessment. Client: Lafarge Canada Inc.

- Lafarge Woodstock Quarry Expansion, Woodstock, Ontario: Project Director and senior hydrogeologist for the hydrogeological investigation of the Woodstock quarry for support of a license amendment. The field program involved borehole drilling, packer testing, monitoring well installations, groundwater quality sampling and analysis, a field water well survey and development of a water budget. An impact assessment was conducted to assess the potential affect of quarry related groundwater level drawdown on surrounding water wells and surface water courses. Client: Lafarge Canada Inc.
- CRH Resource Evaluation and Due Diligence, Ontario: Project Manager and senior geoscientist for a resource evaluation of a property near Orangeville, Ontario for potential acquisition for quarry development. The work program included borehole drilling, geological logging of the rock core, monitoring well installations to determine the depth of the water table, aggregate quality testing and reporting.
- Limestone and Sandstone Resource Evaluation and Due Diligence, Ontario: Project Director and senior hydrogeologist for a resource evaluation for a property developer for potential acquisition of an existing quarry near Mississauga. The work program involved borehole drilling, core logging, aggregate quality testing and reporting. Client: Regional Municipality of Peel.
- Stouffville Resource Drilling, Stouffville, Ontario: Project Manager and senior hydrogeologist for the resource drilling at Lafarge Stouffville Quarry. The drilling was conducted using a sonic drill rig with continuous core sampling. The results were provided to the Lafarge geologist for the resource assessment. Client: Lafarge Canada Inc.
- Lakeridge Resource Drilling, Ontario: Project Manager and senior geoscientist for the resource drilling at the Lafarge Lakeridge site. The drilling was conducted using sonic coring and the results provided to the Lafarge geologist for development of a resource assessment. Client: Lafarge Canada Inc.
- Votorantim Thomas Quarry License Application, Ontario: Senior hydrogeologist for the hydrogeological component of the Votorantim Thomas Quarry Extension license application. The work program involved borehole drilling, packer testing, geophysical borehole logging monitoring well installations and groundwater quality sampling and analysis. Three-dimensional groundwater flow monitoring was conducted to assessment the potential hydrogeological impacts of the quarry. Client: Votorantim Cimentos.
- Lafarge Pinkney Pit #3, Ontario: Senior Hydrogeologist for the hydrogeological work program for the Lafarge Pinkney Pit #3 license application. The work program involved borehole drilling, monitoring well installations and a hydrogeological impact assessment. Client: Lafarge Canada Inc.
- Lafarge Mosport Resource Drilling, Ontario: Project Manager and senior geoscientist for the sonic borehole drilling at the Lafarge Mosport Pit. The results of the resource drilling were provided to the Lafarge geologist as part of the site resource assessment. Client: Lafarge Canada Inc.

- Lafarge Goodwood Resource Drilling, Ontario: Project Manager and senior geoscientist for sonic borehole drilling of the resource near the Lafarge Goodwood Pit. The results of the drilling were provided to the Lafarge geologist for a resource assessment. Client: Lafarge Canada Inc.
- APAO - Water Consumption Study, Ontario: Project Director for a study for the APAO to determine the consumption of water associated with pits and quarries. Client: Aggregate Producers Association of Ontario.
- Lafarge Sunningdale Pit Monitoring Program, Ontario: Senior Hydrogeologist for the Lafarge Sunningdale Pit Monitoring Program. The work program includes hydrogeological monitoring, an assessment of potential impacts and preparation of an annual monitoring report. Client: Lafarge Canada Inc.
- Votorantim Resource Assessment, Ontario: Project Manager and senior geoscientist for a resource assessment at a Votorantim Quarry in central Ontario. The work program involved borehole drilling and borehole geophysics were used to identify and correlate the geological formations and members at the site. Client: Votorantim Cimentos.
- Cox Construction Monitoring Well Network, Wellington County, Ontario: Role on Project. Project Manager and senior hydrogeologist for borehole drilling and monitoring well installations at a property in Wellington County to provide baseline date for potential future licensing as a quarry. The wells were installed in the thick sequence of Amabel Formation at this locates. Groundwater level monitoring was performed to determine the depth to water table. Client: Wellington County.
- Cox Construction Resource Evaluation and Due Diligence, Ontario: Project Director for a drilling program to evaluate to the limestone resource for potential acquisition of a property for development. The work program involved borehole drilling, geological logging of the rock core, monitoring well installations, aggregate quality testing and reporting.

