GOLDER
MEMBER OF WSP

REPORT

Water Report Level 1/2

Proposed Caledon Pit / Quarry

Submitted to:

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Distribution List

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APPENDICES

1.0 INTRODUCTION

CBM Aggregates (CBM), a division of St. Marys Cement Inc. (Canada) is applying to the Ministry of Natural Resources and Forestry (MNRF) for a Class A Licence (Pit and Quarry Below Water) and to the Town of Caledon for an Official Plan Amendment and Zoning By-law Amendment to permit a mineral aggregate operation. Golder Associates Ltd. a WSP company (Golder), has been retained by CBM to complete a Water Report Level 1/2 for the proposed CBM Caledon Pit / Quarry in accordance with the Terms of Reference developed in consultation with the Development Application Review Team (DART) found in Appendix A, and the MNRF, Aggregate Resources Act Ontario Regulation 244/97.

1.1 Site and Adjacent Lands

CBM owns / controls approximately 323 hectares of land located at the northwest, northeast and southwest intersection of Regional Road 24 (Charleston Sideroad) and Regional Road 136 (Main Street). Of these lands, approximately 262 hectares are proposed to be licenced under the Aggregate Resources Act and designated / zoned under the Planning Act to permit the proposed CBM Caledon Pit / Quarry (Figure 1-1). These lands are mapped as a Caledon High Potential Mineral Aggregate Resource Area (CHPMARA) in the Town of Caledon Official Plan and High Potential Mineral Aggregate Resource Area (HPMARA) in the Region of Peel Official Plan and are protected for their aggregate potential.

The remaining approximately 61 hectares of land owned / controlled by CBM are not subject to the application. These lands are referred to as “CBM Additional Lands” and these lands include approximately 36 hectares of land that is located adjacent to the minor urban centre of Cataract. As part of the application, CBM is proposing to create an upland forest and meadow grassland on these lands and is exploring the potential of conveying them permanently to a public authority for long term protection.

The lands proposed to be licenced under the Aggregate Resources Act are referred to as the “Subject Site” (or “Site”) and are legally described as Part of Lots 15-18, Concession 4 WSCR and Part of Lot 16, Concession 3 WSCR (former Geographic Township of Caledon). The Site is approximately 262 hectares and extraction is proposed on approximately 204 hectares. These lands are referred to as the “Extraction Area”. The remaining approximate 58 hectares within the Site and outside of the Extraction Area are referred to as the “Setback / Buffer Lands”. The Setback / Buffer Lands are used to provide setbacks to surrounding land uses and natural heritage features and the majority of these lands include a 5 metre (m) visual / acoustic berm and visual plantings.

For the purpose of this assessment, “Adjacent Lands” are defined as lands within 120 m of the Site, and the “Study Area” for this assessment included all lands within 1,000 m of the Site, as well as additional lands beyond this distance, as discussed in this Report.

2.0 DESCRIPTION OF PROPOSED DEVELOPMENT

The proposed Extraction Area includes approximately 80 million tonnes (Mt) of a high quality bedrock resource and approximately 5 Mt of a high quality sand and gravel resource. Testing has confirmed that the mineral aggregate resource found on-site is suitable for the production of a wide range of construction products, including the use for high performance concrete. The bedrock resource provides some of the strongest and most durable aggregate material in Southern Ontario. The primary market area for the proposed CBM Caledon Pit / Quarry is the Greater Toronto Area, including the Town of Caledon and the Region of Peel. This site represents a close to market source of a high quality mineral aggregate resource.

2.1 Proposed Site Operations

The proposed tonnage limit for the proposed CBM Caledon Pit / Quarry is 2.5 Mt per year and on average CBM anticipates shipping approximately 2.0 Mt per year. The proposed CBM Caledon Pit / Quarry is proposed to be operated in 7 phases, as shown on Figure 2-1. Phases 1, 2A, 3, 4, 5 are located to the northwest of the intersection of Regional Road 24 and 136. This area is referred to as the “Main Area”. Phase 2B is located to the northeast of the intersection of Regional Road 24 and 136. This area is referred to as the “North Area”. Phases 6 and 7 are located to the southwest of the intersection of Regional Road 24 and 136. This area is referred to as the “South Area”.

Operations would commence in the Main Area and Phase 1 would include the permanent processing area (crushing, screening and wash plant), aggregate recycling area and the entrance / exit for the proposed CBM Caledon Pit / Quarry. Until such time as sufficient space is opened up to establish the permanent processing area, a temporary mobile crushing and processing plant is proposed to be used in Phase 1. The entrance / exit for the CBM Caledon Pit / Quarry is proposed to be located onto Regional Road 24, approximately 775 m west of Regional Road 136. The entrance / exit is proposed to be controlled by a new traffic light and the installation of taper lanes and acceleration lanes on Regional Road 24 at CBM’s expense. The primary haul route for the proposed CBM Caledon Pit / Quarry is trucks will travel eastward on Regional Road 24 and then southward on Highway 10. The proposed haul route is an existing aggregate haul route and is designated as an aggregate haul route in the Town of Caledon Official Plan.

Access to the North Area for aggregate extraction is anticipated approximately 10 years after the start of the operations in the Main Area. There will be no processing in the North Area and aggregate extracted from the North Area is proposed to be transported to the Main Area through a proposed tunnel underneath Regional Road 136. Access to South Area is anticipated approximately 30 years after the start of the operations in the Main Area. In the South Area, CBM is proposing to permit a portable processing plant and the aggregate extracted and / or processed from the South Area is proposed to be moved to the Main Area through a proposed tunnel underneath Regional Road 24. Aside from the establishment of a 1 hectare stormwater settling pond on the easternmost portion of the North Area in the initial year of operation, the North and South areas will be maintained in their current state and agricultural uses until they are required for preparation for aggregate extraction.

The CBM Caledon Pit / Quarry is proposed to operate (extraction, processing and drilling) 7:00 am to 7:00 pm Monday to Saturday, excluding statutory holidays and shipping is proposed from 6:00 am to 7:00 pm Monday to Saturday consistent with other mineral aggregate operations in Caledon. CBM is also proposing to permit limited shipping in the evening and nighttime (7:00 pm to 6:00 am) to support public authority contracts that require the delivery of aggregates during these hours to complete public infrastructure projects. These activities will be limited to only highway trucks and shipping loaders and no other operations will be permitted during evening or nighttime hours. Site preparation and rehabilitation is proposed to be permitted 7:00 am to 7:00 pm Monday to Friday.

The proposed CBM Caledon Pit / Quarry involves stripping topsoil and overburden from the Site to create perimeter berm and any excess soil will be temporarily stored in the northern portion of the Main Area or used for progressive rehabilitation of the site. The proposed Extraction Area includes extracting both sand and gravel below the water table and the site will be dewatered to allow operations in a dry state. The site will be extracted in sequence of the proposed phases (Phase 1 to 7) and following extraction of Phase 7 the permanent processing plant in Phase 1 will be removed and this will be the final area to be extracted and rehabilitated. The phasing of the proposed mineral aggregate operation has been designed to reach final extraction limits and depths within each phase so progressive rehabilitation of the side slopes can be completed.

2.2 Site Servicing

The Site, including the Main, North and South Areas, is not municipally serviced for water or sewer, and no municipal water or sewer servicing is required to support the proposed development. Potable water for workers will be supplied privately to the Site, and septic waste generated on-site will be stored in a holding tank and disposed off-site.

It is noted that there are three properties within the Main Area that currently have private wells supplying water and septic systems for domestic use. Two farms on the western portion of the Main Area (18501 Mississauga Rd. and 18667 Mississauga Rd.) and the other is a residential property on the southeastern portion of the Main Area (1420 Charleston Sideroad). There are no private water wells or septic systems currently in use on the North Area or South Area.

2.3 Proposed Site Rehabilitation

The overall goal of the final rehabilitation plan is to create a landform that represents an ecological and visual enhancement and provides future opportunities for conservation, recreational, tourism and water management. Overall, the progressive and final rehabilitation plan for the Site includes the creation of: lakes, vegetated shorelines, islands, wetlands, upland forested areas, riparian plantings adjacent to the existing watercourse, nodal shrub and tree planting on upland areas, grassland meadows and specialized habitat features for bats and turtles. The proposed rehabilitation has been designed to use all of the on-Site topsoil and overburden and does not require the importation of additional soils.

2.4 Summary

The Water Report Level 1 / 2 assessed the proposed CBM Caledon Pit / Quarry and based on the implementation of the recommendations found in Section 11 of this report, this assessment concluded the following:

- The proposed Caledon Pit / Quarry is within the Credit Valley Source Protection Area but is not located in a wellhead protection area (WHPA) or an intake protection zone (IPZ) and there will be no impacts to municipal water supplies.
- Of the approximately 100 water supply wells evaluated a majority of the wells are located at a depth below the proposed pit / quarry floor and they will not be impacted. There are 15 residential wells that have the potential to be impacted during operations by the proposed pit / quarry development. These 15 wells are susceptible to water quantity impacts due to their location relative to the predicted zone of influence of the Site, and their relatively shallow well construction in comparison to other wells in the area.

- In all cases, these wells could be deepened to the depth of other wells in the surrounding area to restore the water supply. In the event of a water well complaint there is an established procedure that the licensee must follow which requires an immediate investigation and supply of temporary water if required. In the event, any well was impacted by the proposed pit / quarry operation it is the licensee’s responsibility to restore the water supply, at their expense.
- As part of the operation there will be an extensive on-site and off-site groundwater monitoring program and annual reports that will be submitted to the government agencies and publicly available. As a result of the proposed design of the quarry, the comprehensive groundwater monitoring and reporting requirements and the water well complaint procedure, it is concluded that water supply wells in the surrounding area will be protected.;
- The proposed extraction area does not contain any identified water resources on the Region of Peel Schedule A-1 (Water Resources, Systems and Features). The proposed licence area includes an identified feature in the northwest corner of the Main Area and this feature is located outside of the extraction area and will be protected.
- A small portion of Main Area, a very small portion of the North Area and the majority of the South Area is mapped as a Highly Vulnerable Aquifer on the Region of Peel Schedule A-2 (Highly Vulnerable Aquifers). This is very common for mineral aggregate resource areas, and based on the design of the operation, and the implementation of the recommendations contained this Report, the proposed Caledon Pit / Quarry does not result in additional risk to the aquifer.
- Almost all of the Rural Area in the Region of Peel including the Main Area, North Area and South Area are mapped as a Significant Groundwater Recharge Area on the Region of Peel Schedule A-3 (Significant Groundwater Recharge Area). This is very common for mineral aggregate resource areas, and based on the design of the operation, and the implementation of the recommendations contained in this report, the groundwater recharge function of the area (i.e., providing flow to the Credit River) will be maintained, and will report to the Credit River and its tributaries via quarry dewatering (operational) or groundwater inputs and lake outflows (rehabilitation).
- There are no key hydrologic features located within the proposed extraction area. There is a 0.1 ha key hydrologic feature (i.e., wetland) that will be impacted for the construction of the proposed berm and this feature is permitted to be removed in accordance with applicable policies. There are also key hydrologic features (i.e., wetland and tributary) in the northwest corner of the Main Area and these features will be protected. Taking into consideration the rehabilitation plan, there are 4.8 ha of wetland to be created and 158.3 ha lake to be created resulting in 163 ha of new key hydrologic features.
- The extraction of aggregates and creation of ponds at the Site upon rehabilitation is not predicted to have adverse impacts on the local surface water hydrology of the Credit River or the surrounding tributaries/water features with the exception of Tributary #1, Tributary #8, and the golf course ponds at SW13, via land use changes, surface water drainage alterations and / or quarry operation. The decrease in surplus and increase in groundwater drawdown, over the operational period, to the remaining adjacent tributaries/water features is predicted to have minor localized impacts to flow that will see a total decrease in flow of less than 9% of existing flows. The decrease in surplus and increase in groundwater drawdown, over the operational period, at Tributaries #1 and #8 as well as the two golf course ponds situated adjacent to SW13 is predicted to have minor localized impacts to flow that will see a total decrease in flow of less than 25% of existing flows.

- Compared to existing conditions, average annual surplus over the Site footprint area increases under operational conditions by approximately 18%, while under rehabilitated conditions the surplus decreased by approximately 14%.
- Compared to existing conditions (579,245 m^3/yr), average annual infiltration decreases over the Site footprint area under operational and increases under rehabilitated conditions to 281,245 m^3/yr and 628,000 m^3/yr, respectively.
- Compared to existing conditions (312,385 m^3/yr), average annual on-Site runoff increases under operational conditions to 767,780 m^3/yr and decreases under rehabilitated conditions to 136,925 m^3/yr.
- The application includes detailed monitoring and reporting requirements to ensure adjacent sensitive groundwater features and sensitive surface water features will be assessed as extraction proceeds to help ensure these features will be protected, improved or restored.
- With the implementation of the recommendations in this Report, sensitive surface water features and sensitive groundwater features will be protected, improved and restored during operations.
- Taking into account rehabilitation, there will be a long term enhancement to the water resources system and features.

The proposed Aggregate Resources Act Site Plans includes all of the technical recommendations from this report to ensure that the site operates in accordance with applicable provincial standards and the applicable policy requirements of the Provincial Policy Statement, Places To Grow Plan, Greenbelt Plan, Region of Peel Official Plan and Town of Caledon Official Plan.

3.0 BACKGROUND REVIEW / REGIONAL SETTING

The objective of the background review was to assemble available geoscientific information for the Site to develop an understanding of the regional and local geology, hydrogeology and hydrology, and to inform the water resources investigation plan. The review included geological and hydrogeological data, water well records and mapping from public sources, including the MNRF, the Ontario Geological Survey (OGS), the Ministry of Environment, Conservation and Parks (MECP), Ministry of Northern Development and Mines (MNDM) and Credit Valley Conservation (CVC), as well as previous geologic and hydrogeologic reports for the Site and Study Area.

