



October 03, 2022

Ms. Debra Walker
MHBC Planning
7050 Weston Road, Suite 230
Woodbridge, ON L4L 8G7

**Subject: Response to JART Hydrogeological Comments
Proposed Upper's Quarry
WSP Project No. 161-11633-03**

Dear Ms. Walker:

We are pleased to provide our response to agency review comments on the WSP Canada Inc. (WSP) Level 1 and 2 Water Report for the proposed the proposed Upper's Quarry (Site).

The Level 1 and 2 Water Report and Maximum Predicted Water Table Report (WSP, October 2021) were submitted as part of the ARA Licence Application package in 2021. A number of comments related to the reports were provided by the Joint Agency Review Team (JART) in their correspondence dated August 23, 2022. Comments from the peer reviewer (Terra-Dynamics Consulting Inc.) and Niagara Peninsula Conservation Authority (NPCA) staff related to the Level 1 and 2 Water Report are provided in Appendix 4 of the JART correspondence and reproduced below in blue font. WSP responses to the comments are provided.

A number of tables and figures from the Level 1 and 2 Water Report have been revised as part of this response to comments. References to this appended material are also provided in the response to comments below.

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WSP Canada Inc.



PEER REVIEW COMMENTS (TERRA-DYNAMICS CONSULTING INC.)

1. **S. 3.1 Field investigations – The field investigations followed standard acceptable industry practice, however it is recommended borehole logs that are final have the “draft” watermark removed in the report.**

Agreed. Finalized borehole logs (i.e., **Appendix C-1**) are appended to this memorandum.

2. **S. 3.1.1 Water Quality:**

- a. **The summary of the 2019 PW1 Pumping Test Discharge as presented on page 55 of Section 4.1.2.2 utilizes values from four different sample dates without explanation of presentation (e.g. pH and calcium from February 22, 2019, hardness, chloride, sodium, boron and iron from February 23, 2019, sulphate and alkalinity from February 24, 2019 and hydrogen sulphide from February 26, 2019), please clarify the data selection procedure for this table.**

The table from page 55 of **Section 4.1.2.2** is reproduced below. The values included in the column representing the 2019 PW1 Pumping Test Discharge are the median concentrations of the seven (7) samples obtained during the pumping test, as shown in **Table D.7.2**. The column title has been clarified as “median” in the reproduced table below.



Parameter	PWQO	2019 PW1 Pumping Test Discharge Median	Baseline Median				
			Surface Water	Contact Aquifer	Shallow Bedrock Aquifer	Goat Island Member Bedrock	DeCew / Rochester Formation Bedrock
General Parameters							
pH (lab) (pH units)	6.5 – 8.5	7.52	7.98	7.90	7.64	7.52	6.68
Total Dissolved Solids		--	273	982	951	13,200	127,500
Total Suspended Solids		<2 – 14	27	--	--	--	--
Hardness		824	215	710	730	3,500	44,000
Turbidity	(a)	Visually clear	32	--	--	--	--
Hydrogen Sulphide (undissociated)	0.002	3.7	--	<0.005	0.9	0.6	1.8
Major Ions							
Chloride		150	85	46	74	9,000	75,500
Sulphate		352	68	240	310	780	1,000
Alkalinity	(b)	443	125	440	420	230	99
Calcium		188	55	98	140	950	9,350
Magnesium		88	17	110	91	270	4,850
Sodium		80	53	65	47	3,600	29,500
Potassium		4.0	4.0	3.2	3.1	51	435
Nutrients							
Nitrate		--	0.4	0.3	<0.1	<0.1	<1
Un-ionized Ammonia	0.02	<0.001	<0.001	--	--	--	--
Total Phosphorus	0.03	--	0.14	0.80	0.07	0.30	0.40
Metals *							
Aluminum	0.075	<0.01	0.009	0.006	<0.005	<0.005	<0.175
Boron	0.2	0.15	0.03	0.04	0.06	0.92	3.2
Total Chromium	0.0089	<0.001	<0.005	<0.005	<0.005	<0.025	<0.175
Cobalt	0.0009	<0.0002	0.0009	<0.0005	<0.0005	<0.0025	<0.0175
Copper	0.005	<0.001	0.0054	0.001	<0.001	<0.005	<0.035
Iron	0.3	0.73	2.15	<0.1	<0.1	<0.5	1.3
Lead	0.025	<0.001	0.0013	<0.0005	<0.0005	<0.0025	<0.0175
Molybdenum	0.04	<0.005	0.0008	0.0032	<0.0005	<0.0025	<0.0175
Nickel	0.025	<0.005	0.004	0.001	<0.001	<0.005	<0.035
Uranium	0.005	--	0.0008	0.0091	0.0018	0.008	<0.0015
Vanadium	0.006	<0.001	0.0030	0.0014	<0.0005	<0.001	<0.0175
Zinc	0.03	<0.01	0.010	0.011	<0.005	<0.025	<0.175

Notes: Concentrations in mg/L unless otherwise noted.
PWQO – Provincial Water Quality Objectives (MECP 1994 and updates)
Shaded values exceed the PWQO.
(a) Turbidity does not have a firm objective
(b) Alkalinity should not decrease by more than 25% of the natural concentration
* Total metals concentrations shown for 2019 pumping test and baseline surface water median; dissolved metals concentrations shown for baseline groundwater median.



- b. **The Provincial Water Quality Objective for nickel of 0.025 µg/L is missing from surface water quality table criteria, please add and discuss any exceedances (MECP, 1994).**

Agreed. **Table G-1** has been revised to include the PWQO for nickel, please see attached. Only one (1) exceedance of the nickel PWQO was observed during the baseline monitoring period, at DP1 on May 1, 2017. This single exceedance suggests that locally, background nickel PWQO exceedances in surface water are not a widespread or continuous water quality concern.

3. S. 3.1.2 Groundwater Levels:

- a. **The water levels at groundwater monitoring wells MW5A-GP and MW5AR-GP are different by approximately 3-4m. Is the difference between the two monitors believe related to gas production or another cause?**

Natural gas has been observed at both MW16-5A and MW16-5AR, although qualitatively, a greater amount of gas has been noted by WSP at MW16-5AR. We are unable to provide a definitive conclusion as to the difference in water levels between these two wells based on the available data. However, we would agree that a greater rate of natural gas infiltration to MW16-5AR could be the cause of the elevated water levels. The seasonal water level pattern at MW16-5AR is similar to that of MW16-5A, albeit at a higher elevation.

- b. **Also, it is recommended a different colour line be used for one of the Gasport monitors on Figure E-6 in order to distinguish between locations (Groundwater Hydrograph for Well Nest MW16-5).**

Agreed. **Figure E-6** has been revised to distinguish the graph colours for MW16-5A and MW16-5AR, please see attached.

- c. **It is recommended, if appropriate, that MW16-6A be listed in Section 2.5.2.4 (Page 30) as having slow water level recovery inhibiting specific interpretation.**

Agreed. The third paragraph of **Section 2.5.2.4** (on page 30) should be revised as follows (underlined for emphasis):

"The majority of the deep bedrock aquifer wells show no response to precipitation events. Long recovery periods of a year or more following sampling are observed at most wells. Following the April 2018 sampling event, groundwater levels in most deep bedrock aquifer wells appear to have stabilized to static conditions and indicate a muted response to seasonal fluctuations observed in the overlying hydrostratigraphic units. Slow water level recovery at MW16-6A, MW16-9A, MW16-10A and MW16-13A inhibits specific interpretation with the available data set."

- d. **It is recommended to fix what appears to be a typographical error (page 33, Section 2.5.3.1, underlined added here for clarity): "These observations show that an upward vertical gradient between the contact aquifer and the Existing Watercourse exists at MW16-16/DP3 near the south end of the Site, except for the summer months when an upward hydraulic gradient occurs."**

Agreed. The last sentence of the second paragraph of **Section 2.5.3.1** (on page 33) should be revised as follows (underlined for emphasis):



“These observations show that an upward vertical gradient between the contact aquifer and the Existing Watercourse exists at MW16-16 / DP3 near the south end of the Site, except for the summer months when a downward hydraulic gradient occurs.”

4. **S. 3.1.3 Surface Water – The calculation of 35 mm/year of runoff at SW1 for 2017 (page 13, Section 2.3.1) is incredibly low compared to existing reporting for the area (e.g. 288 mm/year and 196 mm/year for NPCA catchments BDSC_BRDC_W100 and W200, respectively, AquaResource Inc. and NPCA, 2009). It is acknowledged that WSP has already provided clarification by email to Terra-Dynamics of the surface water flow measurement challenges at this station that may have erroneously influenced calculation of flows from stage measurements (WSP, 2022). It is recommended that this value be removed given it appears unrealistic. It is also consequently recommended the analyses in the second last paragraph of Section 2.3.1 with respect to Site recharge rates in 2017 be reworded based on removal of this low value.**

Agreed. The fourth paragraph of **Section 2.3.1** (on page 13) should be revised as follows (underlined for emphasis):

*“Station SW1 monitors flow along Beaverdams Creek from the east of the Site. None of the flow passing through this station originates from the Site itself, and this station is considered a background / upstream monitoring station for the Beaverdams Creek reservoir / wetland complex present to the north of the Site. The catchment area for this upstream station is approximately 3.26 km². The hydrograph on **Figure E-26** shows that flow within this upstream branch of the Beaverdams Creek is intermittent, with flow occurring only following large precipitation or melt events. During 2017, the estimated total flow at SW1 is approximately 112,844 cubic metres (m³), with daily average flow rates ranging between 150 L/s to no measurable flow. When the catchment area is considered, this results in a total runoff of 35 mm/year. As shown on **Table I-12**, the estimated water surplus during 2017 is about 474 mm. Therefore, a runoff coefficient of 7% is calculated for 2017. It is noted that the calculated runoff appears to be erroneously low compared to published NPCA values, which WSP attributes to underestimation of flows measured in the field due to the presence of thick vegetation in the creek. Therefore, this calculated runoff value is not considered further in the analysis.”*

Furthermore, the second last paragraph of **Section 2.3.1** (on page 15) should be revised as follows (underlined for emphasis):

“It is noted that the published runoff values for the study area (AquaResource Inc. and NPCA, 2009) range between 196 mm/year and 288 mm/year. Excluding the erroneous value calculated for SW1, the 2017 runoff amounts calculated for the SW2, SW3 and SW4 catchment areas are between 114 mm/year and 317 mm/year, similar to the published range.”

5. **S. 3.2 Identification of Features – features were adequately identified. However, it is recommended**
 - a. **Figures 16 through 21 not truncate well identifiers;**

Agreed. **Figures 16 through 21** have been revised, please see attached.

- b. **References to the ‘Brown Road Landfill’ (Sections 2.4.1, Table C-2, Figure 8 and Figures H-1 and H-4) be changed to the ‘Cytex Canada Inc. Welland Plant Site’, as the ‘Brown Road Landfill’ is only a small part of that site; and**



Agreed. **Figures 8, H-1 and H-4** and **Table C-2** have been revised, please see attached. In addition, references to “*Brown Road Landfill Site*” (two in **Section 2.4.1** on page 16 and one in **Section 2.4.2.1** on page 19) should be revised to read “*Cytec Canada Inc. Welland Plant Site*”.

c. Section H.4.3.1, 3rd paragraph reference Figure 9, not Figure 8, with respect to the Welland Canal.

Agreed. The first sentence of the third paragraph of **Section H.4.3.1** (on page H-13) should be revised as follows (underlined for emphasis):

*“The Welland Canal is located west of the Site and is shown on the conceptual east-west cross section (**Figure 9** of the main report).”*

6. S. 3.3 Monitoring, Trigger Mechanisms and Contingency Plans – The proposed groundwater monitoring and response program is acceptable:

a. However, it is recommended that clarification be provided with respect to the specific meaning of the columns “Interpolated” and “Predicted” on Tables 2 and 3 as it is not clear.

Interpolated available drawdown was defined earlier in **Section 2.5.4.5** (on page 42), but we agree that a reference should have been included in **Section 5.2.2** for improved clarity. The interpolated available drawdown in the shallow and deep bedrock aquifers was calculated using ArcGIS by subtracting the elevation of the interpolated lower contact of the Gasport member bedrock from the potentiometric surface elevation shown on **Figure 15**. The interpolated available drawdown is shown in **Figure 24**.

The predicted available drawdown was defined in **Section 4.1.1.1** (on page 51), and again, we agree that a reference should have been included in **Section 5.2.2** for improved clarity. Numerical groundwater modeling was completed to simulate the predicted available drawdown in the shallow and deep bedrock aquifers as a result of the proposed quarry dewatering during the drier summer and fall months as shown on **Figure 26**.

Both the interpolated and predicted available drawdown from **Figures 24 and 26** are provided for each well location included on **Tables 2 and 3**.

b. Also, it is acknowledged that WSP (2021a) has stated that “There is currently limited continuous water level data for most private wells”, but a specific reason was not provided for the discontinuous hydrographs for private well monitoring locations R1, R2, R3, R4 and R7. Please clarify if these locations are still appropriate for listing on the Proposal Monitoring Program (Table 1) given collection of baseline background water levels appear incomplete.

We can confirm that R1, R2, R3, R4 and R7 are still equipped with data loggers and are included in the on-going monitoring program. Data logger downloads were only completed at R5, R6, R8 and R12 in July 2020, during the early portion of the Covid-19 pandemic. Data loggers were not downloaded at the remaining private wells at that time in order to limit potential contact between WSP staff and the well owners. The most recent download of all residential wells was completed in August 2022.

NPCA STAFF COMMENTS

7. Section 2.5.3 Groundwater / Surface Water Interaction – The NPCA offers no objection to the conclusion that the site’s surface water features are underlain with a thick layer of silt and clay. As



such, the surface water features are not anticipated to be impacted by the quarry dewatering as there is minimal groundwater/surface water interaction occurring.

Acknowledged.

- 8. Section 2.5.3.1 Existing Watercourse and Associated Wetland Complex – The NPCA offers no objection to the conclusion that the site’s surface water and wetland features are underlain with a thick layer of silt and clay. As a result, there is minimal groundwater/surface water interaction occurring in these features.**

Acknowledged.

- 9. Section 2.6.1 Groundwater Quality – The NPCA offers no objection to the characterization of the quality of the groundwater in the area. Within the shallow overburden, groundwater is fresh and similar in quality to precipitation. Within the bedrock aquifers, the groundwater varies between fresh and sulfur type waters.**

Acknowledged.

- 10. Section 2.6.3 Surface Water Quality – The NPCA offers no objection to the conclusion that the ambient surface water quality is generally in poor condition and is typically turbid with elevated nutrient loads.**

Acknowledged.

- 11. Section 3.1 Proposed Development Phases – The NPCA has no general objection to the proposed phasing of this development.**

Acknowledged.

- 12. Section 4.1.2.1 Impact Assessment Surface Water Flow – The NPCA understands that during the quarry’s operational life approximately 50L/s (4,268 cubic meters/day) will be discharged from the quarry into the receiving watercourse. The NPCA will require that an erosion assessment be undertaken in order to determine the impact of these discharge rates and volumes on the receiving watercourse.**

The impacts of future quarry discharge on erosion in the designed watercourse channel are addressed by others (Stantec) in the report accompanying the Licence application.

- 13. Section 4.1.2.2 Impact Assessment Surface Water – The NPCA has no objection to the comparison between the quality of the surface water and the local groundwater regime. Staff note that the groundwater contains elevated levels of Hydrogen Sulphide.**

Acknowledged.

- 14. Section 4.1.2.2 Impact Assessment Surface Water – Staff have no objection to the conclusion that the proposed quarry discharge into the existing watercourse is predicted to generally improve the surface water quality in the watercourse downstream of the site. However, NPCA staff still remain**



concerned about the ability of this development to mitigate the elevated levels of Hydrogen Sulphide prior to discharge into the watercourse.

Acknowledged.

15. Section 4.2 Final Rehabilitation Conditions – NPCA staff offer no objection to the proposal that the quarry be rehabilitated as a series of lakes from an engineering perspective.

Acknowledged.

16. Section 5.1 Proposed Monitoring Program – NPCA staff have no objection to the proposed monitoring plan as described in Table 1 and Figure 29. However, with respect to preventing elevated levels of Hydrogen Sulphide from being discharged for a prolonged period of time into the existing watercourse, Staff would recommend that the Quarry Sump Discharge be sampled at least once a week for this parameter.

Paragraph 7 of **Section 5.4** (on page 67) outlines the quarry discharge trigger mechanism with respect to hydrogen sulphide. Routine monthly sampling is recommended, with weekly confirmatory sampling completed in the event of a trigger exceedance. This proposed routine sampling frequency for hydrogen sulphide is consistent with the Environmental Compliance Approval for Industrial Sewage Works (ECA) no. 4148-89YHGE for the closest known quarry where hydrogen sulphide is included as a trigger for quarry discharge.

17. Section 5.4 Discharge Trigger Mechanism and Contingency Plan:

a. NPCA has no objection to the proposed trigger concentrations.

Acknowledged.

b. Staff recommend that the trigger mechanism for total phosphorus be added. The trigger concentration should be that the quarry discharge concentration be less than the concentration in the watercourse upstream of the quarry.

We agree that the proponent should monitor and report on total phosphorus in quarry discharge as per the future Site ECA. We are, however, unaware of any other operating pit or quarry on the Niagara peninsula that has a discharge trigger for total phosphorus as a condition of licence. Given that the upstream and downstream total phosphorus concentrations in the Existing Watercourse, Beaverdams Creek and the Welland Canal south turn basin surface waters generally exceed the Provincial Water Quality Objective (PWQO), we would recommend that total phosphorus not be included in the proposed trigger mechanism for quarry discharge. Because of their ubiquitous nature on the Niagara peninsula, concerns over total phosphorus concentrations should be addressed on an annual basis as part of the proposed routine long term hydrogeological monitoring.

c. Should monthly sample results indicate exceedances above the trigger criteria, staff would recommend that weekly sampling be initiated until all parameter concentrations fall below the trigger thresholds.

Agreed. Paragraph 5 of **Section 5.4** (on page 66) should be modified as shown below (underlined for emphasis):

“The monthly sump discharge sample results will be compared with the background conditions in the Existing Watercourse (station SW3) and Beaverdams Creek (station SW1). If parameter concentrations in the sump

discharge exceed the above trigger concentrations without a corresponding exceedance in the background surface water, then weekly sampling of the quarry sump will be initiated. Weekly sampling will continue until ~~less than two~~ parameter concentrations in the sump discharge ~~exceed~~ fall below any trigger concentrations.”

- d. After 4 weeks of exceedances of the pH, TSS, and oil/grease trigger thresholds, this would initiate a review and redesign of quarry discharge concentrations. There is no timeline provided for implementing these changes. The NPCA recommends adding a timeline and the immediate reduction in quarry discharge until the issue is addressed.

Agreed. Paragraph 6 of **Section 5.4** (on page 66) should be modified as shown below (underlined for emphasis):

“If weekly sampling is required for a period of more than four (4) weeks, contingency measures would be implemented to reduce concentrations in the future quarry discharge within four (4) weeks of receipt of the laboratory results confirming a fourth consecutive trigger exceedance. Trigger exceedances for pH, TSS and total oil and grease all trigger parameters would initiate a review of the design and operation of the quarry discharge system. Where required, improvements would be made to reduce discharge concentrations.”

- e. After 4 weeks of exceedances of the Hydrogen Sulphide trigger threshold, the NPCA recommends that this should initiate a review and redesign of quarry discharge concentrations. There is no timeline provided for implementing these changes. The NPCA recommends adding a timeline and the immediate reduction in quarry discharge until the issue is addressed.

Agreed. Please refer to the response to comment 17 (d) above.

18. Other General Comments:

- a. The “study area” needs to be defined as it appears to different than the “site area”. This is important because NPCA ambient monitoring is mentioned study area sections 2.6.1 and 2.6.3 and it’s not clear what is being referred too.

The study area is defined in **Section 1.3** (on page 3), reproduced below for clarity.

*“The study area extends to the Niagara Escarpment brow to the north, the Queenston-Chippewa Power Canal to the east, the Welland River to the South, and the modern Welland Canal to the west. This area roughly coincides with the extent of **Figure 1.**”*

- b. **Section 2.6.1 Groundwater Quality** – This section mentions that the NPCA has completed “on-going ambient monitoring”. While the NPCA does have ambient groundwater monitoring program throughout its watershed jurisdiction, there is no NPCA monitoring near the study area of the proposed work. This report should include the monitoring NPCA sites/data that are relevant to this study. NPCA is willing to provide any groundwater data from it’s ambient monitoring program to assist.

The text included in the Level 1 and 2 report was a general comment on the regional groundwater quality, rather than refer to specific monitoring stations operated by the NPCA. The second paragraph of **Section 2.6.1** (on page 43 of the Level 2 report) was intended to reference Section 2.4.1 (on page 25) of the Updated Assessment Report for the Niagara Peninsula Source Protection Area (2013). This section notes that NPCA operates 15 monitoring wells as part of the Provincial Groundwater Monitoring Network (PGMN), as shown in Figure 2.11 of the Updated Assessment Report. Figure 2.11 indicates that there are four (4) PGMN wells situated in relatively



close proximity to the study area (GA-356-A, GA290, GA362-A and GA362-B). Nonetheless, we propose that the second paragraph of **Section 2.6.1** should be modified as shown below (underlined for emphasis):

“On-going monitoring of ambient groundwater quality has been completed by NPCA. ~~Within the study area~~ At various locations throughout the Niagara peninsula, ambient groundwater quality for the contact and shallow bedrock aquifers generally meets Ontario Drinking Water Quality Standards (ODWQS) (MECP 2006 and updates) for parameters with health-related standards. Exceptions include sporadic exceedances of some dissolved metals concentrations. Agricultural and / or septic system impacts are also observed regionally, resulting in elevated nitrate concentrations in the groundwater.”

- c. **Section 2.6.3 Surface Water Quality-** This section also mentions that the NPCA has completed “on-going ambient monitoring”. It would be helpful to include the NPCA monitoring sites/data or reference to provide context. The NPCA currently has two ongoing water quality monitoring stations in the Beaver Dams/Shriner Creek watershed. The Beaver Dams Creek station is located on the west side of the canal and rated as “Fair” water quality using Canadian Water Quality index based on the last five years (2020-2016) of data. The Shriners Creek station is located on Thorold Stone Road just west of Kalar Road as rated as “Poor” water quality using again Canada WQI (2020-2016 - 5 yrs of data). There is also historic NPCA data (2008-2010) that was generated from the Beaver Dams/Shriners Creek watershed study may provide additional background watershed information. Both of these data sets are available from the NPCA.

The text included in the Level 1 and 2 report was a general comment on the regional surface water quality, rather than refer to specific monitoring stations operated by the NPCA. The second paragraph of **Section 2.6.3** (on page 44 of the Level 2 report) was intended to reference Section 2.3.5 (on page 24 of the Updated Assessment Report), in particular, paragraph four. The stations referenced in this section are spread throughout the entire Niagara peninsula as shown in Figure 2.10 of the Updated Assessment Report. Therefore, we propose that the second paragraph of **Section 2.6.3** should be modified as shown below (underlined for emphasis):

*“On-going monitoring of ambient surface water quality has been completed by the NPCA. ~~Within the study area~~ At various locations throughout the Niagara peninsula, results from over two-thirds of the surface water quality stations operated by the NPCA suggest surface water conditions are poor or impaired, and only 5% of the stations regularly indicate good conditions. The main contaminants of concern are total phosphorus, *E. coli*, suspended solids and chloride, originating from sources including agricultural activities, poorly maintained septic systems, road salting activities and untreated stormwater runoff from urban areas.”*

The 2008-2010 Beaverdams Creek / Shriners Creek surface water results were provided by NPCA to WSP following the JART meeting of May 2022. These data can be incorporated into future reports.

- d. **Section 5.4 Discharge Trigger Mechanism and Contingency Plan - NPCA staff would recommend that dissolved oxygen be considered as trigger owing to the potential present of hydrogen sulphide in dewatering discharge. The NPCA has observed DO depletion in watercourses downstream of sulphur springs in the Hamilton portion of the NPCA watershed. DO concentrations should meet PWQO before quarry discharge into the receiving watercourse.**

Similar to our response to comment 17 (b) above, we agree that the proponent should monitor and report on dissolved oxygen in quarry discharge as per the future Site ECA. We are, however, unaware of any other operating pit or quarry on the Niagara peninsula that has a discharge trigger for dissolved oxygen as a condition of licence. We would recommend that dissolved oxygen not be included in the proposed trigger mechanism for



quarry discharge. Concerns over dissolved oxygen concentrations should be addressed on an annual basis as part of the proposed routine long term hydrogeological monitoring.

- e. **Staff note that the closest NPCA monitoring well to the site is located at Baden-Powell Park. Annual geochemistry and hourly water level elevation data is available as far back as 2015 if there is interest. The data from the Baden-Powell NPCA monitoring well appears to be consistent with the groundwater elevation and chemistry data findings of the report.**

Acknowledged.

- f. **Under Section 2.5.4- NPCA staff agree that the water levels within the Welland Canal that supply the DeCew Falls Water Treatment Plant will not be impacted by the proposed quarry dewatering.**

Acknowledged.

- g. **Under Section 2.5.4.4 – NPCA staff agree that they have identified the groundwater takings surrounding the site that likely have had an impact on the regional potentiometric surface, including the lesser-known impacts from the Welland Canal tunnel dewatering.**

Acknowledged.

CLOSING

We trust that the responses to comments above meet your expectations. Please contact us if you have additional questions or concerns.

Yours truly,
WSP Canada Inc.

Leigh Davis, M.A.Sc., P.Eng.
Project Engineer, Earth & Environment

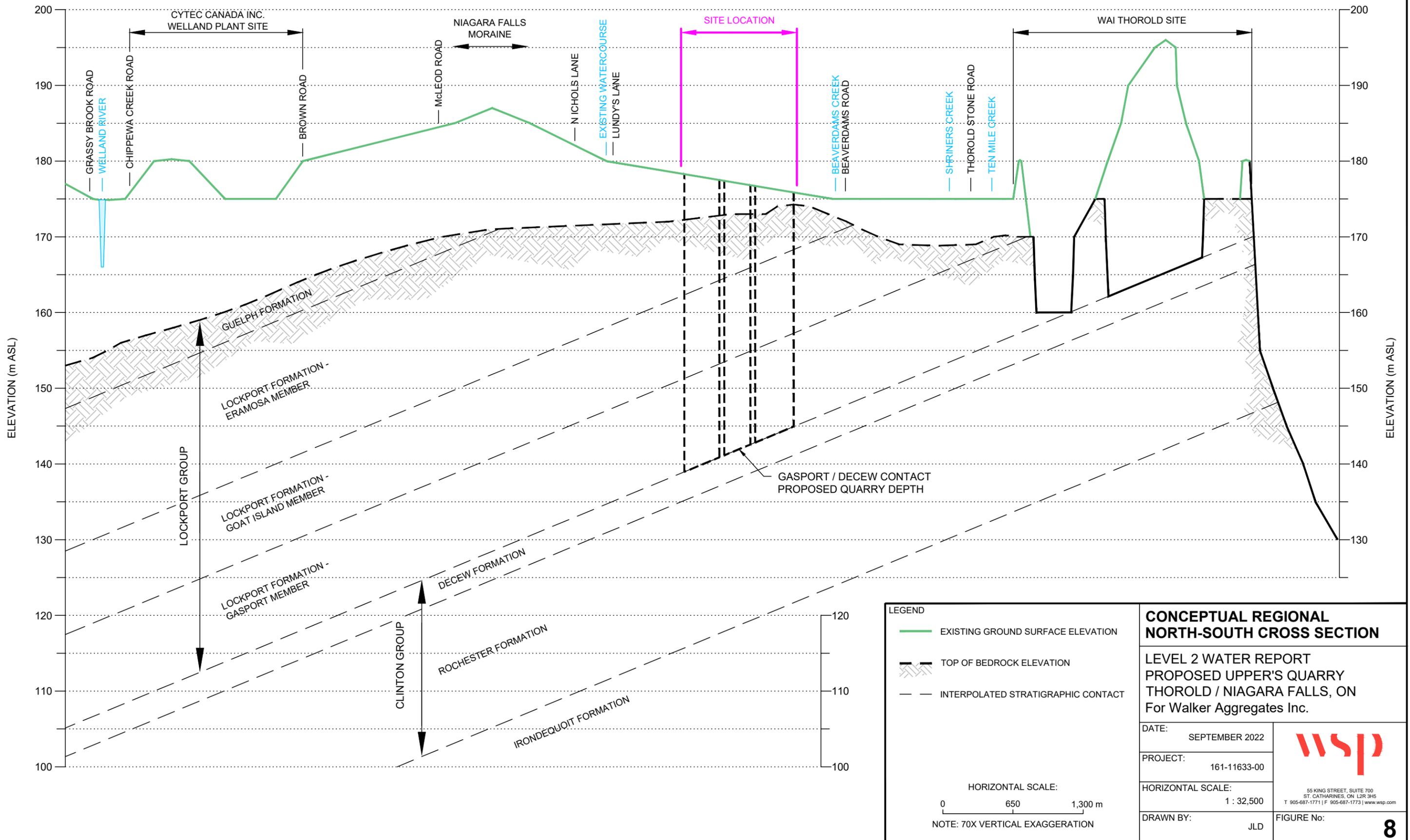
Kevin Fitzpatrick, P.Eng.
Senior Project Engineer, Earth & Environment

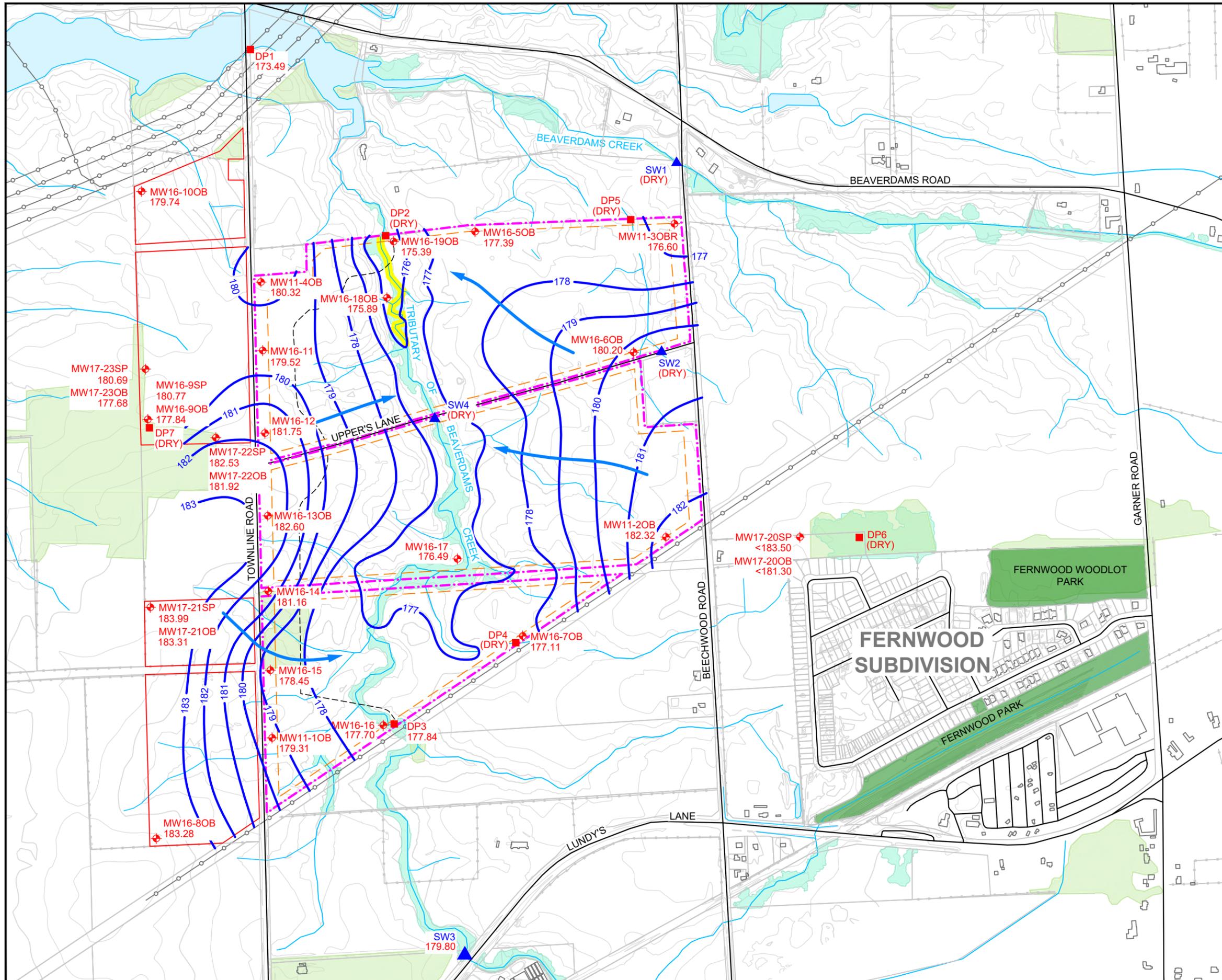
Attachments: **Figure 8 – Conceptual Regional North-South Cross Section (Revised)**
Figures 16 through 21 – Potentiometric Contours (Revised)
Appendix C-1 - Borehole Logs (Finalized)
Table C-2 – Off-Site Well Details (Revised)
Figure E-6 – Groundwater Hydrograph for Well Nest MW16-5 (Revised)
Table G-1 – Surface Water Chemical Results (Revised)
Figure H-1 – Model Domain Grid (Revised)
Figure H-4 – Recharge Zones (Revised)

SOUTH

LOOKING WEST

NORTH





LEGEND

- SITE BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- REALIGNED WATERCOURSE SETBACK
- ADDITIONAL LANDS OWNED BY WAI
- APPROXIMATE LAND PARCELS
- WOODLOT
- WETLAND
- DESIGNATED PARK AREA
- SURFACE WATER COURSE
- GROUND SURFACE CONTOUR, 5 m INTERVAL
- GROUND SURFACE CONTOUR, 1 m INTERVAL
- FENCELINE
- UTILITY LINE
- ◆ MW11-10B MONITORING WELL LOCATION AND DESIGNATION
- DP1 DRIVEPOINT LOCATION AND DESIGNATION
- ▲ SW1 STAFF GAUGE LOCATION AND DESIGNATION
- 179.31 GROUNDWATER ELEVATION, OCTOBER 1, 2017 (masl)
- 179 INTERPOLATED POTENTIOMETRIC CONTOURS (masl)
- INFERRED GROUNDWATER FLOW DIRECTION
- AREA OF INFERRED GROUNDWATER DISCHARGE TO EXISTING WATERCOURSE



0 180 360 m

**CONTACT AQUIFER
POTENTIOMETRIC
CONTOURS - OCTOBER 2017**

LEVEL 2 WATER REPORT
PROPOSED UPPER'S QUARRY
THOROLD / NIAGARA FALLS, ON
For Walker Aggregates Inc.