Waste Management

- Adams Mine, Kirkland Lake, Ontario: Project Hydrogeologist and Project Manager for the hydrogeological assessment of the Adams Mine near Kirkland Lake, Ontario over a five-year period as part of the proposed development of 20 million tonne engineered landfill facility for solid non-hazardous waste. The facility will receive waste from the Greater Toronto Area (GTA) via a rail line system. The landfill facility incorporates a hydraulic containment design, which prevents outward migration of contaminants from the landfill, which reduces environmental impacts and long-term operating costs. Provided expert witness testimony in an environmental assessment (EA) hearing. Client: Adams Mine.
- Brow Landfill, Dundas, Ontario: Project Hydrogeologist then Project Manager for hydrogeological assessment for landfill expansion of the existing Redland Quarries Inc. (formerly Steetley Quarry Products Ltd.) solid industrial waste Brow Landfill in Flamborough, Ontario. Subsequent work included ongoing groundwater and surface water quality monitoring and preparation monitoring reports submitted to the MOE, followed by development of a closure plan and an ongoing compliance monitoring program.
- South Quarry Landfill, Flamborough, Ontario: Project Hydrogeologist for hydrogeological assessment of the proposed Redland Quarries Inc. (formerly Steetley Quarry Products Ltd.) South Quarry in Flamborough, Ontario for the proposed development of an engineered landfill facility. Participated in

environmental assessment (EA) hearings and assisted with the preparation of final arguments with legal counsel. Client: Redland Quarries Inc.

- Siting Task Force Secretariat, Chalk River, Ontario: Project Hydrogeologist, then Project Manager for geological and hydrogeological characterizations of the Chalk River Nuclear laboratories property, near Chalk River, Ontario for siting of a proposed facility for the disposal of low-level nuclear waste for the federal Siting Task Force Secretariat (STFS).
- Siting Task Force Secretariat, Port Hope, Ontario: Project Hydrogeologist then Project Manager for geological and hydrogeological characterization of the Lakeshore site in Port Hope, Ontario, for the federal Siting Task Force Secretariat (STFS). The work was carried out as part of the feasibility level I study for dispose of low-level waste in engineered caverns beneath Lake Ontario and the Cameco Uranium fuel processing facility in Port Hope.
- Interim Waste Authority, Regional Municipality of Peel, Ontario: Project Hydrogeologist for geological and hydrogeological characterization comparative evaluation of five short-listed sites for siting of an engineered landfill facility as part of the provincial Interim Waste Authority (IWA) landfill site selection process for the Region of Peel. Client: Regional Municipality of Peel.
- Guelph-Wellington County WMMP, Wellington County, Ontario: Project Hydrogeologist for geological and hydrogeological characterization of five candidate sites and identification of a preferred site in Wellington County for siting of an engineered municipal landfill facility, as part of the joint City of Guelph - County of Wellington Waste Management Master Plan (WMMP).
- Model City Landfill, Lewiston, NY: Project Hydrogeologist for hydrogeological investigation of the Model City hazardous waste landfill, near Lewiston, New York, carried out as part of landfill expansion.
- Welland-Wainfleet WWMP, Townships of Welland and Wainfleet, Ontario: Project Hydrogeologist for the identification of preferred sites for development of a municipal landfill facility, as part of the Welland-Wainfleet Waste Management Master Plan (WMMP).
- Brock South Landfill, Pickering, Ontario: Role on Project. Project Hydrogeologist for assessment of the proposed Brock South Landfill near Pickering, Ontario, to assess the suitability of the site for development of an engineered municipal landfill facility for Metropolitan Toronto.
- Redland Queenston Quarry, Queenston, Ontario: Project Hydrogeologist for hydrogeological assessment of the Redland Quarries Inc., Queenston Quarry to determine the suitability of the site for disposal of waste rock saline shale, from the construction of the proposed diversion tunnels of the Sir Adam Beck III hydroelectric generating facility in Niagara Falls, Ontario.
- Fly Ash Disposal Facility, , Ontario: Project Hydrogeologist for hydrogeological investigations at four quarries located near Hagersville, Cayuga, Smithville and Milton to determine their suitability for development an engineered landfill for disposal of fly ash from the Ontario Hydro Lakeview Power Generating Station
- Mohawk Street Landfill, Brantford, Ontario: Project Hydrogeologist for assessment of groundwater and surface water quality impacts at the municipal Mohawk Street Landfill in Brantford, Ontario.