3.1 Documents Reviewed

The following data sources and technical reports were identified and included in the data compilation and background review.

- OBM mapping – MNRF base data layers obtained from Land Information Ontario (LIO), 2020. Used for map generation and analysis.
- Aerial imagery – Recent aerial imagery obtained from Digital Globe, 2019. Used for map generation and analysis.
- Topography - MNRF SWOOP 1 m contour DEM data, 2015. Used for map generation and terrain analysis.
- Quaternary mapping - Ontario Geological Survey 2003: MRD128-Surficial Geology of Southern Ontario, MNDM. Used for map generation and analysis.
- Bedrock mapping - Ontario Geological Survey 2011: MRD126-Bedrock Geology of Southern Ontario, MNDM. Used for map generation and bedrock geology analysis.
- Amabel Formation Outcrop, Ontario Geological Survey, ARO 2018. Used for map generation and analysis.
- ARIP report #165 - Aggregate resources inventory of the Regional Municipality of Peel, southern Ontario; Ontario Geological Survey, Aggregate Resources Inventory Paper 165 – Revised, 57p. Reviewed for general information on aggregate resources in the Study Area.
- Water Well Records (WWRs) and Permits to Take Water (PTTWs) – Database obtained from MECP, first obtained in September 2019 and updated July 2022. Used to evaluate neighbouring water users in the Study Area.
- Pits and Quarries Ontario MNRF - https://www.gisapplication.lrc.gov.on.ca/PitsandQuarries/index.html - accessed September 2019. Used to identify nearby active aggregate extraction sites.
- A three-dimensional geological model of the Paleozoic bedrock of southern Ontario; report in Ontario Geological Survey, Groundwater Resources Study 19 / Geological Survey of Canada, Open File 8618. (Carter et al. 2019). Used to inform bedrock geology interpretation and development of the site conceptual and numerical model.
- Early Silurian sequence stratigraphy and geological controls on karstic bedrock groundwater-flow zones, Niagara Escarpment region and the subsurface of southwestern Ontario; report in Ontario Geological Survey, Groundwater Resources Study 13. (Brunton and Brintnell 2020). Used to inform bedrock geology interpretation and development of the site conceptual and numerical model.

- Credit Valley Source Protection Area - Assessment Report. https://ctcswp.ca/the-science/credit-valley-spa-assessment-report/ - updated 2019. Provided context to assess Source Water Protection for the Study Area.
- Credit Valley – Toronto and Region – Central Lake Ontario (CTC) Source Protection Plan. https://ctcswp.ca/the-science/credit-valley-spa-assessment-report/ - updated 2022. Provided context to assess Source Water Protection for the Study Area.
- Region of Peel WHPA Study for Municipal Residential Groundwater Systems Located within the Credit River Watershed (AquaResource 2007). Used to inform development of the site conceptual and numerical model.
- Integrated Water Budget Report - Tier 2, Credit Valley Source Protection Area (AquaResource 2009). Used to inform development of the site conceptual and numerical model.
- Orangeville, Mono, Amaranth Tier 3 Water Budget and Local Area Risk Assessment Appendix A (AquaResource 2011). Used to inform development of the site conceptual and numerical model.
- Shaws Creek Subwatershed Study - Subwatershed 17 Phase 1 Characterization Report (CVC 2014). Used to inform development of the site conceptual and numerical model.
- West Credit Subwatershed Study Characterization Report (County of Wellington 1998). Used to inform development of the site conceptual and numerical model.
- Caledon Creek and Credit River Subwatershed Study (Subwatersheds 16 & 18) - Phase 1 Characterization Report (CVC 1999). Used to characterize existing site and watershed conditions.
- Caledon Creek and Credit River Subwatershed Study (Subwatersheds 16 & 18) - Phase 3 Implementation Report (CVC 2003). Used to inform development of the site conceptual and numerical model.
- Jagger Hims Ltd. 2001. Geotechnical Drilling – Proposed Effluent Storage Ponds, Caledon Centre for Well Being/Osprey Valley Golf Course Development. File 960776.02, dated Aug 16, 2001. Boreholes incorporated into the site hydrogeological model (conceptual and numerical).
- Jagger Hims Ltd. 2003. Proposed Osprey Valley Quarry, Geologic Information. File 011228.01, dated Sept 17, 2003. Boreholes incorporated into the site hydrogeological model (conceptual and numerical).

3.2 Climate

The Site is located approximately 21.5 km south and 10.5 km southeast of the Environment Canada (EC) Mono Centre and Orangeville MOE climate stations, respectively. The composite Orangeville MOE - Mono Centre period of record spans 60 years (1961-2021) and is a reasonably proximal dataset to characterize average climatological conditions in the vicinity of the Study Area.

Based on the composite Orangeville MOE / Mono Centre climate station data, average annual precipitation is 899 millimetres (mm) per year (mm/yr) and the average annual temperature is 6.2°C.

Additional information on climate is provided in Section 7: Water Balance.

3.3 Topography

Topography for the Site and surrounding lands is presented on Figure 3-1. The dominant physiographic feature in the area is the Niagara escarpment, which runs from northwest to southeast to the east and south of the Site. The Credit River flows from northwest to southeast along the base of the escarpment east and south of the Site and into a gorge south of the Site. In the areas above the escarpment, the topography generally slopes southeast towards the escarpment and the Credit River, with some rolling hills.

Topography in the Main Area of the Site ranges from a high of 424 metres above sea level (masl) in the northwest, to lows of 407 masl in the southeast corner and 402 masl in the southwest corner, with the terrain sloping to the east, south and southwest from that central high point. Topography in the North Area of the Site ranges from a high of 415 masl along the northwest side to a low of 401 masl in the southeast corner, with the terrain again sloping to the east, south and southwest from that central high point. Topography in the South Area of the Site ranges from a high of 407 masl in the northeast corner to a low of 396 masl along the southwest side and southwest corner, with the terrain mainly sloping to the south.

Topography east of the Site slopes eastward towards the Credit River valley and topography south of the Site slopes southeastward, also towards the Credit River valley. Topography west of the Site generally slopes southward. Topography north of the Site generally slopes eastward, from a topographic high of 431 masl along Mississauga Road, to an elevation of 421 masl in north central area north of the Site, and then to an elevation of 410 masl along Main Street.

Northeast of the Site, the Credit River is at an elevation of about 380 masl, and as the river flows to the southeast. South of Cataract, it enters a gorge where the river rapidly drops to an elevation of 320 masl once it is about 2 km downstream of Cataract.

3.4 Drainage

The predominant surface water features in the vicinity of the Site include the Credit River Main and Erin Branches to the east and southwest, respectively. The Credit River Erin Branch receives the majority of drainage from the Site under existing conditions via Tributaries #1 and #8. Tributary #1 enters at the northwest corner of the Site and flows southeast and then west within the Site before it exits through the southwestern boundary. Tributary #1 continues until its convergence with Tributary #8 before ultimately flowing towards the Credit River Erin Branch to the west. The Erin Branch of the Credit River is a major tributary of the Credit River, draining a catchment area of approximately 6.239 km^2, delineated using the Ontario Watershed Information Tool (OWIT), with about 3.22 km^2 of the catchment being located within the Site boundaries.

Several unnamed tributaries of these Credit River branches exist within or proximal to the Site including: Tributary #1 and Tributaries #4-9 (Figure 3-1). Tributaries #4 and #5 are situated directly north of the Site and partially drain the north portion of the Site and the Coulterville Wetland Complex, respectively. These two tributaries converge into a single watercourse (Tributary #4), and eventually discharge through the Osprey Valley Golf Course to the Credit River 0.7 km downstream of the Site. Tributaries #6 – #9 are situated southwest of the Site and drain the surrounding Coulterville Wetland Complex and rural areas. Tributary #9 sits above the remaining tributaries and drains into Tributary #7 which flows alongside Tributary #6 on a roadside ditch before converging into a single watercourse (Tributary #8). Tributary #8 continues to flow southwest before discharging into the Erin branch of the Credit River over 5.8 km downstream of the Site.

3.5 Geology

3.5.1 Surficial Geology

The Site is located within the eastern portion of the Guelph Drumlin Field physiographic region comprised mainly of glacial spillways, till plains, and drumlinized till plains (Chapman and Putnam 1984), and immediately west of the Niagara escarpment. The Site is entirely mapped as a glacial spillway, with the nearest drumlins mapped approximately 1 km northwest of the Site (M2226 OGS 1972) (Chapman and Putnam 1984).

Surficial geology mapping for the area (MRD128 OGS 2003) is presented on Figure 3-2, and summarized as follows (from oldest to youngest):

- Unit 3: Paleozoic Bedrock – Bedrock outcrops east and south of the Site along the steep slopes of the Niagara escarpment, at or east of the Credit River. Bedrock geology is further described in the next subsection.
- Unit 5b: Stone-Poor, Carbonate-Derived Silty to Sandy Till – Fine grained glacial till (Port Stanley Till) is mapped by the OGS at surface in the eastern and central part of the Main Area, the northeast part of the South Area, and the entirety of the North Area of the Site. This till is also mapped at surface west of the Site.
- Unit 6: Ice-Contact Stratified Deposits – Stratified deposits are not mapped on the Site, but are mapped at surface northwest of the Site, and southeast of the Site in the valley along the Credit River.
- Unit 7 / 7a: Glaciofluvial Deposits / Sandy Deposits – Glaciofluvial deposits mainly comprised of sand and gravel are mapped at surface by the OGS on the west side of the Main Area and the central portion of the South Area. These deposits are also mapped to the northeast, south and southwest, including the area of the Coulterville Wetland Complex. These deposits are also the source of sand and gravel for aggregate pit operations to the southwest of the Site and east of the Site, east of the Credit River.
- Unit 8a: Massive-Well Laminated – These unconsolidated deposits are reportedly not present on the Site but are mapped in a small area in the Credit River valley east of the Site.
- Unit 9c: Foreshore-Basinal Deposits – These deposits are mainly comprised of sand and gravel and are mapped in the south part of the South Area and shown to extend eastward into the Cataract minor urban centre.
- Unit 19: Modern Alluvial Deposits – These modern alluvial deposits are found along the Credit River east and south of the Site and Tributary #8 southwest of the Site.
- Unit 20: Organic Deposits – Organic deposits are mapped to north of the Site in parts of the Coulterville Wetland Complex and in the wooded wetland area immediately north of the Site referred to herein as the “Northwest Wetland”.

Water well records and borehole data indicate that overburden thickness is relatively shallow across the Site and variable in thickness in the surrounding area. On top of the escarpment, the overburden varies from less than a metre to ten’s of metres thick. Bedrock is exposed along the face of the escarpment in some places and covered by a thin veneer of overburden in other places, particularly as one moves further northwest along the escarpment. In the Credit River valley east and south of the Site, the overburden varies from a few metres thick west of the river to more than 100 m thick east of the Credit River.

There are “buried” bedrock valleys inferred to be present in the area, to the east and southwest of the Site and Study Area, as noted in AquaResource (2009). This includes a large northwest-southeast trending buried valley that parallels the escarpment east of the Credit River, and a southwest-northeast trending buried valley southwest of the Site, which appears to be a former glacial meltwater channel that “emerges” and joins the aforementioned buried valley that parallels the escarpment, and drains to the southeast towards Lake Ontario.

3.5.2 Bedrock Geology

The bedrock formations in the Cataract area consist of Paleozoic sedimentary rocks of the northern Appalachian foreland basin and Michigan structural basin (Brunton et al. 2012). The bedrock strata consist of an interlayered succession of sandstones, carbonates, evaporites, shales and siltstones and exhibit a gentle regional dip to the southwest at 3 to 6 m/km. These rocks comprise the Niagara escarpment, which forms a topographic ridge that slopes steeply to the east along the face of the escarpment cross-cutting and exposing the strata, and slopes gently to the southwest generally following the dip of the strata.

The general bedrock geology in the area is presented on Figure 3-3 (MRD126 OGS, 2011) and shows the approximate location of the geological contacts between the main geologic units in plan view.

The OGS has been updating the mapping of Palaeozoic strata in southern Ontario in recent years and has revised the framework for the stratigraphy of this area. Following the revised stratigraphic framework (Carter et al. 2019), a brief description of the upper bedrock formations at the Site and surrounding area is provided below (from oldest to youngest).