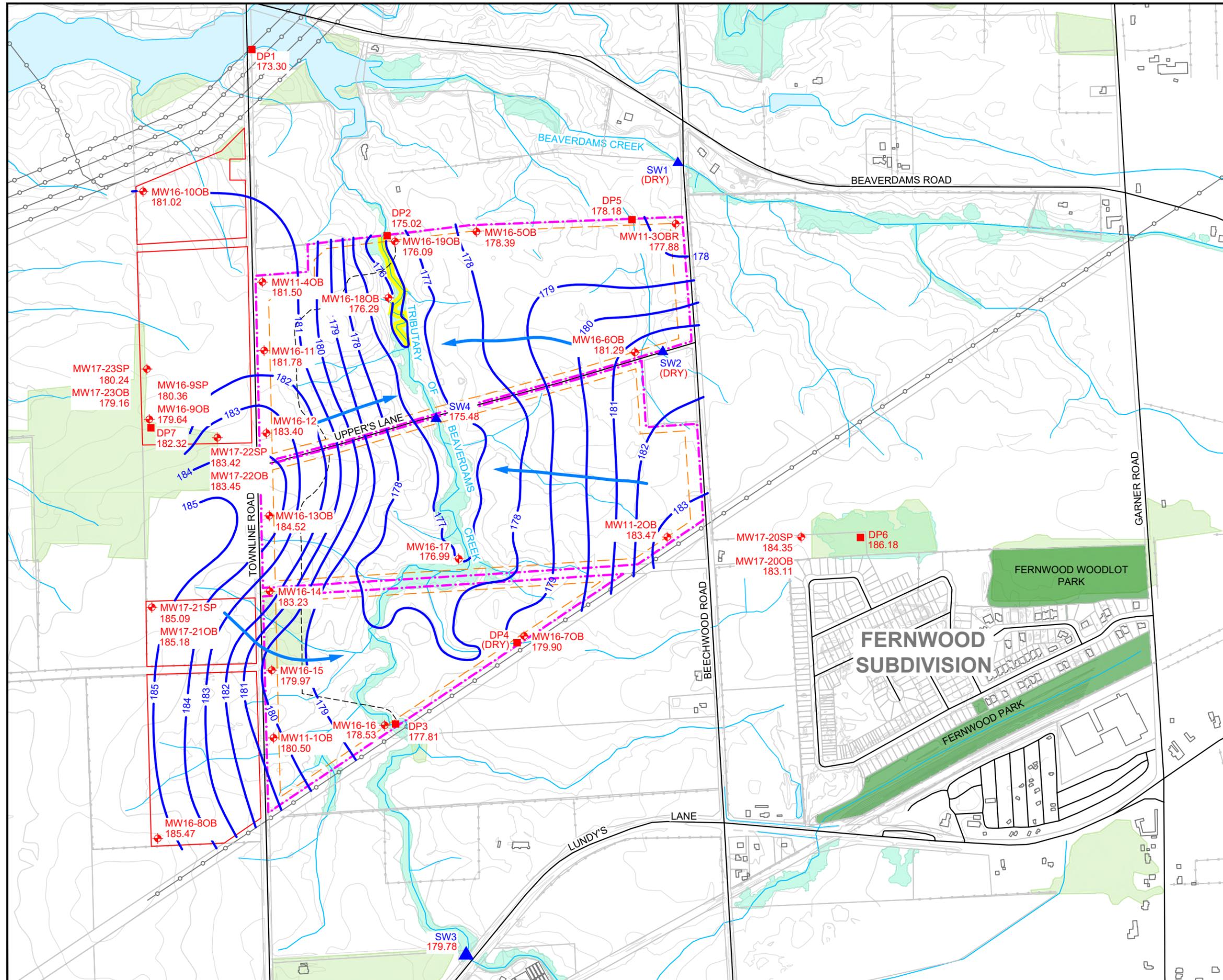
DATE:	SEPTEMBER 2022
PROJECT:	161-11633-00
SCALE:	1 : 9,000
DRAWN BY:	JLD



55 KING STREET, SUITE 700
ST. CATHARINES, ON L2R 3H5
T 905-687-1771 | F 905-687-1773 | www.wsp.com

FIGURE No: **16**

H:\PROJECTS\2016\161-11633 UPPER'S QUARRY\SEPT 2022 REVISIONS\161-11633-3-F-16-GW.DWG



LEGEND

- SITE BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- REALIGNED WATERCOURSE SETBACK
- ADDITIONAL LANDS OWNED BY WAI
- APPROXIMATE LAND PARCELS
- WOODLOT
- WETLAND
- DESIGNATED PARK AREA
- SURFACE WATER COURSE
- GROUND SURFACE CONTOUR, 5 m INTERVAL
- GROUND SURFACE CONTOUR, 1 m INTERVAL
- FENCELINE
- UTILITY LINE
- ◆ MW11-10B MONITORING WELL LOCATION AND DESIGNATION
- DP1 DRIVEPOINT LOCATION AND DESIGNATION
- ▲ SW1 STAFF GAUGE LOCATION AND DESIGNATION
- 179.31 GROUNDWATER ELEVATION, MAY 1, 2018 (masl)
- 179 INTERPOLATED POTENTIOMETRIC CONTOURS (masl)
- INFERRED GROUNDWATER FLOW DIRECTION
- AREA OF INFERRED GROUNDWATER DISCHARGE TO EXISTING WATERCOURSE

CONTACT AQUIFER POTENTIOMETRIC CONTOURS - MAY 2018

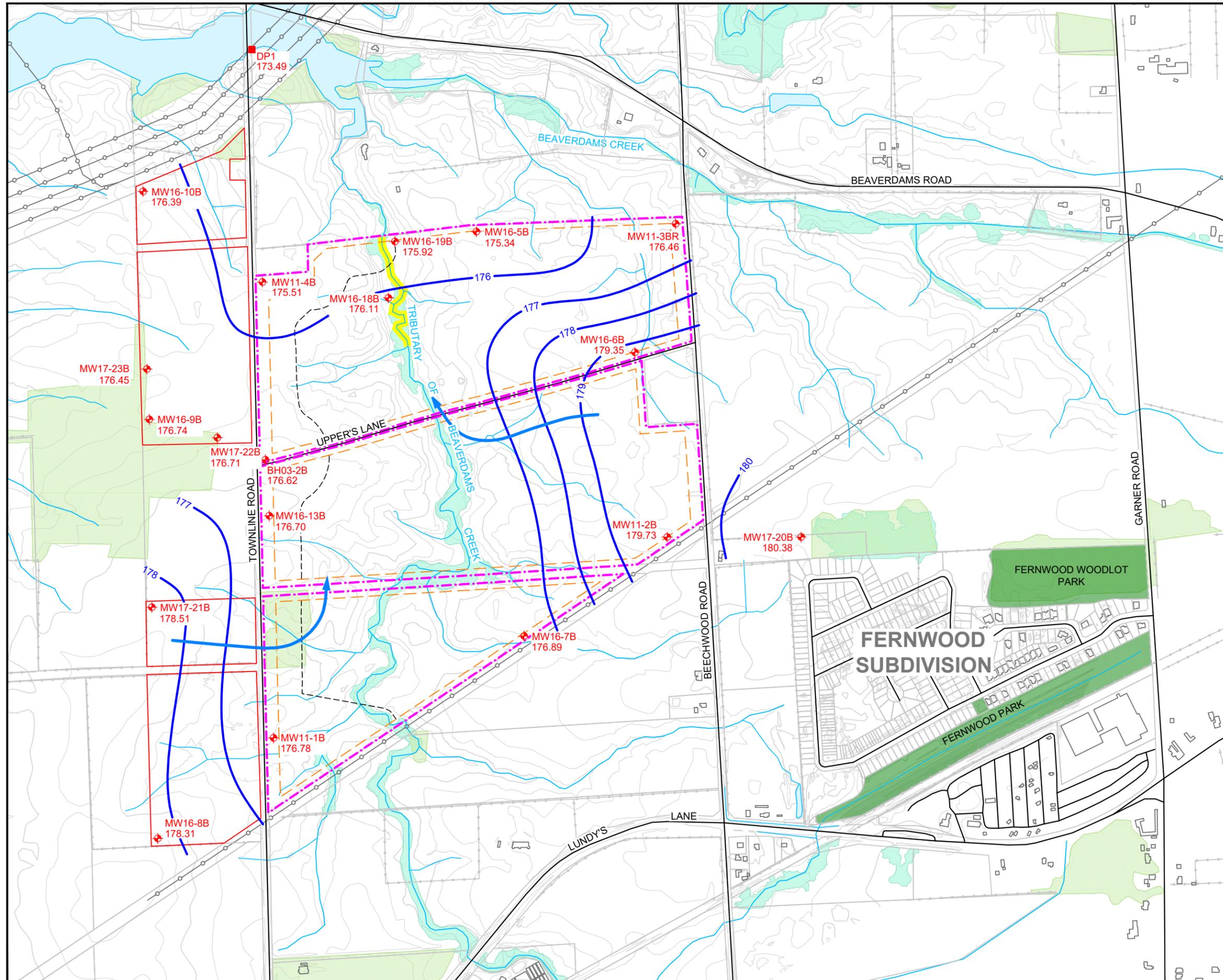
LEVEL 2 WATER REPORT
PROPOSED UPPER'S QUARRY
THOROLD / NIAGARA FALLS, ON
For Walker Aggregates Inc.

DATE:	SEPTEMBER 2022
PROJECT:	161-11633-00
SCALE:	1 : 9,000
DRAWN BY:	JLD

55 KING STREET, SUITE 700
ST. CATHARINES, ON L2R 3H5
T 905-687-1771 | F 905-687-1773 | www.wsp.com

FIGURE No: 17

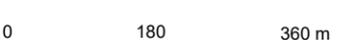
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LEGEND

- SITE BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- REALIGNED WATERCOURSE SETBACK
- ADDITIONAL LANDS OWNED BY WAI
- APPROXIMATE LAND PARCELS
- WOODLOT
- WETLAND
- DESIGNATED PARK AREA
- SURFACE WATER COURSE
- GROUND SURFACE CONTOUR, 5 m INTERVAL
- GROUND SURFACE CONTOUR, 1 m INTERVAL
- FENCELINE
- UTILITY LINE
- ◆ MW11-1B MONITORING WELL NEST LOCATION AND DESIGNATION
- DP1 DRIVEPOINT LOCATION AND DESIGNATION
- 176.78 GROUNDWATER ELEVATION, OCTOBER 1, 2017 (masl)
- 179 INTERPOLATED POTENTIOMETRIC CONTOURS (masl)
- INFERRED GROUNDWATER FLOW DIRECTION
- AREA OF INFERRED GROUNDWATER DISCHARGE TO EXISTING WATERCOURSE





SHALLOW BEDROCK AQUIFER POTENTIOMETRIC CONTOURS - OCTOBER 2017

LEVEL 2 WATER REPORT
PROPOSED UPPER'S QUARRY
THOROLD / NIAGARA FALLS, ON
For Walker Aggregates Inc.

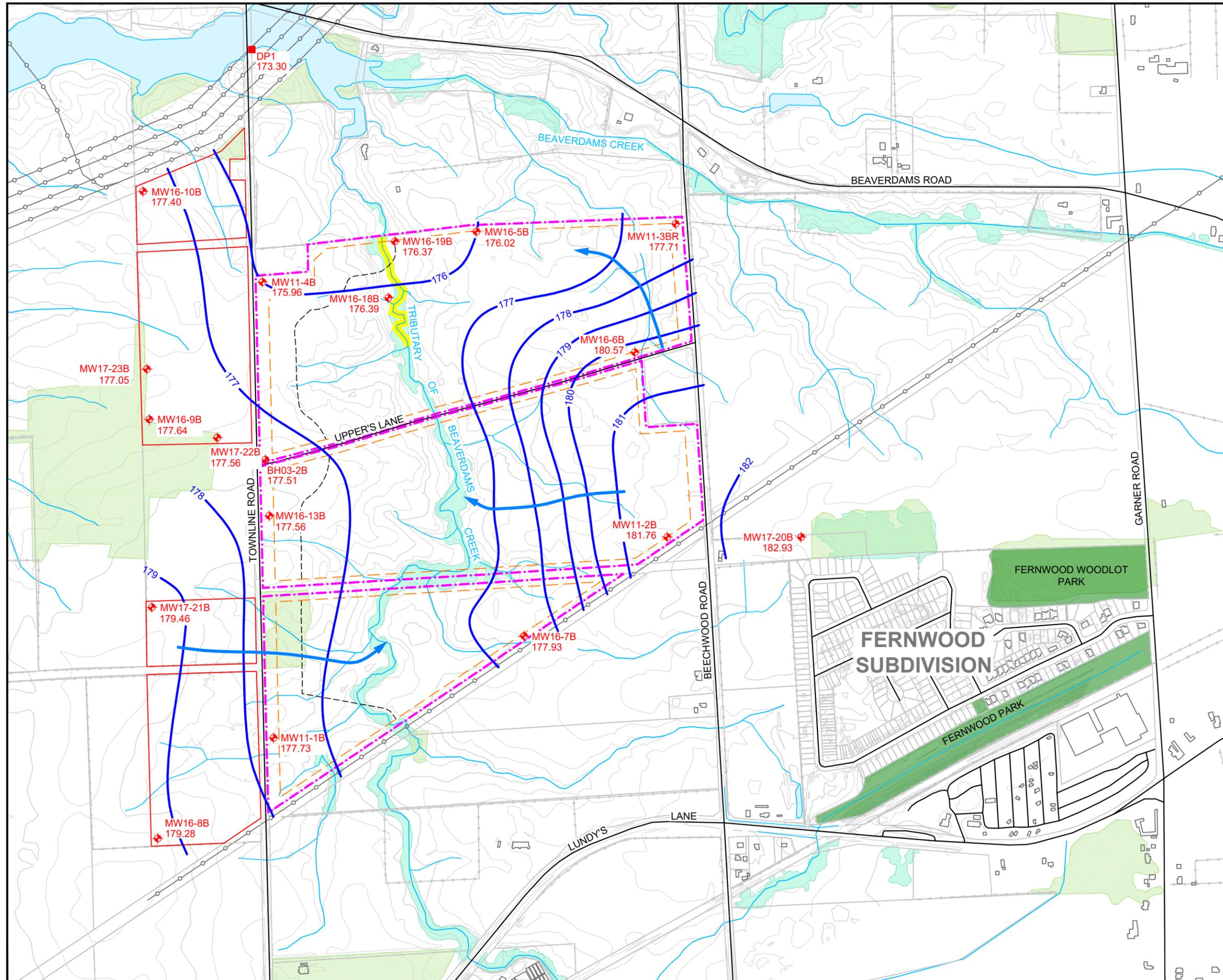
DATE:	SEPTEMBER 2021
PROJECT:	161-11633-00
SCALE:	1 : 9,000
DRAWN BY:	JLD



55 KING STREET, SUITE 700
ST. CATHARINES, ON L2R 3H5
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FIGURE No: **18**

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LEGEND

- SITE BOUNDARY
- PROPOSED LIMIT OF EXTRACTION
- REALIGNED WATERCOURSE SETBACK
- ADDITIONAL LANDS OWNED BY WAI
- APPROXIMATE LAND PARCELS
- WOODLOT
- WETLAND
- DESIGNATED PARK AREA
- SURFACE WATER COURSE
- GROUND SURFACE CONTOUR, 5 m INTERVAL
- GROUND SURFACE CONTOUR, 1 m INTERVAL
- FENCELINE
- UTILITY LINE
- ◆ MW11-1B MONITORING WELL NEST LOCATION AND DESIGNATION
- DP1 DRIVEPOINT LOCATION AND DESIGNATION
- 176.78 GROUNDWATER ELEVATION, MAY 1, 2018 (masl)
- 179 INTERPOLATED POTENTIOMETRIC CONTOURS (masl)
- INFERRED GROUNDWATER FLOW DIRECTION
- AREA OF INFERRED GROUNDWATER DISCHARGE TO EXISTING WATERCOURSE

**SHALLOW BEDROCK
AQUIFER POTENTIOMETRIC
CONTOURS - MAY 2018**

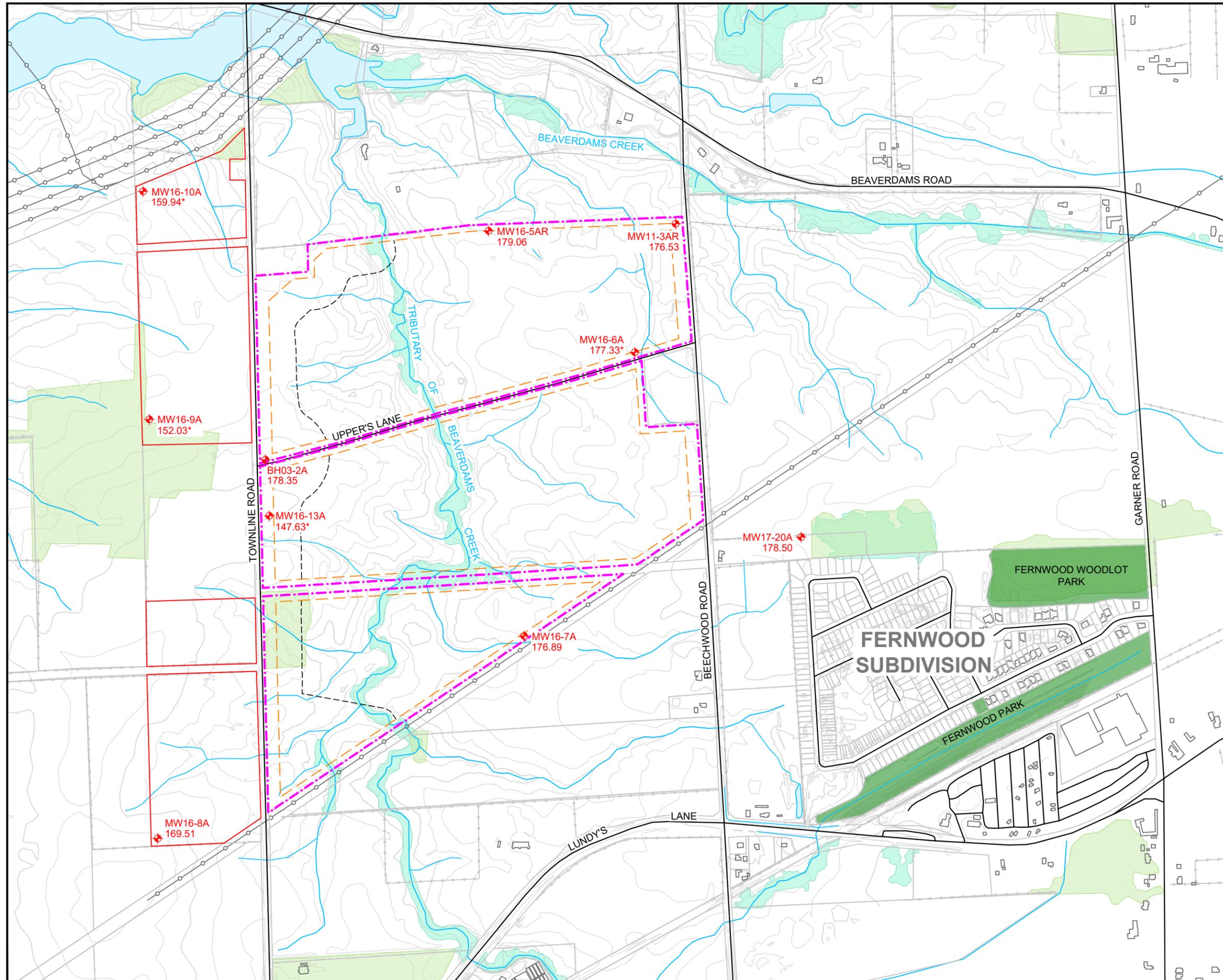
LEVEL 2 WATER REPORT
PROPOSED UPPER'S QUARRY
THOROLD / NIAGARA FALLS, ON
For Walker Aggregates Inc.

DATE:	SEPTEMBER 2022
PROJECT:	161-11633-00
SCALE:	1 : 9,000
DRAWN BY:	JLD

55 KING STREET, SUITE 700
ST. CATHARINES, ON L2R 3H5
T 905-687-1771 | F 905-687-1773 | www.wsp.com

FIGURE No: **19**

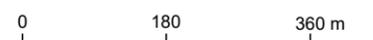
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LEGEND

- - - SITE BOUNDARY
- - - PROPOSED LIMIT OF EXTRACTION
- - - REALIGNED WATERCOURSE SETBACK
- ADDITIONAL LANDS OWNED BY WAI
- APPROXIMATE LAND PARCELS
- WOODLOT
- WETLAND
- DESIGNATED PARK AREA
- SURFACE WATER COURSE
- GROUND SURFACE CONTOUR, 5 m INTERVAL
- GROUND SURFACE CONTOUR, 1 m INTERVAL
- FENCELINE
- UTILITY LINE
- ◆ MW16-7A MONITORING WELL NEST LOCATION AND DESIGNATION
- 176.89 GROUNDWATER ELEVATION, OCTOBER 1, 2017 (masl)
- * GROUNDWATER ELEVATION DATA NOT AVAILABLE FOR OCTOBER 1, 2017; DATA FROM NOVEMBER 2, 2017 SHOWN





**DEEP BEDROCK AQUIFER
POTENTIOMETRIC
ELEVATIONS - OCTOBER 2017**

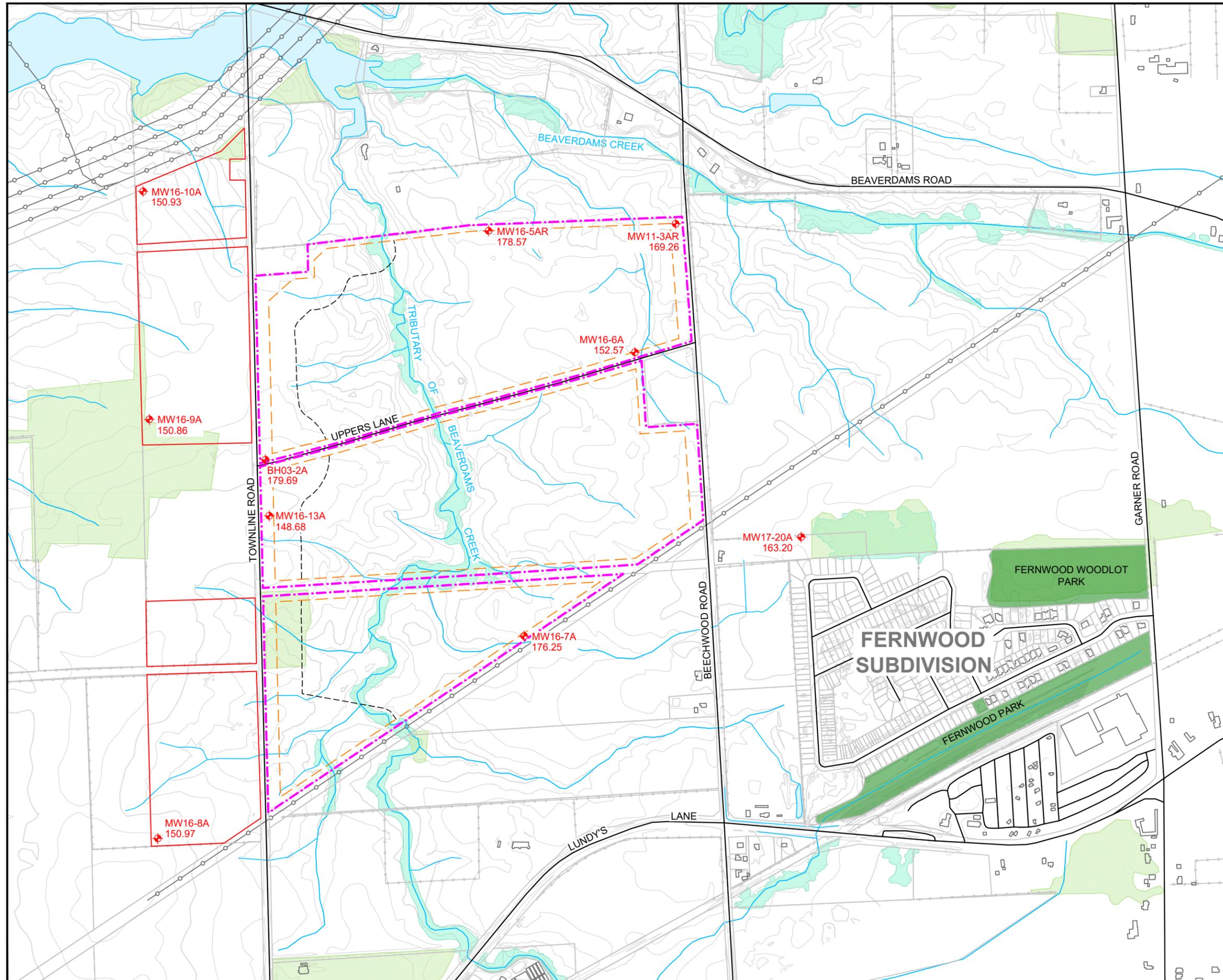
LEVEL 2 WATER REPORT
PROPOSED UPPER'S QUARRY
THOROLD / NIAGARA FALLS, ON
For Walker Aggregates Inc.

DATE:	SEPTEMBER 2022
PROJECT:	161-11633-00
SCALE:	1 : 9,000
DRAWN BY:	JLD



55 KING STREET, SUITE 700
ST. CATHARINES, ON L2R 3H5
T 905-687-1771 | F 905-687-1773 | www.wsp.com

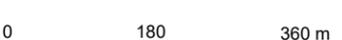
FIGURE No: **20**



LEGEND

- - - - - SITE BOUNDARY
- - - - - PROPOSED LIMIT OF EXTRACTION
- - - - - REALIGNED WATERCOURSE SETBACK
- - - - - ADDITIONAL LANDS OWNED BY WAI
- - - - - APPROXIMATE LAND PARCELS
- WOODLOT
- WETLAND
- DESIGNATED PARK AREA
- SURFACE WATER COURSE
- GROUND SURFACE CONTOUR, 5 m INTERVAL
- GROUND SURFACE CONTOUR, 1 m INTERVAL
- FENCELINE
- UTILITY LINE
- ◆ MW16-7A MONITORING WELL NEST LOCATION AND DESIGNATION
- 176.89 GROUNDWATER ELEVATION, MAY 1, 2018 (masl)





DEEP BEDROCK AQUIFER POTENTIOMETRIC ELEVATIONS - MAY 2018	
LEVEL 2 WATER REPORT PROPOSED UPPER'S QUARRY THOROLD / NIAGARA FALLS, ON For Walker Aggregates Inc.	
DATE:	SEPTEMBER 2022
PROJECT:	161-11633-00
SCALE:	1 : 9,000
DRAWN BY:	JLD
FIGURE No:	21



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LOG OF BOREHOLE BH03-2 Retrofit



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648519 N: 4772919 (17T, Geodetic)

rig type | CME 75
 method |
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/08
 supervisor | SK
 reviewer | KJF

SUBSURFACE PROFILE		SAMPLE		Penetration Test Values (Blows/0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Uncoupled ● Pooled Parameter + Fract Vane + Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (M1)
Elev. Depth (m)	STRATIGRAPHY	Graphic Plot Number	Type					
184.3	GROUND SURFACE							
0	CLAYEY SILT, reddish brown, dolostone boulders at 3.4 m							
179.9	at 4.4m below grade							
4.4	ERAMOSIA FORMATION, hard, fresh, brownish-grey to grey, medium grained dolostone with saccharoidal texture, with a petrolierous odour when broken. Thin to medium horizontal beds with occasional 2 mm thick shale layers. Rare stylolites and nodules of gypsum and other minerals. Approximately 3% vug content. ... Vugs 1-25 mm, to 1%, large ones at 6.2 m, 6.8 m, 7.5 m, 8.1 m and 8.4m. Some encrusted with dolomite, calcite, siderite and sphalerite.							
172.2	... Gypsum nodules at 12.4 m and 13.7 m, up to 100 mm, less than 1% by volume.							
170.0	... Vuggy zone, 14.7 m to 14.8 m, 2 mm to 50 mm, approximately 13% by volume.							
168.0	... Vuggy zone, 17.1 m to 17.6 m, 2 mm to 45 mm, approximately 10% by volume.							
166.0	... Coarse grained layer, 18.6 m to 20.1 m.							
164.2	GOAT ISLAND FORMATION, hard, grey, fine grained, fresh dolostone with occasional gypsum and chert nodules. Weak petrolierous odour when broken. Rare fossil fragments, minor calcite and gypsum veins. Occasional to common stylolites and shale partings 2 mm thick. Fracture surfaces clean. Medium bedded.							
20.1	... Occasional chert, gypsum and other nodules, 20.1 m to 26.5 m, 2-3% by volume.							
	(continued on next page)							

(continued next page)

LOG OF BOREHOLE BH03-2 Retrofit



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648519 N: 4772919 (17T, Geodetic)

rig type | CME 75
 method |
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/08
 supervisor | SK
 reviewer | KJF

SUBSURFACE PROFILE		SAMPLE		Penetration Test Values (Blows/0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Uncoupled ● Pooled Parameter + Fract Vane + Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (M1)
Elev. Depth (m)	STRATIGRAPHY	Graphic Plot Number	Type					
	(continued)							
27	...Fossiliferous and stylonitic layer, 26.5 m to 26.8 m. Rare chert and gypsum nodules 26.5 m to 31.5 m.							
28	GOAT ISLAND FORMATION, hard, grey, fine grained, fresh dolostone with occasional gypsum and chert nodules. Weak petrolierous odour when broken. Rare fossil fragments, minor calcite and gypsum veins. Occasional to common stylolites and shale partings 2 mm thick. Fracture surfaces clean. Medium bedded. (continued)							
152.9	GASPORT FORMATION, hard, fresh, grey to dark grey, fine to medium grained fossiliferous dolostone with saccharoidal texture. Medium bedded with fossil fragments up to 6%. Occasional stylolites. Rare gypsum nodules, less than 1% by volume.							
31.5	... Dark grey fossiliferous dolomitic limestone from 36.2 m to 39.8 m. ... Frequent shale partings below 37.0 m, up to 10 mm thick.							
143.1	... Fossiliferous conglomeratic layer from 41.0 m to 41.2 m marks lower contact.							
41.2	DECEW FORMATION, medium hard, dark grey, fine grained. Fresh argillaceous dolostone with occasional shale partings 3 mm thick.							
139.0	ROCHESTER FORMATION, very dark grey to black, dolomitic to calcareous shale. Increase in calcareous content below 45.9 m. ... Frequently splits horizontally along bedding planes. Conchoidal fractures.							
45.3	... Fossiliferous layers below 49.7 m.							
134.0	END OF BOREHOLE							
50.3								
	Borehole was dry and open upon completion. 25 mm monitoring well installed. No. 10 screen installed.							
	WELL 1 WATER LEVEL MONITORING Date: Nov 10, 2016 Depth (m): 8.5 Elevation (m): 175.9							
	WELL 2 WATER LEVEL MONITORING Date: Nov 10, 2016 Depth (m): 8.6 Elevation (m): 175.8							

LOG OF BOREHOLE 11-3A/B Decom



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position |

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/25
 supervisor | SK
 reviewer | KJF

Depth Scale (m)	SUBSURFACE PROFILE		SAMPLE		Elevation Scale (mGS)	Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Pocket Penetrometer + Frakt Vane ■ Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments
	Elev. Depth (m)	STRATIGRAPHY	Graphic Plot	SPT N-Value						
0		GROUND SURFACE		Core Recovery						
0.5		Bentonite grout								
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
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24										
25										
26										
27										
28										
29										
30										

END OF BOREHOLE

Borehole was dry and open upon completion.

LOG OF BOREHOLE 11-3OB Decom



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position |

rig type | CME 75
 method |
 coring | n/a

project no. | 161-11633-00
 date started | 2016/10/25
 supervisor | SK
 reviewer | KJF

Depth Scale (m)	SUBSURFACE PROFILE		SAMPLE		Elevation Scale (mGS)	Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Pocket Penetrometer + Frakt Vane ■ Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments
	Elev. Depth (m)	STRATIGRAPHY	Graphic Plot	SPT N-Value						
0		GROUND SURFACE		Core Recovery						
0.5		Granular bentonite								
1										
2										
3										

END OF BOREHOLE

Borehole was dry and open upon completion.