- Vale Industrial Landfill, Port Colborne, Ontario: Project director for the preparation of an annual report for the groundwater monitoring program for an industrial waste landfill at a former nickel refinery. The work program included interpretation of groundwater flow directions and water quality trends, evaluation of the extent of the leachate plume, and an impact assessment.
- Vale Industrial Refinery Landfill Monitoring, Port Colborne, Ontario: Project Director and senior hydrogeologist for an evaluation of the effectiveness of the purge well system at a former nickel refinery and the development of mitigation and rehabilitation measures for well clogging. The work program involved step drawdown pumping tests, longer term pumping tests, hydraulic analysis of pumping test data, assessment of the decline of well efficiency due to scaling and bio fouling and the development of a work program for well rehabilitation and maintenance including acidification.
- Project Title, City, Ontario: Role on Project. Brief project description.
- Municipal Landfill Annual Monitoring Programs, Niagara Region, Ontario: Project Director for the annual monitoring program for 8 landfills in bedrock and escarpment settings in Niagara Region. The work program involves field water quality sampling, groundwater level monitoring, and provision of progress and annual reports.
- Proposed Walker Ingersoll Landfill, Ontario: Senior Hydrogeologist for the hydrogeological investigation for the proposed Walker Landfill near Ingersoll, Ontario. The field program involved borehole drilling, monitoring well installations, packer testing, geophysical borehole logging, downhole flow profiling, groundwater quality sampling and analysis, a karst study and a water well survey. Three-dimensional groundwater flow modeling was conducted to assess the potential impacts of the landfill.

Shale Industry

- Mississauga, Ontario: Role on Project. Specialist for assessment of geological controls upon shale quality at the Canada Brick Britannia Road quarry site. The work was carried out in conjunction with quality control estimate of shale reservoir on the property. Client: Canada Brick.
- Halton Region, Ontario: Project Manager for a hydrogeological work program in support on an application for a license for the Hanson Brick Tremaine Quarry in Halton Region, Ontario. Client: Canada Brick.
- Halton and Peel Region, Ontario: Project Director for a hydrogeological and surface water program in support of a license application for a proposed shale quarry for a brick manufacturer. The work programs involved borehole drilling and monitoring well installations, surface water flow monitoring, water quality sampling, groundwater flow modelling and preparation of an Adaptive Management Plan (AMP). Client: Brampton Brick Limited.
- Halton Region, Ontario: Project Director for the assessment of the potential gas migration from a landfill to an adjacent brick manufacturing facility containing a brick kiln. The program identified potential risks and a monitoring and response program. Client: Hanson Brick Limited.

Mining

- Elliot Lake, Ontario: Project Hydrogeologist for assessment of the Rio Algom Stanleigh Mine near Elliot Lake, Ontario. The project included development of a three-dimensional flow model of a low-level radioactive waste tailings facility in

Precambrian bedrock of the Canadian Shield. The model was used to develop estimates of seepage rates from the facility and was submitted to the Atomic Energy Control Board (AECB) as part of the regulatory approvals process. Client: Stanleigh Mine.