- 55A: Queenston Formation – The Queenston Formation is a thick Upper Ordovician sequence of red and grey shales with thin siltstone, limestone and sandstone interlayers. This unit is exposed in the Credit River valley gorge south of Cataract, and is on the order of 200 m thick. It is the lowermost rock unit considered in this assessment.
- 56D: Clinton / Medina (Cataract) Group – The Clinton / Medina Group is locally comprised of the Whirlpool (sandstone), Manitoulin (shaley dolostone), Cabot Head (shale), and Fossil Hill (shaley dolostone) Formations (from oldest to youngest). This Group is of Lower Silurian age, and lies unconformably atop the Queenston Formation.
  - Whirlpool Formation – The Whirlpool Formation consists of well-sorted, fine- to medium-grained sandstone with thin shale clasts and interbeds.
  - Manitoulin Formation - The Manitoulin Formation consists of thinly- to medium-bedded, blue-grey to tan weathered dolostones with intermittent shaley partings.
  - Cabot Head Formation - The Cabot Head Formation, readily distinguished by its grey-green colour, is a non-calcareous laminated fine-grained shale with thin interbeds of sandstone and limestone.
  - Rockway, Merritton, Reynales and Fossil Hill Formations – These are dolostone and argillaceous dolostone units that are present in some local areas. As discussed in Section 4, examination of the bedrock from drill cores at the site suggest that these units are not present in the Study Area.
- 58C: Lockport Group – The Lockport Group is comprised of the Gasport (dolostone), Goat Island (dolostone) and Eramosa (dolostone) Formations (from oldest to youngest). This group lies disconformably atop the Clinton / Medina Group, and forms the caprock of the Niagara escarpment cuesta.
  - Gasport Formation - The Gasport Formation is a massive to cross-bedded crinoidal dolostone with sequences of reef mound and coquina (shell bed) lithofacies. This unit was previously referred to as the Amabel Formation in older reports. **This is the main upper bedrock unit on the Site and is the primary target formation for aggregate production.**

- Goat Island Formation – The Goat Island Formation consists of two members; the lower Niagara Falls Member and the upper Ancaster Member. The Niagara Falls Member is a finely crystalline and cross-laminated crinoidal dolostone with small reef mounds and the Ancaster Member is a chert rich, finely crystalline dolostone that is medium to ash grey in colour. This unit is found immediately west of the Site in the Study Area.
- Eramosa Formation - The Eramosa Formation consists of three members including, from oldest to youngest, the Vinemount Member, the Reformatory Quarry Member and the Stone Road Member. The Vinemount Member is comprised of thinly bedded, fine crystalline dolostone with shaley beds that give off a distinctive petroliferous odour when broken. The Reformatory Quarry Member is described as light brown to cream coloured, pseudo-nodular, thickly bedded and coarsely crystalline dolostone. This unit also often contains mud-rich and microbial mat-bearing lithofacies that may act as aquitard materials, reducing the vertical permeability across this unit. This unit is found west of the Study Area.

3.6 Hydrogeologic Setting

The regional groundwater flow system in the Credit River Watershed is generally controlled by topographic relief and the hydraulic properties of the subsurface materials (AquaResource 2009). Areas of high permeability geologic units such as sand and gravel are typically dominated by rapid lateral movement of groundwater while low permeability units such as silt and clay are typically dominated by slow vertical movement of groundwater. Shallow groundwater moves from areas of high hydraulic head to areas of low hydraulic head, generally following topography, unless flow is modified by geologic conditions or intercepted by stream valleys that intersect the water table. In areas where rivers or streams intersect the water table, groundwater discharges and contributes baseflow to surface water features.

West of the Niagara escarpment, shallow groundwater flow follows topographic relief, and generally flows from northwest to southeast, towards the escarpment. East of the escarpment in the Credit River valley, shallow groundwater is inferred to flow mainly towards the river. In the areas east and south of the Site where the escarpment is a steep scarp face, the overburden above and below the escarpment are not hydraulically connected, and groundwater discharge (seeps) can occur in places on the escarpment face. The water table declines dramatically across the slope of the Niagara escarpment, following the ground surface topography. Below the escarpment groundwater flow is generally towards Lake Ontario but is strongly influenced by the Credit River and the underlying buried bedrock valley (AquaResource 2009).

Deep groundwater flow in the watershed is found to generally mimic bedrock topography and the groundwater flow in the shallow overlying system. Above the escarpment, the highest water level elevations occur where bedrock elevations are highest (AquaResource 2009).

3.7 Hydrostratigraphy

Hydrostratigraphic units are derived from geologic units based on their general hydrogeologic properties. The hydrostratigraphic units identified for the Credit Valley Watershed and used in Source Water Protection studies (AquaResource 2009), and informed by the OGS 3D bedrock model for the area, were used to develop the current hydrostratigraphic model for the Study Area, as summarized in the table below.

Table 3-1: Hydrostratigraphic Units for the Study Area

Hydrostratigraphic Unit	Zone	Geologic Units Represented
Upper Sand (Aquifer)	Overburden	Sand and gravel at surface
Till (Aquitard)	Overburden	Port Stanley Till
Lower Sand (Aquifer)	Overburden	Sand and gravel below the till
Weathered Bedrock (Aquifer)	Bedrock Contact	Contact zone, upper 1-5 m of weathered bedrock
Eramosa Fm (Aquifer)	Bedrock	Eramosa Formation
Goat Island Fm (Aquifer)	Bedrock	Goat Island Formation
Gasport Fm (Aquifer)	Bedrock	Gasport Formation (upper and middle)
Shaley Dolostone (Aquitard)	Bedrock	Gasport Formation (lowermost 2 to 3 m)
Cabot Head Fm (Aquitard)	Bedrock	Cabot Head Formation
Manitoulin Fm (Aquifer)	Bedrock	Manitoulin Formation
Whirlpool Fm (Aquifer)	Bedrock	Whirlpool Formation
Queenston Fm (Aquiclude)	Bedrock	Queenston Formation

The incorporation of these units in the groundwater-surface water model is discussed in Section 8: Groundwater and Surface Water Modelling.

3.8 Water Users

3.8.1 MECP Water Well Record Review

The MECP Water Well Information System (WWIS) database was queried and 125 well records were identified within a 1 km radius of the Site, in addition to the monitoring wells installed by Golder for this investigation program, as described in Section 5. Two additional wells just north of the 1 km limit on the Osprey Valley Golf Course property were also included in the compilation of water well records.

The well information in the database was initially tabulated, and then each original water well record was examined and used to verify and refine the information in the MECP database, correcting or adding information if the database was found to have erroneous or missing entries. Hydrostratigraphy for each well was added to the table, in order to identify the aquifer unit(s) that each well draws groundwater from.

The water wells were categorized by aquifer into the following four categories:

- Overburden - Wells installed in the overburden only.
- Bedrock (Gasport) - Bedrock wells installed in the Gasport Formation only.
- Bedrock (below Gasport) - Bedrock wells installed below the Gasport Formation (typically targeting the Manitoulin and/or Whirlpool Formations).
- Bedrock (Gasport and Lower) - Bedrock wells penetrating multiple bedrock units, including the Gasport and the underlying Manitoulin and/or Whirlpool Formations.

A compilation of the water well record information is presented in Appendix B, Table B-1. The water well locations are shown on Figure 3-4, where they have been colour coded by purpose and symbolically coded by aquifer category.

Table 3-2: Summary of Water Wells by Purpose/Use and Aquifer Category

Well Purpose / Use	Number of Wells	Overburden	Bedrock (Gasport)	Bedrock (below Gasport)	Bedrock (Gasport and Lower)
Water Supply - Domestic	88	12	18	6	52
Water Supply - Commercial	7	2		3	2
Water Supply - Industrial	2	1			1
Water Supply - Other	3	1		1	1
Observation / Monitoring	14	6	4	4	
Recharge	9		8	1	
Dewatering	2	2			
Other	2	2			
Number of Wells	127	26	30	15	56

With reference to the table above, Figure 3-4 and Table B-1 the following is noted:

- The wells range in depth from 5.3 to 82.6 m and are, on average, approximately 28 m deep. Static water levels in the wells at the time of construction reportedly ranged from 1.5 to 24.1 m, with an average static water level of approximately 9.3 m.
- Of the 100 water supply wells, 16 wells draw groundwater from the overburden, 18 wells draw groundwater from the Gasport Formation, 10 wells draw groundwater from aquifers below the Gasport Formation, and 56 wells draw groundwater from a combination of the Gasport Formation and aquifers underlying the Gasport Formation (i.e., Manitoulin and Whirlpool Formations).

- Most bedrock water supply wells were rated for low yields, typically on the order of 10 to 25 L/min (approximately 3 to 5 imperial gallons / minute (Igal/min)).
- The two overburden water supply wells (commercial use) were rated at yields of 450 and 560 L/min (approximately 100 and 125 Igal/min).
- The majority of overburden wells are located east of the Credit River or southwest of the Site, where sand and gravel deposits are prominent.
- The majority of domestic water users above the escarpment (i.e., Cataract residents and rural residents) have wells that penetrate multiple bedrock units and draw groundwater from a combination of the Gasport Formation and underlying bedrock units.

3.8.2 Private Well Survey

A door-to-door private well survey was conducted by CBM and Golder in July 2021 at approximately 150 properties within 1 km of the Site to supplement and help verify the MECP WWIS information and confirm water users around the Site. Participation by neighbouring property owners was entirely voluntary. During the door-to-door survey, residents received an explanation of the purpose of the survey and were provided an opportunity to ask questions. The survey form was left with the residents to complete and return by self-addressed mail or email, or elect to complete the survey over the phone.

Unfortunately, there was minimal public participation in the survey with only five property owners / tenants returning surveys on CBM-owned lands. Due to the limited participation, a follow-up private well survey is proposed to be carried out upon licence approval and prior to the initiation of aggregate extraction, to supplement information regarding private well use compiled from the MECP WWIS database.

3.8.3 MECP Permit to Take Water Review

A search of MECP PTTWs identified two permits within approximately 1 km of the Site.

The first is active Permit 1807-AC9P9J for irrigation and water supply at the Osprey Valley Golf Course, owned by Osprey Valley Resorts, Forgehill Equities Inc. This permit includes a water intake from the Credit River which is used to supplement two irrigation ponds (Pond 1 and Pond 3 West) on the property, and a bedrock well (WWR #4909177) that reportedly draws water from the Gasport, Manitoulin and Whirlpool formations. The intake, ponds and well are located approximately 1 to 1.5 km northeast of the Site at the base of the escarpment (Figure 3-4). A copy of the PTTW has been provided to CBM by the permit holder, including groundwater level monitoring data.

The second is expired Permit 7541-72ZM8Z, which is held by Aquaterra Corporation for the purposes of producing bottled water. The MECP database indicates that the permit expired in 2017, but it is our understanding that the MECP currently has a moratorium on renewing bottled water permits, and that the owner may be allowed to operate under the current (expired) permit.

Our review of water well records on the property associated with Permit 7541-72ZM8Z indicates there are two overburden water wells on the property (WWR #4903950 and WWR #4905439), located approximately 650 m southeast of the Site). The wells are rated at yields of 450 and 560 L/min (approximately 100 and 125 Igal/min), and it is assumed that the permit is associated with one of these wells, most likely the newer one. It is not known whether the bottled water operation is currently active. Golder has requested information about this PTTW from the MECP through the Freedom of Information (FOI) process, and are awaiting a response.

A summary of the two PTTWs is included in the table below.

Table 3-3: Summary of MECP Permits to Take Water

Permit No	Active	Easting, Northing (m)	Owner	Purpose / Use	Expiry Date	Type of Taking	Source ID	Max m3 / day	Max days / year	Max hours / day	Max L / min
1807-AC9P9J	Yes	576698, 4855364	Forgehill Equities Inc.	Commercial / Irrigation	12-31-2026	Surface and Groundwater	Pond 1	6546	210	24	4546
1807-AC9P9J	Yes	577011, 4855769	Forgehill Equities Inc.	Commercial / Irrigation	12-31-2026	Surface and Groundwater	Pond 3 West	8510	210	24	5910
1807-AC9P9J	Yes	577122, 4856078	Forgehill Equities Inc.	Commercial / Irrigation	12-31-2026	Surface and Groundwater	Credit River	6546	210	24	4546
1807-AC9P9J	Yes	577144, 4855727	Forgehill Equities Inc.	Commercial / Water Supply	12-31-2026	Surface and Groundwater	PW1	426	365	24	295
7541-72ZM8Z	?	578459, 4851827	Aquaterra Corporation Ltd.	Commercial / Bottled Water	03-31-2017	Groundwater	Cataract Well	364	260	18	455

3.9 Land Use / Neighbouring Aggregate Sites

General land use designations for the Site and Study Area, based on information available from Land Information Ontario (LOI), is presented on Figure 3-5 and was supplemented by a review of the land use designations in the Tier 2 Integrated Water Budget Report for Credit Valley Source Protection Area (Figure 2-4, AquaResource 2009). Current land uses for the Site and surrounding lands are described below.

With reference to Figure 3-5, the Main and South areas of the Site are mapped as agricultural (tilled) and undifferentiated land use, while the North Area is mapped as having agricultural (tilled), (tree) plantation, and undifferentiated land use. The agricultural lands include areas of intensive and non-intensive agriculture (AquaResource 2009).

Land uses in the area surrounding the Site are mapped as a mixture of agricultural (tilled), (tree) plantation, built up, undifferentiated, and aggregate extraction use. The agricultural lands include areas of intensive and non-intensive agriculture. Other developed land uses in the surrounding area (AquaResource 2009) include a golf course (Osprey Valley Golf Course northeast of the Site), rural residential properties (various locations), unclassified urban development (Cataract), coniferous plantations (various locations), and a landfill (east of the Credit River).

With reference to Figure 3-5 and the table below, there are eight neighbouring aggregate extraction operations, all of which are pits. Two pits (#6524 and #6525) are located above the Niagara escarpment approximately 600 m southwest of the Site in glaciofluvial sand and gravel deposits; one of them (#6525) is licenced for above water table extraction, and the other (#6524) is licenced for below water table extraction.

At pit #6524, below water table extraction has been completed on the majority of the property (Figure 1-1, 2019 aerial imagery) creating a pit pond, which has flattened the water table locally relative to pre-extraction conditions. This pit pond is considered to have a moderating effect on groundwater levels in that vicinity relative to other areas away from the pond that are likely to exhibit higher seasonal fluctuations in the water table.

The remaining six pits are located east of the Study Area and east of the Credit River, below the escarpment, in glaciofluvial sand and gravel deposits; three are licenced for above water table extraction, and three are licenced for below water table extraction.

The table below provides a summary of the neighbouring aggregate sites.