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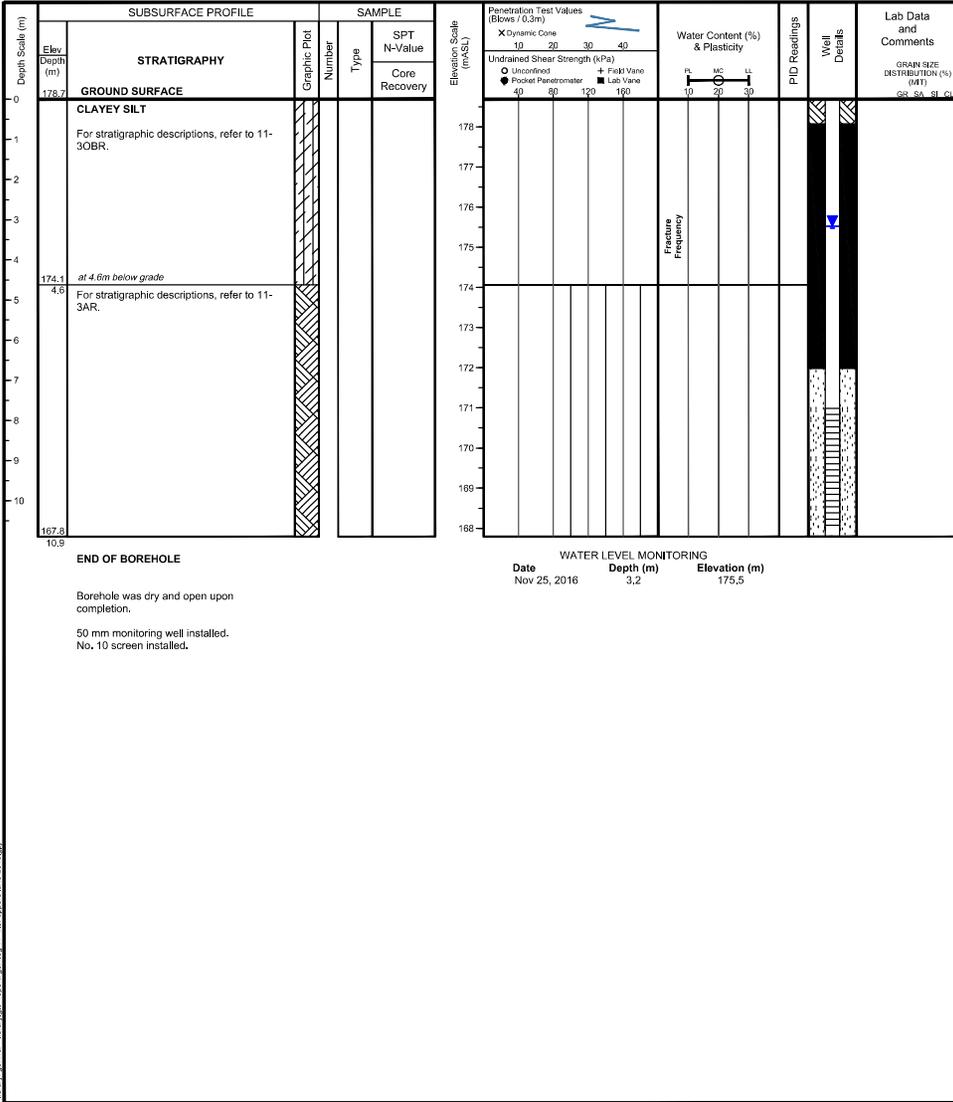
LOG OF BOREHOLE 11-3BR



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649515 N: 4773487 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/27
 supervisor | SK
 reviewer | KJF



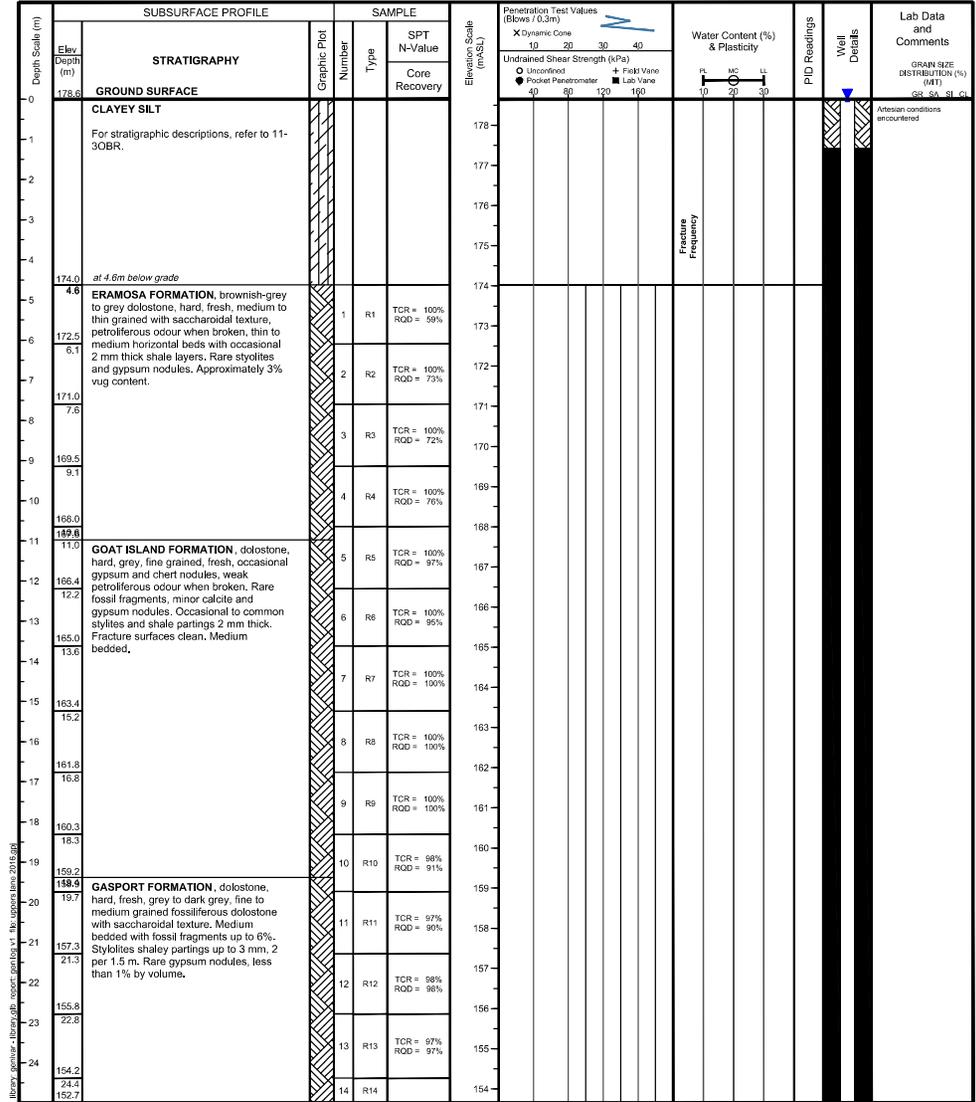
LOG OF BOREHOLE 11-3AR



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649515 N: 4773489 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/26
 supervisor | SK
 reviewer | KJF



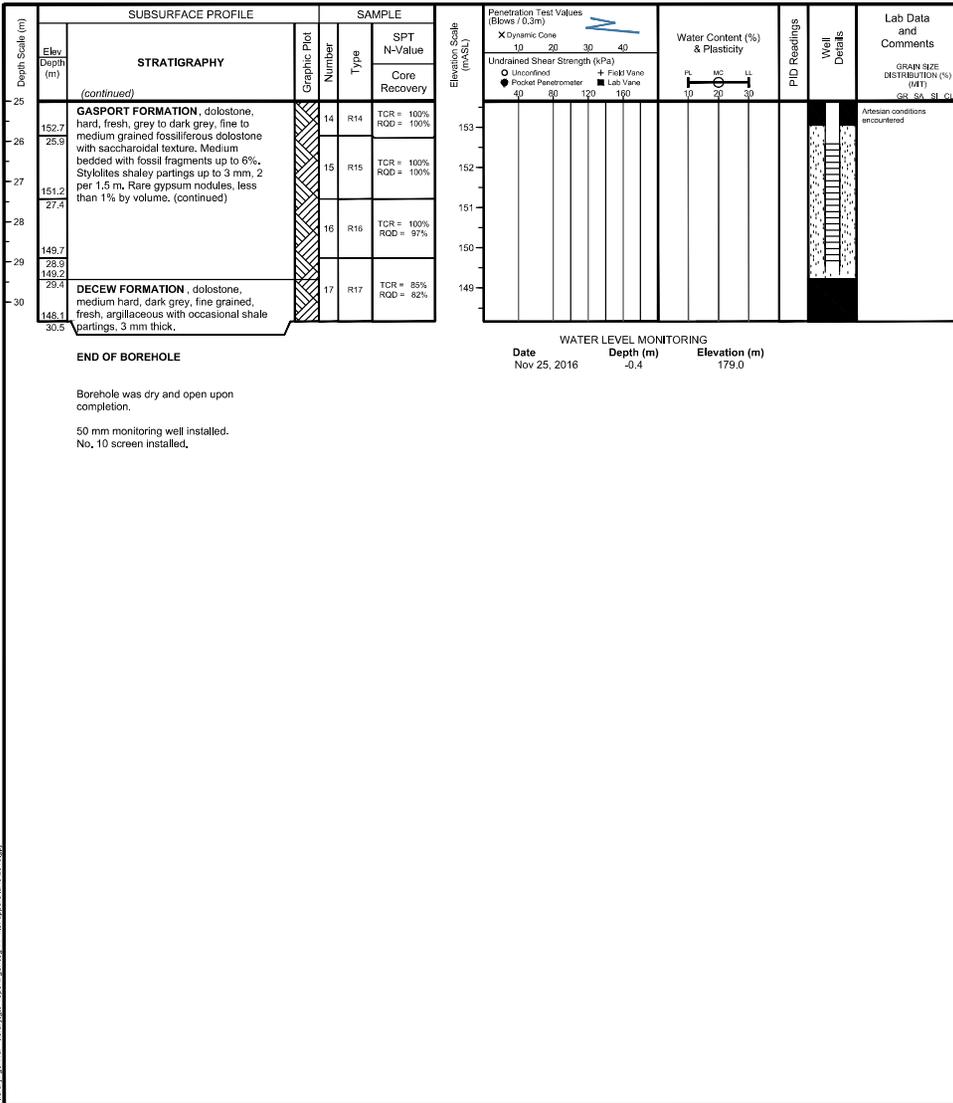
LOG OF BOREHOLE 11-3AR



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649515 N: 4773489 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/26
 supervisor | SK
 reviewer | KJF



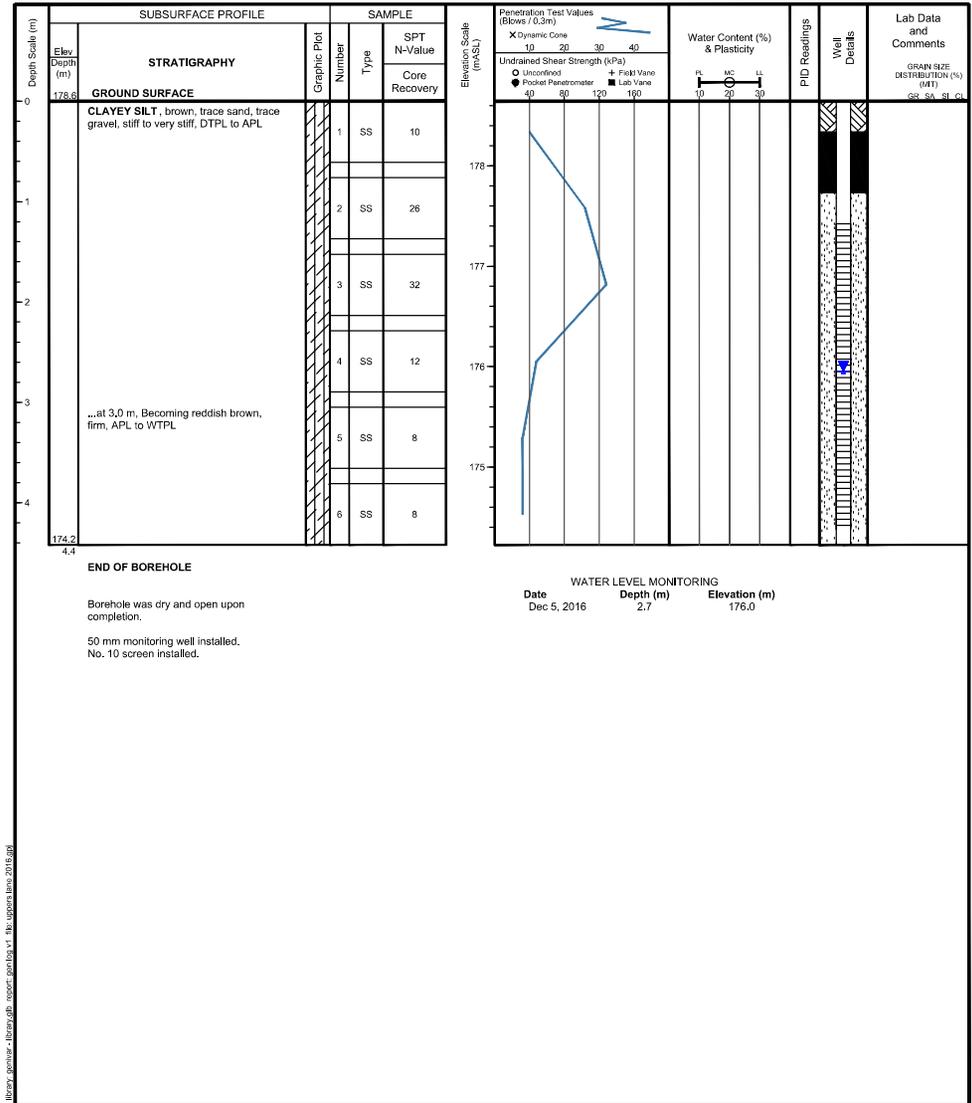
LOG OF BOREHOLE 11-3OBR



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649515 N: 4773486 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/10/27
 supervisor | SK
 reviewer | KJF



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libray_gponse-library.gbl_report_pontis_v1_16_uppers.lane.2016.pdf

LOG OF BOREHOLE 16-5A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649017 N: 4773470 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/28
 supervisor | SK
 reviewer | KJF

SUBSURFACE PROFILE		SAMPLE			Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Uncorrelated ● Pocket Penetrometer	Water Content (%) & Plasticity	Fracture Frequency	PID Readings	Well Details	Lab Data and Comments
Elev. Depth (m)	Graphic Plot	Number	Type	SPT N-Value Core Recovery						
GROUND SURFACE										
STRATIGRAPHY										
CLAVEY SILT For stratigraphic details, refer to 16-50B.										
at 5.2m below grade										
174.3	5.2	1	R1	TCR = 99% ROD = 19%	ERAMOSIA FORMATION, brownish-grey to grey dolostone, hard, fresh, medium to thin grained with saccharoidal texture, petroliferous odour when broken, thin to medium horizontal beds with occasional 2 mm thick shale layers. Rare stylolites and gypsum nodules. Approximately 3% vug content. ...Coarsely broken core recovery from 5.49 m to 6.10 m. ...Trace vugs below 7.16 m as 2-3 mm blebs, some encrusted. ...Thin calcite or fracture surface at 7.39 m. ...Trace 4 cm gypsum nodules below 9.70 m. ...Trace sharp lower contact of change in colour and texture.					
173.3	6.2	2	R2	TCR = 100% ROD = 9%						
171.8	7.7	3	R3	TCR = 87% ROD = 63%						
170.3	9.2	4	R4	TCR = 98% ROD = 83%						
168.7	10.7	5	R5	TCR = 100% ROD = 72%						
167.2	12.2	6	R8	TCR = 100% ROD = 94%						
165.6	13.8	7	R7	TCR = 98% ROD = 85%						
164.1	15.3	8	R8	TCR = 98% ROD = 88%						
162.7	16.7	9	R9	TCR = 98% ROD = 98%						
161.3	18.1	10	R10	TCR = 97% ROD = 97%						
159.7	19.7	11	R11	TCR = 100% ROD = 100%						
158.1	21.3	12	R12	TCR = 100% ROD = 85%						
156.5	22.9	13	R13	TCR = 100% ROD = 100%						
155.0	24.4	14	R14							
GOAT ISLAND FORMATION, dolostone, hard, grey, fine grained, fresh, occasional gypsum and chert nodules, weak petroliferous odour when broken, Rare fossil fragments, minor calcite and gypsum nodules. Occasional to common stylolites and shale partings 2 mm thick. Fracture surfaces clean. Medium bedded, ...Chert as 5 cm to 10 cm nodules from 14.47 m to 16.18 m, 2 to 3 % of core.										
GASPORT FORMATION, dolostone, hard, fresh, grey to dark grey, fine to medium grained fossiliferous dolostone with saccharoidal texture. Medium bedded with fossil fragments up to 6%, Stylolites shaly partings up to 3 mm, 2 per 1.5 m. Rare gypsum nodules, less than 1% by volume. ...2 cm very fine grained (graphite like) shale layer.										

(continued next page)

LOG OF BOREHOLE 16-5A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649017 N: 4773470 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/28
 supervisor | SK
 reviewer | KJF

SUBSURFACE PROFILE		SAMPLE			Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Uncorrelated ● Pocket Penetrometer	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments		
Elev. Depth (m)	Graphic Plot	Number	Type	SPT N-Value Core Recovery							
(continued)											
...2.5 cm chert nodule. ...Chert nodule, slightly chalky at 24.79 m.											
153.4	26.1	14	R14	TCR = 98% ROD = 98%	GASPORT FORMATION, dolostone, hard, fresh, grey to dark grey, fine to medium grained fossiliferous dolostone with saccharoidal texture. Medium bedded with fossil fragments up to 6%. Stylolites shaly partings up to 3 mm, 2 per 1.5 m. Rare gypsum nodules, less than 1% by volume. (continued) ...Noticably darker and more fossiliferous below 26.59 m.						
151.9	27.6	15	R15	TCR = 102% ROD = 95%							
150.4	29.1	16	R16	TCR = 100% ROD = 100%							
148.9	30.6	17	R17	TCR = 94% ROD = 87%							
147.7	31.8	18	R18	TCR = 102% ROD = 89%							
145.8	33.7	19	R19	TCR = 100% ROD = 100%							
DECEW FORMATION, dolostone, medium hard, dark grey, fine grained, fresh, argillaceous with occasional shale partings, 3 mm thick. ...Trace fossils below rhythmic bed at 33.02 m.											
END OF BOREHOLE											
Borehole was dry and open upon completion. 50 mm monitoring well installed. No. 10 screen installed.											
WATER LEVEL MONITORING Date Nov 17, 2016 Depth (m) 6.0 Elevation (m) 173.6											

LOG OF BOREHOLE 16-5AR



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649040 N: 4773471 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Solid stem augers, 150 mm dia.
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2017/07/10
 supervisor | SCL/SM
 reviewer | KJF

SUBSURFACE PROFILE		SAMPLE		Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Pocket Penetrometer + Fisk Vane ● Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments
Elev Depth (m)	STRATIGRAPHY	Graphic Plot Number	Type SPT N-Value Core Recovery					
0	GROUND SURFACE							
179.7	CLAYEY SILT							
	For stratigraphic details, refer to 16-50B.							
173.6	at 6.1m below grade							
173.6	ERAMOSIA FORMATION, brownish-grey to grey dolostone, hard, fresh, medium to thin grained with saccharoidal texture, petroliferous odour when broken, thin to medium horizontal beds with occasional 2 mm thick shale layers. Rare stylolites and gypsum nodules. Approximately 3% vug content.		R1 TCR = 84% ROD = 27%					
172.0			R2 TCR = 52% ROD = 50%					
170.5			R3 TCR = 100% ROD = 98%					
168.8	GOAT ISLAND FORMATION, dolostone, hard, grey, fine grained, fresh, occasional gypsum and chert nodules, weak petroliferous odour when broken, Rare fossil fragments, minor calcite and gypsum nodules. Occasional to common stylolites and shale partings 2 mm thick. Fracture surfaces clean. Medium bedded.		R4 TCR = 100% ROD = 68%					
167.4			R5 TCR = 100% ROD = 92%					
165.9			R6 TCR = 100% ROD = 95%					
164.3			R7 TCR = 100% ROD = 95%					
162.8	GASPORT FORMATION, dolostone, hard, fresh, grey to dark grey, fine to medium grained fossiliferous dolostone with saccharoidal texture. Medium bedded with fossil fragments up to 6%, Stylolites shaley partings up to 3 mm, 2 per 1.5 m, Rare gypsum nodules, less than 1% by volume.		R8 TCR = 100% ROD = 98%					
161.3			R9 TCR = 100% ROD = 100%					
159.8			R10 TCR = 98% ROD = 100%					
158.3			R11 TCR = 100% ROD = 85%					
156.7			R12 TCR = 100% ROD = 100%					
155.2			R13					

(continued next page)

LOG OF BOREHOLE 16-5AR



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649040 N: 4773471 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Solid stem augers, 150 mm dia.
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2017/07/10
 supervisor | SCL/SM
 reviewer | KJF

SUBSURFACE PROFILE		SAMPLE		Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Pocket Penetrometer + Fisk Vane ● Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments
Elev Depth (m)	STRATIGRAPHY	Graphic Plot Number	Type SPT N-Value Core Recovery					
25	(continued)							
153.7	GASPORT FORMATION, dolostone, hard, fresh, grey to dark grey, fine to medium grained fossiliferous dolostone with saccharoidal texture. Medium bedded with fossil fragments up to 6%, Stylolites shaley partings up to 3 mm, 2 per 1.5 m, Rare gypsum nodules, less than 1% by volume. (continued)		R13 TCR = 100% ROD = 100%					
152.2			R14 TCR = 99% ROD = 99%					
150.7			R15 TCR = 100% ROD = 100%					
149.1			R16 TCR = 97% ROD = 90%					
147.9	DECEW FORMATION, dolostone, medium hard, dark grey, fine grained, fresh, argillaceous with occasional shale partings; 3 mm thick.		R17 TCR = 103% ROD = 85%					
147.9	END OF BOREHOLE							
	Borehole was dry and open upon completion.							
	50 mm monitoring well installed. No. 10 screen installed.							

WATER LEVEL MONITORING
 Date Jul 14, 2017
 Depth (m) 5.2
 Elevation (m) 174.5

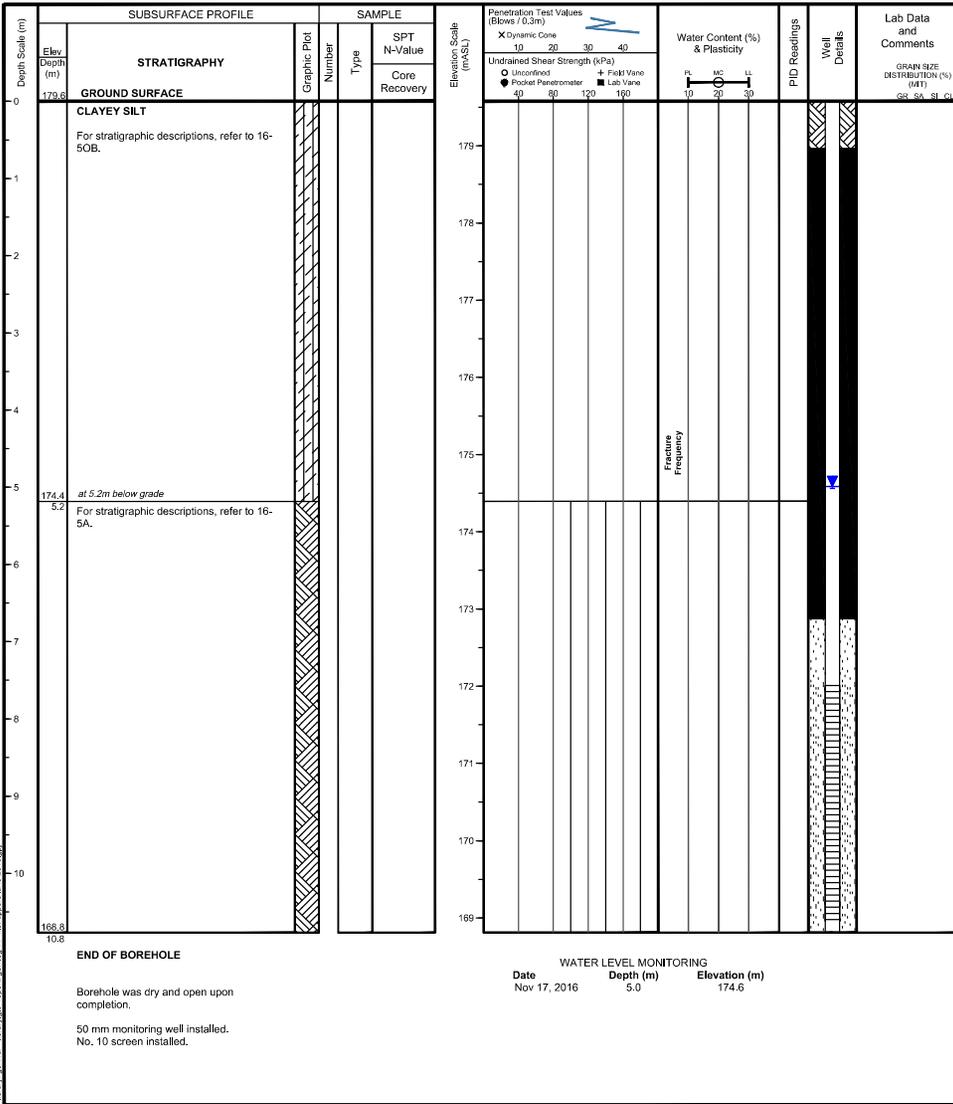
LOG OF BOREHOLE 16-5B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649015 N: 4773470 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/03
 supervisor | SK
 reviewer | KJF



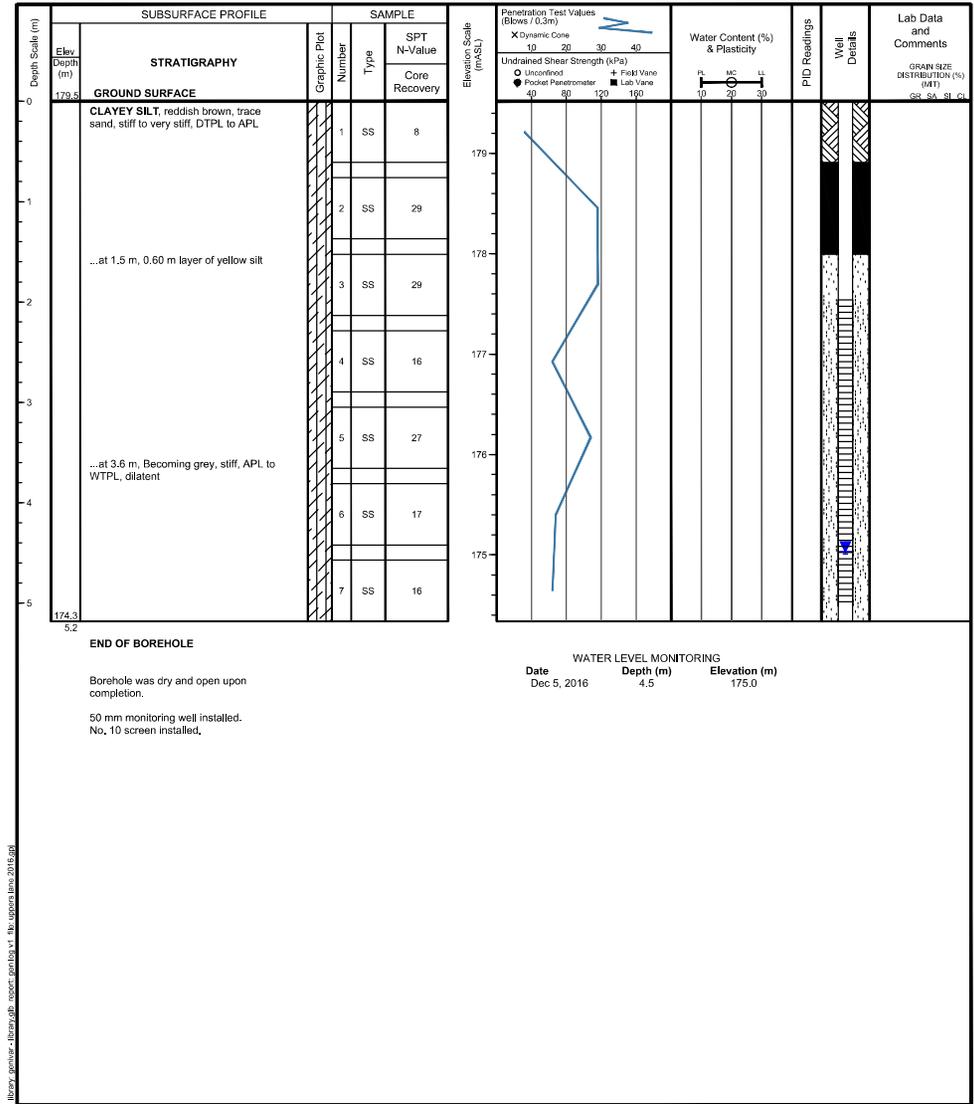
LOG OF BOREHOLE 16-50B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649014 N: 4773469 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/03
 supervisor | SK
 reviewer | KJF



LOG OF BOREHOLE 16-6A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649415 N: 4773168 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/19
 supervisor | SK
 reviewer | KJF

SUBSURFACE PROFILE		SAMPLE		Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Pocket Penetrometer + Frakt Vane ● Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments
Elev Depth (m)	STRATIGRAPHY	Graphic Plot Number	Type SPT N-Value Core Recovery					
0	GROUND SURFACE							
0	CLAYEY SILT							
0	For stratigraphic descriptions, refer to 16-60B.							
177.1	at 4.4m below grade							
4.4	ERAMOSA FORMATION, brownish-grey to grey dolostone, hard, fresh, medium to thin grained with saccharoidal texture, petroliferous odour when broken, thin to medium horizontal beds with occasional 2 mm thick shale layers. Rare stylolites and gypsum nodules. Approximately 3% vug content.	1	R1	TCR = 78% ROD = 42%				
175.4		2	R2	TCR = 100% ROD = 45%				
174.0		3	R3	TCR = 94% ROD = 63%				
172.4		4	R4	TCR = 100% ROD = 63%				
171.1	GOAT ISLAND FORMATION, dolostone, hard, grey, fine grained, fresh, occasional gypsum and chert nodules, weak petroliferous odour when broken. Rare fossil fragments, minor calcite and gypsum nodules. Occasional to common stylolites and shale partings 2 mm thick. Fracture surfaces clean, Medium bedded.	5	R5	TCR = 100% ROD = 89%				
169.3		6	R6	TCR = 100% ROD = 100%				
167.9		7	R7	TCR = 98% ROD = 82%				
166.4		8	R8	TCR = 100% ROD = 100%				
164.7		9	R9	TCR = 100% ROD = 83%				
163.2		10	R10	TCR = 100% ROD = 100%				
161.8		11	R11	TCR = 100% ROD = 100%				
160.2		12	R12	TCR = 100% ROD = 95%				
158.6		13	R13	TCR = 98% ROD = 92%				
157.1		14	R14					

(continued next page)

LOG OF BOREHOLE 16-6A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649415 N: 4773168 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/19
 supervisor | SK
 reviewer | KJF

SUBSURFACE PROFILE		SAMPLE		Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Pocket Penetrometer + Frakt Vane ● Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments
Elev Depth (m)	STRATIGRAPHY	Graphic Plot Number	Type SPT N-Value Core Recovery					
25	(continued)							
155.6	GASPORT FORMATION, dolostone, hard, fresh, grey to dark grey, fine to medium grained fossiliferous dolostone with saccharoidal texture. Medium bedded with fossil fragments up to 6%. Stylolites shaley partings up to 3 mm, 2 per 1.5 m. Rare gypsum nodules, less than 1% by volume. (continued)	14	R14	TCR = 100% ROD = 95%				
25.9		15	R15	TCR = 95% ROD = 95%				
154.0		16	R16	TCR = 100% ROD = 100%				
27.5		17	R17	TCR = 100% ROD = 100%				
152.6		18	R18	TCR = 100% ROD = 100%				
28.9								
151.1								
30.4								
149.6	END OF BOREHOLE							
31.9	Borehole was dry and open upon completion. 50 mm monitoring well installed. No. 10 screen installed.							
WATER LEVEL MONITORING Date: Nov 10, 2016 Depth (m): 4.1 Elevation (m): 177.4								

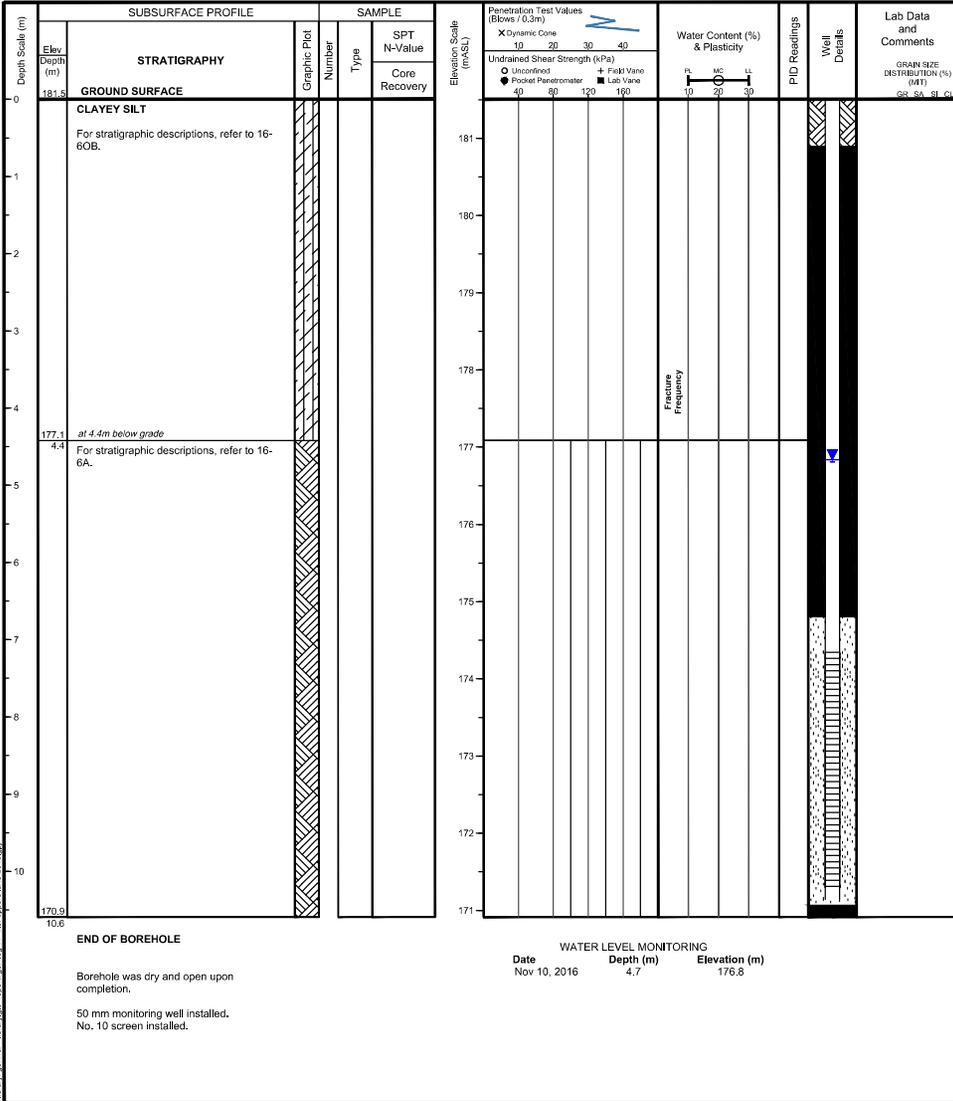
LOG OF BOREHOLE 16-6B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649413 N: 4773167 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/24
 supervisor | SK
 reviewer | KJF