- Labrador: Technical specialist for hydrogeological modelling at the Voisey's Bay Mine site involving development of three-dimensional groundwater flow models of a proposed tailings basin, mine waste rock disposal facility, and an open pit mine at the Voisey's Bay Mine Site in Labrador. The modelling was carried out for the Voisey's Bay Nickel Company (VBNC) as part of the hydrogeological assessment of the mine. The work was subject to regulatory review and presented as evidence at an environmental assessment hearing. Client: Voisey's Bay Mine.
- Balry, Russia: Project Hydrogeologist for an Environmental Impact Assessment (EIA) as part of a feasibility study for mine expansion. The hydrogeological component included evaluation of potential for water quality impacts for an open pit mine and tailings basin, reduction of flow in stream and interference with the municipal water well supply. Client: Baley Gold Mine.
- Kamchatka, Russia: Project Hydrogeologist of the proposed Asacha Gold Mine in northeastern Russia. The assessment focused upon chemical water quality and streamflow impacts associated dewatering of an underground mine and construction of a tailings basin. The results of the assessment formed part of the mine feasibility study. Client: Asacha Gold Mine.
- Timmins Mine Water Study, Timmins, Ontario: Project Hydrogeologist for assessment of flooding of an extensive array of underground mine working beneath the City of Timmins. The assessment included evaluation of the potential impacts arising from the discharge of water from the flooded mine workings at surface within the city. Client: Timmins Mine.
- Saskatchewan, Manitoba: Project Hydrogeologist for assessment of potential groundwater inflows into proposed shaft in northern Saskatchewan for the Cigar Lake Mining Corporation (CLMC). The results of the assessment were used as the basis for the engineering design at the shaft. Client: Cigar Lake Mining Corporation.
- Elliot Lake, Ontario: Project Hydrogeologist for an assessment of low-level nuclear waste tailings basin at the Denison Mines near Elliot Lake, Ontario. The hydrogeology study included assessment of seepage of uranium-impacted groundwater from the basin. Client: Denison Mines.
- Kirkland Lake, Ontario: Project Hydrogeologist for hydrogeological assessment at the Lac Minerals MaCassa Mine tailing basins in Precambrian bedrock near Kirkland Lake, Ontario. The work was carried out to evaluate the potential impacts during operation and following decommissioning of the facility. Client: MaCassa Mines.

Contaminated Industrial Sites

- Nobel, Ontario: Hydrogeological assessment of groundwater and surface water quality at the former ICI explosives and war productions plant near Parry Sound, Ontario for ICI Canada. The program included assessment of groundwater and surface water quality impacts and removal of buried underground fuel storage tanks. The results of the investigations were submitted to the Ontario Ministry of the Environment as part of the site decommissioning.
- North York, Ontario: Dewatering of a groundwater collection gallery and discharge of the contaminated (chlorinated solvent) wastewater to the municipal sewer system

(under special conditions), at the Ford Motor Company Plant in North York, Ontario. Client: Ford Motor Company.

- North York, Ontario: Dewatering of a groundwater collection gallery and discharge of the contaminated (chlorinated solvent) wastewater to the municipal sewer system (under special conditions), at the Ford Motor Company Plant in North York, Ontario. Client: Shell Oil.
- Cole Harbour, NS: Excavation of underground storage tank (fuel oil) at the Beaver Lumber store at Cole Harbour, Nova Scotia. The results of the investigation favoured Beaver Lumber, by indicating that damage to the store was due to lack of delivery of the fuel supplier rather than leakage from the site fuel storage tank. Client: Beaver Lumber.
- Oakville, Ontario: Hydrogeological impact assessment of cadmium concentrations in groundwater at the ICI Surfactants (formerly Atkemix) site in Oakville, Ontario. The results of the monitoring were submitted to the Ministry of Environment and Energy for regulatory purposes. Client: ICI Surfactants.
- Batawa, Ontario: Participation in the hydrogeological investigation of chlorinated solvent contamination of a bedrock limestone aquifer at the Bata Footwear plant site in Batawa, Ontario. The results of the hydrogeological impact assessment were submitted to the Ministry of Environment and Energy and used during subsequent legal proceedings to determine financial liability of Bata Footwear for the groundwater contamination. Client: Bata Footwear.
- Niagara Falls, Ontario: Project Director and senior hydrogeologist for the annual operational and monitoring programs for a hydrogeological work program involving groundwater contaminated with chlorinated solvents at the Niagara Recycling Centre related to prior industrial land use. The work program involved operation of the groundwater injection remediation system, assessment of subsurface contamination and preparation of annual monitoring reports. Client: Niagara Recycling Centre.
- Rankin Construction Fill Management Plan, Port Colborne, Ontario: Project Director and senior geoscientist for the development of a fill management plan for Pit 1 at the Rankin Construction Port Colborne Quarry. The program included a plan to take excess fill from the area to fill Pit 1. This included a sampling and reporting program to meet MECP requirements. Client: Rankin Construction.