Table 3-4: Neighbouring Aggregate Sites

ALPS ID	6525	6524	6506	6670
Client Name	Warren Paving (Lafarge Canada Inc.)	Warren Paving (Lafarge Canada Inc.)	2004295 Ontario Inc.	Town of Caledon
Location Name	Caledon No. 3 (Pinkney)	Caledon No. 3 (Pinkney)	Caledon Pit	N/A
Current Status	ACTIVE	ACTIVE	ACTIVE	ACTIVE
Operation Type	Pit	Pit	Pit	Pit
Authorization Type	CLASS A LICENCE > 20000 TONNES	CLASS A LICENCE > 20000 TONNES	CLASS A LICENCE > 20000 TONNES	CLASS A LICENCE > 20000 TONNES
Max. Annual Tonnage	N/A	N/A	N/A	200000
Water Status	Above Water	Below Water	Below Water	Above Water
Licensed Area (Ha)	37.47	36.6	571.7	9.2
Lot	E 1/2 13	W 1/2 15	13,14,15 and 16	E 1/2 PT. LOT 15
Concession	5 WHS	5 WHS	III WHS	3 WHS
Lower Tier Municipality	CALEDON	CALEDON	CALEDON	CALEDON
Upper Tier Municipality	PEEL R	PEEL R	PEEL R	PEEL R

ALPS ID	625823	6568	608341	6619
Client Name	Lafarge Canada Inc.	Warren Paving (Lafarge Canada Inc.)	Lafarge Canada Inc.	Warren Paving (Lafarge Canada Inc.)
Location Name	Limebeer Pit	Petch Pit	Lawford Pit	N/A
Current Status	ACTIVE	ACTIVE	ACTIVE	ACTIVE
Operation Type	Pit	Pit	Pit	Pit
Authorization Type	CLASS A LICENCE > 20000 TONNES	CLASS A LICENCE > 20000 TONNES	CLASS A LICENCE > 20000 TONNES	CLASS A LICENCE > 20000 TONNES
Max. Annual Tonnage	1000000	N/A	750000	450000
Water Status	Mixed Above / Below	Below Water	Above Water	Above Water
Licensed Area (Ha)	39.7	41.88	107.9	78.2
Lot	Pt. 14, 15	E 1/2 LOT 16	Pt Lot 18 & 19	17
Concession	2 WHS	2 WHS	2 WHS	2 WHS
Lower Tier Municipality	CALEDON	CALEDON	CALEDON	CALEDON

ALPS ID	625823	6568	608341	6619
Upper Tier Municipality	PEEL R	PEEL R	PEEL R	PEEL R

3.10 Source Water Protection Considerations

The Site lies within the Credit Valley Source Protection Area, which is one of three source protection areas in the Credit Valley – Toronto and Region – Central Lake Ontario (CTC) Source Protection Region.

The Clean Water Act was established in 2006 to protect municipal sources of drinking water from contamination and over-use. Under the Clean Water Act, communities across Ontario are required to prepare a technical assessment report of municipal water sources to identify potential vulnerabilities. These reports act as the background to develop and implement source protection plans. The source protection plans, which have been approved and are in effect, contain policies that protect the municipal water supplies. The following is summarized from the Approved Assessment Report: Credit Valley Source Protection Area (CTC Source Protection Committee 2019).

With respect to municipal drinking water systems, the Site is not located within a WHPA or an IPZ. The closest municipal drinking water systems are the Alton Well Supply to the north and the Caledon Village-Alton Well Supply to the north and east-northeast. The Alton municipal wells are located approximately 3.4 km north-northwest of the Site, and the Caledon Village-Alton wells are located approximately 2.3 km north of the Site and 3.8 km east-northeast of the Site. The closest WHPA is approximately 1.9 km east-northeast of the Site and part of the Caledon Village-Alton WHPA. Since the Site is not located in an WHPA or IPZ, the project cannot potentially contribute a Significant Threat to Municipal water supplies in the area.

On a regional watershed scale, Highly Vulnerable Aquifers (HVA) and Significant Groundwater Recharge Areas (SGRA) were also reviewed. Aquifers are layers of rock or unconsolidated materials that can hold and transmit water easily. Aquifers can be considered highly vulnerable depending on the depth of the aquifer, type of material and type of overlying material. The vulnerability depends on how quickly water can move from surface to the aquifer and describes how easily a source of water can become polluted with a dangerous material.

The HVA mapping for the Study Area (Figure 3-6) is based on an aquifer vulnerability assessment, which was determined through assessment of aquifer depth and geologic setting, and provides an intrinsic vulnerability of the aquifer to sources of surface contamination. As noted on Figure 3-6, portions of the site and Study Area are mapped as a HVA (Figure 3-6). These HVA areas generally coincide with areas mapped as having coarse grain materials at surface (as shown earlier on Figure 3-2).

Drinking water threats, if present, are not considered Significant in an HVA and as such, policies in local Source Protection Plans that apply to HVAs rely on education and outreach to reduce risk to drinking water sources, as outlined in the Source Protection Plan (CTC Source Protection Committee 2022).

Significant Groundwater Recharge Areas are landscapes that allow water to recharge the aquifers below, typically at higher than average rates for the watershed. Similar to HVAs, the SGRAs are mapped where upper soils or rock are more permeable and are typically located in upland areas. The role of SGRAs is to support the protection of drinking water across a broader landscape. The entire Site and Study Area is mapped as a SGRA.

4.0 AGGREGATE RESOURCE INVESTIGATION

The objective of the aggregate resource investigation was to evaluate the quantity, quality and distribution of bedrock and sand and gravel aggregate resources on the Site, by means of a comprehensive borehole drilling and laboratory testing program.

4.1 Drilling Methodology

The borehole drilling was carried out by Choice Sonic Drilling Ltd. (CSD) of Brighton, Ontario under Golder supervision. The drilling took place over a nine month period from February to October 2020, during which time 27 boreholes, BH20-01 to BH20-27, were drilled on the Site at the locations shown on Figure 4-1.

As discussed later in Section 5.1, an additional 28 boreholes were drilled on the Site and surrounding area and completed as monitoring wells from February 2020 to March 2021. Of the additional 28 boreholes, 13 were located on or proximal to the Site and were included in the aggregate resource assessment.

The general methodology for the drilling and sample collection was as follows.

- The boreholes were drilled using a track-mounted Sonic SDC 550 drill rig and support equipment including 4x4 pickup trucks, a skid-steer, and a utility trailer equipped with low-impact tires.
- The rotasonic drilling method was used at the start of each borehole, which obtained a continuous 114 mm diameter (4 ½”) soil core through the overburden and ~1 m into competent bedrock, leaving a temporary casing in place. The overburden samples were logged and bagged for future testing as drilling proceeded.
- Once in competent bedrock, tooling was switched on the rig and the borehole was advanced into the rock by diamond drilling, obtaining HQ-sized (63.5 mm) continuous rock core. Most boreholes were drilled through the overburden and bedrock zone of interest, until shale or shaley dolostone was encountered.
- The rock cores were logged, photographed and boxed. The rock core was later split, with one half of the core sent for testing, and the other half retained for future reference.
- Upon the completion of the drilling, the open rock boreholes were left in place temporarily to allow for downhole geophysical logging and packer testing, as required.
- Once downhole testing was completed, the resource boreholes were abandoned in accordance with O.Reg. 903.

All boreholes were later surveyed by Delph and Jenkins North Ltd. of Aurora, Ontario and the results provided to Golder via CBM. Record of Borehole Logs are provided in Appendix C. A summary of the resource boreholes drilled is provided in Table 4-1. A summary of the additional boreholes drilled that were completed as monitoring wells is provided in Table 5-1 and shown on Figure 5-1, noting that 13 of those boreholes were also used in the aggregate resource assessment.

Table 4-1 - Summary of Resource Boreholes Drilled
Caledon Pit / Quarry

Borehole	Date Drilled:	Easting (m) UTM 17T	Northing (m) UTM 17T	Ground Elevation (masl)	Total Hole Depth (mbgs)	Depth of casing (mbgs)	Depth to Bedrock (mbgs)	Depth to bottom of Gasport (mbgs)	Depth to top of Cabot Head (mbgs)	Downhole Geophysics Completion	Packer Testing Completion
BH20-01(CAL)	07-Feb-20	578000.61	4853292.80	406.80	22.07	2.60	1.80	17.10	18.94	18-Feb-20	06-Mar-20
BH20-02(CAL)	10-Feb-20	577839.36	4853078.92	405.52	22.02	4.22	3.84	21.19	22.02	18-Feb-20	09-Mar-20
BH20-03(CAL)	26-Feb-20	577655.12	4852796.26	402.91	19.33	3.05	2.74	17.88	19.33	10-Mar-20	18-Mar-20
BH20-04(CAL)	18-Feb-20	577511.78	4852528.07	400.81	19.57	8.89	6.52	17.40	19.57	24-Feb-20	10-Mar-20
BH20-05(CAL)	19-Feb-20	577786.25	4852520.23	398.83	16.35	5.93	4.87	13.05	15.80	24-Feb-20	11-Mar-20
BH20-06(CAL)	20-Feb-20	578056.45	4852520.24	397.70	16.60	8.88	7.32	13.50	16.60	25-Feb-20	11-Mar-20
BH20-07(CAL)	21-Feb-20	578129.13	4853102.34	404.73	18.67	2.79	2.29	17.32	18.67	25-Feb-20	13-Mar-20
BH20-08(CAL)	24-Feb-20	577961.99	4852832.00	404.50	17.90	5.49	5.33	17.27	17.90	11-Mar-20	17-Mar-20
BH20-09(CAL)	25-Feb-20	578186.33	4852803.00	402.26	16.77	3.86	2.74	15.63	16.77	10-Mar-20	16-Mar-20
BH20-10(CAL)	17-Mar-20	577940.09	4853952.34	411.07	19.55	8.89	7.62	16.75	18.57	25-Mar-20	06-Apr-20
BH20-11(CAL)	18-Mar-20	578065.10	4854240.45	402.10	10.20	2.79	1.83	8.64	10.20	26-Mar-20	07-Apr-20
BH20-12(CAL)	23-Mar-20	577780.56	4854244.92	415.22	21.76	12.04	10.40	19.34	21.76	25-Mar-20	02-Apr-20
BH20-13(CAL)	27-Mar-20	577209.70	4854103.25	412.94	22.80	5.94	5.18	20.78	22.64	20-Apr-20	20-Apr-20
BH20-14(CAL)	02-Apr-20	577288.55	4853881.70	417.27	31.46	8.99	8.08	27.48	29.42	14-Apr-20	21-Apr-20
BH20-15(CAL)	07-Apr-20	576925.21	4854113.14	421.52	34.76	15.14	13.41	33.86	34.76	14-Apr-20	22-Apr-20
BH20-16(CAL)	15-Apr-20	576991.38	4853859.50	420.74	34.18	13.71	11.89	32.44	34.16	20-Apr-20	27-Apr-20
BH20-17(CAL)	20-Apr-20	577474.67	4853391.65	413.06	28.83	5.84	3.35	26.77	28.83	27-Apr-20	29-Apr-20
BH20-18(CAL)	23-Apr-20	577313.39	4853571.83	417.53	31.84	5.94	3.96	31.00	31.84	27-Apr-20	28-Apr-20
BH20-19(CAL)	24-Mar-20	577733.06	4853579.97	411.42	24.64	3.05	2.74	22.48	24.40	27-Apr-20	30-Apr-20
BH20-20(CAL)	30-Apr-20	577031.10	4853551.56	423.60	40.98	14.94	14.33	38.65	40.58	20-May-20	27-May-20
BH20-21(CAL)	05-May-20	576935.66	4853276.58	413.53	33.48	6.12	5.49	31.54	33.48	20-May-20	28-May-20
BH20-22(CAL)	07-May-20	576701.79	4853293.98	410.98	28.61	5.71	3.96	27.52	28.61	20-May-20	03-Jun-20
BH20-23(CAL)	11-May-20	576779.85	4853559.83	420.27	37.62	14.98	12.80	35.82	37.62	25-May-20	04-Jun-20
BH20-24(CAL)	27-May-20	577296.02	4852710.32	403.60	22.76	12.24	8.80	21.75	22.45	08-Jun-20	11-Jun-20
BH20-25(CAL)	10-Jun-20	577402.13	4852974.96	405.48	22.03	6.18	4.88	21.04	22.03	15-Jun-20	17-Jun-20
BH20-26(CAL)	11-Jun-20	577037.86	4852942.75	404.82	22.73	5.89	3.96	21.04	22.73	15-Jun-20	16-Jun-20
BH20-27(CAL)	22-Oct-20	577212.29	4853168.73	408.64	27.65	2.60	1.60	25.08	26.87	22-Oct-20	26-Oct-20

4.2 Laboratory Testing

4.2.1 Sand and Gravel Core Testing

The soil core samples were temporarily stored in an enclosed laydown area on the Site, and then transported to Golder's Materials Testing Laboratory in Whitby, which is accredited for Aggregate Testing by the Canadian Council of Independent Laboratories (CCIL) and the Ministry of Transportation Ontario (MTO).

As summarized in the table below, of the 40 resource boreholes / wells drilled on or proximal to the Site, a total 177 soil samples were collected, and of those, 71 representative samples were selected for sieve analysis. This includes 48 representative samples tested for both sieve and wash loss, and for which Fineness Modulus (FM), % Wash Loss, % Crushable Stone and Stone-to-Sand Ratio were also calculated.

Table 4-2: Summary of Sand and Gravel Core Samples Tested

Resource Assessment Boreholes	# BHs / MWs	Soil Samples	Sieve	Sieve and Wash Loss	Fineness Modulus	Wash Loss (%)	Crushable Stone (%)	Stone to Sand Ratio
BH20-01 to BH20-27	27	113	51	38	38	38	38	38
MW20-01, 02, 07, 08, 09, 10,11, 12, 14, 15, 16, 17, 18	13	64	20	10	10	10	10	10
Totals	**40**	**177**	**71**	**48**	**48**	**48**	**48**	**48**

4.2.2 Rock Core Testing

The rock core samples were also temporarily stored in an enclosed laydown area on the Site where they were photographed, and then transported to Golder's Materials Testing Laboratory in Whitby, which is accredited for Aggregate Testing by the CCIL and the MTO.