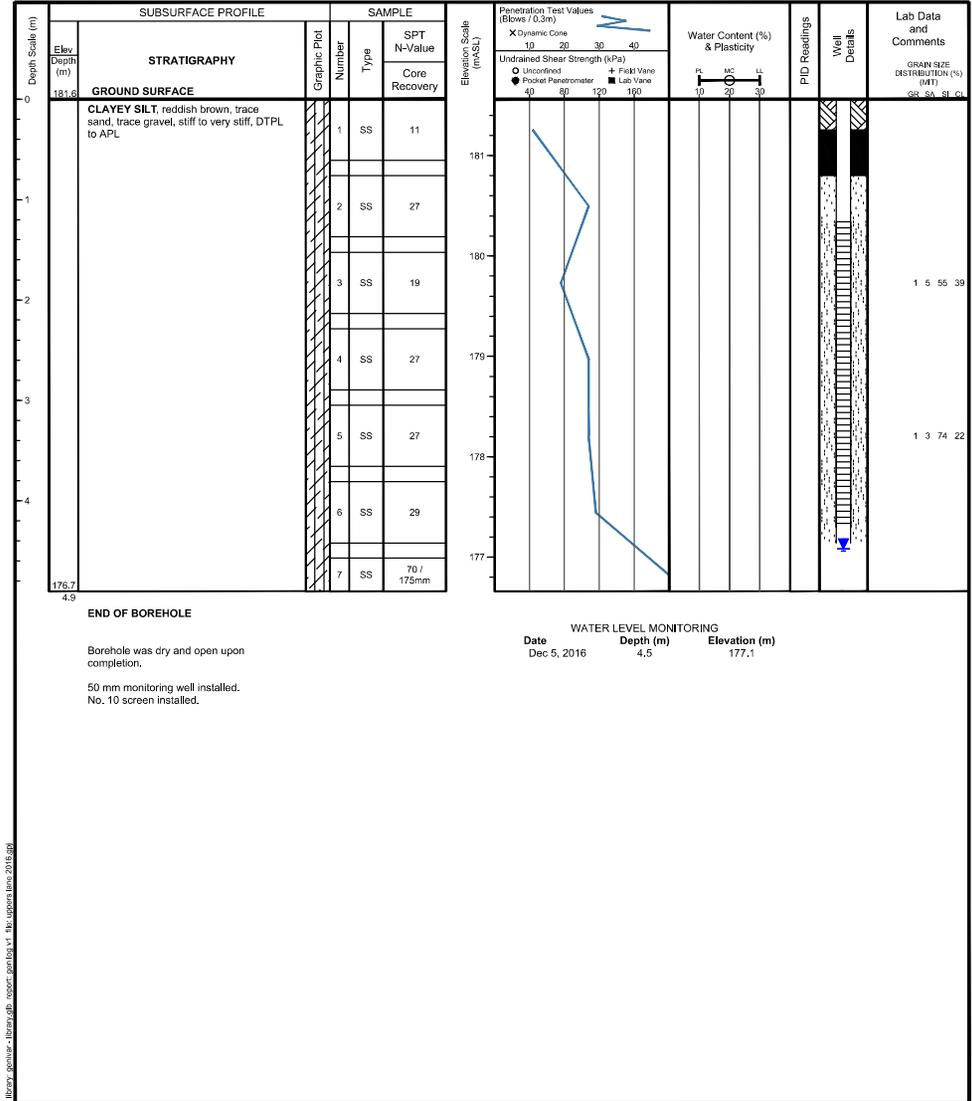
LOG OF BOREHOLE 16-60B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649412 N: 4773167 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/10/24
 supervisor | SK
 reviewer | KJF



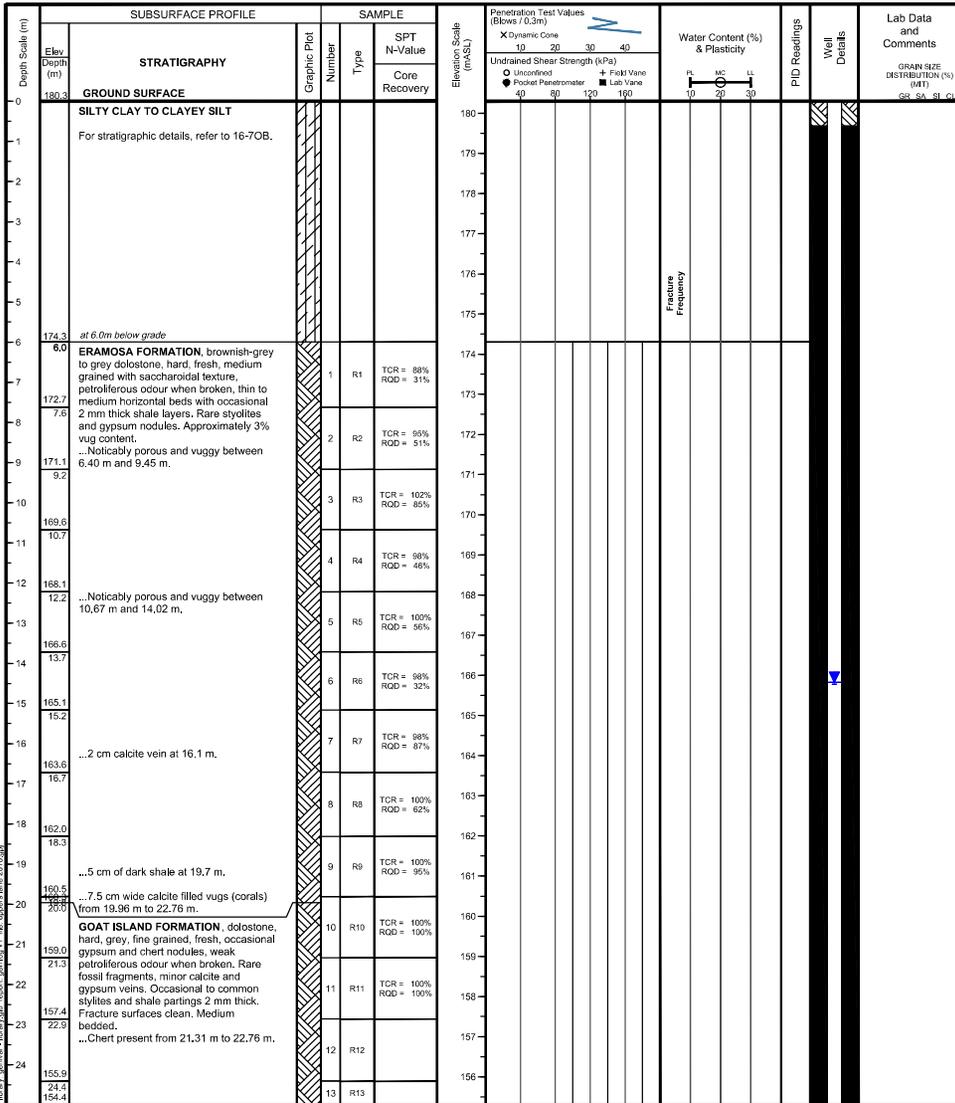
LOG OF BOREHOLE 16-7A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649147 N: 4772486 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/18
 supervisor | SK
 reviewer | KJF



(continued next page)

Sheet No. 1 of 2

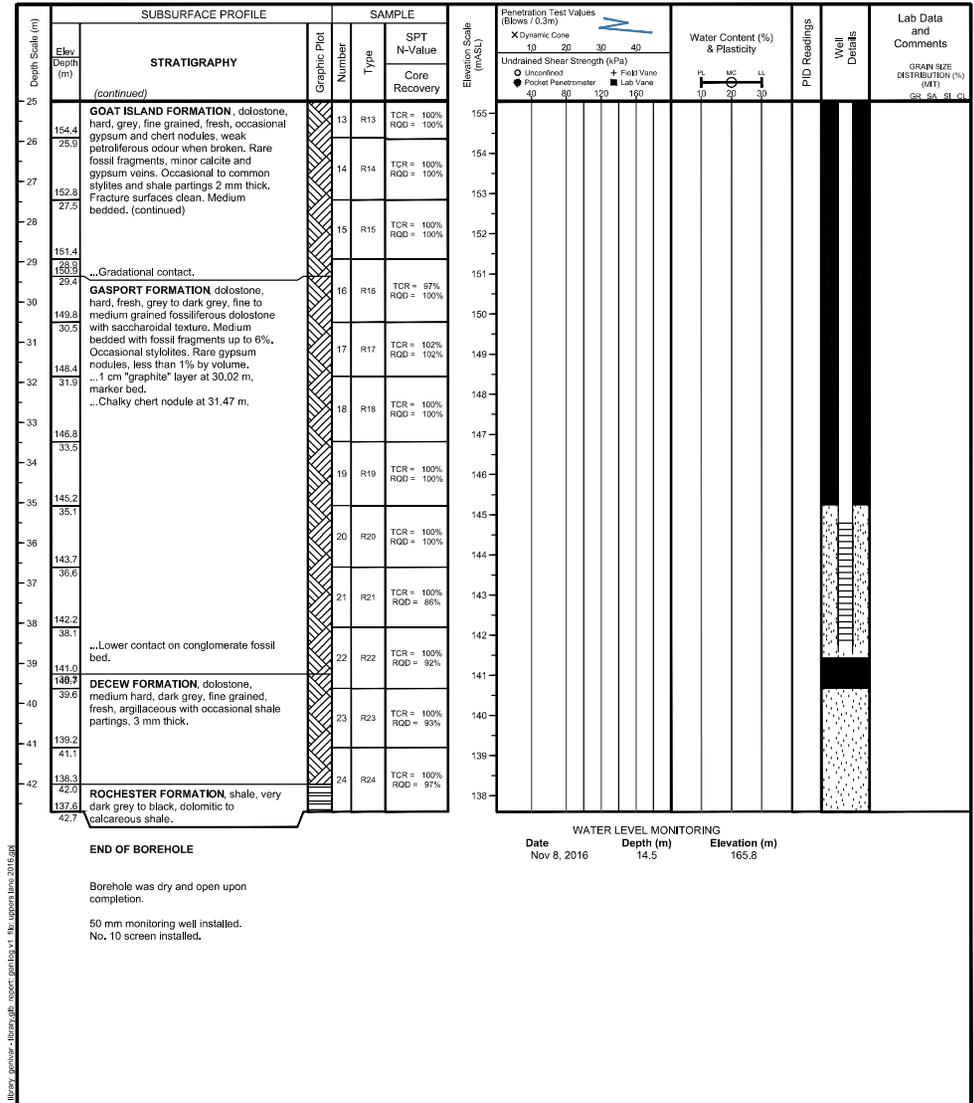
LOG OF BOREHOLE 16-7A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649147 N: 4772486 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/18
 supervisor | SK
 reviewer | KJF



Sheet No. 2 of 2

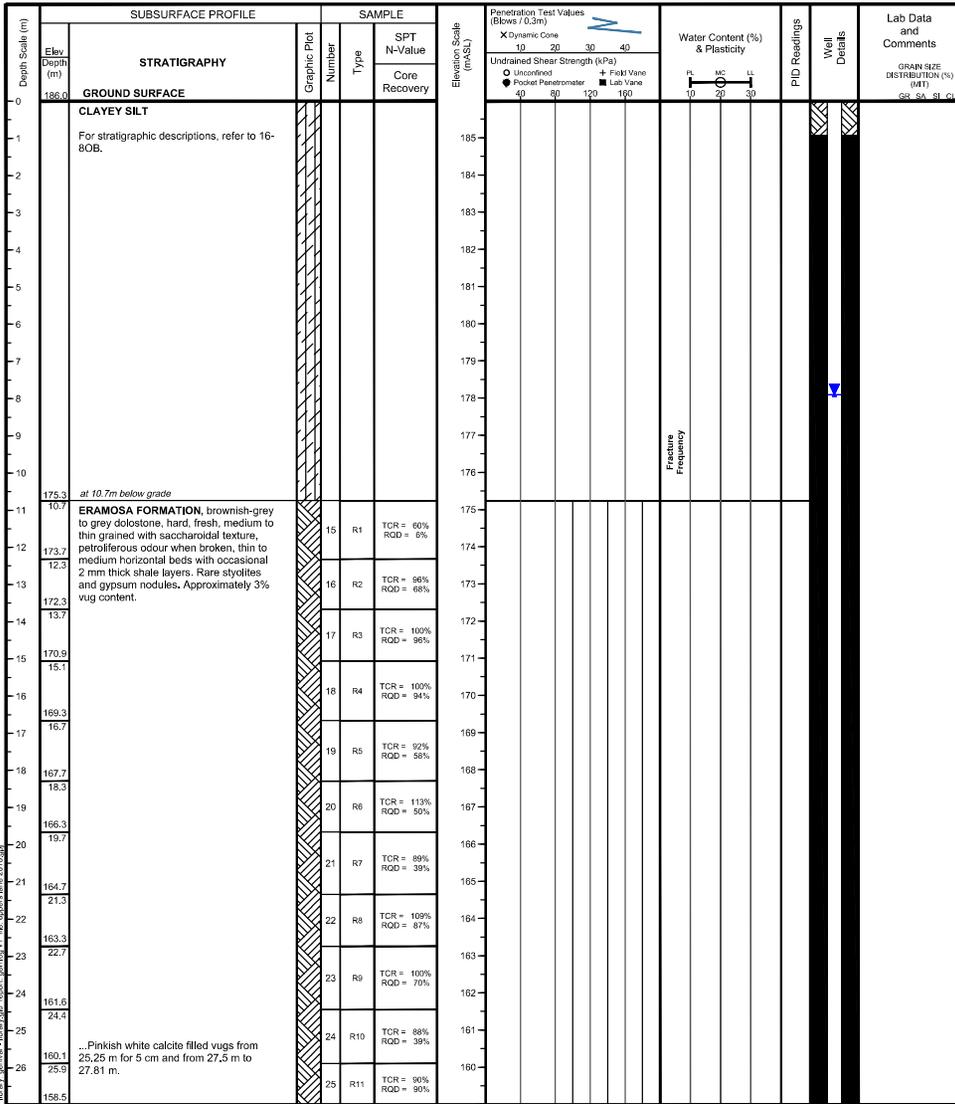
LOG OF BOREHOLE 16-8A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648272 N: 4772003 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/04
 supervisor | SK
 reviewer | KJF



(continued next page)

Sheet No. 1 of 2

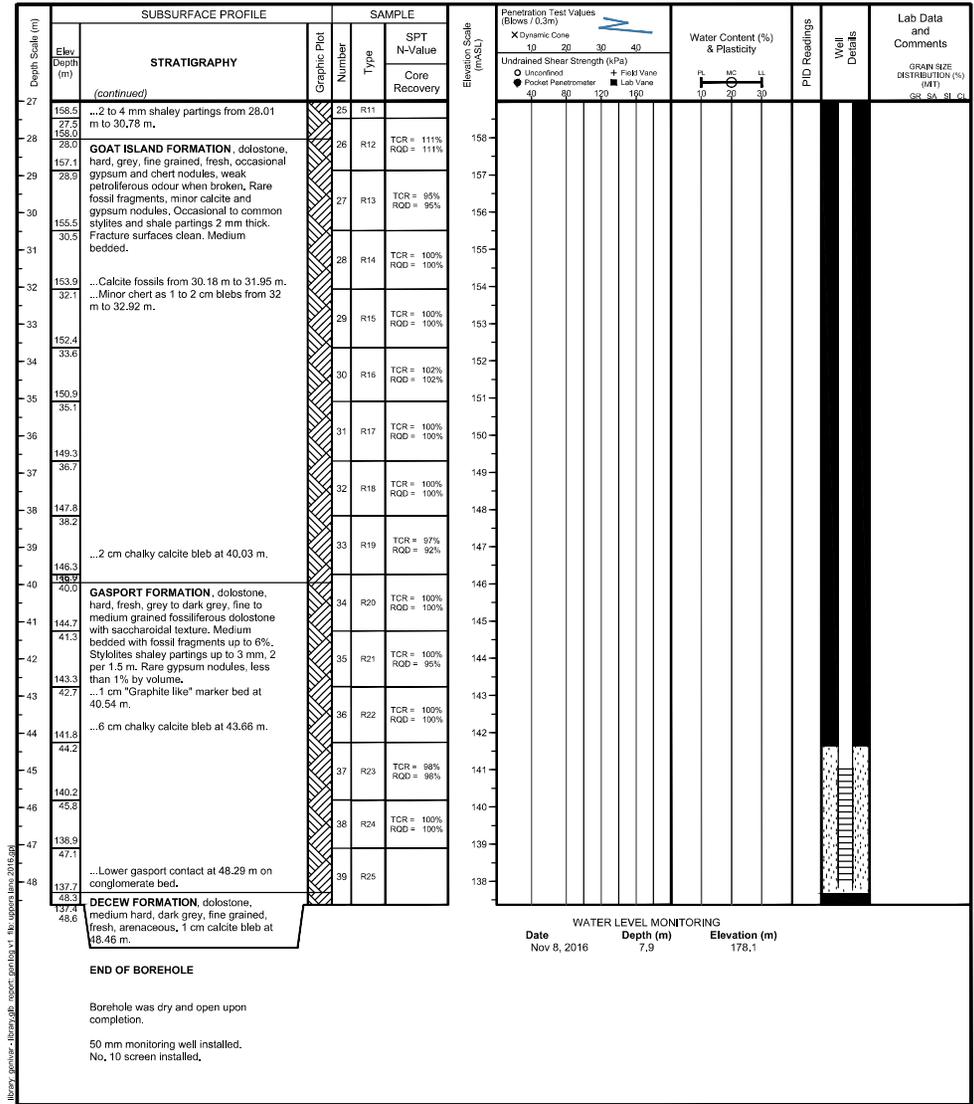
LOG OF BOREHOLE 16-8A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648272 N: 4772003 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/04
 supervisor | SK
 reviewer | KJF



END OF BOREHOLE

Borehole was dry and open upon completion.

50 mm monitoring well installed. No, 10 screen installed.

WATER LEVEL MONITORING
 Date Nov 8, 2016
 Depth (m) 7.9
 Elevation (m) 178.1

Sheet No. 2 of 2

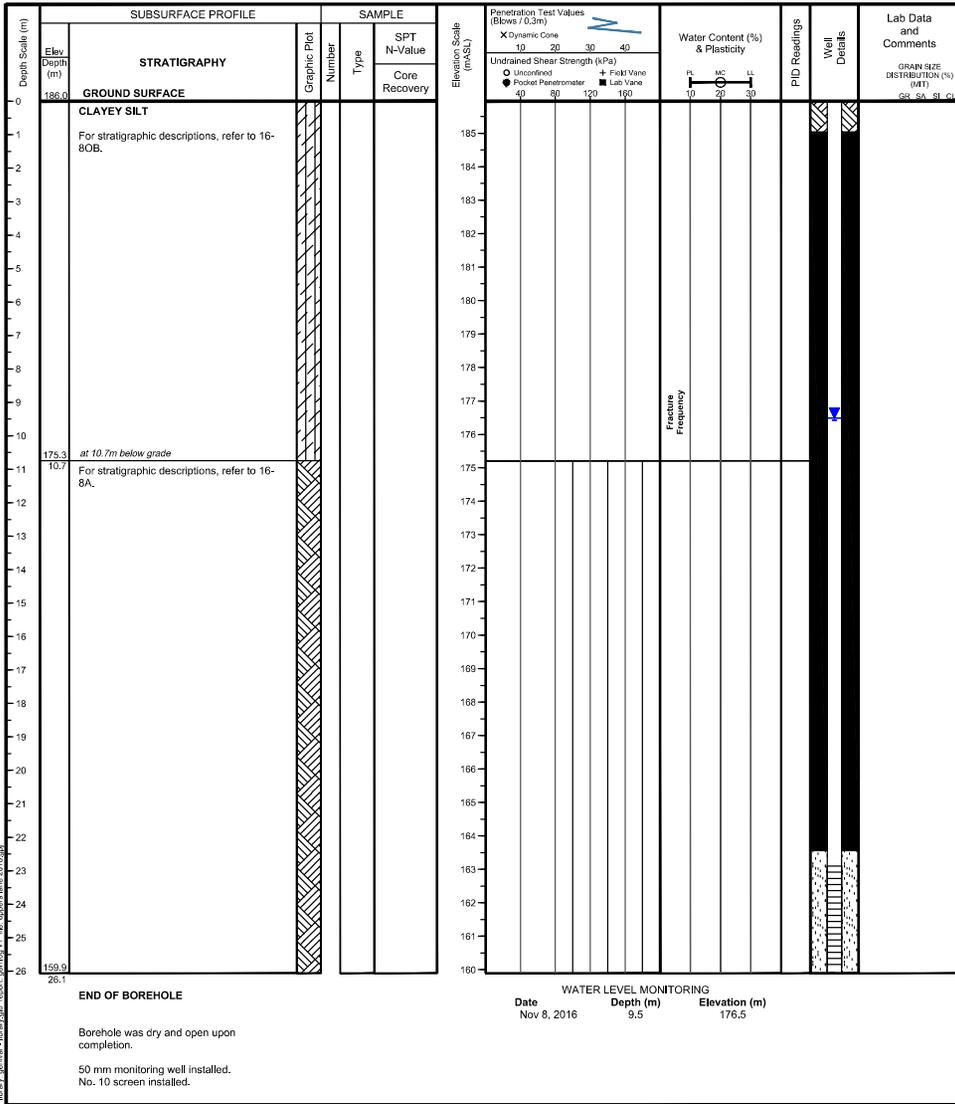
LOG OF BOREHOLE 16-8B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648270 N: 4772003 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/10/11
 supervisor | SK
 reviewer | KJF



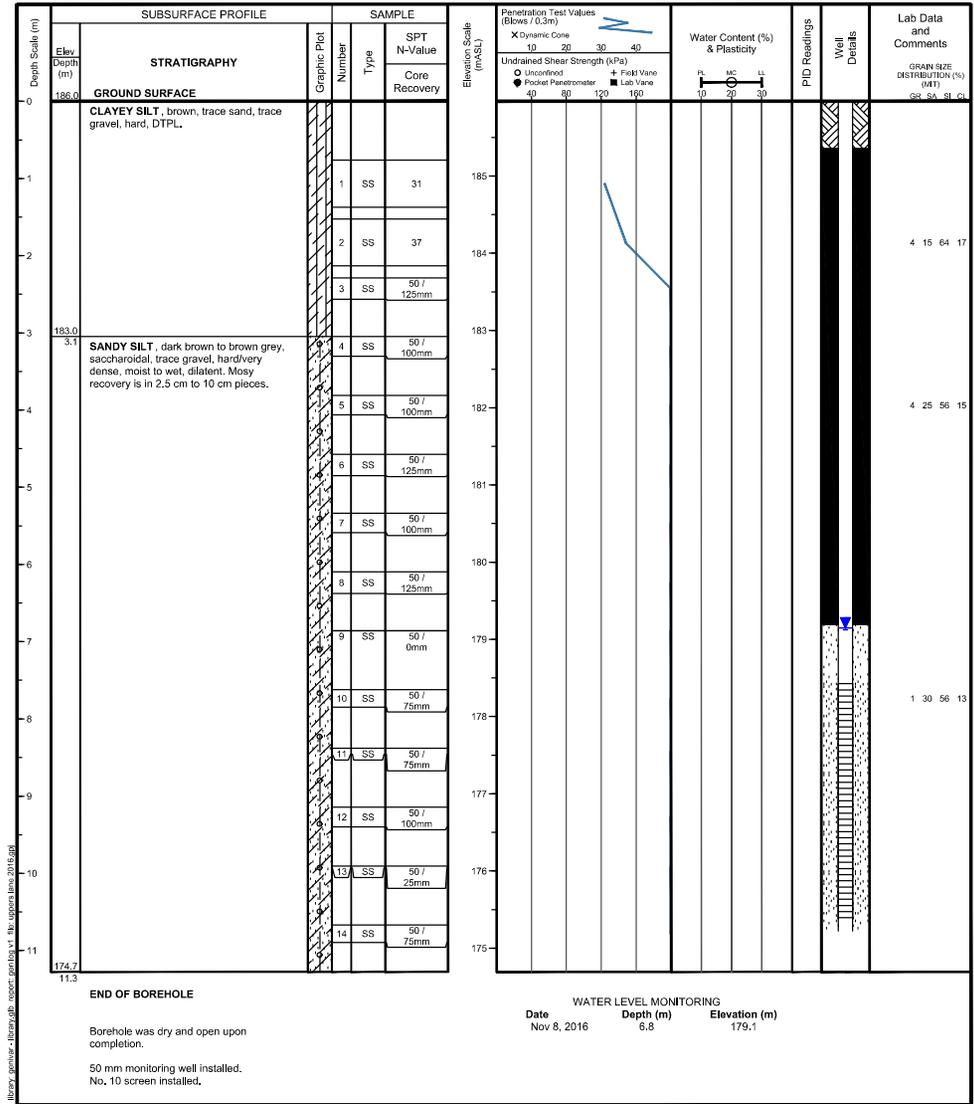
LOG OF BOREHOLE 16-80B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648269 N: 4772003 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/10/04
 supervisor | SK
 reviewer | KJF



LOG OF BOREHOLE 16-9A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648258 N: 4773007 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/18
 supervisor | SK
 reviewer | KJF

SUBSURFACE PROFILE			SAMPLE			Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Uncorrelated ● Pocket Penetrometer + Fskt Vane ■ Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (M1) GS SA SI CL
Elev. Depth (m)	Graphic Plot	SPT N-Value Core Recovery	Number	Type	TCR = % ROD = %					
0	GROUND SURFACE									
0	CLAYEY SILT									
1	For stratigraphic descriptions, refer to 16-90B.									
7	at 7.2m below grade									
7.2	ERAMOSIA FORMATION, brownish-grey to grey dolostone, hard, fresh, medium to thin grained with saccharoidal texture, petroliferous odour when broken, thin to medium horizontal beds with occasional 2 mm thick shale layers. Rare stylolites and gypsum nodules. Approximately 3% vug content.	1	R1	TCR = 100% ROD = 0%						
7.7		2	R2	TCR = 88% ROD = 74%						
8.2		3	R3	TCR = 100% ROD = 82%						
10.8		4	R4	TCR = 95% ROD = 44%						
12.3		5	R5	TCR = 100% ROD = 22%						
13.8		6	R6	TCR = 100% ROD = 89%						
15.4		7	R7	TCR = 58% ROD = 89%						
16.9		8	R8	TCR = 100% ROD = 81%						
18.4		9	R9	TCR = 100% ROD = 100%						
20.0		10	R10	TCR = 97% ROD = 97%						
21.5		11	R11	TCR = 100% ROD = 100%						
22.9		12	R12	TCR = 100% ROD = 88%						
24.0		13	R13							
24.0	GOAT ISLAND FORMATION, dolostone, hard, grey, fine grained, fresh, occasional gypsum and chert nodules, weak petroliferous odour when broken. Rare fossil fragments, minor calcite as 1.25 cm to 3.8 cm nodules. Occasional to common stylolites and shale partings 2 mm thick. Fracture surfaces clean. Medium bedded. ...Three 1-3 cm nodules at 23.48 m to 22.53 m.									

(continued next page)

Sheet No. 1 of 2

LOG OF BOREHOLE 16-9A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648258 N: 4773007 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/18
 supervisor | SK
 reviewer | KJF

SUBSURFACE PROFILE			SAMPLE			Penetration Test Values (Blows / 0.3m) X Dynamic Cone Undrained Shear Strength (kPa) ● Uncorrelated ● Pocket Penetrometer + Fskt Vane ■ Lab Vane	Water Content (%) & Plasticity	PID Readings	Well Details	Lab Data and Comments GRAIN SIZE DISTRIBUTION (%) (M1) GS SA SI CL
Elev. Depth (m)	Graphic Plot	SPT N-Value Core Recovery	Number	Type	TCR = % ROD = %					
25	(continued)									
25.0	GOAT ISLAND FORMATION, dolostone, hard, grey, fine grained, fresh, occasional gypsum and chert nodules, weak petroliferous odour when broken. Rare fossil fragments, minor calcite as 1.25 cm to 3.8 cm nodules. Occasional to common stylolites and shale partings 2 mm thick. Fracture surfaces clean. Medium bedded. (continued)	13	R13	TCR = 100% ROD = 100%						
26.0		14	R14	TCR = 100% ROD = 100%						
27.6		15	R15	TCR = 102% ROD = 192%						
29.3		16	R16	TCR = 100% ROD = 100%						
30.6		17	R17	TCR = 100% ROD = 100%						
32.2		18	R18	TCR = 100% ROD = 100%						
33.7		19	R19	TCR = 100% ROD = 100%						
35.2		20	R20	TCR = 100% ROD = 100%						
36.7		21	R21	TCR = 100% ROD = 100%						
38.2		22	R22	TCR = 100% ROD = 100%						
39.8		23	R23	TCR = 100% ROD = 95%						
41.3		DECEW FORMATION, dolostone, medium hard, dark grey, fine grained, fresh, argillaceous with occasional shale partings, 3 mm thick.								
41.3		END OF BOREHOLE								

WATER LEVEL MONITORING
 Date Nov 25, 2016 Depth (m) 5.3 Elevation (m) 176.7

Borehole was dry and open upon completion.

50 mm monitoring well installed.
 No. 10 screen installed.

library: geoscan - library.gdb, report: points.txt file: uppers.lane.2016.gdb

Sheet No. 2 of 2

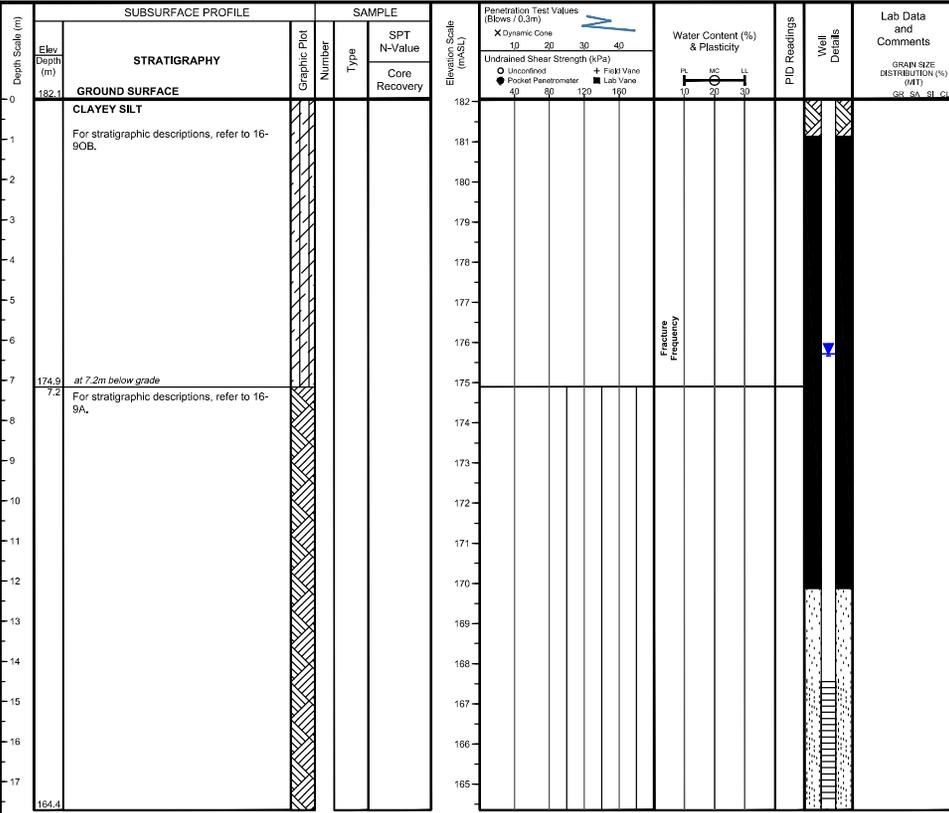
LOG OF BOREHOLE 16-9B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648259 N: 4773006 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/22
 supervisor | SK
 reviewer | KJF



WATER LEVEL MONITORING
 Date: Nov 25, 2016
 Depth (m): 6.3
 Elevation (m): 175.7

Borehole was dry and open upon completion.
 50 mm monitoring well installed.
 No. 10 screen installed.

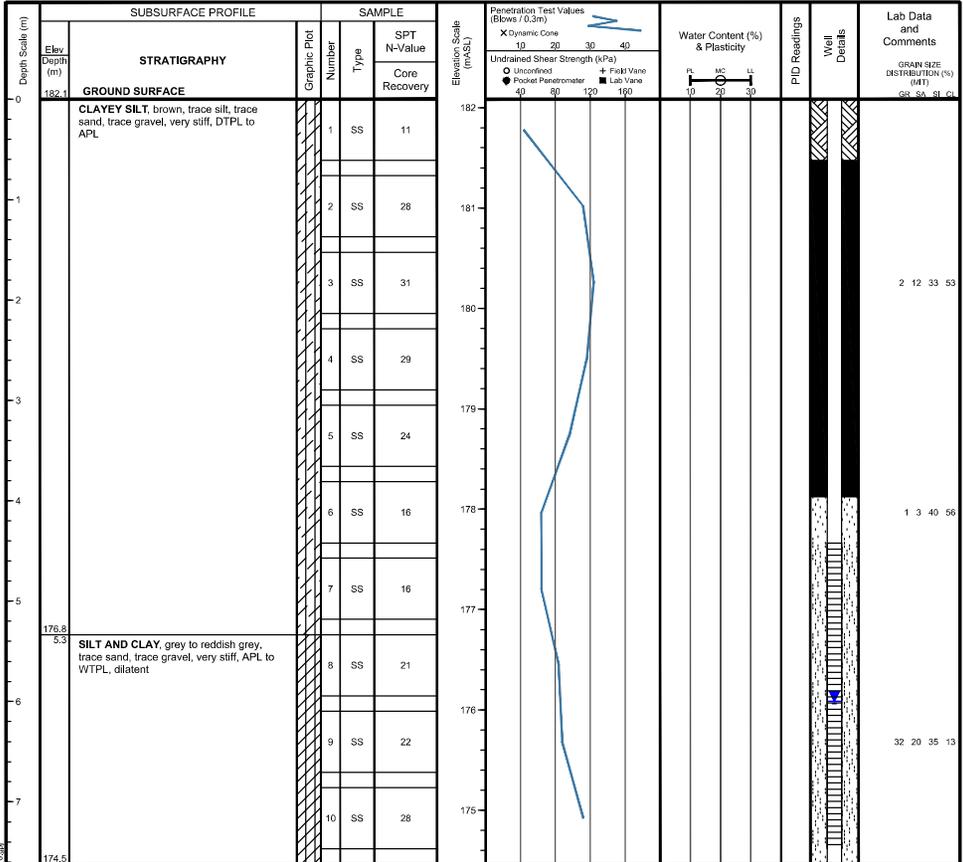
LOG OF BOREHOLE 16-90B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648261 N: 4773005 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/23
 supervisor | SK
 reviewer | KJF



WATER LEVEL MONITORING
 Date: Dec 7, 2016
 Depth (m): 6.0
 Elevation (m): 176.1

Borehole was dry and open upon completion.
 50 mm monitoring well installed.
 No. 10 screen installed.