Oil & Gas

- Assessment of Natural Gas Storage Potential, Lake Erie, Ontario: Project Manager for an assessment of the potential for natural gas storage on Crown Lands beneath Lake Erie. The study involved the assessment of natural gas reservoirs to evaluate their suitability for use as gas storage facilities. Estimated available storage volumes were provided for each of the reservoirs.
- Assessment of Natural Gas Storage Potential, Southwestern Ontario, Ontario: Project Manager for an evaluation of the hydrocarbon resources in Southwestern Ontario for the Petroleum Resources Centre of the Ministry of Natural Resources. The study included the interpretation and mapping of pool boundaries for major pools, calculations of in place and recoverable reserves, tabulation of reservoir characteristics, and estimation of potential hydrocarbon resources in the Ordovician strata of southern Ontario.

Municipal Groundwater Studies

- Groundwater Study for the County of Victoria, Ontario: Project Director and senior hydrogeologist for a large-scale groundwater study for the County of Victoria with funding from the Provincial Water Protection Plan (PWPP). The work program involved a groundwater resource assessment, evaluation of existing groundwater usage, contamination assessment, development of management options and protection strategies, and an economic evaluation.
- Groundwater Study for the City of Stratford, Ontario: Project Director and senior hydrogeologist for a Groundwater Study for the City of Stratford involving an assessment of groundwater resources, source of contamination, pump testing of deep wells in limestone bedrock, and development of groundwater management options and protection strategies.
- Simcoe and South Simcoe Groundwater Studies, Ontario: Provided specialist hydrogeological services for both the North Simcoe Groundwater Study and South Simcoe Groundwater Study. The work program involved a characterization of the hydrogeology of the study areas and numerical groundwater modelling of Well Head Protection Areas for municipal wells (WHPAs).

KARST

- Nelson Quarry Extension, Ontario: Project Director and Senior Hydrogeologist for karst assessment of the proposed Nelson Quarry extension that involved mapping of the Amabel Formation along the exposed cliff faces of the Mount Nemo outlier, identification of karstic springs in the Medad Valley and associated water courses, mapping of karst features along more than 1 km of exposed quarry faces. Examination of surface karst features including sinkholes and internal drainage were mapped in the area of the quarry. An ERI (Electrical Resistivity Imaging) survey was conducted over a linear distance to identify potential anomalies that could represent karstic features. Boreholes were drilled into the karstic features to evaluate karstic conditions. The boreholes were video logged along the length of the hole to evaluate karstic features such as solution enlarged fractures and voids. The flow in the boreholes were pumped and logged during an impeller flow meter to assess inflow into boreholes from potential karstic features. An array of 8 wells and a pumping well were drilled to conduct a tracer test using fluorescein dye. The dye was injected into the wells and the travel time and dye concentrations were recorded to evaluate karstic flow paths and velocities. The results were incorporated in a report submitted as part of the regulatory approvals process and presented and defended at an Ontario Municipal Board hearing.
- Proposed Redland Quarries Landfill, Ontario: Project Hydrogeologist for a karst study as part of a geological and hydrogeological evaluations of a proposed hydraulic containment engineered landfill facility in a quarry near Dundas, Ontario. The karst study involved examination and evaluation of karstic features in the vicinity of the quarry including solution-enhanced weathering and extensive network of surficial dolostone plain, and examination of epi-karst on more than 1 km of quarry faces including solution enlarged and materialized vertical joints. The results of groundwater level monitoring results were evaluated for patterns indicative of presence of karst including rapid rises in groundwater levels (‘spiking’). Pump tests were analysed to evaluate the drawdown and recovery responses characteristic of karst.
- Proposed Dundas Quarry Extension, Ontario: Project Director and Senior Hydrogeologist for a karst assessment as part of a hydrogeological work program for

the approval of an application for a large dolostone quarry near Dundas, Ontario. The work program involved an ERI surface geophysical survey along more than 500 m of line to test for potential karstic anomalies. Boreholes were drilled in the areas of identified anomalies to evaluate the potential presence of karst. The faces of the quarries were also examined for layers of karstic groundwater inflow. The results of the karst study have been peer reviewed and are currently being used in support of the license application for quarry expansion.