As summarized in the table below, the 477.58 m of rock core obtained from 33 resource boreholes / wells drilled on the Site were subjected to the following suite of quality tests:

- Material Finer than 75µm (LS-601)
- Sieve Analysis (LS-602)
- Absorption and Specific Gravity, Coarse Aggregate (LS-604)
- Absorption and Specific Gravity, Fine Aggregate (LS-605)
- Magnesium Sulphate Soundness, Coarse Aggregate (If Required) LS-606
- Percent Flat and Elongated Particles (LS-608)
- Petrographic Number (PN), Coarse Aggregate (LS-609)
- Organic Impurities (LS-610)
- Unconfined Freeze-Thaw Loss (LS-614)
- Micro-Deval Abrasion Loss, Coarse Aggregate (LS-618)
- Micro-Deval Abrasion Loss, Fine Aggregate (LS-619)
- Accelerated Mortar Bar Expansion (LS-620 Coarse and Fine Aggregate)

A summary of the rock core testing is provided in the table below, noting that rock quality was only tested for boreholes on the Site and not boreholes proximal to the Site.

Table 4-3: Summary of Rock Core Samples Tested

Resource Assessment Boreholes	# BHs / MWs	Core Tested (m)	Wash Loss	SG / Absorption	PN	Unconfined Freeze / Thaw	Micro-Deval Abrasion	Accel. Mortar Bar	Alkali-Carbonate Reactivity
BH20-01 to BH20-27	27	384.60	16	27	27	16	27	27	27
MW20-11, 12, 14, 15, 16, 18	6	92.98	0	6	6	0	6	6	6
Totals	**33**	**477.58**	**16**	**33**	**33**	**16**	**33**	**33**	**33**

4.3 Results

4.3.1 Sand and Gravel Resource

Based on borehole drilling and soil core logging, the distribution of sand and gravel material on the Site considered to be of interest for aggregate use is presented on Figure 4-2. Sand and gravel of significant thickness was found to be present in the South Area and in the western corner of the Main Area of the Site. This distribution is generally consistent with surficial geology mapping presented on Figure 3-2. The sand and gravel thickness increases from east to west, where it is in excess of 12 m thick in the western part of the Main and South areas.

The sieve and wash loss results for the 48 samples tested are summarized in the table below. The samples tested indicate that the sand and gravel deposit has an average Fineness Modulus of 4.15, contains 17% crushable stone on average, and has an average Stone:Sand ratio of 58:43, indicating that the material has a gradation suitable for producing a range of aggregate products.

Table 4-4: Sand and Gravel Sieve and Wash Loss Results

Full FM Value	Sand Portion FM Value	% Wash Loss	% Crushable Stone	% Stone	% Sand	Stone : Sand Ratio	Stats
1.00	0.88	7	0	0	1	0:100	Min
11.23	5.99	53	75	99	100	99:1	Max
4.15	2.87	28	17	33	67	58:43	Avg

There is estimated to be approximately 3.2 million m^3 of sand and gravel present on the Site within the two areas noted above. Based on the maximum predicted water table determined through the groundwater monitoring program and presented later in the report on Figure 5-6, approximately 75% of the sand and gravel resource is estimated to lie above the high water table on the Site, and the remaining 25% of the resource is below the high water table. Assuming an average material density of 1.65 t/m^3 and an approximate processing loss of 12.5% there is estimated to be approximately 4.6 Mt of economic sand and gravel on the Site.

4.3.2 Rock Resource

The cored boreholes were typically advanced through the entire thickness of the Gasport Formation and into the underlying Shaley Dolostone, and in some cases, were drilled through the Shaley Dolostone and into the Cabot Head Formation shale. Representative rock core photos of the main rock units encountered by the drilling program: the Gasport, Fossil Hill and Cabot Head Formations, are shown on Figure 4-3. These cores were drilled at BH20-01 located in the eastern half of the South Area, the first borehole drilled in February 2020, and are representative of these rock units on the Site.

With reference to the borehole logs in Appendix C, the thickness of the Gasport Formation on the Site encountered during drilling varied from 6.18 m to 27.04 m. The overall inferred thickness of the Gasport formation on the Site within the proposed licence area, based on contouring data from cored boreholes and monitoring wells on and proximal to the Site, is presented on Figure 4-4, and varies from approximately 3 m to 28 m. The Gasport formation is thickest in the northcentral part of the Main Area, where it forms a local topographic high (see Figure 3-1), and becomes thinner to the east and to the south. The Gasport Formation was found to be present in all boreholes drilled on the Site.

The rock core quality test results were very favourable, as all samples tested from the 33 boreholes drilled on the Site met all of the required MTO specifications for concrete aggregate.

There is estimated to be approximately 32.1 million m^3 of dolostone present on the Site within the areas shown on Figure 4-4. Based on the maximum predicted water table determined through the groundwater monitoring program and presented later in the report on Figure 5-6, approximately 8% of the dolostone bedrock resource is estimated to lie above the high water table on the Site, and the remaining 92% of the resource is below the high water table. Assuming an average material density of 2.60 t/m^3 and an approximate processing loss of 5% there is estimated to be approximately 79.4 Mt of economic dolostone on the Site.

4.3.3 Geologic Model

The resource investigation results were used (in conjunction with geologic information from the background review) to develop a geological model of the Site and Study Area. This model, based on the hydrostratigraphic units defined in Table 3-1, is illustrated in the two orthogonal geological cross-sections through the Site shown on Figures 4-5 and 4-6. Development of the geological model for the Site and its use in the development and implementation of integrated surface water-groundwater numerical model is discussed further in Section 8: Numerical Modelling.

5.0 GROUNDWATER INVESTIGATION

The overall objective of the groundwater investigation was to collect the hydrogeologic information necessary to characterize current hydrogeologic conditions on the Site and in the Study Area, in order to assess the potential impacts of the proposed Caledon Pit / Quarry on groundwater resources, groundwater users and ecological receptors. The groundwater investigation was comprised of the following key components, which are further described in the subsections below:

- Drilling and Monitoring Well Installation;
- Downhole Geophysical Logging;
- Groundwater Level Monitoring;
- Hydraulic Testing - Packer Testing;
- Hydraulic Testing - Single Well Response Tests (SWRTs);
- Hydraulic Testing - Pumping Tests;
- Groundwater Quality Assessment;
- Supplemental Investigations in the Northwest Area; and
- A Karst Assessment.

5.1 Drilling and Monitoring Well Installation

5.1.1 Methodology

Similar to the resource drilling described in Section 4, drilling and monitoring well installation at the Site and Study Area was carried out by CSD under Golder supervision. The drilling and monitoring well installation took place over a 14 month period from February to June 2020, November to December 2020, and lastly, February to April 2021. Monitoring well locations are shown on Figure 5-1.

The general methodology for the drilling and installation of monitoring wells MW20-01 to MW20-28 was as follows.

- The drilling of boreholes for the monitoring well network and resource boreholes were completed concurrently and followed the same drilling methodology. The drilling methodology was previously described in Section 4.1 (Aggregate Resource Investigation).

- Upon the completion of the drilling, the open rock boreholes were left in place temporarily to allow for downhole geophysical logging and packer testing, as required.

- Once downhole testing was completed, the boreholes were either abandoned in accordance with O.Reg. 903, or the boreholes were completed as bedrock monitoring well nests.

- Monitoring well nests (typically two per location) were installed in the 96 mm open rock borehole using 25 mm (1”) SCH40 PVC well screen and riser pipe. A sand pack was placed in the borehole annulus at each well screen interval, and bentonite pellets were placed in the borehole annulus between the screened intervals to provided hydraulic separation. The borehole annulus was then sealed to surface using bentonite pellets. Each installation was completed at surface with a lockable protective well casing.

- Additional shallow overburden monitoring wells were installed in five locations, including three locations where the shallow well was offset and installed in a separate borehole. The offset wells were drilled and installed in the overburden using the same rotasonic drilling method. The wells were installed with 25 mm (1”) SCH40 PVC well screen and riser pipe. A sand pack was placed in the borehole annulus at each well screen interval and bentonite pellets were placed in the borehole annulus to surface. Each offset installation was completed at surface with a lockable protective well casing.

- The monitoring wells were later developed by purged, using a 13 mm inner diameter Waterra tubing with an inertial foot valve. Development was considered complete based on one of the following conditions being met: development water became clear, ten times the volume of water in the monitoring well had been pumped, or the well was pumped dry allowed to recover (fully or partially depending on recovery speed) and pumped dry again.

The general methodology for the drilling and installation of the four test pumping wells PW21-01 to PW21-04 was as follows:

- A 171 mm (6 ¾”) diameter rotasonic borehole was initially drilled through the overburden and into competent bedrock, obtaining a continuous 136 mm diameter (5 ¼”) soil and rock core. The bit and casing were left in place and the annulus was grouted to surface.
- The borehole was then advanced through the bedrock to the required depth with the rotasonic method, obtaining a continuous 114 mm diameter (4 ½”) rock core and leaving a 124 mm (4 7/8”) open borehole in the rock.
- Each installation was then completed at surface with a lockable protective well casing.

The general methodology for the drilling and installation the 15 additional monitoring wells MW21-1-1 to MW21-1-4; MW21-2-1 to MW21-2-4; MW21-3-1 to MW21-3-4 and MW21-4-1 to MW21-4-3, was as follows.

- The borehole was advanced through the overburden and bedrock to the required depth with the rotasonic method, obtaining a continuous 114 mm diameter (4 ½”) soil rock core and leaving a 124 mm (4-7/8”) open borehole in the rock.
- The well installation was completed using 50 mm (2”) SCH40 PVC well screen and riser pipe. These wells were screened across the entire bedrock interval with a sand pack and then sealed up to surface using bentonite pellets.
- Each installation was then completed at surface with a lockable protective well casing.

All boreholes and monitoring wells were later surveyed by Delph and Jenkins North Ltd. of Aurora, Ontario and the results provided to Golder via CBM.

All monitoring and pumping wells were tagged and registered with the MECP in their WWIS. The well records were submitted to the MECP by CSD on behalf of CBM, the owner of the wells.

5.1.2 Results

A summary of the boreholes drilled and monitoring well installation details is provided in Table 5-1. Monitoring well locations are shown on Figure 5-1. Record of Borehole and Monitoring Well Logs are provided in Appendix C. The wells were subsequently used for groundwater level monitoring, single well response tests, pumping tests, and groundwater quality sampling, as discussed in later subsections.

Table 5-1 - Summary of Monitoring Wells Drilled and Installed
Caledon Pit / Quarry