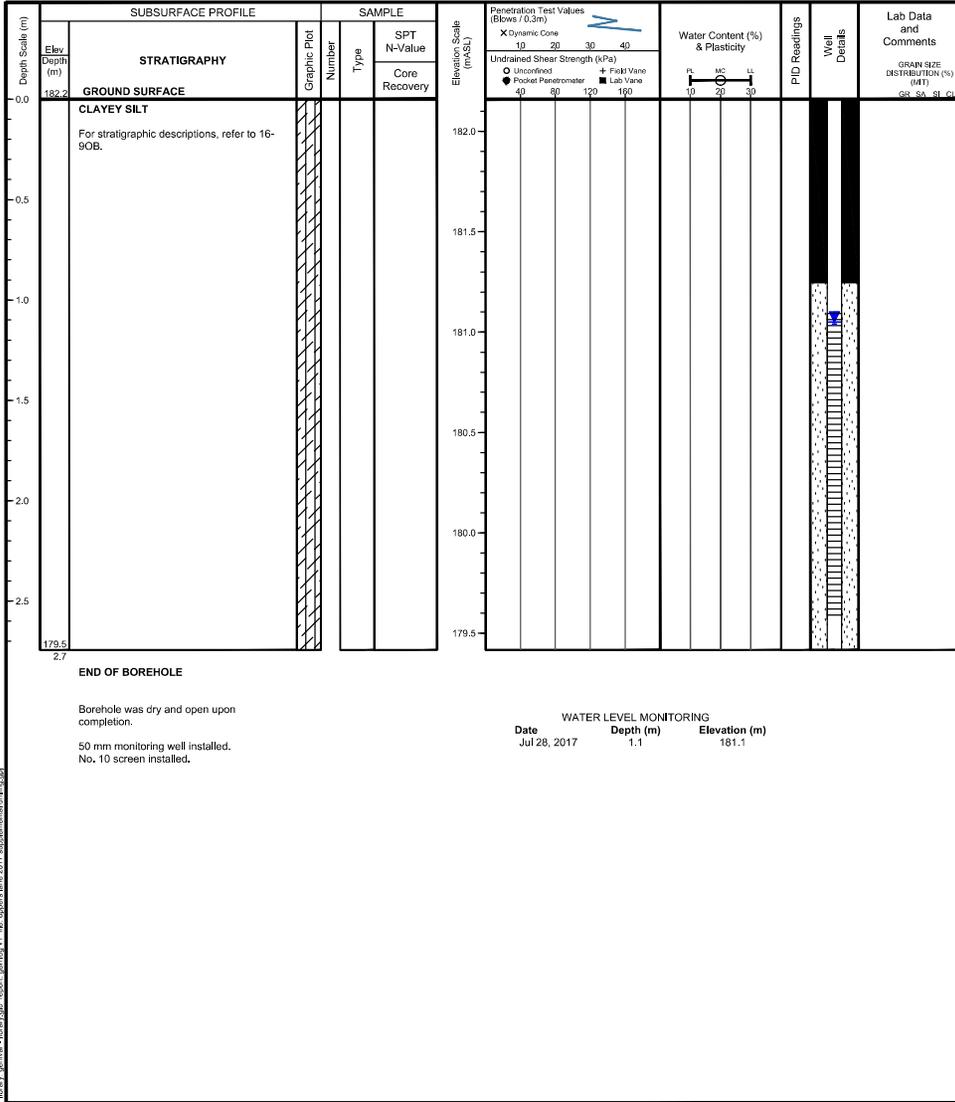
LOG OF BOREHOLE 16-9SP



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648263 N: 4773003 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2017/07/26
 supervisor | SCL
 reviewer | KJF



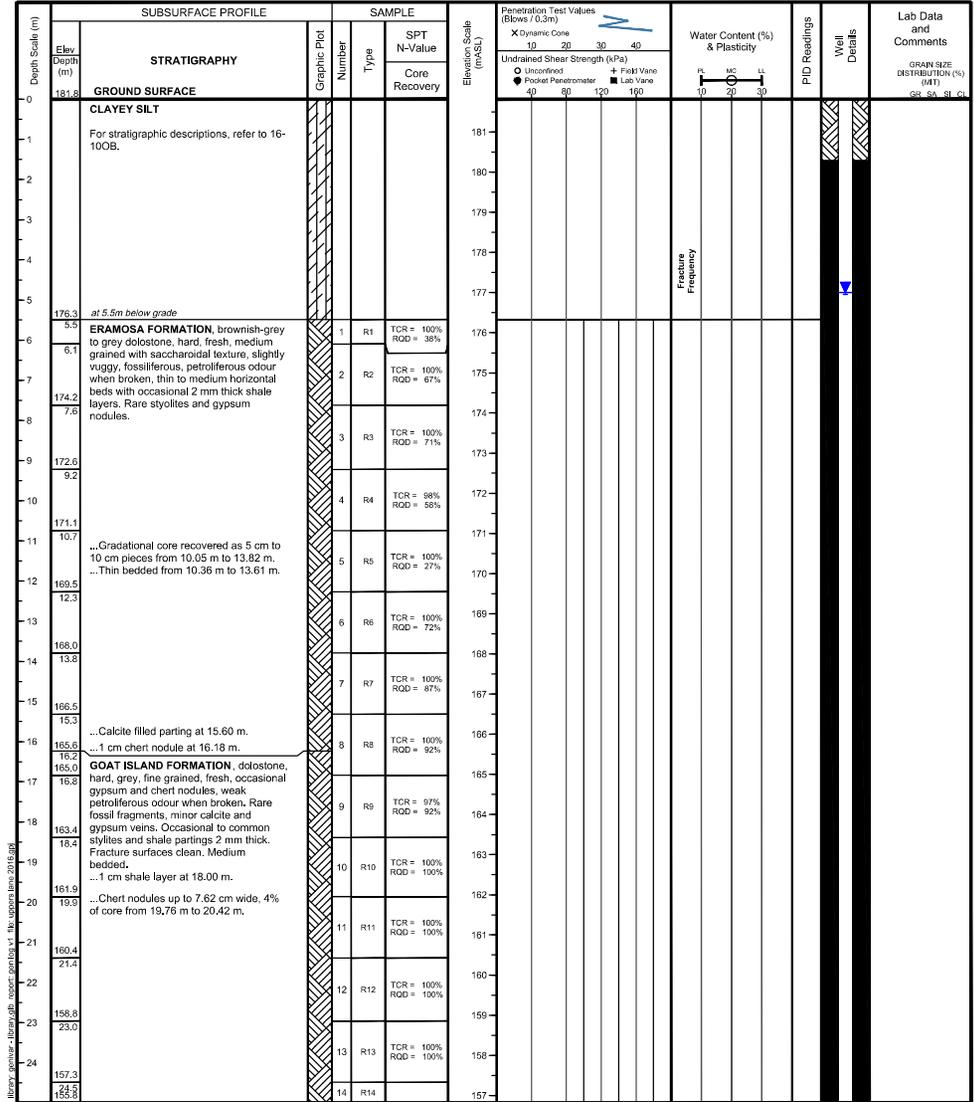
LOG OF BOREHOLE 16-10A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648212 N: 4773549 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/24
 supervisor | SK
 reviewer | KJF



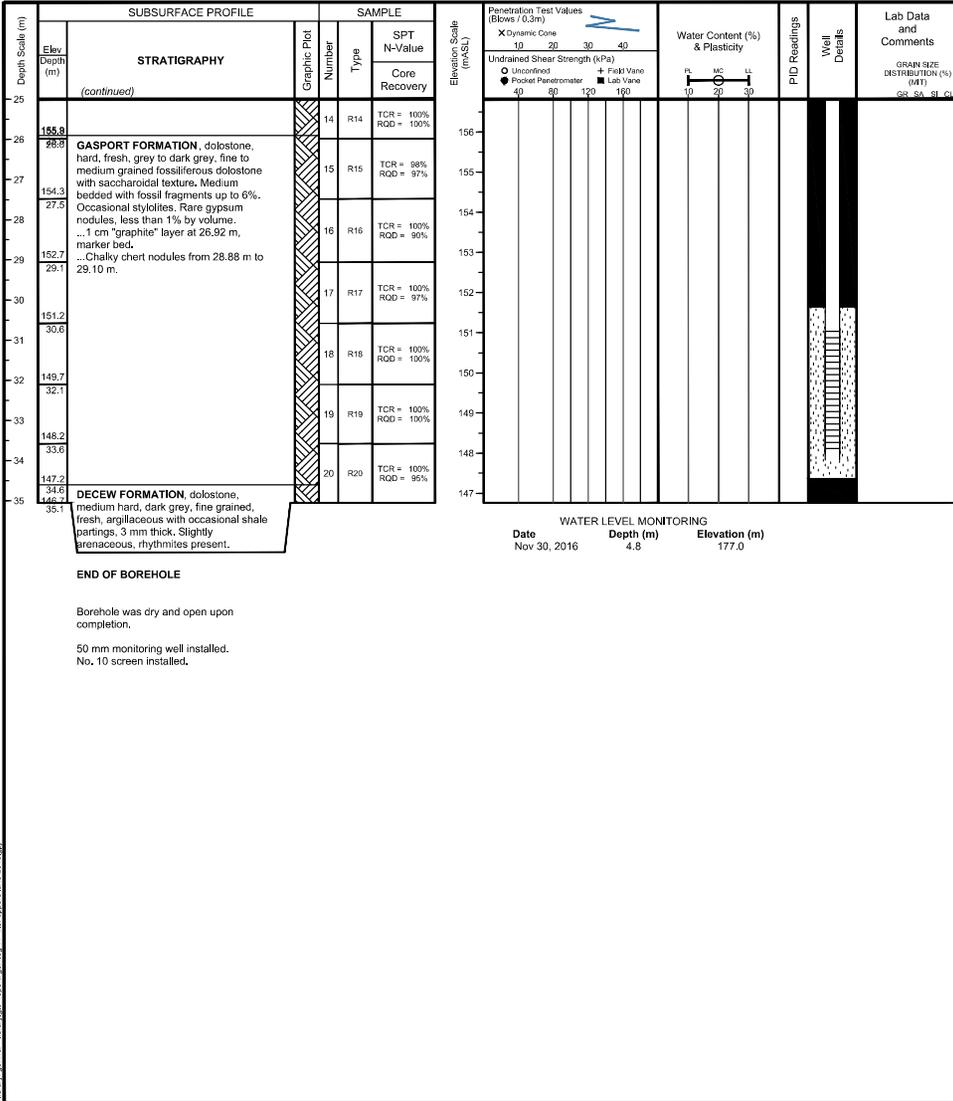
LOG OF BOREHOLE 16-10A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648212 N: 4773549 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/24
 supervisor | SK
 reviewer | KJF



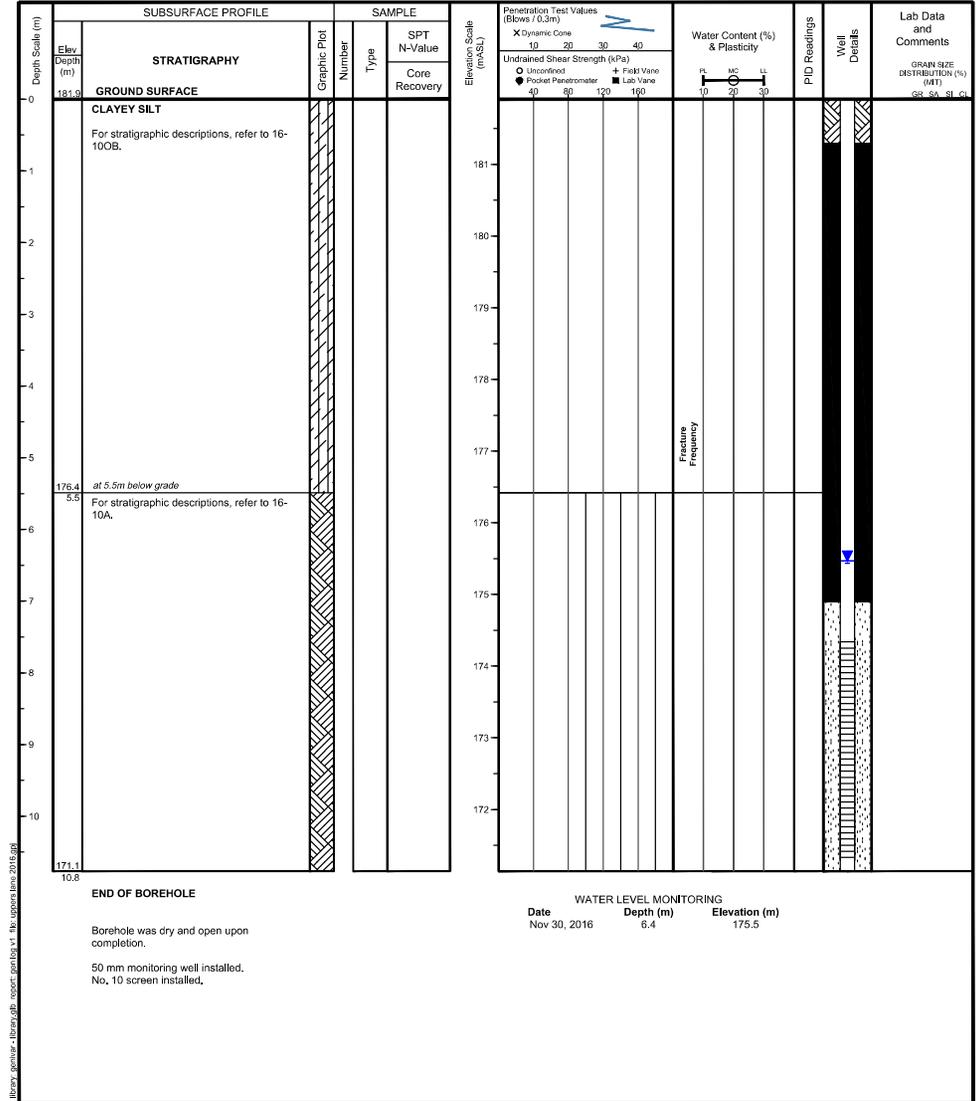
LOG OF BOREHOLE 16-10B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648212 N: 4773547 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/28
 supervisor | SK
 reviewer | KJF



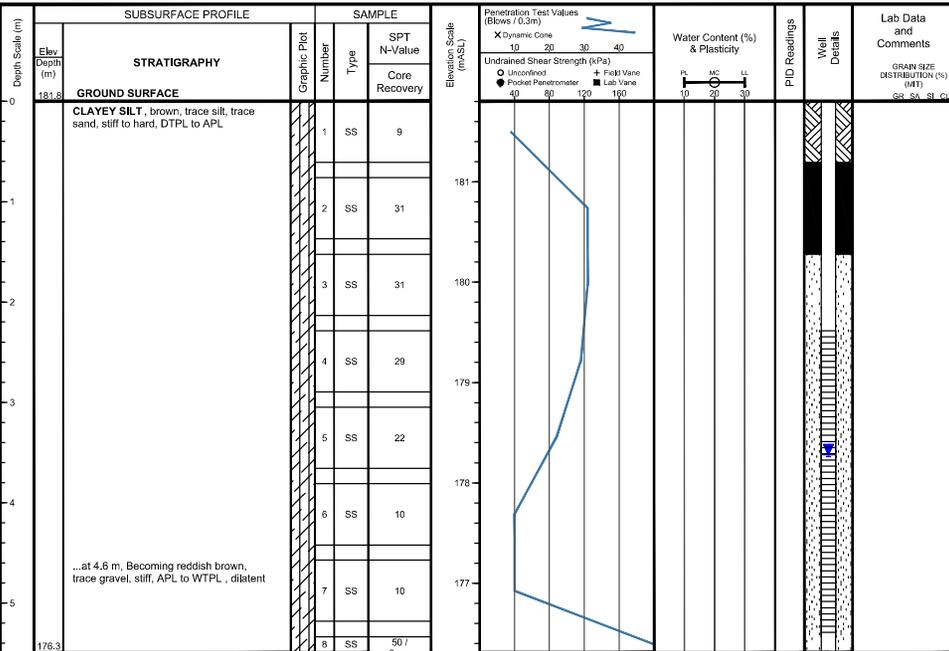
LOG OF BOREHOLE 16-100B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648212 N: 4773550 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/23
 supervisor | SK
 reviewer | KJF



END OF BOREHOLE

Borehole was dry and open upon completion.

50 mm monitoring well installed.
No. 10 screen installed.

WATER LEVEL MONITORING

Date	Depth (m)	Elevation (m)
Dec 7, 2016	3.5	178.3

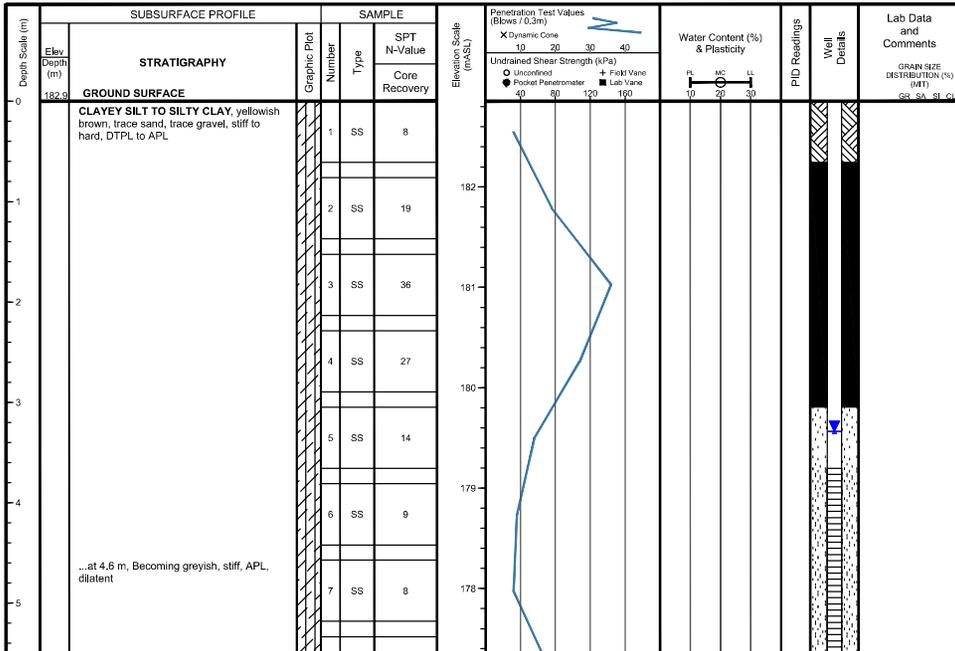
LOG OF BOREHOLE 16-11



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648503 N: 4773178 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/08
 supervisor | SK
 reviewer | KJF



END OF BOREHOLE

Borehole was dry and open upon completion.

50 mm monitoring well installed.
No. 10 screen installed.

WATER LEVEL MONITORING

Date	Depth (m)	Elevation (m)
Nov 10, 2016	3.3	179.6

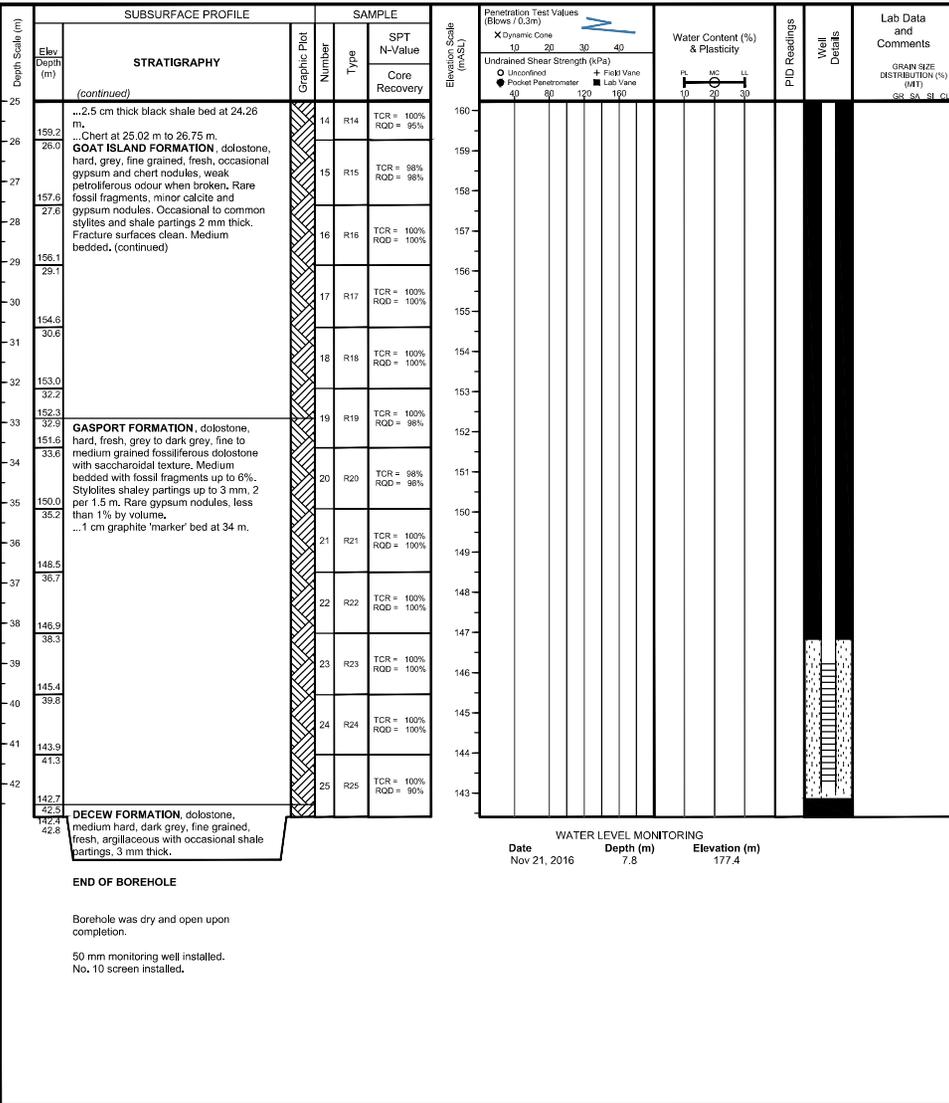
LOG OF BOREHOLE 16-13A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648513 N: 4772784 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/11
 supervisor | SK
 reviewer | KJF



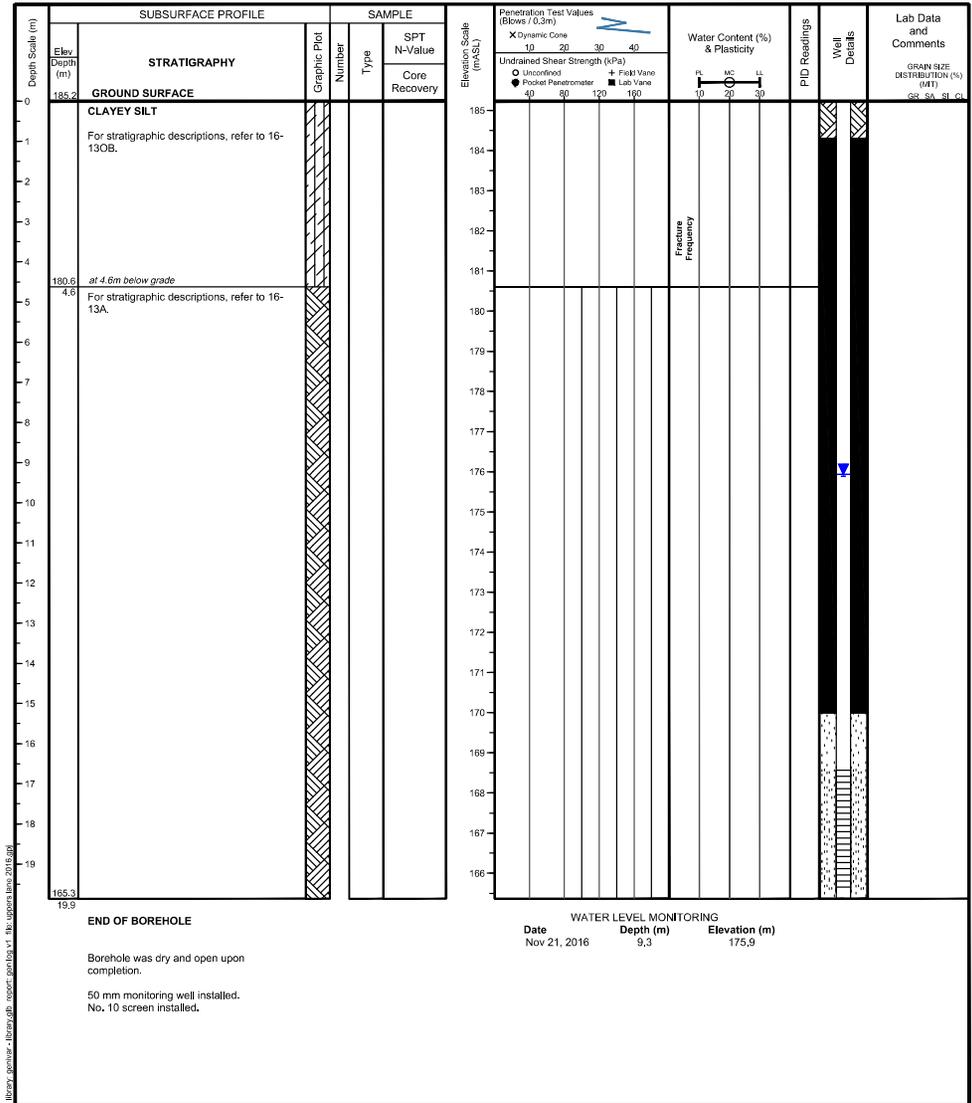
LOG OF BOREHOLE 16-13B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648513 N: 4772783 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/16
 supervisor | SK
 reviewer | KJF



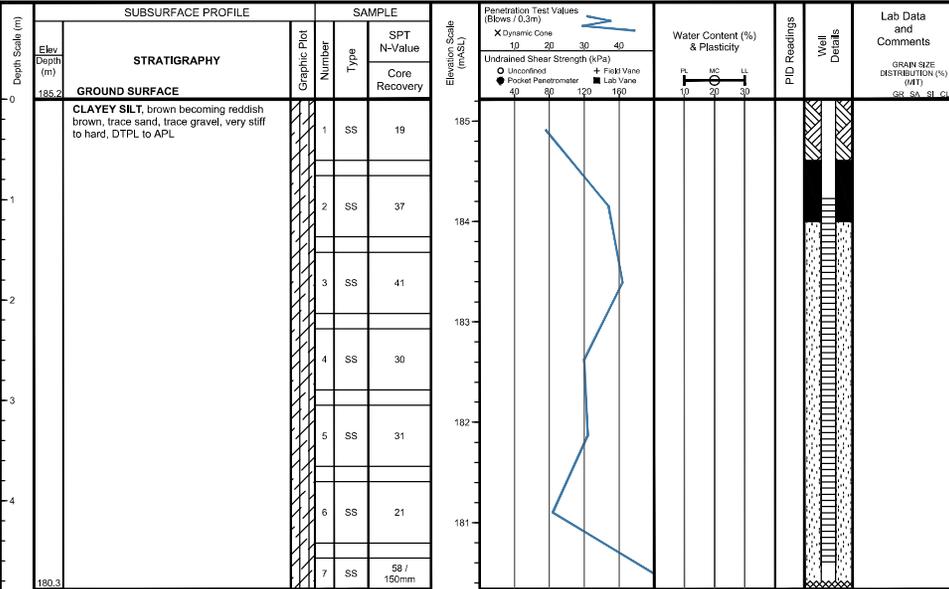
LOG OF BOREHOLE 16-130B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648513 N: 4772782 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/17
 supervisor | SK
 reviewer | KJF



END OF BOREHOLE

Borehole was dry and open upon completion.
 50 mm monitoring well installed.
 No. 10 screen installed.

WATER LEVEL MONITORING

Date	Depth (m)	Elevation (m)
Dec 5, 2016	dry	n/a

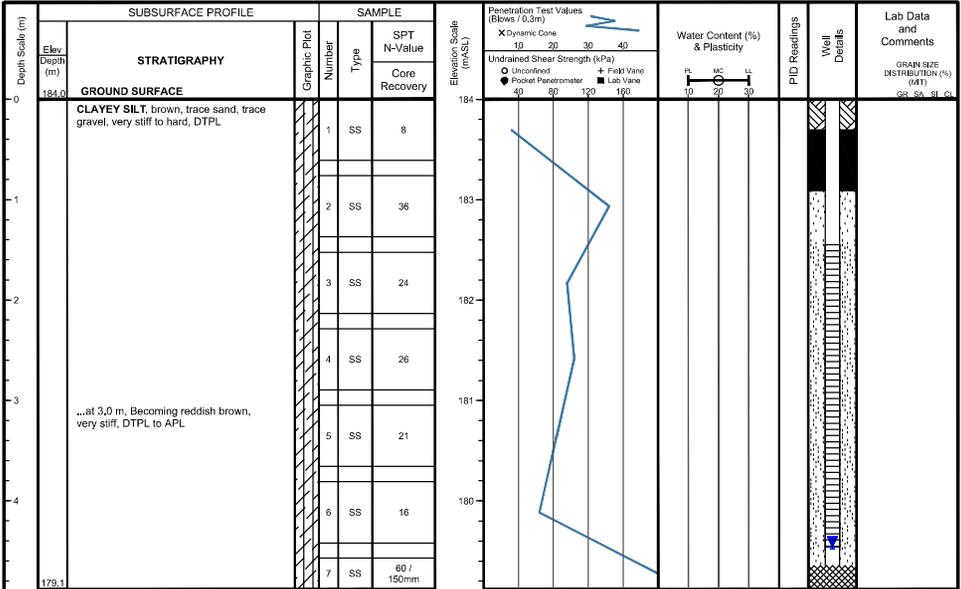
LOG OF BOREHOLE 16-14



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648520 N: 4772609 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/10
 supervisor | SK
 reviewer | KJF



END OF BOREHOLE

Borehole was dry and open upon completion.
 50 mm monitoring well installed.
 No. 10 screen installed.