- Karst Remediation, Hamilton, Ontario: Role on Project. Senior Hydrogeologist for a karst assessment of a remediated industry site in the area of the Eramosa Karst Conservation Area in Hamilton, Ontario. The work program involved a review of literature on karst in the area. An inspection of the karstic features includes sinkholes, internal drainage and inferred subsurface karstic flow pathways was undertaken in areas around the site. A report in support of a property transaction was provided to regulatory authorities and agencies.
- Brow Landfill Monitoring Program, Ontario: Project Hydrogeologist for an assessment of leachate seepage from an industrial solid waste landfill along karstic flow pathways including epi-karst, solution weathered vertical joints and horizontal fracture networks. The assessment involved monitoring of the flow rates from leachate springs and water quality of springs.
- Hydrocarbon Reserve Evaluation, Southwestern Ontario, Ontario: Project Director and Senior Geologist/Hydrogeologist for the estimation of hydrocarbon reserves in Southern Ontario for the Petroleum Resource Centre of Ontario Ministry of Natural Resources. The work program involved extensive analysis of karstic reservoirs formed and dolomitization from solution weathering and collapse along vertical joints and horizontal sub horizontal fracture networks. Prepared a report summarizing the study and provided to the MNR as a commercial publication. Land Development and Infrastructure
- Peer Review, Ontario: Peer review of the hydrogeological work program for a proposed residential development in Palgrave for the Town of Caledon planning department. The work program involved review of hydrogeological reports, discussions with the Town and preparation of a peer review reports with recommendations. Client: Town of Caledon.
- Peer Review, Caledon, Ontario: Peer review of the hydrogeological and geotechnical work program for a proposed residential development in Beaverhall for the Town of Caledon planning department. The work program involved review of hydrogeological reports, discussions with the Town and preparation of a peer review reports with recommendations. Client: Town of Caledon.
- Niagara-on-the-Lake, Ontario: Hydrogeological assessment of the potential impacts associated with the development of an infrastructure for a zipline facility along the Niagara river at Thompsons Point. The work program involved an evaluation of the potential for reduction of groundwater seepage along the Niagara Gorge and related environmental effects. A report was prepared that was submitted to agencies as part of the regulatory approvals process. Client: Niacon Construction.
- Niagara Falls, Ontario: Senior hydrogeologist for the hydrogeological assessment of the existing conditions and potential impacts associated with the development of a condominium adjacent to the Niagara River in Niagara Falls. The work program involved borehole drilling, monitoring wells installation, groundwater level monitoring and assessment of groundwater levels and flow directions. The results of

the work program were incorporated into a geotechnical and hydrogeological report. Client: Time Developments.

- \Niagara Falls, Ontario: Phase 1 and Phase 2 Environmental Site Assessments (ESA) for regulatory approval for condominium development on River Road in Niagara Falls, Ontario. The work program involved test pitting and surface sampling as well as collection and analysis of soil and water samples and evaluation of potential soil and water contamination. Client: Time Developments.
- Oakville, Ontario: Hydrogeological assessment of the excavation and construction of a water pumping station in till and bedrock adjacent to a surface water course. The work program involved borehole drilling, monitoring well installations, hydraulic conductivity testing and a hydrogeological assessment of impacts on surrounding private wells associated with construction dewatering. Client: AECOM.
- Hydrogeological assessment in support of approval for a proposed residential development involving borehole drilling, monitoring well installations, hydraulic conductivity testing, groundwater level monitoring, determination of groundwater levels and flow directions and a hydrogeological impact assessment involving a water balance to evaluate reduction in infiltration and potential interference with surrounding water wells and effects on an adjacent provincially significant wetland. Participated in meetings with the TRCA as part of the approvals process. A report was prepared in support of the approvals process. Client: Geranium Homes Woodview Development.
- Hydrogeological assessment in support of approval for a proposed residential development. The work program involved borehole drilling, monitoring well installations, groundwater level monitoring, development of a water balance and a hydrogeological impact assessment. A report was prepared in support of the application. Client: Geranium Homes Altona Development.

WSP Canada Inc.