Well	Date Drilled	Easting (m) UTM 17T	Northing (m) UTM 17T	Elevation (masl)	Total Hole Depth (mbgs)	Depth of casing (mbgs)	Depth to Bedrock (mbgs)	Depth to bottom of Gasport (mbgs)	Depth to top of Cabot Head (mbgs)	Downhole Geophysics Completion	Packer Testing Completion	Mon Well Completion	Deep (A) Well Stickup (m)	Deep (A) Well Formation	Screen from (m)	Screen to (m)	Shallow (B) Well Stickup (m)	Shallow (B) Well Formation	Screen from (m)	Screen to (m)
MW20-01(CAL) A/B	27-Feb-20	577458.50	4852268.28	395.10	19.41	9.06	8.53	14.86	17.32	13-Mar-20	19-Mar-20	20-Mar-20	0.99	Shaley Dolostone or Cabot Head Fm	15.40	17.10	0.99	Gasport Fm	11.10	12.62
MW20-02(CAL)	02-Mar-20	577900.04	4852138.37	399.63	19.57	15.94	15.24	18.05	19.57	11-Mar-20	N/A	23-Mar-20	1.05	Shaley Dolostone or Cabot Head Fm	16.96	18.48				
MW20-03(CAL)	04-Mar-20	578243.54	4851907.30	390.67	35.97	N/A	34.44	Not present	35.66	N/A	N/A	05-Mar-20	1.00	Overburden	15.58	18.63				
MW20-04(CAL)	06-Mar-20	578264.75	4852313.19	399.46	18.50	15.08	14.33	Not present	16.54	13-Mar-20	N/A	24-Mar-20	1.04	Shaley Dolostone or Cabot Head Fm	16.11	17.63				
MW20-05(CAL) A/B	09-Mar-20	578423.10	4852712.60	399.63	14.84	2.06	1.52	10.60	13.91	20-Mar-20	25-Mar-20	25-Mar-20	1.00	Shaley Dolostone or Cabot Head Fm	12.25	13.77	1.00	Gasport Fm	4.25	5.77
MW20-06(CAL) A/B	10-Mar-20	578474.24	4852972.59	400.15	16.03	2.32	2.14	10.96	14.25	23-Mar-20	26-Mar-20	26-Mar-20	0.99	Gasport Fm	10.12	11.64	0.99	Gasport Fm	4.20	5.72
MW20-07(CAL) A/B	11-Mar-20	578359.89	4853250.44	404.07	19.45	2.74	2.13	13.20	16.40	18-Mar-20	01-Apr-20	01-Apr-20	0.77	Shaley Dolostone or Cabot Head Fm	15.11	16.63	0.77	Gasport Fm	9.74	11.26
MW20-08(CAL) A/B	13-Mar-20	578009.81	4853574.83	406.93	18.59	2.74	1.98	15.10	17.32	19-Mar-20	30-Mar-20	31-Mar-20	0.92	Gasport Fm	13.30	14.82	0.92	Gasport Fm	5.38	6.90
MW20-09(CAL)	17-Mar-20	578343.84	4854157.49	399.95	9.01	5.79	5.33	Not Present	7.48	26-Mar-20	N/A	07-Apr-20	1.01	Shaley Dolostone or Cabot Head Fm	6.85	8.37				
MW20-10(CAL) A/B	19-Mar-20	577837.95	4854407.28	411.32	21.19	12.04	10.97	16.76	19.55	24-Mar-20	08-Apr-20	08-Apr-20	0.92	Shaley Dolostone or Cabot Head Fm	18.62	20.14	0.89	Gasport Fm	14.49	16.01
MW20-11(CAL) A/B	24-Mar-20	577671.98	4853921.39	409.72	19.39	3.07	2.13	16.46	18.16	07-Apr-20	14-Apr-20	15-Apr-20	1.03	Gasport Fm	13.81	15.33	1.01	Gasport Fm	3.96	5.48
MW20-12(CAL) A/B	26-Mar-20	577271.90	4854321.42	412.43	22.65	5.94	3.66	19.80	21.66	08-Apr-20	17-Apr-20	17-Apr-20	1.02	Gasport Fm	17.09	18.62	1.01	Gasport Fm	4.42	5.94
MW20-13(CAL) A/B	08-Apr-20	576873.11	4854473.14	415.53	28.23	15.08	13.10	23.92	25.68	15-Apr-20	23-Apr-20	24-Apr-20	0.93	Shaley Dolostone or Cabot Head Fm	24.05	25.57	0.93	Gasport Fm	18.14	19.66
MW20-13 (CAL) C	08-Apr-20	576873.11	4854473.14	415.53	5.10	N/A	N/A	N/A	N/A	N/A	N/A	08-Apr-20	0.93	Overburden	3.08	4.60				
MW20-14(CAL) A/B	28-Apr-20	577575.99	4853100.42	406.71	26.35	2.74	2.29	22.40	24.50	14-May-20	26-May-20	26-May-20	0.96	Shaley Dolostone or Cabot Head Fm	22.60	24.12	1.05	Gasport Fm	14.98	16.50
MW20-15(CAL) A/B	20-May-20	576576.79	4853544.15	417.06	37.17	12.30	11.60	33.84	35.62	27-May-20	08-Jun-20	09-Jun-20	0.70	Shaley Dolostone or Cabot Head Fm	33.77	35.29	0.71	Gasport Fm	28.81	30.33
MW20-15 (CAL) C	20-May-20	576576.79	4853544.15	417.06	5.00	N/A	N/A	N/A	N/A	N/A	N/A	20-May-20	0.70	Overburden	2.74	4.27				
MW20-16(CAL) A/B	22-May-20	576784.58	4853806.76	421.40	39.77	14.90	11.90	35.52	37.28	26-May-20	10-Jun-20	10-Jun-20	1.05	Gasport Fm	34.84	36.36	1.05	Gasport Fm	16.80	18.33
MW20-17(CAL) A/B	26-May-20	576752.28	4852966.36	406.64	28.82	3.15	3.05	24.84	27.49	01-Jun-20	02-Jun-20	02-Jun-20	1.05	Shaley Dolostone or Cabot Head Fm	25.64	27.16	0.99	Gasport Fm	12.75	14.27
MW20-18(CAL)	09-Jun-20	577058.36	4852658.80	404.29	28.15	12.19	11.88	23.80	26.06	12-Jun-20	15-Jun-20	15-Jun-20	1.03	Gasport Fm	12.42	13.94				
MW20-19(CAL) A/B	27-Oct-20	576906.96	4851999.96	396.98	27.39	6.20	2.14	22.05	24.48	29-Oct-20	30-Oct-20	31-Oct-20	1.07	Gasport Fm	15.95	17.47	1.07	Gasport Fm	8.00	9.52
MW20-20(CAL) A/B	29-Oct-20	576476.35	4852467.69	403.00	27.99	5.98	2.14	25.15	27.18	30-Oct-20	03-Nov-20	03-Nov-20	0.82	Shaley Dolostone or Cabot Head Fm	25.33	26.85	0.82	Gasport Fm	12.97	14.49
MW20-20(CAL) C	03-Nov-20	576476.26	4852468.33	403.00	5.00	N/A	2.14	N/A	N/A	N/A	N/A	03-Nov-20	0.96	Gasport Fm	2.42	3.95				
MW20-21(CAL) A/B	04-Nov-20	576014.37	4852839.77	415.23	39.70	15.10	12.51	36.73	38.38	05-Nov-20	06-Nov-20	07-Nov-20	1.07	Gasport Fm	33.27	34.79	1.07	Gasport Fm	15.77	17.29
MW20-22(CAL) A/B	18-Nov-20	575785.36	4851966.28	399.27	30.75	5.94	4.57	28.16	29.81	18-Nov-20	N/A	19-Nov-20	0.97	Goat Island Fm	23.47	25.00	0.97	Goat Island Fm	6.89	8.41
MW20-23(CAL) A/B	23-Nov-20	576205.53	4851555.91	395.05	26.76	12.19	11.28	23.54	25.30	24-Nov-20	N/A	24-Nov-20	0.87	Shaley Dolostone or Cabot Head Fm	22.59	24.11	0.87	Goat Island Fm	14.68	16.20
MW20-23 (CAL) C	23-Nov-20	576205.91	4851556.34	395.00	7.00	N/A	N/A	N/A	N/A	N/A	N/A	23-Nov-20	0.88	Overburden	4.57	6.09				
MW20-24(CAL) A/B	03-Dec-20	575337.66	4854341.85	437.75	37.49	20.88	20.11	37.49	N/A	04-Dec-20	N/A	04-Dec-20	0.87	Gasport Fm	33.81	35.33	0.87	Goat Island Fm	21.49	23.02
MW20-25(CAL) A/B	10-Dec-20	574853.76	4852900.48	419.02	51.82	13.39	10.52	48.93	50.67	10-Dec-20	N/A	11-Dec-20	1.56	Gasport Fm	44.03	45.55	1.55	Goat Island Fm	16.84	18.36
MW20-26(CAL) A/B	17-Dec-20	574373.86	4853638.42	438.89	66.11	15.55	12.19	64.55	66.11	18-Dec-20	N/A	21-Dec-20	1.16	Gasport Fm	55.16	56.68	1.16	Goat Island Fm	31.12	32.64
MW20-26 (CAL) C	17-Dec-20	574375.17	4853637.62	438.88	10.00	N/A	N/A	N/A	N/A	N/A	N/A	17-Dec-20	1.07	Overburden	7.26	8.78				
MW20-27(CAL) A/B	12-Feb-21	575953.96	4853770.16	431.15	52.43	31.24	28.96	50.32	51.93	17-Feb-21	N/A	18-Feb-21	0.97	Goat Island Fm	41.99	43.51	0.98	Goat Island Fm	33.85	35.37
MW20-28(CAL) A/B	22-Feb-21	576139.79	4854987.82	419.31	30.82	12.80	12.19	28.45	30.20	23-Feb-21	N/A	23-Feb-21	0.96	Gasport Fm	24.07	25.59	0.93	Gasport Fm	16.51	18.03
MW21-1-1	03-Mar-21	576882.20	4853485.00	418.94	36.27	11.89	10.06	34.30	36.27	04-Mar-21	N/A	09-Mar-21	0.86	Gasport Fm	12.80	36.27				
MW21-1-2	24-Feb-21	576909.58	4853505.06	420.58	36.00	13.11	12.19	35.36	36.00	03-Mar-21	N/A	09-Mar-21	0.90	Gasport Fm	11.89	36.00				
MW21-1-3	02-Mar-21	576965.46	4853420.30	417.51	37.49	8.84	7.32	34.90	36.58	03-Mar-21	N/A	09-Mar-21	1.07	Gasport Fm	13.11	37.49				
MW21-1-4	04-Mar-21	576866.19	4853450.60	417.83	35.96	11.89	10.97	33.53	35.66	05-Mar-21	N/A	09-Mar-21	1.01	Gasport Fm	8.84	35.96				
MW21-2-1	16-Mar-21	577279.08	4854021.09	413.40	23.47	8.99	5.79	22.71	23.32	18-Mar-21	N/A	18-Mar-21	0.93	Gasport Fm	11.89	23.47				
MW21-2-2	15-Mar-21	577260.02	4854050.91	412.64	23.47	15.39	6.10	20.96	22.88	17-Mar-21	N/A	18-Mar-21	0.96	Gasport Fm	8.99	23.47				
MW21-2-3	11-Mar-21	577349.69	4854098.46	410.76	23.77	5.64	2.74	18.98	20.62	17-Mar-21	N/A	18-Mar-21	0.93	Gasport Fm	15.39	23.77				
MW21-2-4	16-Mar-21	577297.52	4854001.66	413.86	26.52	12.19	4.27	23.64	25.60	17-Mar-21	N/A	19-Mar-21	0.87	Gasport Fm	5.64	26.52				
MW21-3-1	30-Mar-21	577871.84	4852814.09	403.69	21.03	5.79	4.57	17.07	19.50	31-Mar-21	N/A	01-Apr-21	0.96	Gasport Fm	12.19	21.03				
MW21-3-2	30-Mar-21	577920.27	4852838.38	404.87	21.03	5.79	3.66	17.96	20.20	01-Apr-21	N/A	02-Apr-21	0.84	Gasport Fm	5.79	21.03				
MW21-3-3	30-Mar-21	577935.55	4852730.93	405.12	19.20	8.84	8.23	18.90	19.20	31-Mar-21	N/A	02-Apr-21	1.06	Gasport Fm	5.79	19.20				
MW21-3-4	29-Mar-21	577837.91	4852827.25	403.16	19.20	5.94	3.35	16.16	18.45	31-Mar-21	N/A	01-Apr-21	1.03	Gasport Fm	8.84	19.20				
MW21-4-1	22-Mar-21	577793.12	4854211.47	415.22	23.77	11.89	8.84	19.86	22.60	22-Mar-21	N/A	24-Mar-21	0.97	Gasport Fm	5.94	23.77				
MW21-4-2	22-Mar-21	577790.26	4854247.25	415.07	23.77	11.89	9.14	19.52	22.40	22-Mar-21	N/A	24-Mar-21	0.83	Gasport Fm	11.89	23.77				
MW21-4-3	23-Mar-21	577813.86	4854182.83	414.78	21.64	9.25	9.14	19.58	21.64	23-Mar-21	N/A	25-Mar-21	0.92	Gasport Fm	11.89	21.64				
PW21-1	08-Mar-21	576890.23	4853478.69	418.76	38.41	12.19	10.97	34.42	36.58	08-Mar-21	N/A	08-Mar-21	0.66	Gasport Fm	12.19	38.41				
PW21-2	17-Mar-21	577286.29	4854027.50	413.07	25.15	12.19	4.27	22.56	24.38	18-Mar-21	N/A	17-Mar-21	0.84	Gasport Fm	12.19	25.15				
PW21-3	31-Mar-21	577875.55	4852797.50	405.45	21.34	8.84	6.10	18.68	21.00	01-Apr-21	N/A	31-Mar-21	0.57	Gasport Fm	8.84	21.34				
PW21-4	23-Mar-21	577802.09	4854214.36	415.08	21.64	9.25	8.84	19.60	21.49	23-Mar-21	N/A	23-Mar-21	0.75	Gasport Fm	9.25	21.64				

5.2 Downhole Geophysical logging

5.2.1 Methodology

The downhole geophysical logging of resource boreholes and monitoring wells at the proposed Caledon Pit / Quarry Site was carried out by Golder personnel over a 14 month period from February to June 2020, November to December 2020, and lastly, February to April 2021, as the drilling of boreholes and installation of monitoring wells progressed. The overall objective of downhole geophysical logging was to help characterize the subsurface stratigraphy and hydrostratigraphy at the Site and Study Area, by helping to identify geological contacts and rock types, and potential water bearing zones in the bedrock.

A description of the geophysical logging methods used is provided below.

Natural Gamma

The natural gamma log provides a measurement that is proportional to the natural radioactivity of the soil and rock formations in the borehole and is recorded in counts per second (cps). The gamma log is typically responds to soil and/or rock material within a 25 to 30 cm radius from the borehole. The gamma log is principally used for lithologic identification and stratigraphic correlation.

Natural gamma logging employs a sodium iodide (NaI) scintillation detector. The gamma-emitting radioisotopes that naturally occur in geologic materials (such as clays, shales, gypsum and some crystalline rocks) are potassium^{40} and nuclides in the uranium^{238} and thorium^{232} decay series. Potassium^{40} occurs with all potassium bearing minerals including k-feldspars. Uranium^{238} is typically associated with dark shales and uranium mineralization. Thorium^{232} is typically associated with biotite, sphene, zircon and other heavy minerals. In the current study, the natural gamma response is related to the clay content of the soils and the shale content of the sedimentary rocks.

Apparent Conductivity

The apparent conductivity log is a measure of the electrical conductivity of the soil and rock in the borehole. The apparent conductivity tool works by electromagnetic induction, transmitting a focussed primary electromagnetic signal into the soil and rock around the borehole, and measuring the secondary magnetic field induced by the soil or rock. The transmitter and receiver coils are configured so that the tool is “focussed” approximately 30 cm into the formation, to minimize the influence of borehole itself. Because it works by electromagnetic induction, it also responds to metal, and it cannot penetrate through a metal casing. Apparent conductivity is measured in units of milliSiemens / metre (mS/m).

Apparent conductivity is primarily a function of clay / shale content, water content and the dissolved ion concentration in the pore fluid. When clays are saturated, the adsorbed ions can become partially dissociated and available for ionic conduction. Since clay particles have a relatively large surface area, the presence of small amounts of clay can significantly increase electrical conductivity.

Typically, the apparent conductivity of sediments or rocks correlates to the natural gamma response. However, when the pore fluid contains elevated dissolved solids, as in the case of some groundwater contaminant plumes, the apparent conductivity will increase irrespective of the natural gamma response. In the current study, the apparent conductivity response is related to the clay content of the soils and the shale content of the sedimentary rocks.