WATER LEVEL MONITORING

Date	Depth (m)	Elevation (m)
Dec 6, 2016	4.5	179.5

library:\genuser-library\geotech\report\portlog.v1_16_uppers\line 2016_08

library:\genuser-library\geotech\report\portlog.v1_16_uppers\line 2016_08

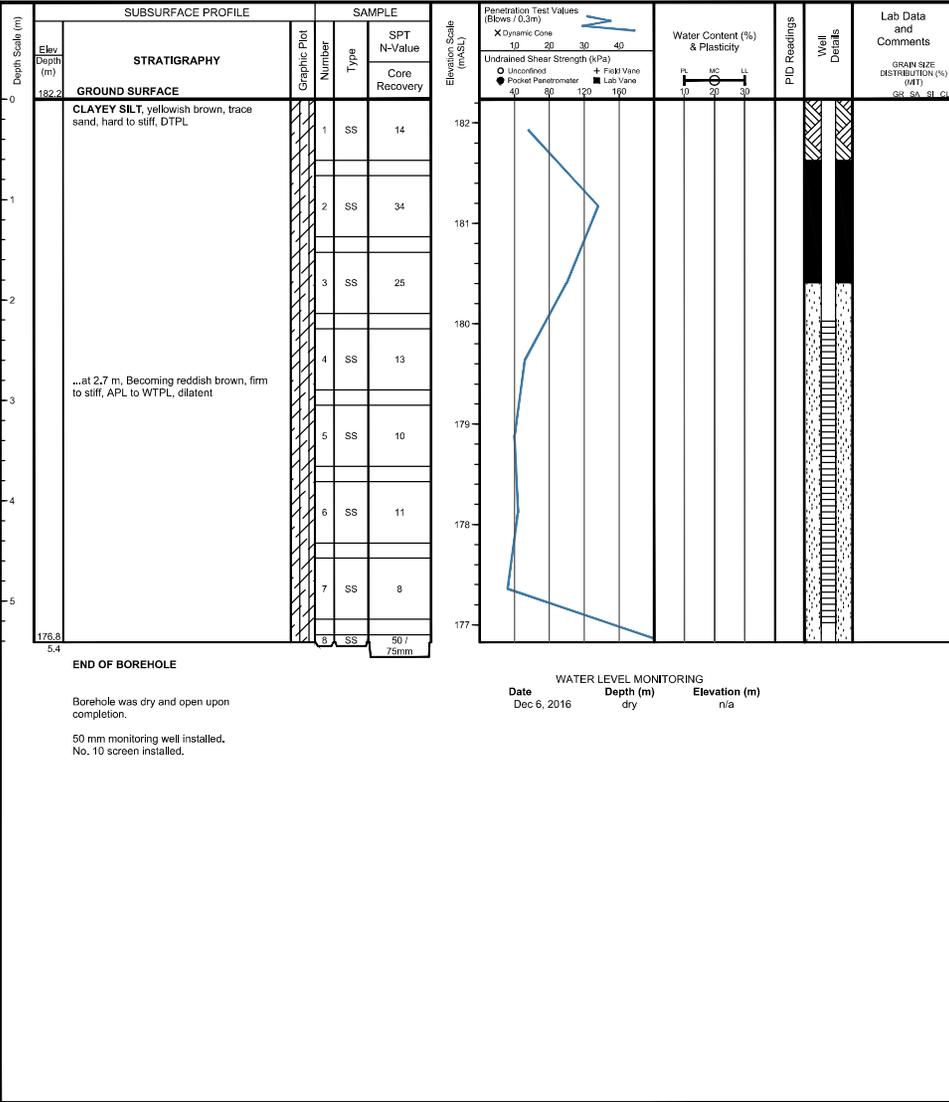
LOG OF BOREHOLE 16-15



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648524 N: 4772420 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/10/13
 supervisor | SK
 reviewer | KJF



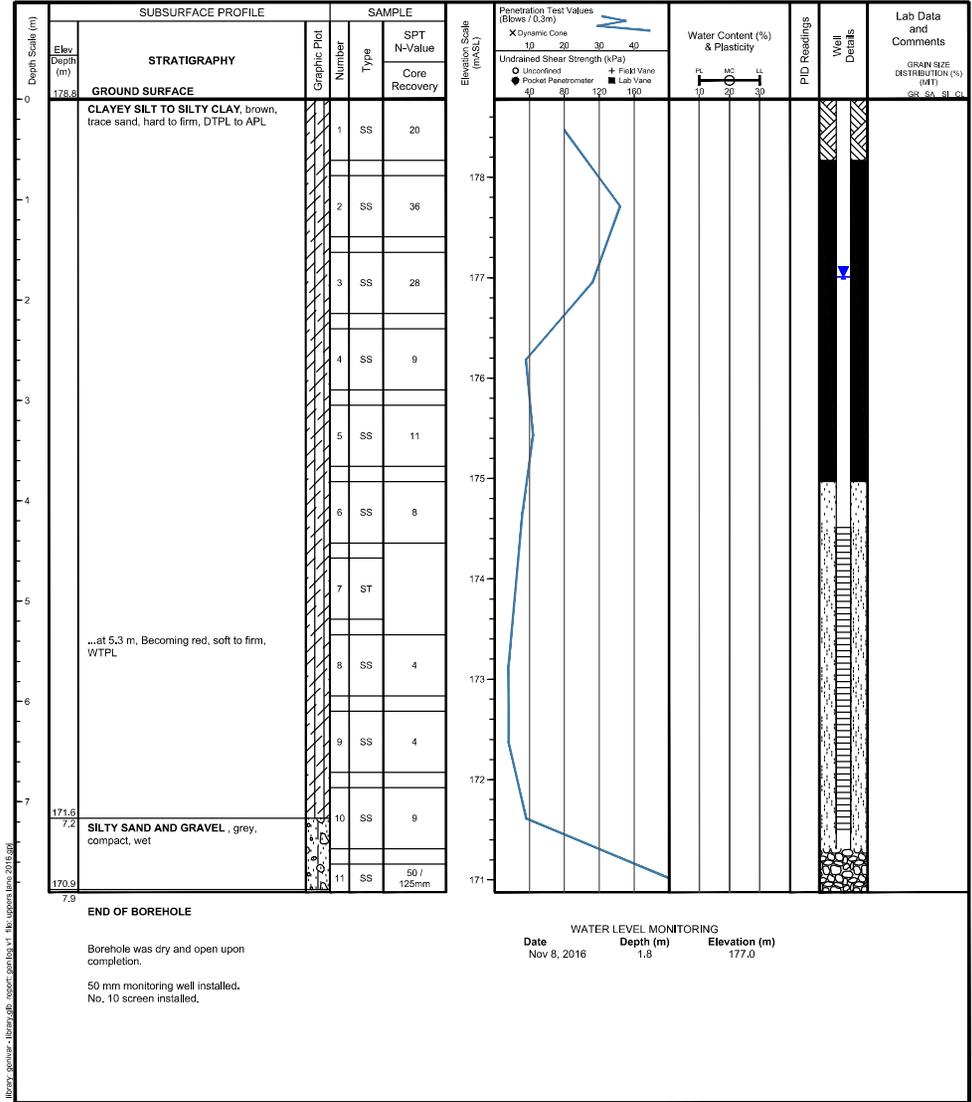
LOG OF BOREHOLE 16-16



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648806 N: 4772274 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/10/13
 supervisor | SK
 reviewer | KJF



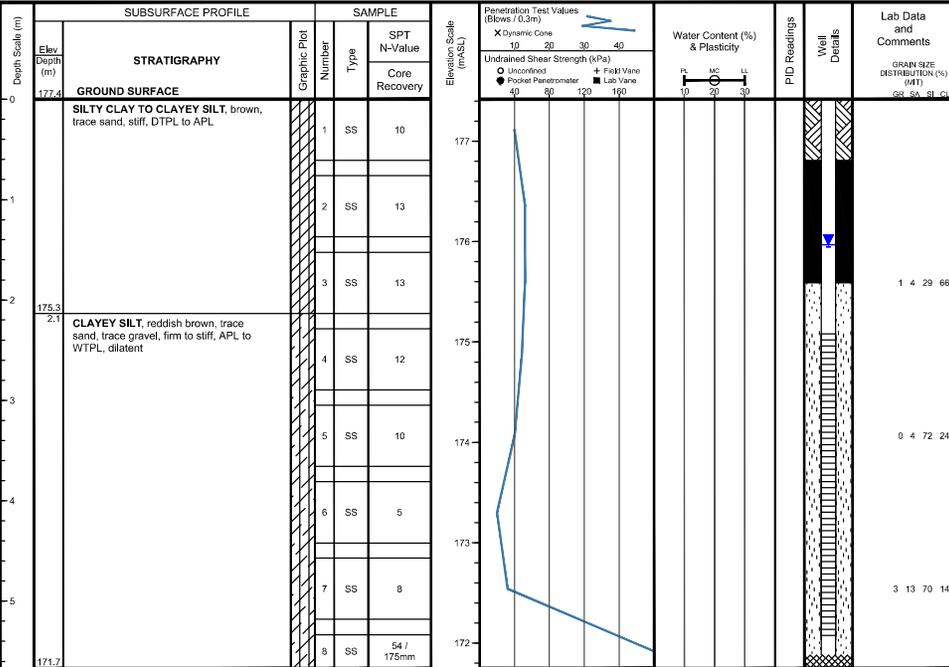
LOG OF BOREHOLE 16-17



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648996 N: 4772677 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/10
 supervisor | SK
 reviewer | KJF



END OF BOREHOLE

Borehole was dry and open upon completion.

50 mm monitoring well installed. No. 10 screen installed.

WATER LEVEL MONITORING
 Date: Nov 21, 2016
 Depth (m): 1.5
 Elevation (m): 176.0

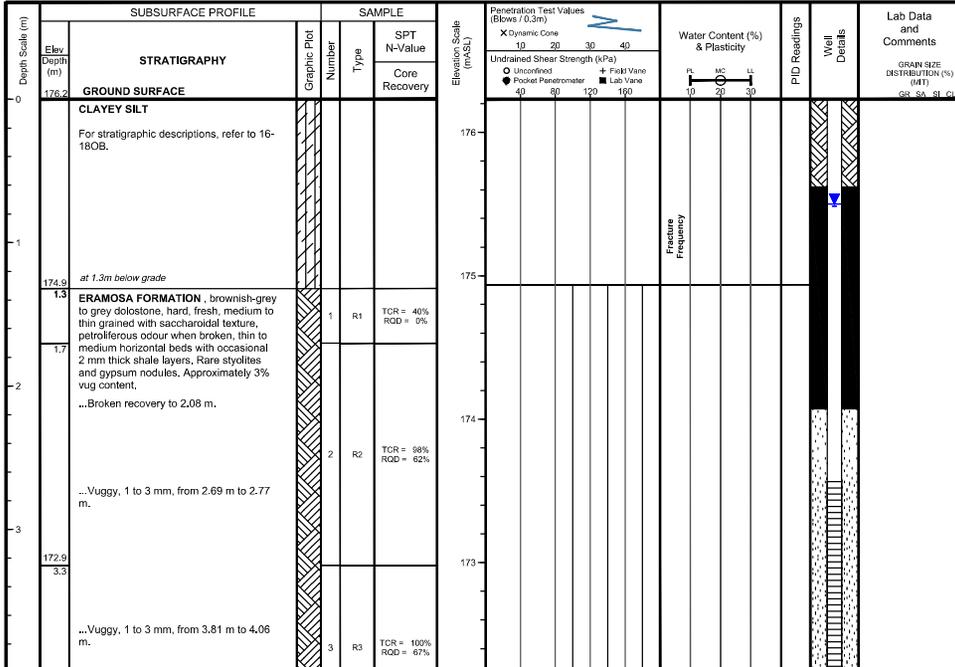
LOG OF BOREHOLE 16-18B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648816 N: 4773300 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/07
 supervisor | SK
 reviewer | KJF



END OF BOREHOLE

Borehole was dry and open upon completion.

50 mm monitoring well installed. No. 10 screen installed.

WATER LEVEL MONITORING
 Date: Nov 17, 2016
 Depth (m): 0.7
 Elevation (m): 175.5

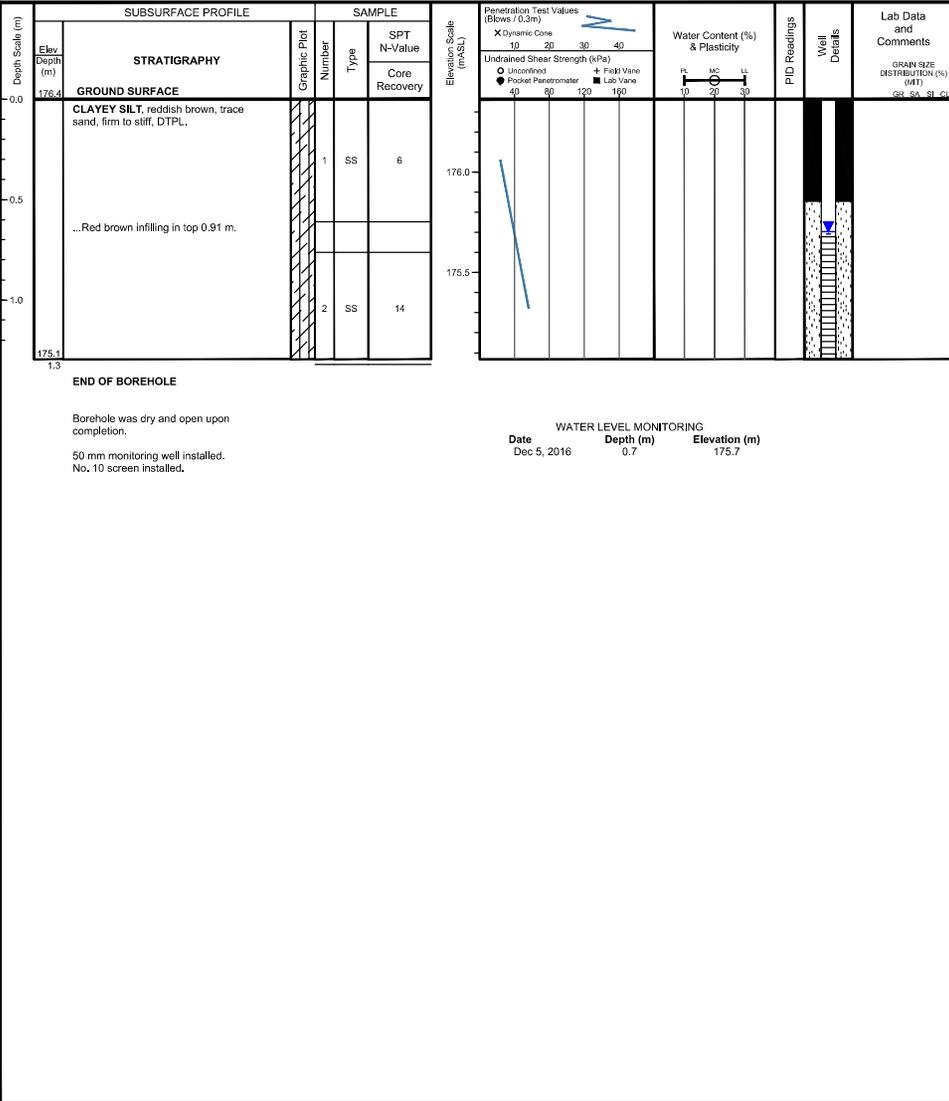
LOG OF BOREHOLE 16-180B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648815 N: 4773302 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/07
 supervisor | SK
 reviewer | KJF



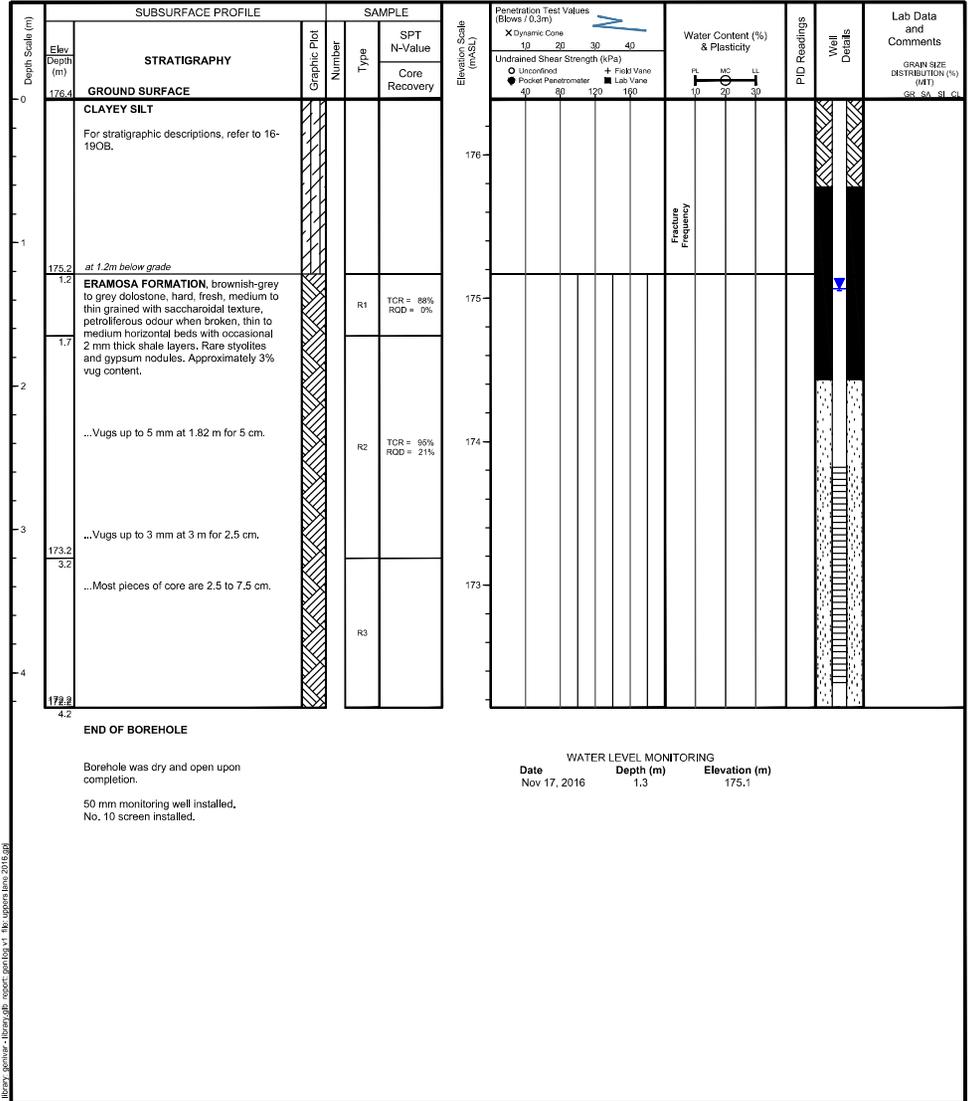
LOG OF BOREHOLE 16-19B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648826 N: 4773443 (17T, Geodetic)

rig type | CME 75
 method | Rock coring
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2016/11/04
 supervisor | SK
 reviewer | KJF



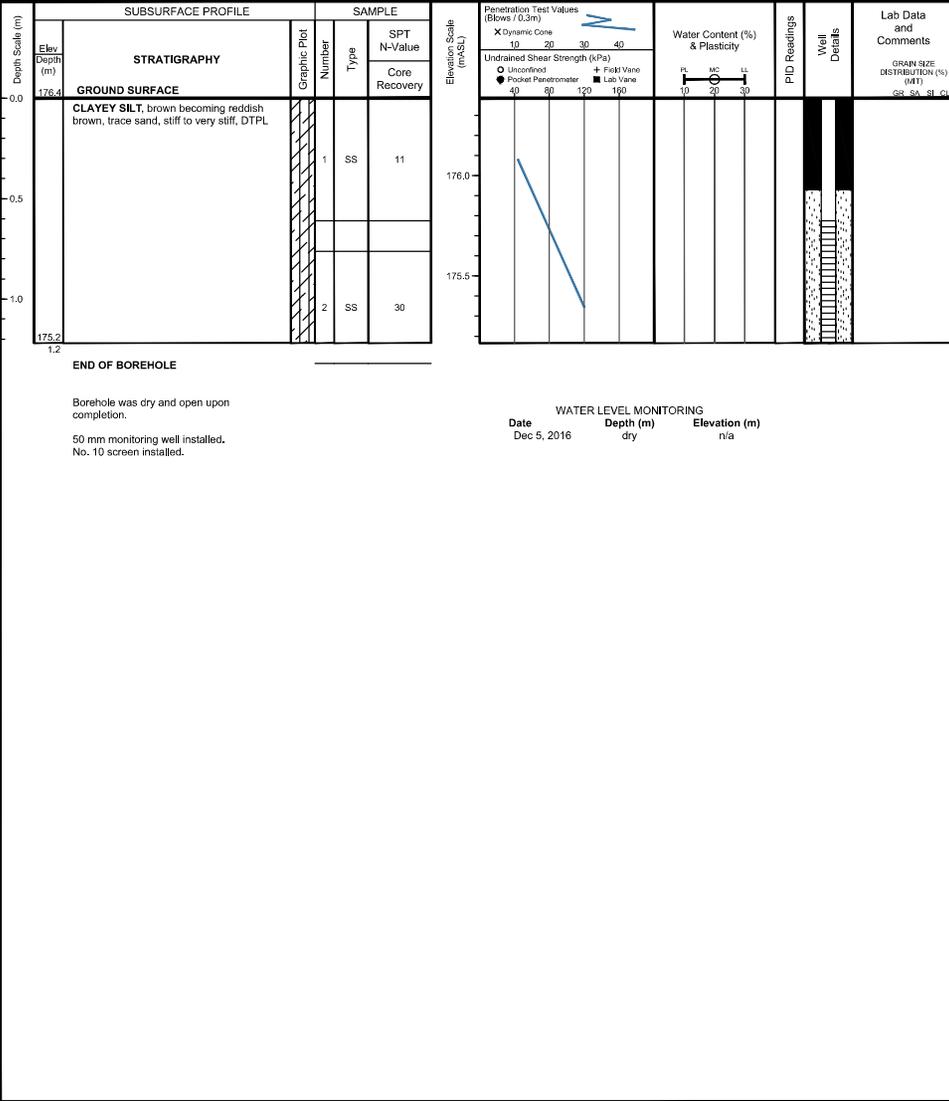
LOG OF BOREHOLE 16-190B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648826 N: 4773444 (17T, Geodetic)

rig type | CME 75
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2016/11/03
 supervisor | SK
 reviewer | KJF



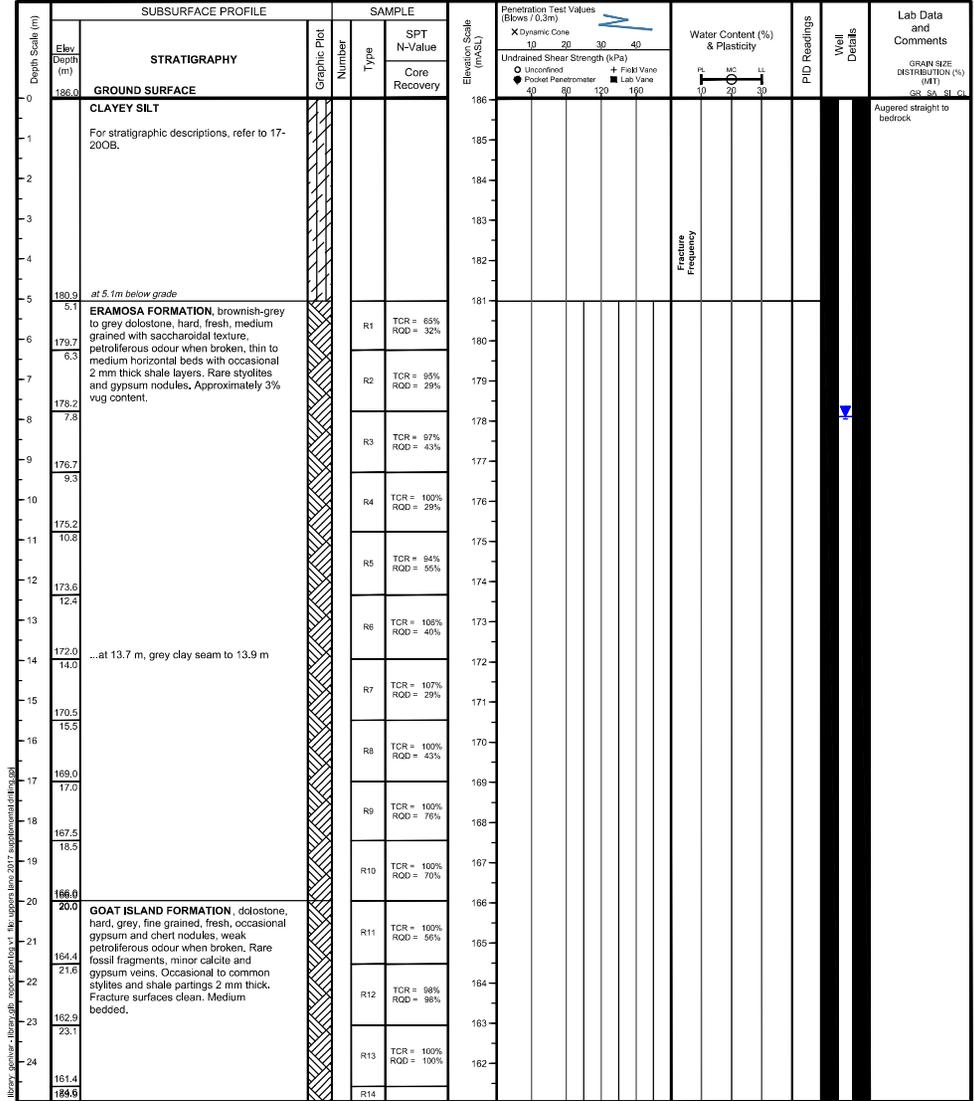
LOG OF BOREHOLE 17-20A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649805 N: 4772733 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Solid stem augers, 150 mm dia.
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2017/06/29
 supervisor | SM
 reviewer | KJF



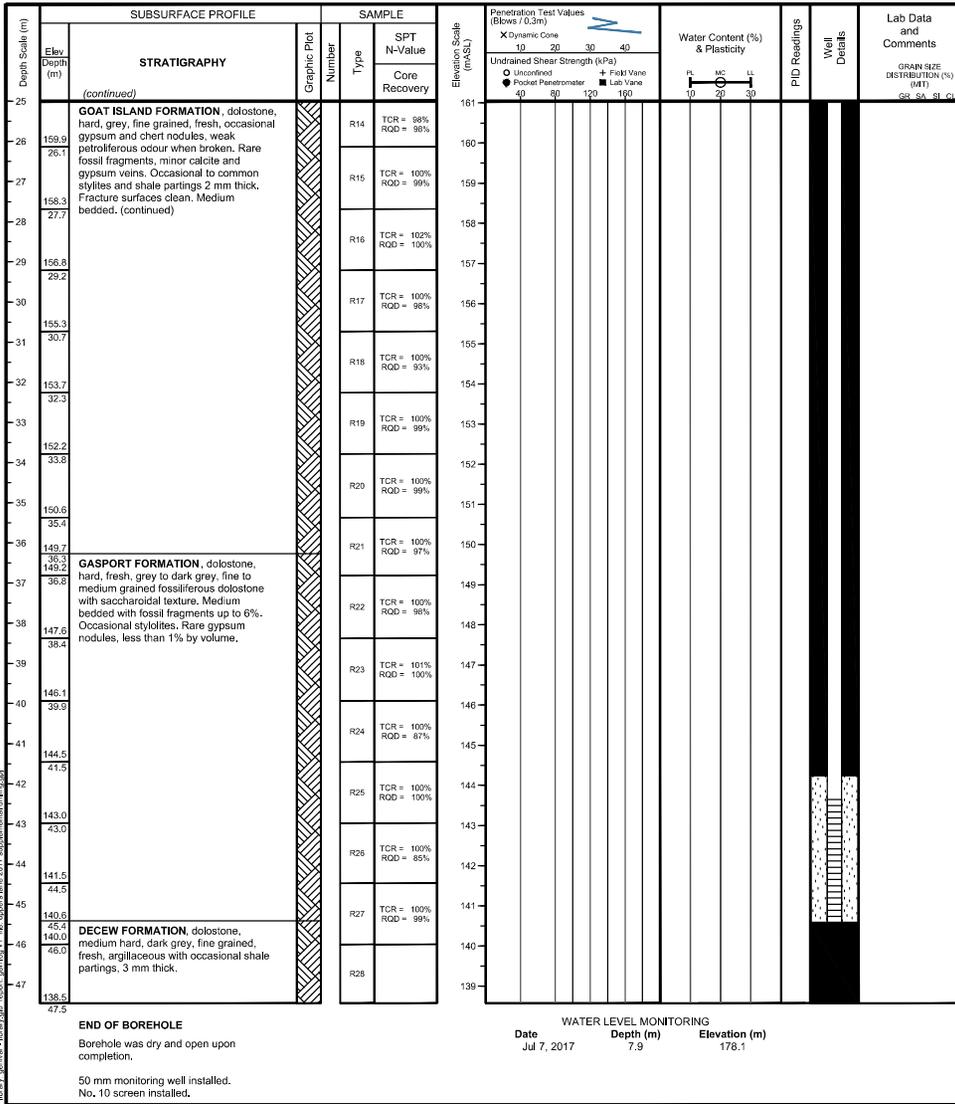
LOG OF BOREHOLE 17-20A



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649805 N: 4772733 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Solid stem augers, 150 mm dia.
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2017/06/29
 supervisor | SM
 reviewer | KJF



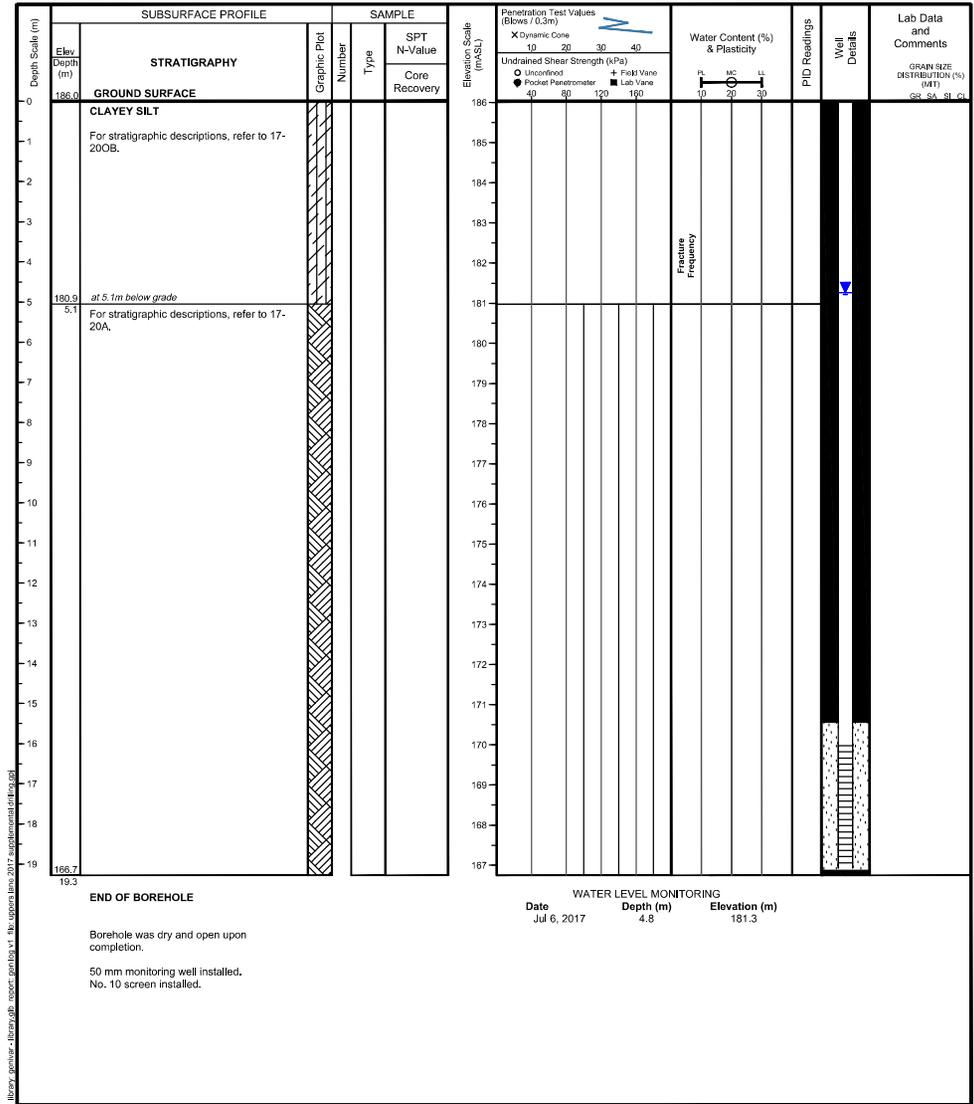
LOG OF BOREHOLE 17-20B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649805 N: 4772731 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Solid stem augers, 150 mm dia.
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2017/07/06
 supervisor | SM
 reviewer | KJF



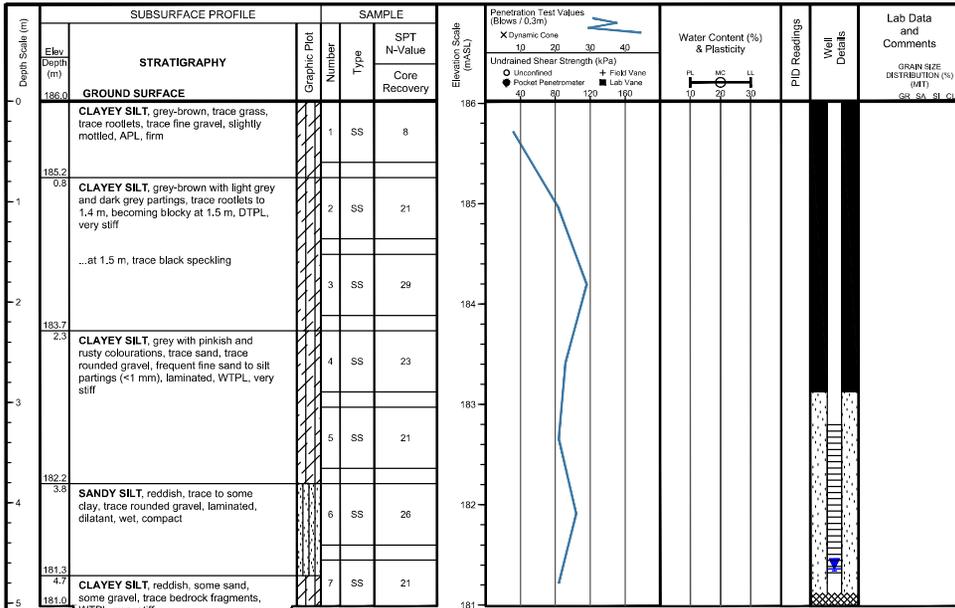
LOG OF BOREHOLE 17-200B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649804 N: 4772730 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2017/07/07
 supervisor | SCL
 reviewer | KJF



END OF BOREHOLE
 Borehole was dry and open upon completion.
 50 mm monitoring well installed.
 No. 10 screen installed.

WATER LEVEL MONITORING
 Date: Jul 7, 2017
 Depth (m): 4.7
 Elevation (m): 181.4

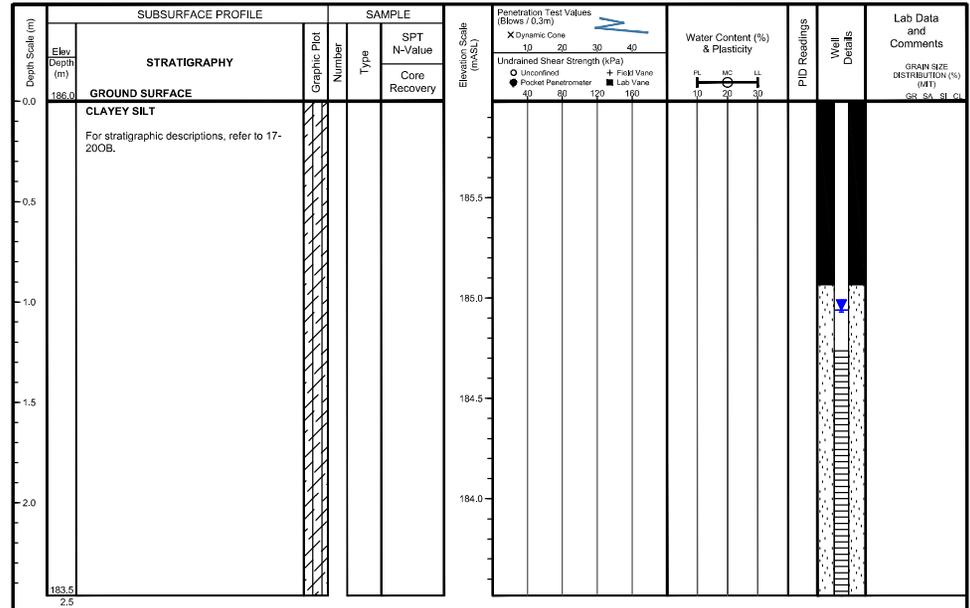
LOG OF BOREHOLE 17-20SP



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 649803 N: 4772728 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2017/07/07
 supervisor | SCL
 reviewer | KJF



END OF BOREHOLE

Borehole was dry and open upon completion.
 50 mm monitoring well installed.
 No. 10 screen installed.