Education

M.E.Sc. Environmental Engineering, University of Western Ontario, Ontario, 2018

B.E.Sc. Civil-Environmental Engineering, University of Western Ontario, Ontario, 2016

Professional Affiliations

Registered Professional Engineer, Ontario

Geo-Environmental Engineer

Hayley is a geo-environmental engineer with WSP. Her experience is in the fields of water resources and hydrogeology, specializing in numerical modelling. Her project experience is in conceptual and numerical groundwater and groundwater-surface water flow model development for hydrogeologic investigations. She has provided technical support for projects utilizing FEFLOW, MODFLOW, Groundwater Vistas, HydroGeoSphere, GoldSim, Surfer, and QGIS. Hayley also has experience with application of field techniques for groundwater monitoring and sampling, and aquifer test analysis related to water supply permitting.

PROJECT EXPERIENCE

Hydrologic Modelling of the Osprey Quarry
Ontario, Canada

Involved in conceptual and numerical model development for a transient groundwater- surface water model developed using the HydroGeoSphere (HGS) code, for the Osprey Quarry site in Ontario. This work included site characterization, transient calibration to 10 years of site surface water and groundwater monitoring data, and forecast simulations of quarry development under several climate scenarios. The model was used estimate the potential impacts of future quarry development on surrounding groundwater and surface water features, as part of the quarry's Adaptive Management Plan (AMP).

Cameco Key Lake Leapfrog Model Development
Saskatchewan, Canada

Involved in updated the conceptual site model using historic and recent drilling data and constructing a 3D Leapfrog model for the Key Lake Mill Terrace Groundwater Model domain. This involved review of site information, data processing to create geologic unit surfaces, and use of the Leapfrog model to refine and populate the 3D HydroGeoSphere (HGS) model. The results of this study were used to evaluate water management options.

Cameco Rabbit Lake Tailings GoldSim Modelling
Saskatchewan, Canada

Involved in simulating solute mass loading from source areas to various downgradient receptors using the Rabbit Lake GoldSim model. The work involved utilizing flow rates derived from groundwater flow modelling as inputs to the GoldSim model and simulating seven different model scenarios with variable source concentrations and volumes. The results of this component of the study assisted in the process of evaluating potential long term impacts and management practices.

City of Barrie Risk Municipal Water Supply Risk Assessment Modelling
Ontario, Canada

Involved in reviewing and updating groundwater model files for two existing groundwater models covering the City of Barrie (MODFLOW and FEFLOW) to reflect several potential future pumping scenarios for the municipal water supply system. This involved assessment of simulated potential changes to groundwater flow patterns and pressures in the municipal aquifer. The results of this study will be used as part of a groundwater drinking water system contingency plan for the City of Barrie.

Quaternary Groundwater Seepage Modelling of the Horizon Oil Sands Mine
Alberta, Canada

Involved in building, calibrating, and modelling long-term post-closure groundwater heads and flows within the mine closure landscape, using an FEFLOW model. This work involved modelling long term groundwater seepage rates and flow directions from the mine structures to potentially sensitive receptors for several climate scenarios. The results of the study are used in conjunction with results of water quality modelling as part of the reclamation planning submitted to the Alberta Energy Regulator (AER).

Simulating Large Scale Dewatering of Hardy Mine Pit Lake
Ontario, Canada

Involved in building, calibrating, and modelling the large-scale dewatering of a mine pit lake, using a FEFLOW model. This work involved characterization of the conceptual geology and building a geologic model using Leapfrog Works. Model simulations of several largescale dewatering options were conducted, including assessment of dewatering rates and potential impact of the water taking. The results of the study will be used in conjunction with construction cost estimates, in an options analysis process.

PUBLICATIONS

Journal Articles

Wallace, H., Wexler, E.J., Malott, S., Robinson, C.E. (2021). Evaluating lacustrine groundwater discharge to a large glacial lake using regional scale radon-222 surveys and groundwater modelling. *Hydrologic Processes.* https://doi.org/10.1002/hyp.14165

Wallace, H., Ji, T., & Robinson, C. E. (2020). Hydrogeological controls on heterogeneous groundwater discharge to a large glacial lake. *Journal of Great Lakes Research*, *46*(3), 476-485.

Other

Wallace, H. and Robinson, C.E. (2020). Assessment of nearshore groundwater discharge to Lake Simcoe, Ontario and identification of regional hydrogeological controls. In Russell, H.A.J. and Kjarsgaard, B.A. Eds. Southern Ontario groundwater project 2014-2019 summary report. Geological Survey of Canada, Open File 8536. https://doi.org/10.4095/321105