Optical Televiewer (OBI)

The optical televiewer produces is a continuous oriented 360° image of the borehole wall at a mm scale, acquired using an optical imaging system as the probe is slowly moved up / down the borehole. The optical borehole imaging (OBI) tool also records telemetry during logging, so that the azimuth of the scan and the deviation of the borehole can be measured during logging. The tool is centralized and requires that the borehole be either dry or the borehole fluid is clear, in order to have good visibility.

The resulting borehole images are used to help identify rock type and structures in the borehole, including fractures, vugs and voids. In the current study, the optical televiewer is used to delineate rock contacts, rock type and identify potential permeable features in the rock.

Acoustic Televiewer (ABI)

The acoustic televiewer produces an image of the borehole wall at a mm scale, acquired using an ultrasonic pulse from a source that scans the borehole wall as the logging probe is slowly moved up / down the borehole. The acoustic borehole imaging (ABI) tool also records telemetry so that the azimuth of the scan and the deviation of the borehole can be measured during logging. The reflection is uniformly "bright" wherever the borehole wall is solid and smooth. The reflected pulses are scattered wherever a fracture or other irregular opening intersects the borehole wall. Planar features such as fractures produce a linear feature in the borehole image such that the strike and dip of the feature can be estimated.

Software used to analyze the fracture images automatically corrects for the effects of borehole deviation and local magnetic declination, giving fracture orientation with respect to true north. Strike and dip are determined by matching a template to the apparent shape of a fracture. The accuracy of this measurement depends on the degree to which the shape of the feature represents that predicted for a planar feature and by the degree of damage and/or erosion during the drilling process associated with the point where the fracture intersects the borehole wall. The tool is centralized and requires that the borehole be fluid filled (but not clear) in order to have good ultrasonic signal transmission.

The resulting borehole acoustic images are used to help identify rock type and structures in the borehole, including fractures, vugs and voids, and also provides a "caliper" log of borehole diameter. In the current study, the acoustic televiewer is used to delineate rock contacts, rock type and identify potential permeable features in the rock.

Heat Pulse Flowmeter

The heat pulse flowmeter measures the rate of vertical flow within a borehole. It is typically measured under both static conditions and under dynamic conditions using a low flow pump to induce water flow into the borehole from the surrounding formation. The probe consists of a metal grate that, upon start of the test, heats up a slug of water. The slug of heated water moves up or down the borehole where there is vertical flow. Two highly sensitive thermistors located above and below the metal grate measure the direction of flow as well as the time it takes the heated water to move a known distance through a known borehole volume, and records the flow rate.

The testing is done at regular fixed intervals within the borehole. In the current study, the heat pulse flowmeter is used to identify permeable features in the rock.

Equipment

The following field equipment was used to carry out the downhole geophysical logging:

- Mount Sopris Instruments (MSI) wireline winch;
- Advanced Logic Technology (ALT) Matrix logging box;
- Acoustic Televiewer- Model QL40 ABI-2G;
- Natural Gamma - Model QL40 GAM / 2PGA;
- Apparent Conductivity – Model 2PIA-1000;
- Optical Televiewer – Model QL40 OBI-2G;
- Heat Pulse Flow Meter – Model HFP-2293;
- Laptop computer with Logger (ALT) software;
- Borehole wireline tripod and wheel;
- 2KW Generator;
- Grundfos 2” submersible pump and controller;
- Power Line Conditioner and Power bar; and
- Tool kit consisting of tools necessary for troubleshooting and maintaining equipment.

5.2.2 Results

Details of the boreholes that were geophysically logged are summarized in Table 5-2, and their locations are shown on Figures 4-1 and 5-1. The processed downhole geophysical log results are provided in Appendix D at two scales, a “summary” scale and a “detailed” scale.

The downhole geophysical logs were helpful in identifying the following subsurface features:

- Stratigraphic / geologic contacts, using natural gamma, apparent conductivity, and/or televiewer logs;
- Fractures within the bedrock, using televiewer logs; and
- Water bearing zones in the bedrock using televiewer and/or heat-pulse flowmeter logs.

These features were used to refine borehole logs, inform packer testing interval selection, and help the design of monitoring well screen intervals. The downhole geophysical logs were also helpful in confirming geologic contacts in the previously drilled boreholes (Jagger Hims Ltd. 2001, 2003).

Table 5-2 - Summary of Boreholes and Monitoring Wells Geophysically Logged
Caledon Pit / Quarry

Borehole / Monitoring Well	Easting (m) UTM 17T	Northing (m) UTM 17T	Elevation (masl)	Total Hole Depth (mbgs)	Downhole Geophysics Completion	Open Hole / Cased Hole	Natural Gamma	Apparent Conductivity	Televiewer	Heat Pulse Flowmeter
BH20-01(CAL)	578000.61	4853292.80	406.80	22.07	18-Feb-20	Open	Y	Y	OBI (optical)	-
BH20-02(CAL)	577839.36	4853078.92	405.52	22.02	18-Feb-20	Open	Y	Y	OBI (optical)	-
BH20-03(CAL)	577655.12	4852796.26	402.91	19.33	10-Mar-20	Open	Y	Y	OBI (optical)	-
BH20-04(CAL)	577511.78	4852528.07	400.81	19.57	24-Feb-20	Open	Y	Y	OBI (optical)	-
BH20-05(CAL)	577786.25	4852520.23	398.83	16.35	24-Feb-20	Open	Y	Y	OBI (optical)	-
BH20-06(CAL)	578056.45	4852520.24	397.70	16.60	25-Feb-20	Open	Y	Y	OBI (optical)	-
BH20-07(CAL)	578129.13	4853102.34	404.73	18.67	25-Feb-20	Open	Y	Y	OBI (optical)	-
BH20-08(CAL)	577961.99	4852832.00	404.50	17.90	11-Mar-20	Open	Y	Y	OBI (optical)	-
BH20-09(CAL)	578186.33	4852803.00	402.26	16.77	10-Mar-20	Open	Y	Y	OBI (optical)	-
BH20-10(CAL)	577940.09	4853952.34	411.07	19.55	25-Mar-20	Open	Y	Y	OBI (optical)	-
BH20-11(CAL)	578065.10	4854240.45	402.10	10.20	26-Mar-20	Open	Y	Y	OBI (optical)	-
BH20-12(CAL)	577780.56	4854244.92	415.22	21.76	25-Mar-20	Open	Y	Y	OBI (optical)	-
BH20-13(CAL)	577209.70	4854103.25	412.94	22.80	20-Apr-20	Open	Y	Y	OBI (optical)	-
BH20-14(CAL)	577288.55	4853881.70	417.27	31.46	14-Apr-20	Open	Y	Y	OBI (optical)	-
BH20-15(CAL)	576925.21	4854113.14	421.52	34.76	14-Apr-20	Open	Y	Y	OBI (optical)	-
BH20-16(CAL)	576991.38	4853859.50	420.74	34.18	20-Apr-20	Open	Y	Y	OBI (optical)	-
BH20-17(CAL)	577474.67	4853391.65	413.06	28.83	27-Apr-20	Open	Y	Y	OBI (optical)	-
BH20-18(CAL)	577313.39	4853571.83	417.53	31.84	27-Apr-20	Open	Y	Y	OBI (optical)	-
BH20-19(CAL)	577733.06	4853579.97	411.42	24.64	27-Apr-20	Open	Y	Y	OBI (optical)	-
BH20-20(CAL)	577031.10	4853551.56	423.60	40.98	20-May-20	Open	Y	Y	OBI (optical)	-
BH20-21(CAL)	576935.66	4853276.58	413.53	33.48	20-May-20	Open	Y	Y	OBI (optical)	-
BH20-22(CAL)	576701.79	4853293.98	410.98	28.61	20-May-20	Open	Y	Y	OBI (optical)	-
BH20-23(CAL)	576779.85	4853559.83	420.27	37.62	25-May-20	Open	Y	Y	OBI (optical)	-
BH20-24(CAL)	577296.02	4852710.32	403.60	22.76	08-Jun-20	Open	Y	Y	OBI (optical)	-
BH20-25(CAL)	577402.13	4852974.96	405.48	22.03	15-Jun-20	Open	Y	Y	OBI (optical)	-
BH20-26(CAL)	577037.86	4852942.75	404.82	22.73	15-Jun-20	Open	Y	Y	OBI (optical)	-
BH20-27(CAL)	577212.29	4853168.73	408.64	27.65	22-Oct-20	Open	Y	Y	OBI (optical)	-
MW20-01(CAL) A/B	577458.50	4852268.28	395.10	19.41	13-Mar-20	Open	Y	Y	OBI (optical)	Y
MW20-02(CAL)	577900.04	4852138.37	399.63	19.57	11-Mar-20	Open	Y	Y	ABI (acoustic)	-
MW20-03(CAL)	578243.54	4851907.30	390.67	35.97	N/A	-	-	-	-	-
MW20-04(CAL)	578264.75	4852313.19	399.46	18.50	13-Mar-20	Open	Y	Y	OBI (optical)	-
MW20-05(CAL) A/B	578423.10	4852712.60	399.63	14.84	20-Mar-20	Open	Y	Y	OBI (optical)	Y
MW20-06(CAL) A/B	578474.24	4852972.59	400.15	16.03	23-Mar-20	Open	Y	Y	OBI (optical)	Y
MW20-07(CAL) A/B	578359.89	4853250.44	404.07	19.45	18-Mar-20	Open	Y	Y	OBI (optical)	Y
MW20-08(CAL) A/B	578009.81	4853574.83	406.93	18.59	19-Mar-20	Open	Y	Y	OBI (optical)	Y
MW20-09(CAL)	578343.84	4854157.49	399.95	9.01	26-Mar-20	Open	Y	Y	OBI (optical)	-
MW20-10(CAL) A/B	577837.95	4854407.28	411.32	21.19	24-Mar-20	Open	Y	Y	OBI (optical)	Y
MW20-11(CAL) A/B	577671.98	4853921.39	409.72	19.39	07-Apr-20	Open	Y	Y	OBI (optical)	Y
MW20-12(CAL) A/B	577271.90	4854321.42	412.43	22.65	08-Apr-20	Open	Y	Y	OBI (optical)	Y
MW20-13(CAL) A/B	576873.11	4854473.14	415.53	28.23	15-Apr-20	Open	Y	Y	OBI (optical)	Y
MW20-13 (CAL) C	576873.11	4854473.14	415.53	5.10	N/A	-	-	-	-	-
MW20-14(CAL) A/B	577575.99	4853100.42	406.71	26.35	14-May-20	Open	Y	Y	OBI (optical)	Y
MW20-15(CAL) A/B	576576.79	4853544.15	417.06	37.17	27-May-20	Open	Y	Y	OBI (optical)	Y
MW20-15 (CAL) C	576576.79	4853544.15	417.06	5.00	N/A	-	-	-	-	-
MW20-16(CAL) A/B	576784.58	4853806.76	421.40	39.77	26-May-20	Open	Y	Y	OBI (optical)	Y
MW20-17(CAL) A/B	576752.28	4852966.36	406.64	28.82	01-Jun-20	Open	Y	Y	OBI (optical)	Y
MW20-18(CAL)	577058.36	4852658.80	404.29	28.15	12-Jun-20	Open	Y	-	-	-
MW20-19(CAL) A/B	576906.96	4851999.96	396.98	27.39	29-Oct-20	Open	Y	Y	OBI (optical)	Y
MW20-20(CAL) A/B	576476.35	4852467.69	403.00	27.99	30-Oct-20	Open	Y	Y	OBI (optical)	Y
MW20-20(CAL) C	576476.26	4852468.33	403.00	5.00	N/A	-	-	-	-	-
MW20-21(CAL) A/B	576014.37	4852839.77	415.23	39.70	05-Nov-20	Open	Y	Y	OBI (optical)	Y
MW20-22(CAL) A/B	575785.36	4851966.28	399.27	30.75	18-Nov-20	Open	Y	Y	OBI (optical)	-
MW20-23(CAL) A/B	576205.53	4851555.91	395.05	26.76	24-Nov-20	Open	Y	Y	OBI (optical)	-
MW20-23 (CAL) C	576205.91	4851556.34	395.00	7.00	N/A	-	-	-	-	-
MW20-24(CAL) A/B	575337.66	4854341.85	437.75	37.49	04-Dec-20	Open	Y	Y	OBI (optical)	-
MW20-25(CAL) A/B	574853.76	4852900.48	419.02	51.82	10-Dec-20	Open	Y	Y	OBI (optical)	-
MW20-26(CAL) A/B	574373.86	4853638.42	438.89	66.11	18-Dec-20	Open	Y	Y	ABI (acoustic)	-
MW20-26 (CAL) C	574375.17	4853637.62	438.88	10.00	N/A	-	-	-	-	-
MW20-27(CAL) A/B	575953.96	4853770.16	431.15	52.43	17-Feb-21	Open	Y	Y	OBI (optical)	-
MW20-28(CAL) A/B	576139.79	4854987.82	419.31	30.82	23-Feb-21	Open	Y	Y	OBI (optical)	-
MW21-1-1	576882.20	4853485.00	418.94	36.27	04-Mar-21	Open	Y	Y	OBI (optical)	Y
MW21-1-2	576909.58	4853505.06	420.58	36.00	03-Mar-21	Open	Y	Y	-	-
MW21-1-3	576965.46	4853420.30	417.51	37.49	03-Mar-21	Open	Y	Y	-	-
MW21-1-4	576866.19	4853450.60	417.83	35.96	05-Mar-21	Open	Y	Y	-	-
MW21-2-1	577279.08	4854021.09	413.40	23.47	18-Mar-21	Open	Y	Y	OBI (optical)	Y
MW21-2-2	577260.02	4854050.91	412.64	23.47	17-Mar-21	Open	Y	Y	-	-
MW21-2-3	577349.69	4854098.46	410.76	23.77	17-Mar-21	Open	Y	Y	-	-
MW21-2-4	577297.52	4854001.66	413.86	26.52	17-Mar-21	Open	Y	Y	-	-
MW21-3-1	577871.84	4852814.09	403.69	21.03	31-Mar-21	Open	Y	Y	OBI (optical)	Y
MW21-3-2	577920.27	4852838.38	404.87	21.03	01-Apr-21	Open	Y	Y	-	-
MW21-3-3	577935.55	4852730.93	405.12	19.20	31-Mar-21	Open	Y	Y	-	-
MW21-3-4	577837.91	4852827.25	403.16	19.20	31-Mar-21	Open	Y	Y	-	-
MW21-4-1	577793.12	4854211.47	415.22	23.77	22-Mar-21	Open	Y	Y	OBI (optical)	Y
MW21-4-2	577790.26	4854247.25	415.07	23.77	22-Mar-21	Open	Y	Y	-	-
MW21-4-3	577813.86	4854182.83	414.78	21.64	23-Mar-21	Open	Y	Y	-	-
PW21-1	576890.23	4853478.69	418.76	38.41	08-Mar-21	Open	Y	Y	OBI (optical)	Y
PW21-2	577286.29	4854027.50	413.07	25.15	18-Mar-21	Open	Y	Y	OBI (optical)	Y
PW21-3	577875.55	4852797.50	405.45	21.34	01-Apr-21	Open	Y	Y	OBI (optical)	Y
PW21-4	577802.09	4854214.36	415.08	21.64	23-Mar-21	Open	Y	Y	OBI (optical)	Y
JHL-BH1(CAL)	577246.61	4854243.60	410.20	19.70	14-Apr-21	Open	Y	Y	-	-
JHL-BH16(CAL)	577894.81	4854252.89	411.53	19.90	25-Mar-21	Open	Y	Y	-	-
JHL-BH17(CAL)	578028.61	4854138.05	408.11	18.85	25-Mar-21	PVC Cased	Y	Y	-	-
JHL-BH18(CAL)	578153.75	4854324.05	400.69	9.20	25-Mar-21	PVC Cased	Y	Y	-	-
JHL-BH19(CAL)	577482.68	4854486.38	414.13	24.50	25-Mar-21	Open	Y	Y	-	-
Unknown BH2(CAL)	577689.54	4854266.72	?	?	14-Apr-21	Open	Y	Y	-	-