WATER LEVEL MONITORING
 Date: Jul 7, 2017
 Depth (m): 1.0
 Elevation (m): 184.9

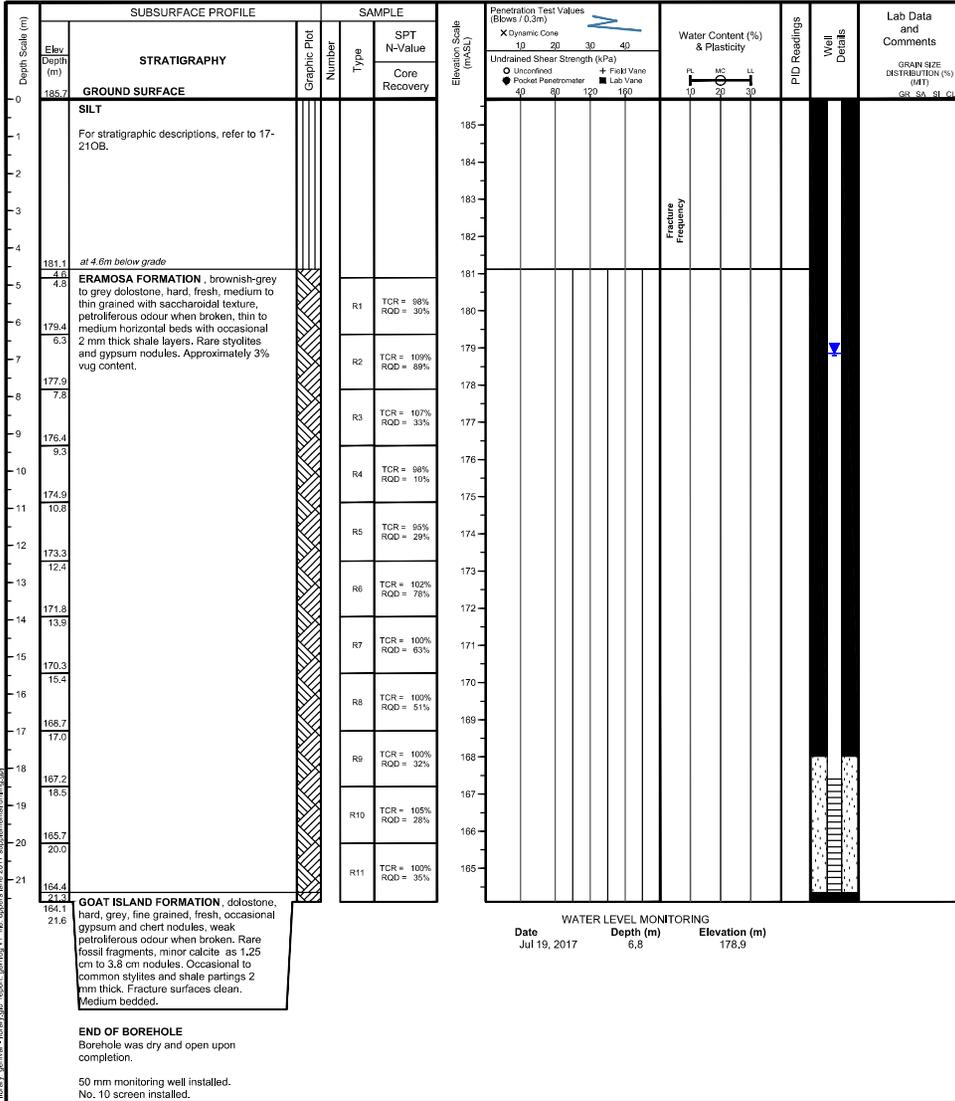
LOG OF BOREHOLE 17-21B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648250 N: 4772587 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2017/07/18
 supervisor | SM
 reviewer | KJF



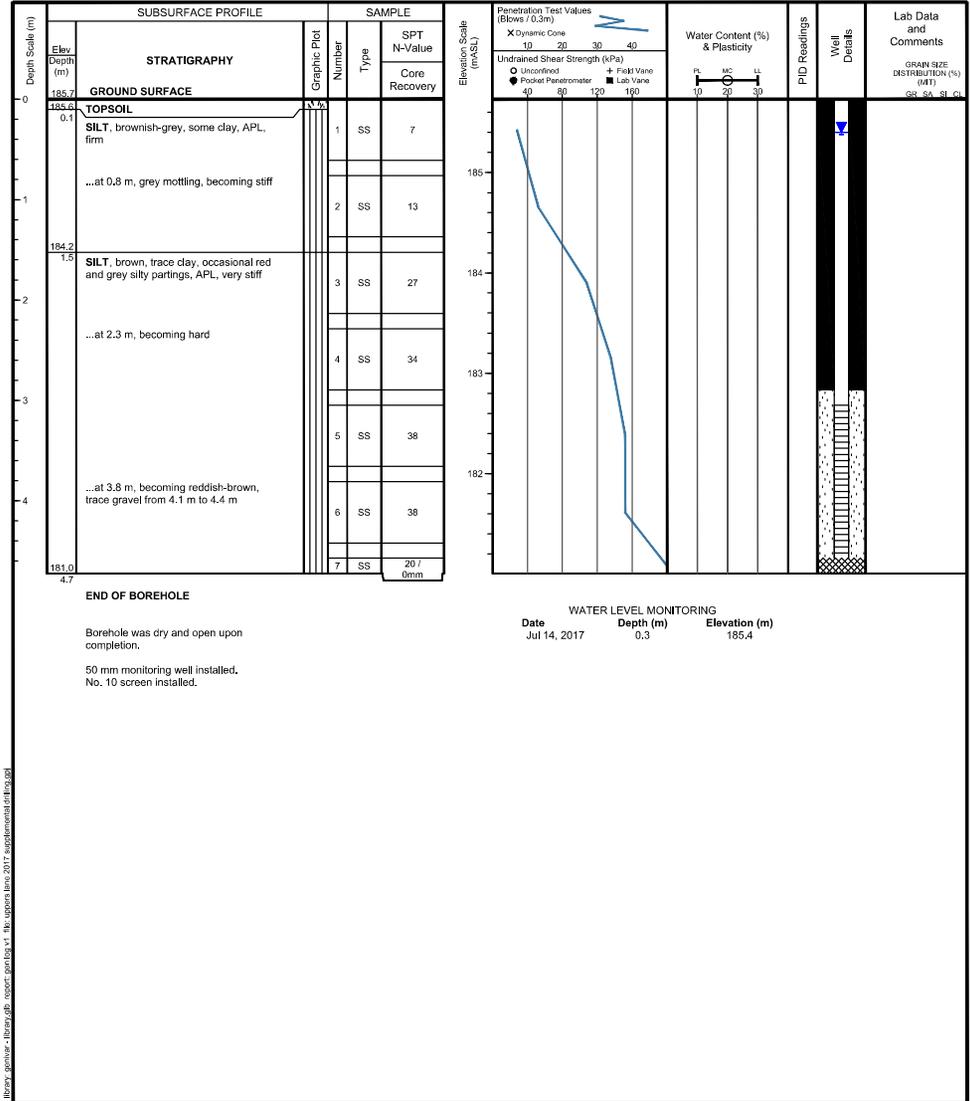
LOG OF BOREHOLE 17-210B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648247 N: 4772587 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2017/07/14
 supervisor | SM
 reviewer | KJF



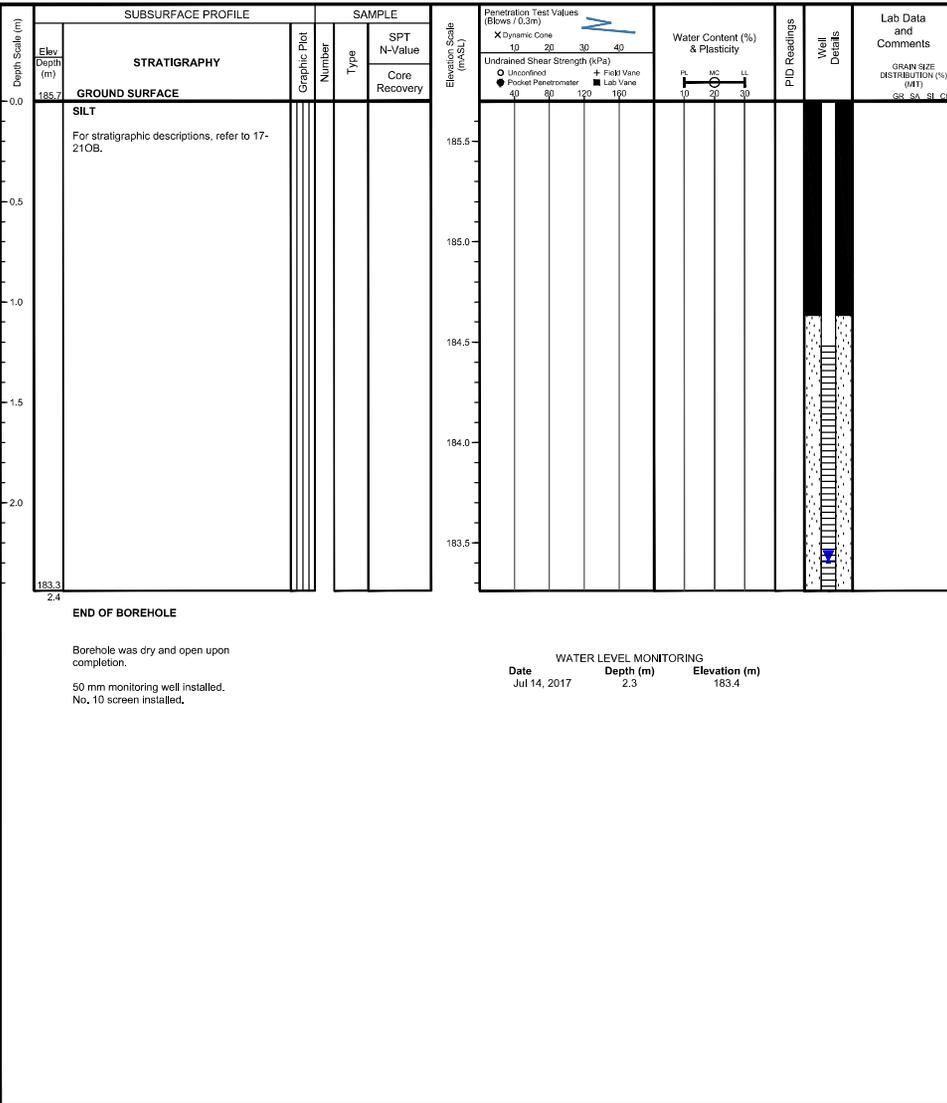
LOG OF BOREHOLE 17-21SP



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648249 N: 4772587 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2017/07/14
 supervisor | SM
 reviewer | KJF



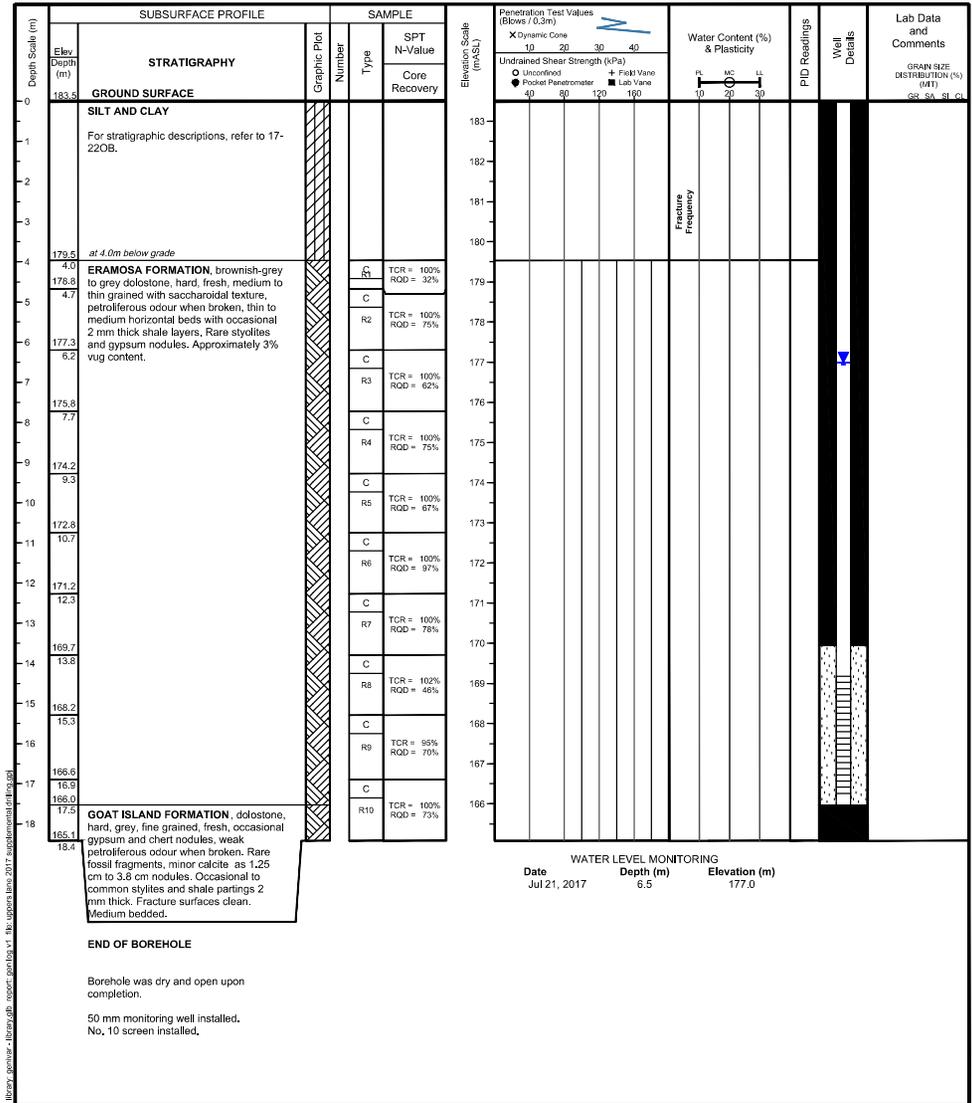
LOG OF BOREHOLE 17-22B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648409 N: 4772965 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2017/07/20
 supervisor | SCL
 reviewer | KJF



library:\genuser-library\gbl_report\portlog.v1_161.uppers.17T_supplemental.dwg (17-21SP)

library:\genuser-library\gbl_report\portlog.v1_161.uppers.17T_supplemental.dwg (17-22B)

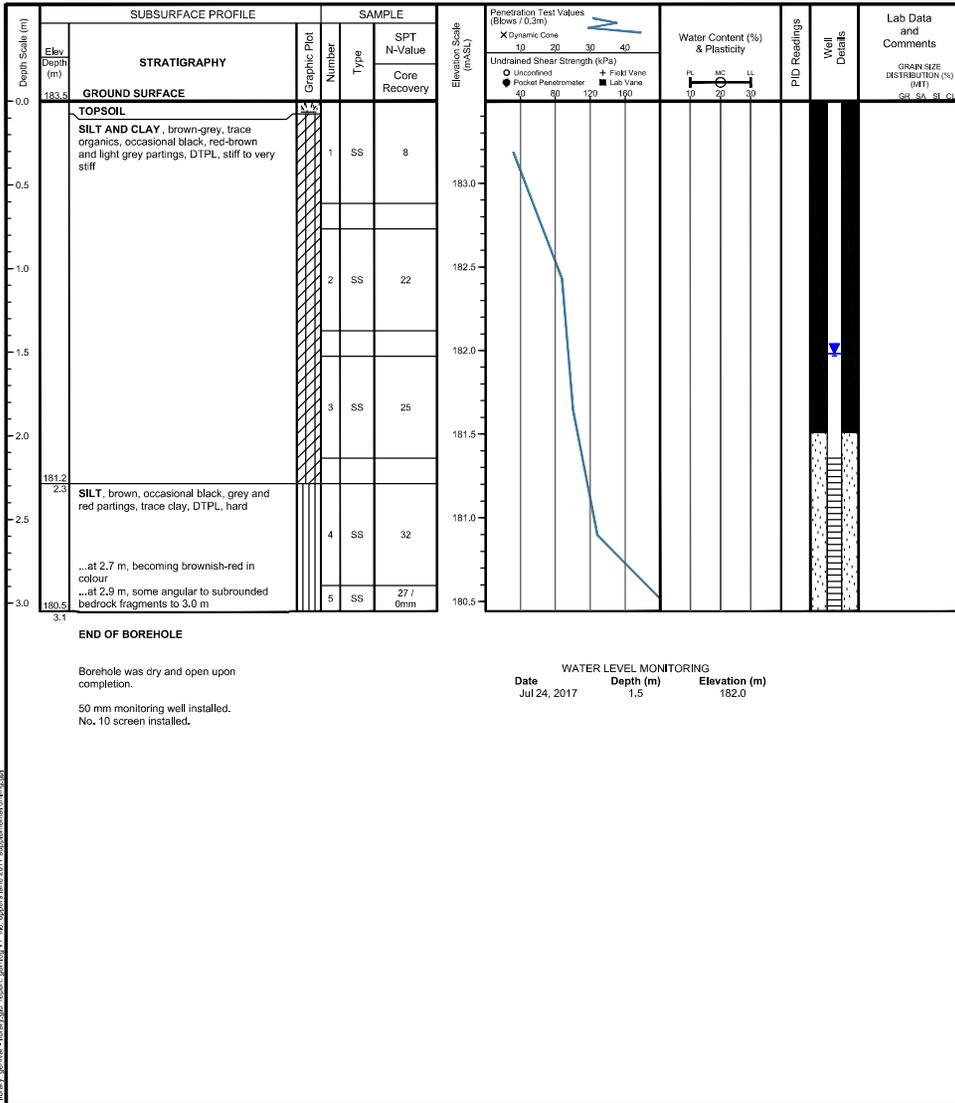
LOG OF BOREHOLE 17-220B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648411 N: 4772964 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2017/07/24
 supervisor | BC
 reviewer | KJF



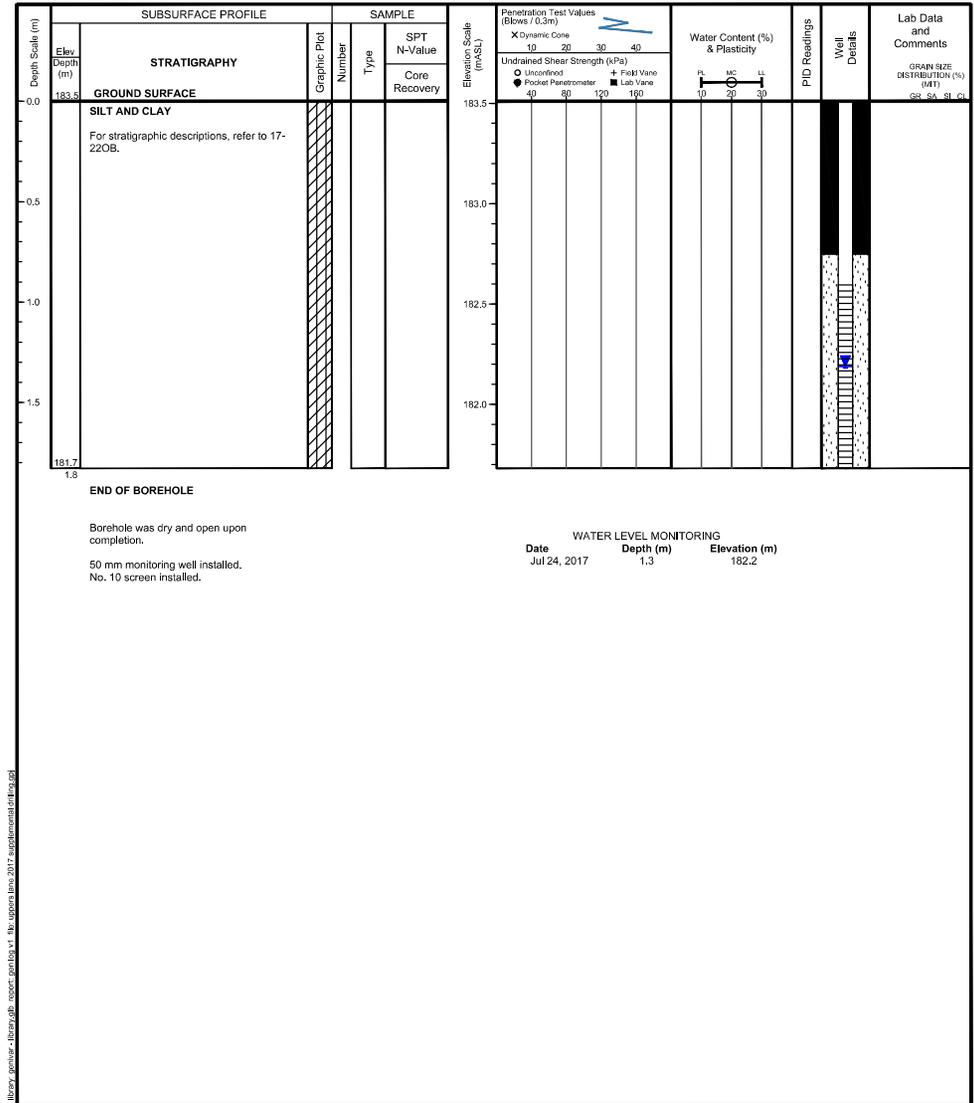
LOG OF BOREHOLE 17-22SP



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648412 N: 4772963 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2017/07/24
 supervisor | BC
 reviewer | KJF



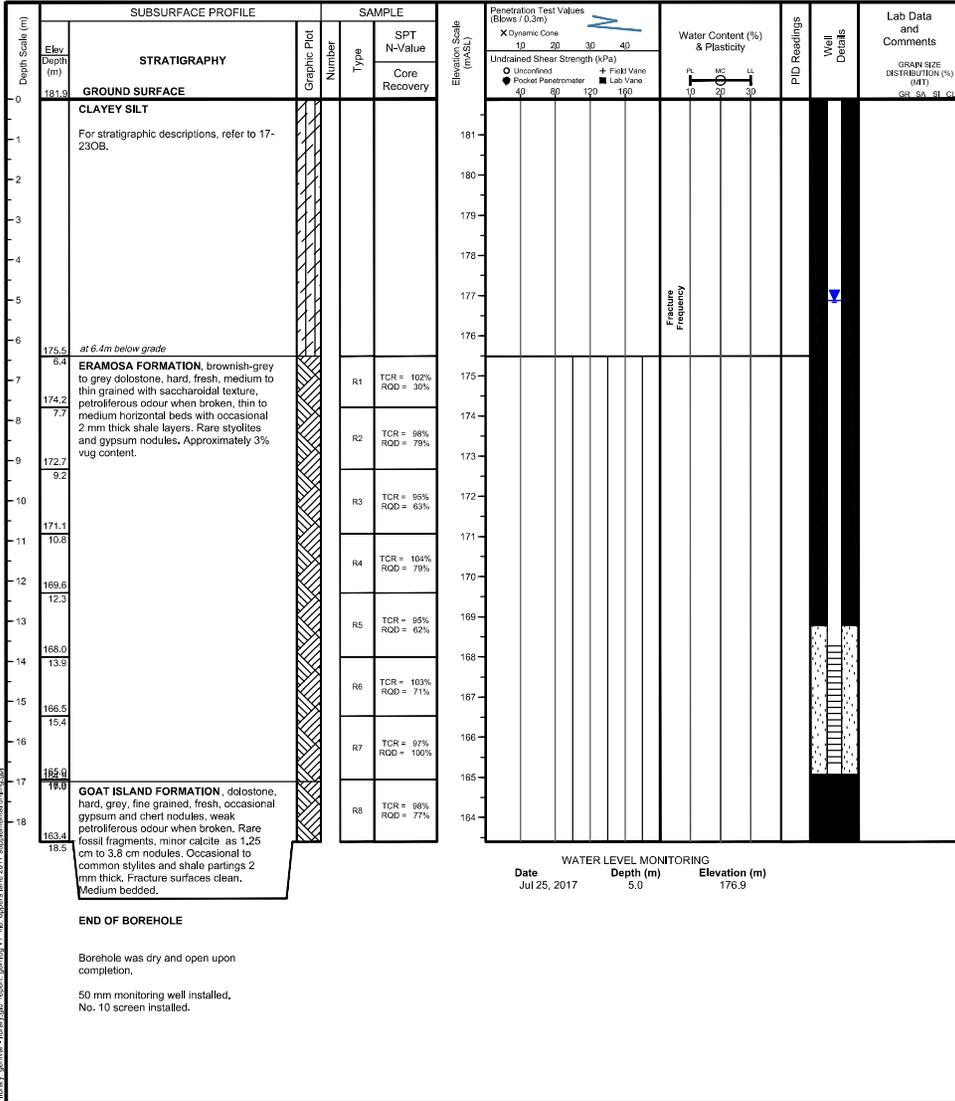
LOG OF BOREHOLE 17-23B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648239 N: 4773134 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | HQ core, OD=96mm, ID=64mm

project no. | 161-11633-00
 date started | 2017/07/25
 supervisor | SCL
 reviewer | KJF



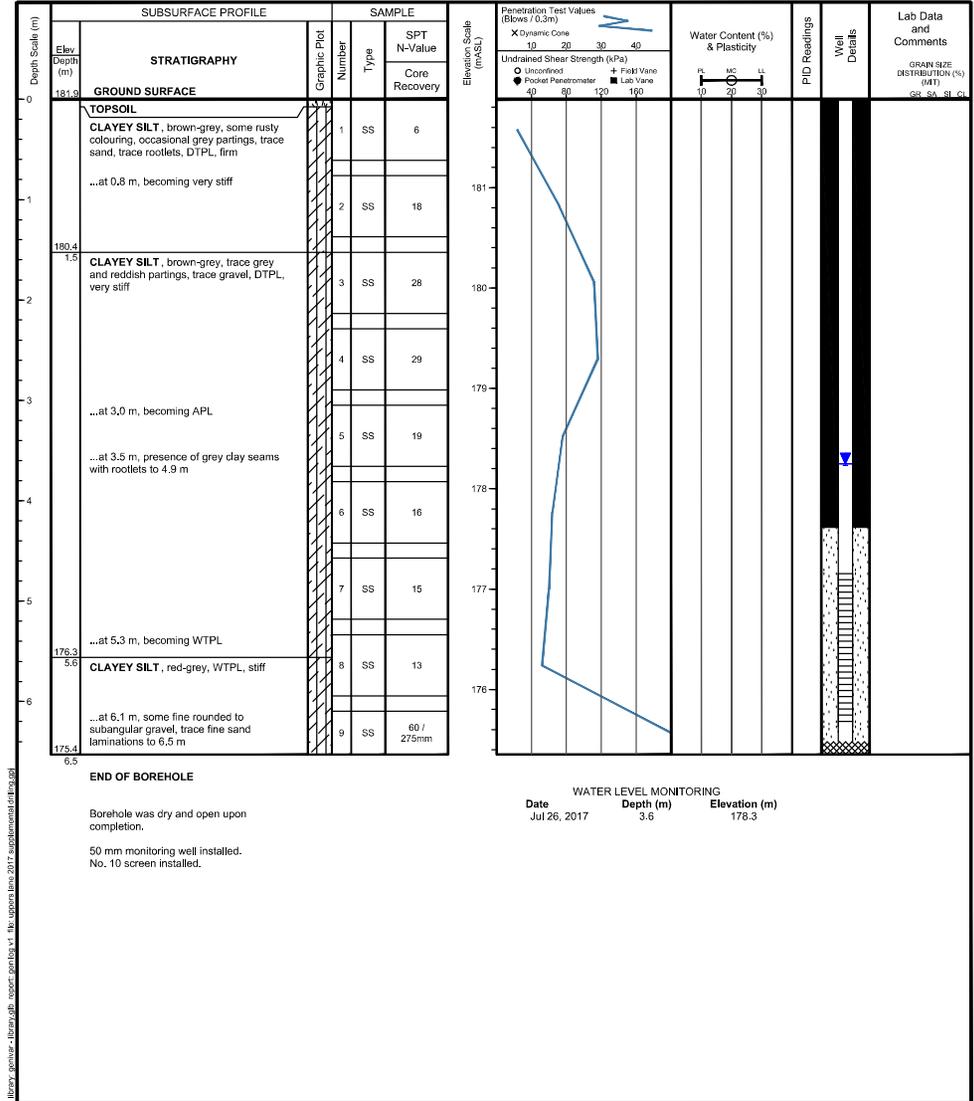
LOG OF BOREHOLE 17-230B



project | Proposed Uppers Quarry
 client | Walker Aggregates Inc.
 location | Thorold / Niagara Falls, ON
 position | E: 648239 N: 4773132 (17T, Geodetic)

rig type | CME 75, track-mounted
 method | Hollow stem augers, 215 mm dia.
 coring | n/a

project no. | 161-11633-00
 date started | 2017/07/26
 supervisor | SCL
 reviewer | KJF



LOG OF BOREHOLE 17-23SP



project | Proposed Uppers Quarry

project no. | 161-11633-00

client | Walker Aggregates Inc.

rig type | CME 75, track-mounted

date started | 2017/07/26

location | Thorold / Niagara Falls, ON

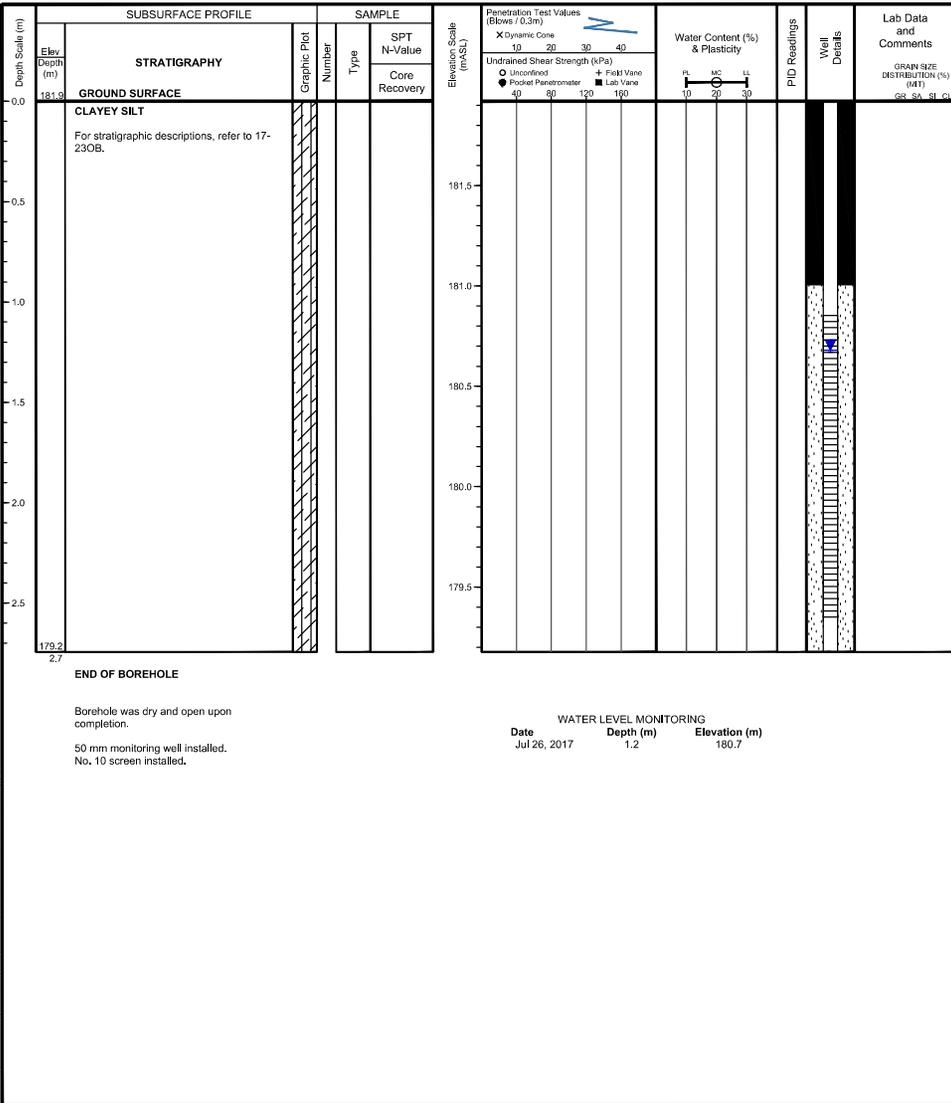
method | Hollow stem augers, 215 mm dia.

supervisor | SCL

position | E: 648239 N: 4773130 (17T, Geodetic)

coring | n/a

reviewer | KJF



library:\genuser-library\gls_report\p0103.v1_161_uppers Quarry 2017_supplemental.dwg (3/26/17)

Table C-2 Off-Site Well Details

Well ID	Site Name	UTM Coordinates		Monitor Installation Date	Ground Elevation	Bedrock Elevation	Bedrock Subcrop	Stratigraphic Contact Summary (masl)							Water Level Data		
		Easting m	Northing m					Guelph Formation	Lockport Eramosa Member	Lockport Goat Island Member	Lockport Gasport Member	DeCew Formation	Rochester Formation	Irondequoit Formation	Date	masl	Formation
BH6	Abitibi Co-Gen Plant	646640	4774257	2006	176.52	163.12	(unspecified)	-	-	-	-	-	-	-	11-May-06	167.42	Overburden
BH14	Abitibi Co-Gen Plant	646579	4774238	2006	179.60	162.40	(unspecified)	-	-	-	-	-	-	-	09-May-06	164.46	Overburden
BH19	Abitibi Co-Gen Plant	646580	4774177	2006	178.13	163.93	(unspecified)	-	-	-	-	-	-	-	04-May-06	171.43	Overburden
MW1-I	Cytec Canada Inc. Welland Plant Site	648684	4768944	1984	181.07	165.83	Guelph Formation	-	-	-	-	-	-	-	18-Sep-84	176.31	Guelph Fm
MW2-I	Cytec Canada Inc. Welland Plant Site	650424	4768922	1984	180.16	162.35	Guelph Formation	-	-	-	-	-	-	-	18-Sep-84	175.88	Guelph Fm
MW3-I	Cytec Canada Inc. Welland Plant Site	649594	4768316	1984	178.56	160.02	Guelph Formation	-	-	-	-	-	-	-	18-Sep-84	175.61	Guelph Fm
MW4-I	Cytec Canada Inc. Welland Plant Site	649261	4767243	1984	176.62	156.38	Guelph Formation	-	-	-	-	-	-	-	18-Sep-84	174.42	Guelph Fm
MW5-I	Cytec Canada Inc. Welland Plant Site	650344	4767373	1984	175.95	155.93	Guelph Formation	-	-	-	-	-	-	-	18-Sep-84	174.11	Guelph Fm
OW12	Mountain Road Landfill Site	653331	4778385	1985	175.29	169.90	Lockport Gasport Member	-	-	-	-	-	-	-	12-Apr-16	172.73	Gasport Mb
OW54(23)	Mountain Road Landfill Site	652517	4777526	2012	195.42	195.42	Lockport Goat Island Member	-	-	-	174.82	169.12	-	-	14-Oct-16	178.42	Overburden
CMT3	Mountain Road Landfill Site	652741	4777578	2007	202.00	178.60	Lockport Gasport Member	-	-	-	-	168.70	167.60	-	14-Oct-16	182.2	Gasport Mb
CMT5	Mountain Road Landfill Site	652386	4778554	2007	174.30	170.60	Lockport Gasport Member	-	-	-	-	165.60	164.30	-	14-Oct-16	168.9	Gasport Mb
CRA-11D-09	Niagara Recycling Centre	652979	4773755	2009	193.60	183.24	Lockport Eramosa Member	-	-	-	-	-	-	-	10-Oct-14	184.90	Eramosa Mb
IW6	Niagara Recycling Centre	652985	4773843	2006	193.16	182.36	(unspecified)	-	-	-	-	-	-	-	10-Oct-14	184.21	(bedrock)
OW13D	Niagara Recycling Centre	652871	4773896	2003	193.20	182.20	(unspecified)	-	-	-	-	-	-	-	10-Oct-14	184.53	(bedrock)
MW10 (NF-30)	Niagara Tunnel Project	656361	4777364	1991	181.06	164.59	Lockport Gasport Member	-	-	-	-	157.61	155.21	136.96			
MW14	Niagara Tunnel Project	656540	4769926	2005	184.04	154.17	Lockport Eramosa Member	-	-	-	-	118.08	115.42	97.54	23-Oct-13	169.80	Eramosa Mb
NF-28	Niagara Tunnel Project	655800	4773685	1991	185.06	169.36	Lockport Goat Island Member	-	-	-	163.06	151.89	149.14	131.49			
BadenPowell (BH31)	NPCA Monitoring Well	652903	4767379	2014	176.63	150.13	Salina Formation	-	-	-	-	-	-	-			
YoungMatthews (BH11)	NPCA Monitoring Well	649479	4763858	2014	181.92	155.82	Guelph Formation	-	-	-	-	-	-	-			
BH03-1	Rolling Meadows	647685	4772408	2003	182.50	176.50	Lockport Eramosa Member	-	-	161.00	149.80	-	-	-			
BH03-3	Rolling Meadows	648112	4771708	2003	186.50	175.90	Guelph Formation	-	173.60	154.80	143.60	134.00	131.10	-			
BH03-4	Rolling Meadows	647569	4771341	2003	183.00	172.70	Guelph Formation	-	170.70	152.90	141.60	132.00	-	-			
4-I	Walker Brothers Quarry	647829	4776539	1976	180.09	168.96	(unspecified)	-	-	-	-	-	-	-	03-Aug-17	169.08	Lockport
19-1R2	Walker Brothers Quarry	649320	4777011	2015	183.90	177.10	Lockport (undifferentiated)	-	-	-	-	169.00	166.40	-	07-Sep-17	172.70	Rochester Fm
40-1r	Walker Brothers Quarry	649322	4776674	2016	184.30	177.60	Lockport Gasport Member	-	-	-	-	167.10	165.60	146.90	07-Sep-17	160.01	Irondequoit Fm
51-I	Walker Brothers Quarry	650399	4776396	1988	184.70	178.90	Lockport (undifferentiated)	-	-	-	-	165.30	163.90	-	07-Sep-17	180.58	Lockport
55-I	Walker Brothers Quarry	648943	4775340	1990	177.87	170.67	Lockport Goat Island Member	-	-	-	162.77	156.27	154.27	-	07-Sep-17	170.31	Lockport

Notes: • Elevations provided in metres above sea level (masl)

Table C-2 Off-Site Well Details

Well ID	Site Name	UTM Coordinates		Monitor Installation Date	Ground Elevation	Bedrock Elevation	Bedrock Subcrop	Stratigraphic Contact Summary (masl)						Water Level Data			
		Easting m	Northing m					Guelph Formation	Lockport Eramosa Member	Lockport Goat Island Member	Lockport Gasport Member	DeCew Formation	Rochester Formation	Irondequoit Formation	Date	masl	Formation
C-2	(Bolton, 1957)	656099	4775820	1949	181.14	166.63	Lockport Goat Island Member	-	-	-	164.81	158.07	154.63	137.37			
D-1	(Bolton, 1957)	655977	4775611	1949	180.53	169.01	Lockport Goat Island Member	-	-	-	164.74	158.04	155.27	137.56			
D-3	(Bolton, 1957)	655740	4775042	1949	184.43	168.13	Lockport Goat Island Member	-	-	-	163.01	155.66	153.16	135.64			
E-2	(Bolton, 1957)	655715	4773202	1949	185.93	166.48	Lockport Eramosa Member	-	-	164.13	159.17	146.09	143.26	126.31			
E-8	(Bolton, 1957)	656949	4770385	1949	167.18	165.08	Guelph Formation	-	146.73	138.84	128.90	123.50	120.94	102.17			
E-18	(Bolton, 1957)	655761	4774468	1950	194.52	172.91	Lockport Goat Island Member	-	-	-	162.15	156.76	153.89	136.18			
E-19	(Bolton, 1957)	656470	4770645	1950	163.80	152.83	Guelph Formation	-	143.74	141.61	131.22	124.60	122.35	104.55			
E-29	(Bolton, 1957)	655737	4771671	1951	195.86	174.92	Guelph Formation	-	159.04	156.39	141.12	135.67	132.77	115.06			
E-32	(Bolton, 1957)	655726	4772390	1951	193.94	172.61	Guelph Formation	-	167.06	162.52	146.70	141.43	137.40	120.18			
F-1	(Bolton, 1957)	658038	4777687	1950	175.05	173.19	Lockport Goat Island Member	-	-	-	164.53	154.44	150.66	134.02			
F-2	(Bolton, 1957)	657176	4777077	1950	178.92	168.46	Lockport Goat Island Member	-	-	-	159.65	152.92	150.82	132.65			
K-1	(Bolton, 1957)	656169	4776923	1950	179.92	165.05	Lockport Goat Island Member	-	-	-	161.91	154.44	151.61	134.02			
N-14	(Bolton, 1957)	657241	4770090	1951	182.76	162.34	Guelph Formation	-	151.46	141.06	127.16	119.27	116.62	97.96			
O-1	(Bolton, 1957)	658218	4770205	1949	174.35	166.70	Guelph Formation	-	138.38	134.29	124.27	117.47	114.91	96.26			
F013366	Oil, Gas and Salt Resources Library	641918	4768816	1947	183.30	154.04	(unspecified)	-	-	-	-	-	-	-			
F013943	Oil, Gas and Salt Resources Library	652452	4772579	1950	194.95	182.45	Guelph Formation	-	-	-	-	-	141.91	125.15			
F014098	Oil, Gas and Salt Resources Library	647220	4764979	1953	179.11	147.41	Guelph Formation	-	-	-	-	-	78.83	59.01			
F014123	Oil, Gas and Salt Resources Library	644275	4764547	1946	183.79	155.75	Salina Formation	131.37	-	-	-	-	72.85	58.22			
N002812	Oil, Gas and Salt Resources Library	652892	4770040	1908	179.83	166.13	(unspecified)	-	-	-	-	-	-	107.89			
N002815	Oil, Gas and Salt Resources Library	646765	4776643		158.10	145.29	(unspecified)	-	-	-	-	-	-	-			
T007932	Oil, Gas and Salt Resources Library	655602	4776811	1992	182.22	165.34	Lockport Gasport Member	-	-	-	-	-	152.51	135.11			
T010011	Oil, Gas and Salt Resources Library	650379	4766538	1926	174.96	145.82	Guelph Formation	-	-	-	-	-	-	145.86			
T012327	Oil, Gas and Salt Resources Library	650359	4766843		174.98	149.10	Guelph Formation	-	-	-	-	-	96.36	78.07			
T012542	Oil, Gas and Salt Resources Library	646587	4775276	2017	179.00	171.60	Lockport Goat Island Member	-	-	-	162.90	-	153.00	-			

Notes: • Elevations provided in metres above sea level (masl)

Figure E-6 - Groundwater Hydrograph for Well Nest MW16-5

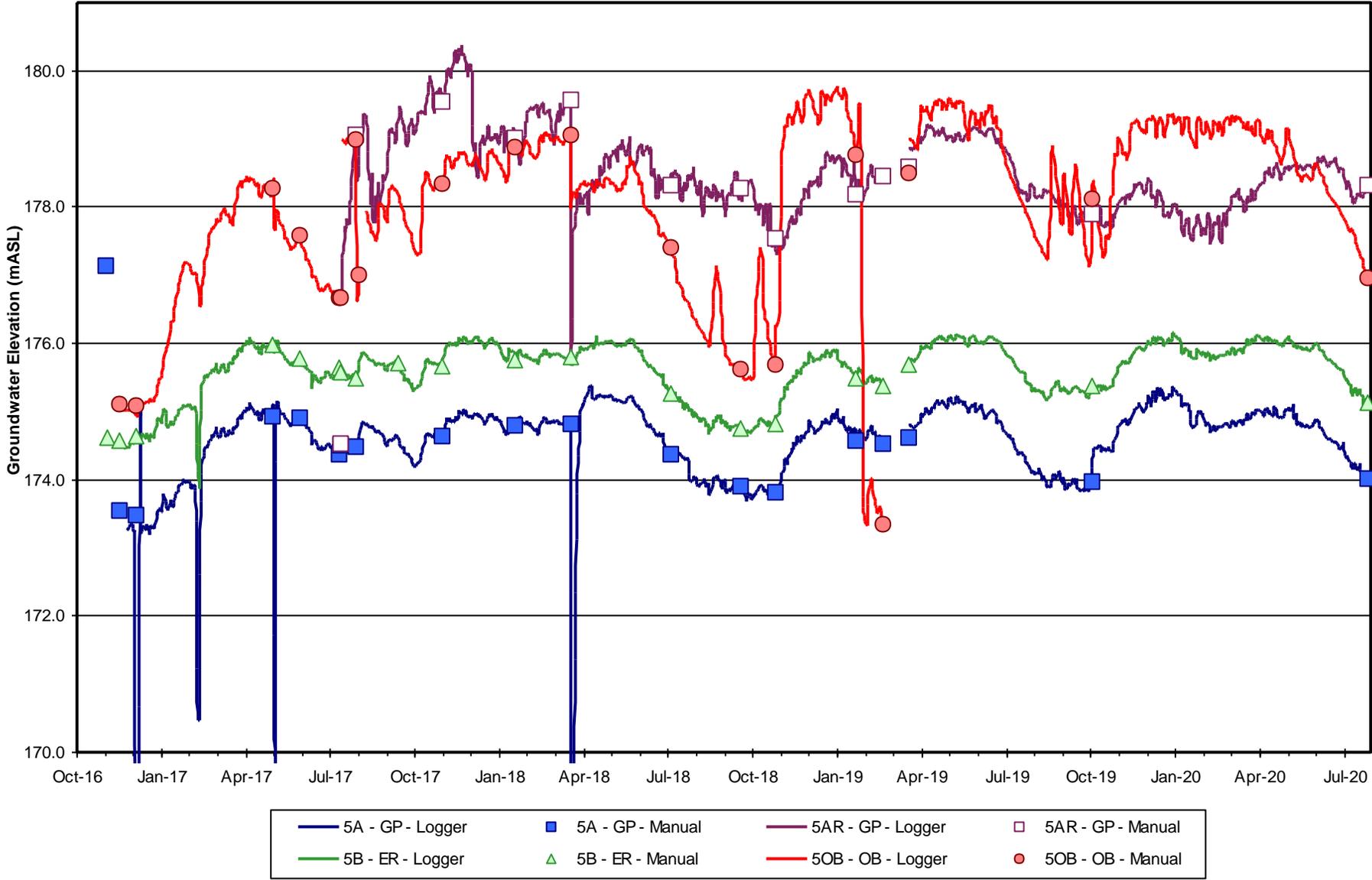


Table G-1 Surface Water Chemical Results

Station	Date	Field				General Chemistry							Major Ions							
		Units PWQO	pH	EC	T	DO	pH	EC	TDS	TSS	Hardness	Turbidity	Total Oil & Grease	Chloride	Sulphate	Alkalinity	Calcium	Magnesium	Sodium	Potassium
			S U	µS/cm	°C	(a)	S U	µS/cm	nc	nc	nc	(b)	(c)	nc	nc	(d)	nc	nc	nc	nc
			6.5 - 8.5	nc	nc		6.5 - 8.5	nc	nc	nc	nc									
SW1	7-Dec-16		8.3	960	4.1	3.3	8.09	870	518	5	340	4.6	<0.5	93	120	200	76	26	57	3.3
	1-May-17		7.5	327	9.9	13.5	7.77	330	178	61	120	130	<0.5	26	31	91	31	11	23	3.1
	19-Mar-18		7.9	796	1.1	13.9	8.00	780	235	16	270	43	0.5	100	67	160	57	21	56	3.3
SW2	7-Dec-16		8.6	480	4.3	2.7	8.06	460	270	7	160	18	<0.5	37	44	120	39	11	33	2.4
	1-May-17		7.4	210	10.5	13	7.62	200	168	77	81	84	<0.5	8.5	<5.0	82	23	8	11	2
	19-Mar-18		8.5	239	1.1	13.4	7.84	250	120	250	95	170	0.7	23	25	59	28	10	9.4	4.1
SW3	7-Dec-16		8.2	820	5.1	3.6	7.99	810	454	9	300	13	<0.5	81	120	160	73	18	50	4
	1-May-17		7.7	341	12.3	12.3	7.76	360	262	67	130	130	<0.5	27	37	100	34	10	20	4
	21-Mar-18		7.7	1,213	0.1	11.7	7.98	1100	450	18	290	14	1.8	160	97	160	72	21	100	5
SW4	7-Dec-16		8.4	920	4.2	4.4	8.00	880	494	17	320	9.1	<0.5	97	140	160	72	21	59	3.6
	1-May-17		7.8	292	9.8	11.1	7.68	280	232	76	96	180	<0.5	23	25	78	27	8	18	3.7
	19-Mar-18		8.3	699	0.1	13	7.99	750	410	17	220	21	2.6	110	73	130	54	15	62	5.1
DP1	7-Dec-16		8.3	1,750	4.5	3.1	8.15	1400	758	98	240	26	<0.5	250	95	170	67	18	220	3.3
	1-May-17		7.7	374	12.4	12.5	7.79	330	352	830	77	690	<0.5	33	24	87	33	17	32	5.3
	21-Mar-18		7.6	1,024	0	11.6	8.10	850	440	29	260	31	<0.5	110	89	160	65	22	67	4.4
DP2	7-Dec-16		8.1	1,130	3.8	3.4	7.60	1100	676	13	410	14	<0.5	110	150	240	94	31	67	4.3
	1-May-17		7.7	281	9.6	12.7	7.71	280	232	120	96	180	<0.5	25	24	78	27	8.5	19	4.2
	19-Mar-18		8.0	676	0.6	13	7.98	690	185	79	210	32	1.6	95	69	120	55	18	56	6.3
DP3	7-Dec-16		8.2	870	4.9	3.8	8.07	850	486	3	290	6.5	<0.5	88	130	160	71	19	57	4
	1-May-17		7.6	344	12.1	12.2	7.75	350	270	77	120	160	<0.5	32	32	91	33	9.9	25	4
	19-Mar-18		7.8	797	2.4	13.2	8.05	830	275	17	230	15	0.8	120	82	140	62	16	71	5.1
DP4	5-Dec-16 (1)																			
	19-Mar-18		7.9	222	1.3	13.9	7.83	230	45	24	92	74	2.4	14	31	60	21	7.3	8.3	3.1
DP5	22-Mar-18 (2)																			

Table G-1 Surface Water Chemical Results

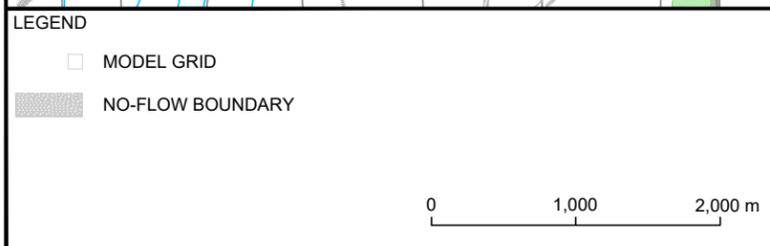
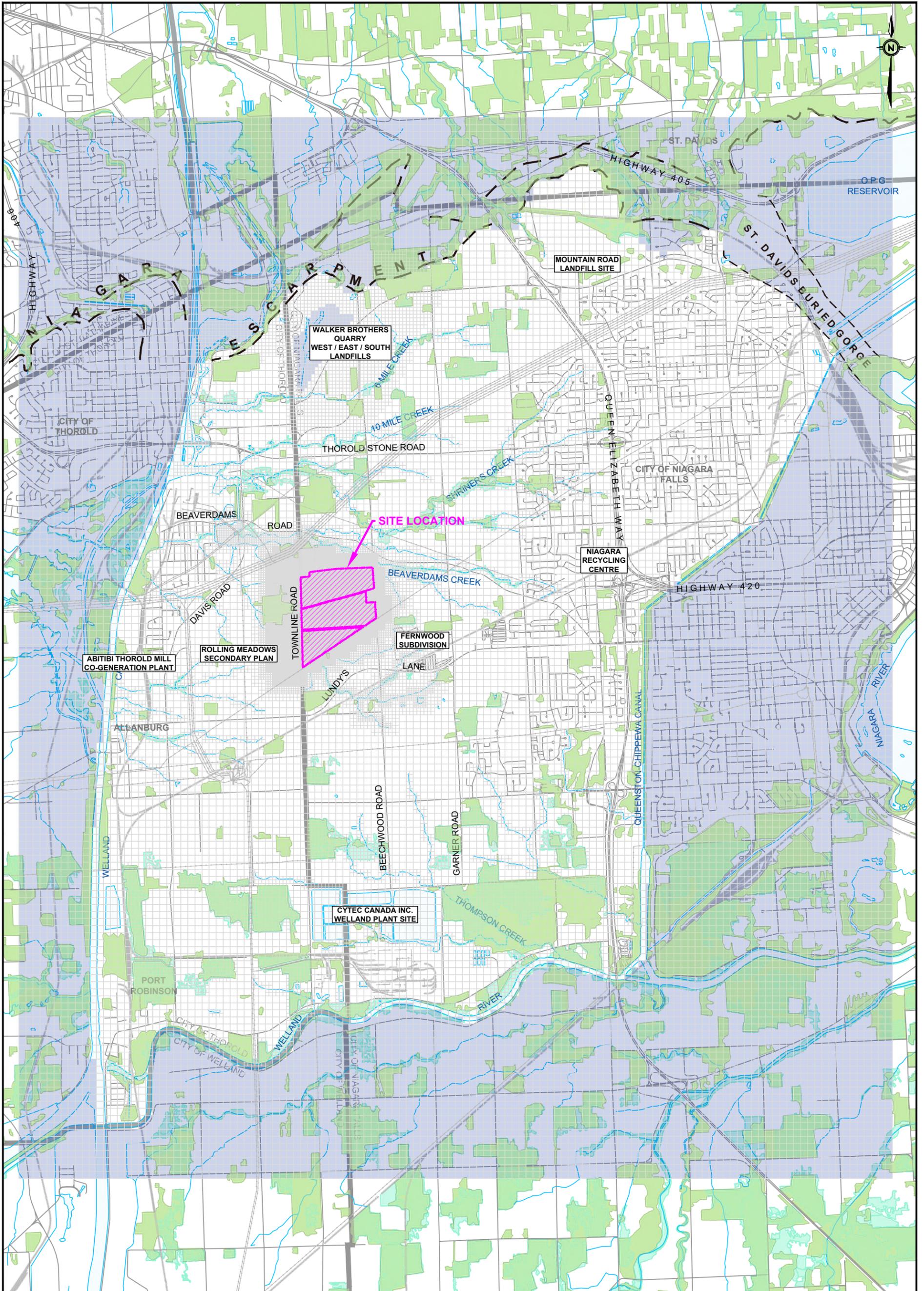
Station	Date Units PWQO	Nutrients and Organic Indicators								Total Metals						
		Nitrate	Nitrite	T K N	Ammonia	Un-ionized Ammonia	Total Phosphorus	T O C	Phenols	Aluminum (dissolved)	Antimony	Arsenic	Barium	Beryllium	Boron	Cadmium
		nc	nc	nc	nc	0.02 (e)	0.03 (f)	nc	0.001	0.075	(0.02)	0.1	nc	0.011	(0.2)	0.0002
SW1	7-Dec-16	0.46	<0.01	0.37	<0.05	<0.001	0.061	5.7	<0.001	<0.005	<0.0005	<0.001	0.035	<0.0005	0.051	<0.0001
	1-May-17	1.5	0.016	0.5	<0.05	<0.001	0.16	7.8	<0.001	0.016	<0.0005	0.0015	0.037	<0.0005	0.039	<0.0001
	19-Mar-18	0.56	<0.01	0.3	0.081	<0.001	0.12		<0.001	0.008	<0.0005	<0.001	0.035	<0.0005	0.026	<0.0001
SW2	7-Dec-16	0.27	0.023	0.85	<0.05	<0.0024	0.075	13	<0.001	0.017	<0.0005	<0.001	0.014	<0.0005	0.017	<0.0001
	1-May-17	1.3	0.017	0.69	<0.05	<0.001	0.2	13	<0.001	0.029	<0.0005	0.0013	0.03	<0.0005	0.029	<0.0001
	19-Mar-18	0.66	<0.01	0.37	<0.05	<0.001	0.37		<0.001	0.031	<0.0005	0.0029	0.08	0.00053	0.012	<0.0001
SW3	7-Dec-16	0.74	0.018	0.36	<0.05	<0.001	0.048	7	<0.001	<0.005	<0.0005	<0.001	0.032	<0.0005	0.035	<0.0001
	1-May-17	0.3	<0.01	0.67	<0.05	<0.001	0.2	11	<0.001	0.017	<0.0005	0.0015	0.041	<0.0005	0.032	<0.0001
	21-Mar-18	0.19	<0.01	1	0.15	<0.001	0.16		<0.001	0.007	<0.0005	<0.001	0.032	<0.0005	0.022	<0.0001
SW4	7-Dec-16	0.34	<0.01	0.4	<0.05	<0.0015	0.032	7.6	<0.001	<0.005	<0.0005	<0.001	0.024	<0.0005	0.028	<0.0001
	1-May-17	0.6	0.013	0.66	<0.05	<0.001	0.25	9.9	<0.001	0.019	<0.0005	0.0011	0.037	<0.0005	0.024	<0.0001
	19-Mar-18	0.36	<0.01	0.52	0.067	0.0011	0.076		<0.001	0.008	<0.0005	<0.001	0.026	<0.0005	0.014	<0.0001
DP1	7-Dec-16	0.28	<0.01	0.31	<0.05	<0.001	0.075	5.2	<0.001	0.008	<0.0005	0.0012	0.051	<0.0005	0.029	<0.0001
	1-May-17	1.44	<0.05	0.46	<0.05	<0.001	0.58	10	<0.001	0.02	<0.0005	0.0054	0.12	0.0009	0.037	0.00025
	21-Mar-18	0.12	<0.01	0.37	0.088	<0.001	0.08		<0.001	0.009	<0.0005	<0.001	0.032	<0.0005	0.028	<0.0001
DP2	7-Dec-16	<0.1	<0.01	0.72	0.11	0.0015	0.12	13	<0.001	0.005	<0.0005	0.0013	0.034	<0.0005	0.024	<0.0001
	1-May-17	0.26	<0.01	0.68	<0.05	<0.001	0.28	10	0.0014	0.021	<0.0005	0.0019	0.045	<0.0005	0.026	<0.0001
	19-Mar-18	0.39	<0.01	0.51	0.05	<0.001	0.18		<0.001	0.009	<0.0005	0.0031	0.094	0.00055	0.016	0.00037
DP3	7-Dec-16	0.42	<0.01	0.43	<0.05	<0.001	0.034	7.3	<0.001	0.005	<0.0005	<0.001	0.024	<0.0005	0.029	<0.0001
	1-May-17	0.33	0.011	0.6	<0.05	<0.001	0.2	11	<0.001	0.02	<0.0005	0.0017	0.044	<0.0005	0.029	<0.0001
	19-Mar-18	0.35	<0.01	0.49	0.059	<0.001	0.073			0.007	<0.0005	<0.001	0.028	<0.0005	0.016	<0.0001
DP4	5-Dec-16 (1)															
	19-Mar-18	<0.1	<0.01	0.33	<0.05	<0.001	0.16		<0.001	0.024	<0.0005	<0.001	0.029	<0.0005	0.01	<0.0001
DP5	22-Mar-18 (2)															

Table G-1 Surface Water Chemical Results

Station	Date	Total Metals								
		Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel
		Units PWQO	0.0089	0.0009	0.005	0.3	0.025	nc	0.0002	(0.04)
SW1	7-Dec-16	<0.005	<0.0005	0.0015	0.22	<0.0005	0.032	<0.0001	0.0007	0.0015
	1-May-17	0.0056	0.0017	0.0065	5	0.0031	0.065	<0.0001	0.00083	0.0055
	19-Mar-18	<0.005	0.00074	0.0033	2.3	0.001	0.053	<0.0001	0.00071	0.0027
SW2	7-Dec-16	<0.005	<0.0005	0.0045	0.66	0.00054	0.012	<0.0001	<0.0005	0.0016
	1-May-17	<0.005	0.0014	0.0062	4.2	0.0028	0.059	<0.0001	<0.0005	0.0048
	19-Mar-18	0.013	0.005	0.013	15	0.0075	0.22	<0.0001	0.00053	0.014
SW3	7-Dec-16	<0.005	<0.0005	0.003	0.53	0.0006	0.072	<0.0001	0.00097	0.0018
	1-May-17	0.0054	0.0017	0.008	5	0.003	0.082	<0.0001	0.00083	0.0058
	21-Mar-18	<0.005	<0.0005	0.0041	0.82	0.00069	0.082		0.0012	0.0021
SW4	7-Dec-16	<0.005	<0.0005	0.0024	0.62	<0.0005	0.05	<0.0001	0.00075	0.002
	1-May-17	<0.005	0.0013	0.0063	3	0.0034	0.088	<0.0001	<0.0005	0.0041
	19-Mar-18	<0.005	0.00053	0.0064	1.2	0.00069	0.054	<0.0001	0.0011	0.0027
DP1	7-Dec-16	<0.005	0.00084	0.0033	1.9	0.0016	0.065	<0.0001	0.001	0.0028
	1-May-17	0.024	0.0097	0.022	25	0.012	0.35	<0.0001	0.0015	0.028
	21-Mar-18	<0.005	0.00066	0.0038	2	0.00097	0.082	<0.0001	0.00087	0.003
DP2	7-Dec-16	<0.005	0.0011	0.0018	1.3	<0.0005	2.3	<0.0001	0.00082	0.0051
	1-May-17	0.0075	0.0025	0.0089	7.2	0.0044	0.12	<0.0001	0.00078	0.0078
	19-Mar-18	0.015	0.0061	0.018	15	0.012	0.61	<0.0001	0.0014	0.017
DP3	7-Dec-16	<0.005	<0.0005	0.0015	0.34	<0.0005	0.076	<0.0001	0.00068	0.0027
	1-May-17	0.0066	0.0022	0.0078	6.4	0.0033	0.1	<0.0001	0.00078	0.007
	19-Mar-18	<0.005	0.00057	0.0062	1.1	0.00071	0.061	<0.0001	0.0011	0.0028
DP4	5-Dec-16 (1)									
	19-Mar-18	<0.005	0.00096	0.0035	3.7	0.0018	0.03	<0.0001	<0.0005	0.004
DP5	22-Mar-18 (2)									

Table G-1 Surface Water Chemical Results

Station	Date Units PWQO	<i>Total Metals</i>							
		Selenium	Silver	Strontium	Tungsten	Uranium	Vanadium	Zinc	Zirconium
		0.1	0.0001	nc	(0.03)	(0.005)	(0.006)	0.03	(0.004)
SW1	7-Dec-16	<0.002	<0.0001	0.49	<0.001	0.0021	0.00091	<0.005	<0.001
	1-May-17	<0.002	<0.0001	0.18	<0.001	0.00058	0.0077	0.023	<0.001
	19-Mar-18	<0.002	<0.0001	0.35	<0.001	0.0016	0.0036	0.0099	<0.001
SW2	7-Dec-16	<0.002	<0.0001	0.12	<0.001	0.00025	0.0017	0.0055	<0.001
	1-May-17	<0.002	<0.0001	0.09	<0.001	0.00016	0.0069	0.019	<0.001
	19-Mar-18	<0.002	<0.0001	0.19	<0.001	0.00047	0.018	0.051	0.0012
SW3	7-Dec-16	<0.002	<0.0001	0.47	<0.001	0.0009	0.001	0.0085	<0.001
	1-May-17	<0.002	<0.0001	0.21	<0.001	0.00054	0.0076	0.026	<0.001
	21-Mar-18	<0.002	<0.0001	0.51	<0.001	0.0013	0.0016	0.0081	<0.001
SW4	7-Dec-16	<0.002	<0.0001	0.42	<0.001	0.00075	0.0012	<0.005	<0.001
	1-May-17	<0.002	<0.0001	0.15	<0.001	0.00037	0.0053	0.02	<0.001
	19-Mar-18	<0.002	<0.0001	0.31	<0.001	0.00089	0.0019	0.0077	<0.001
DP1	7-Dec-16	<0.002	<0.0001	0.38	<0.001	0.0012	0.0029	0.01	<0.001
	1-May-17	<0.002	0.00012	0.17	<0.001	0.00092	0.031	0.094	0.0017
	21-Mar-18	<0.002	<0.0001	0.41	<0.001	0.0013	0.0029	0.0083	<0.001
DP2	7-Dec-16	<0.002	<0.0001	0.42	<0.001	0.00093	0.0013	0.0059	<0.001
	1-May-17	<0.002	<0.0001	0.15	<0.001	0.0005	0.01	0.032	<0.001
	19-Mar-18	<0.002	<0.0001	0.31	<0.001	0.0014	0.017	0.085	0.0012
DP3	7-Dec-16	<0.002	<0.0001	0.42	<0.001	0.0008	0.00089	<0.005	<0.001
	1-May-17	<0.002	<0.0001	0.2	<0.001	0.00043	0.0092	0.028	0.001
	19-Mar-18	<0.002	<0.0001	0.36	<0.001	0.00099	0.0018	0.006	<0.001
DP4	5-Dec-16 (1)								
	19-Mar-18	<0.002	<0.0001	0.096	<0.001	0.00032	0.0061	0.019	<0.001
DP5	22-Mar-18 (2)								



MODEL DOMAIN GRID

NUMERICAL GROUNDWATER MODEL REPORT
 PROPOSED UPPER'S QUARRY
 THOROLD / NIAGARA FALLS, ON
 For Walker Aggregates Inc.

DATE: SEPTEMBER 2022

PROJECT: 161-11633-00

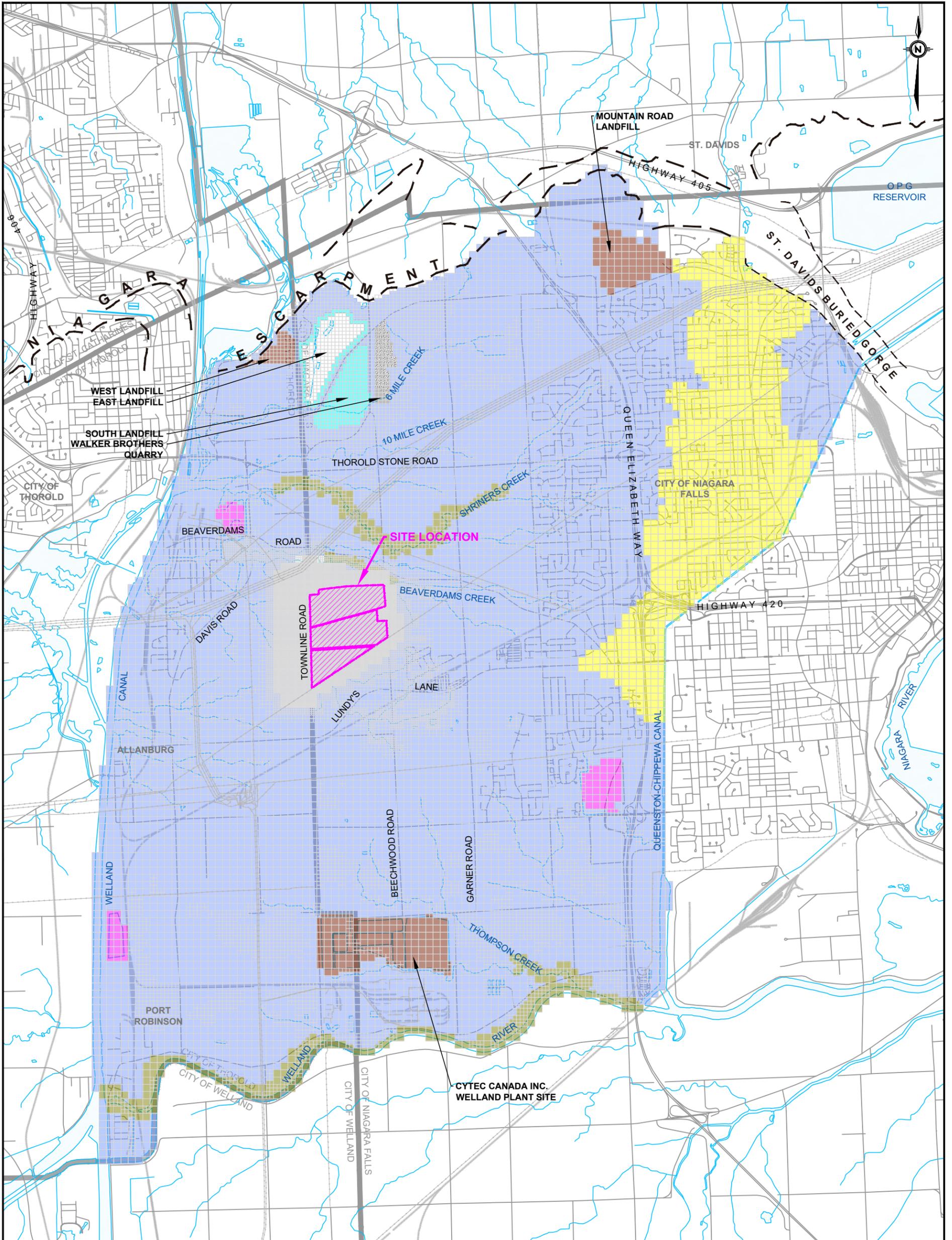
SCALE: 1 : 50,000

DRAWN BY: JLD



55 KING STREET, SUITE 700
 ST. CATHARINES, ON L2R 3H5
 T 905-687-1771 | F 905-687-1773 | www.wsp.com

FIGURE No: **H-1**



LEGEND

□ ACTIVE MODEL GRID

RECHARGE (ZONE / DESCRIPTION)

1	GLACIOLACUSTRINE SILT AND CLAY (8a)
2	GLACIOLACUSTRINE SAND AND GRAVEL (9)
3	ANTHROPOGENIC DEPOSITS (21)
4	MODERN ALLUVIAL DEPOSITS (19)
5	ACTIVE QUARRY EXCAVATION
6	UNLINED LANDFILL
7	LANDFILL WITH LCS

RECHARGE ZONES

NUMERICAL GROUNDWATER MODEL REPORT
 PROPOSED UPPER'S QUARRY
 THOROLD / NIAGARA FALLS, ON
 For Walker Aggregates Inc.

DATE:	SEPTEMBER 2022
PROJECT:	161-11633-00
SCALE:	1 : 50,000
DRAWN BY:	JLD

WSP

55 KING STREET, SUITE 700
 ST. CATHARINES, ON L2R 3H5
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FIGURE No: **H-4**