5.3 Groundwater Level Monitoring

The objectives of the groundwater level monitoring program were to assess current hydrogeologic conditions, seasonal water level fluctuations, support the interpretation of groundwater flow direction on the Site and in the Study Area, support the analysis of groundwater-surface water interaction, and support the impact assessment.

5.3.1 Methodology

Groundwater monitoring began in June 2020 and the scope of monitoring expanded as new monitoring wells were installed and developed during the next 14 months of the hydrogeologic investigation. Monitoring wells were equipped with a Van Essen TD-Diver pressure transducer / logger, following well development. The loggers were generally installed in the screened interval, each with a range suitable for the range of water levels that may be encountered, and programmed to record water levels on a 15-minute interval.

Loggers were typically downloaded quarterly, with manual water levels also collected quarterly at each download event using a water level tape.

Pressures observed by the logger were then corrected using a barometric pressure logger (Van Essen Baro-Diver) deployed on the Site. Water levels below the reference point were then calculated by matching the water level to the manual water level at the time it was observed and to the hydrograph of previous water level data. Groundwater levels were converted to elevations using the surveyed elevation (Delph and Jenkins North Ltd. of Aurora, Ontario) of the lower lip of each monitoring well monument.

The groundwater monitoring program results, presented in Appendix E, include the following.

- Groundwater levels at the monitoring locations as shown on Figure 5-1. Hydrographs presented in Figures E-1 to E-9 include the following:
  - MW20-01 to MW20-28, installed in 2020 for this study;
  - PW21-1 to PW21-4 and MW21-1-1 to MW21-4-3, installed in 2021 for this study;
  - Historic boreholes BH1 to BH3, BH7, and BH16 to BH19 were included in the groundwater level monitoring program (manual measurements only); and
  - Osprey Valley Golf Course groundwater level data as collected by their monitoring program, at the locations shown on Figure E-10.

Well completion details for the wells installed as part of this study are summarized in Table E-1. Borehole and well records are discussed in Section 5.1 and provided in Appendix C.

5.3.2 Results

The groundwater head elevations monitored as part of this program are presented as hydrographs in Appendix E with wells grouped geographically and by monitor type (i.e., by aquifer). The figures present data collected between the start of monitoring (summer 2020 or the time of installation if later) up to the end of 2021, noting that the monitoring program is ongoing. Figures 5-2 to 5-5 show contoured groundwater heads in the Gasport Formation in April, June, September and December 2021. The maximum predicted water table measured over a 12 month period from January to December 2021 is presented on Figure 5-6.

The groundwater monitoring network was designed to observe vertical gradients within the overburden and upper bedrock system by including vertically nested wells.

Vertical gradients observed across the monitoring well network in the Study Area are presented on Figure 5-7, noting that the Gasport Formation along the southeast and southern portion of the Study Area was of limited in thickness, and as such, it was not practical to install a vertical well nest in the bedrock at some locations. However, it is reasonable to infer that the vertical hydraulic gradients in those areas, which are proximal to the escarpment and the Credit River Valley, are most likely to be downward.

With reference to the above noted figures and the hydrographs presented in Appendix E, we note the following.

- Most groundwater levels showed approximately two to three metres of seasonal fluctuation during the monitoring period.
- Figures presenting seasonal groundwater head in the Gasport Formation (Figures 5-2 to 5-5) show similar patterns of groundwater head and horizontal groundwater flow in all four seasons. The seasonal rise and fall of groundwater levels appears to have little affect on groundwater head distribution and or the direction of horizontal groundwater flow, as the dominant influence is inferred to be topography.
- Horizontal groundwater flow is generally from the northwest to the east, southeast and south, and parallels topography from high to low elevation, particularly to the east, southeast and south of the Study Area towards the Niagara escarpment and Credit River valley.
- The highest observed heads in the Gasport Formation were in the northwest part of the Study Area (observed at MW20-24 and MW20-26). The lowest heads are consistently observed southernmost part the Study Area (MW20-03).
- With reference to Figure 5-6, the maximum water table elevation at the Site during the monitoring period closely matches the head distribution observed in the Gasport Formation in April and December 2021. The maximum water table elevation in the Main Area was observed to vary from 420.7 masl at MW20-16 in the north, to 393.5 masl at MW20-18 in the southwest. The maximum water table elevation in the North Area was observed to vary from approximately 407 masl near MW20-11 in the northwest, to 397.3 masl at MW20-09 in the southeast. The maximum water table elevation in the South Area was observed to vary from 405.3 masl at MW20-08 in the northeast, to 391.0 masl at MW20-02 in the south.
- In general, the seasonal trend observed throughout the Study Area during the observation period showed a smooth steady decline in the summer months (2020 and 2021), concurrent with warm weather and active plant growth, which presumably reduces the water available for infiltration and recharge. The summer and early fall period is followed by an increase in groundwater levels in the late fall, concurrent with cooler temperatures and most vegetation becoming dormant, making more water available for recharge. This is followed by the winter period in which groundwater levels further decline, as the ground is frozen and precipitation is stored in the snow pack. This period was followed by the spring freshet, and a corresponding rise in groundwater levels due to increased infiltration and recharge.
- Rapid increases in groundwater levels were observed in response to significant precipitation and / or snow melt events at a number of monitoring locations including MW20-06A/B, MW20-07A/B, MW20-14A/B, MW20-17A/B, MW20-18, MW20-20C, MW20-23A/B/C, and MW20-27A/B.
- Vertical hydraulic gradients at the Site and to east towards the escarpment are predominantly downward or neutral, consistent with this relative topographic high being a groundwater recharge area. To the west and southwest of the Site, vertical hydraulic gradients are a mixture of upward, neutral and downward, generally

consistent with areas of rolling topography, with areas of relatively low topography frequently exhibiting upward vertical gradients.

- Groundwater heads in the southernmost part of the Site and Study Area (i.e., MW20-01, 02, 04, 18 and 19), where the topography is relatively low, exhibit a lower horizontal hydraulic gradient. This is also an area of neutral and/or upward vertical hydraulic gradients. The overburden in this area (MW20-01 and MW20-02) consists mainly of sand and gravel overlying the bedrock with somewhat higher hydraulic conductivities based on the packer testing results at BH20-02, MW20-01, and MW20-18, as discussed in Section 5.4. (Note that MW20-02 was omitted from the packer testing program, as the bedrock thickness in that location was insufficient for testing.)
- A number of wells exhibited rapid short term fluctuations in water level, presumably in response to pumping by neighbouring groundwater users, including wells MW20-01A, MW20-05A, MW20-12A/B, MW20-13A, MW20-15A/B, MW20-22A/B, MW20-25A/B, and MW20-26A/B.

5.4 Hydraulic Testing – Packer Testing

The objective of the packer testing program was to obtain hydraulic testing data to support the derivation of hydraulic properties of the rock within the Study Area, including hydraulic conductivity (transmissivity / thickness) and inferred hydraulic pressures (heads).

5.4.1 Methodology

Packer testing was carried out by Golder staff with support from CSD from March 2020 to November 2020 in BH20-01 to BH20-27 and in MW20-01 to MW20-21, as the boreholes were drilled and following the completion of downhole geophysical logging, and prior to well installation. Boreholes drilled north and west of the Study Area further away from the Site (e.g., MW20-22 to MW20-28) were excluded from the packer testing program due to their distance from the Site and reduced relevance of the data, noting that SWRTs were carried out in these more distanced monitoring wells to estimate hydraulic properties in those areas.

The procedures for data collection are summarized in the following sections.

Equipment

Packer testing in the open boreholes was completed using a wireline packer tool in both single packer and straddle packer configurations. A list of equipment used downhole is provided in Table 5-3, and a list of equipment used at surface is provided in Table 5-4.

Table 5-3: List of Downhole Equipment for Packer Testing

Item Name	Manufacturer	Item Description
Packersx3	RST	RST-H Packer, packers with sliding heads, 5.7 cm deflated diameter, 0.635 m and 1.0 m bladder lengths
Test Tubing within interval	Various	1.9 cm diameter threaded steel pipe, 1.52 m length segments
Test Tubing above tool	Boart Longyear	HQ rods, inner diameter = 77.8 mm, outer diameter = 88.9 mm
Pressure transducer for real time monitoring	Van Essen Diver and RST	RST and Van Essen loggers with direct read cables for real time monitoring in test tubing above interval

Item Name	Manufacturer	Item Description
Interval pressure transducer	In Situ Inc.	Absolute pressure monitoring in test interval for data analyses. Pressure Range: 1000 psi
Solid coupling	Custom	Solid coupling to separate injection interval from observation interval within the test interval

Table 5-4: List of Surface Equipment for Packer Testing

Item Name	Manufacturer	Item Description
Packer inflation lines	Misc.	Manifold to operate packer inflation, 8.0 MPa pressure rating
Nitrogen pressure regulator	Victor SR4J-580	Pressure regulator for controlling pressure outflow from nitrogen cylinder used for packer inflation.
Nitrogen cylinders	Praxair Canada Inc., Mississauga, Ontario	Compressed nitrogen gas cylinder for packer inflation and activation of shut-in tool by pressurizing the inflation pressure vessel.
Flow Totalizer	Inflatable Packers International	Flow totalizer to measure.

Figure F-1a (Appendix F) shows the configuration of the tool for straddle packer testing, in which three packers are employed. One packer is used to seal the tool to the HQ rods, and two are used to isolate the interval in the borehole. Depending on the test interval, the length of the tool can be varied by adding additional lengths of steel tubing. A solid stem coupling is placed between the tubing outlet in the interval and interval pressure transducer to ensure that head losses occurring between the tool's tubing and the interval are not observed by the interval pressure transducer.

Figure F-1b shows the configuration of the tool for single packer testing, in which two packers are used. One packer is used to seal the rods to the tool, and another is used to establish the top of the interval in the borehole. In this configuration, the bottom of the borehole is the lower limit of the test interval.

Test Interval Selection

In general, test intervals were selected to isolate and characterize the hydraulic conductivity of the key formations encountered on Site; the upper and lower Gasport Formation and the underlying Shaley Dolostone and Cabot Head Formation. Typically, the resource boreholes advanced into the Shaley Dolostone were tested in two intervals (upper and lower) spanning the open rock borehole using the straddle packer configuration. The boreholes drilled for monitoring well installation within the Site and immediate Study Area were typically tested in three intervals: two straddle packer tests in the Gasport Formation, and one test in either the Shaley Dolostone unit or the Cabot Head Formation.

Occasionally, an additional test was completed on a feature or stratum of interest, and in a small number of cases, no test was completed where fractured rock was encountered that prevented an adequate packer seal.

Packer Testing

As noted above, the packer testing was carried out by Golder staff, with drill rig operation support and water supply provided by CSD. A driller and helper were on site each day to support testing operations. To coordinate with the borehole drilling, geophysical surveys, and site access, packer testing was completed in two mobilizations as follows.

- First Mobilization - MW20-01 to MW20-18, and BH20-01 to BH20-1 from March 4 to June 17, 2020.
- Second Mobilization - MW20-19 to MW20-21, and BH20-27 from October 23 to November 6, 2020.

The following describes the typical methodology for hydraulic testing at each location.

- The drill rig and containers of fresh water were mobilized to the borehole location by CSD.
- Flow totalizer calibration was checked daily typically by pumping ~25L into graduated buckets and comparing to the totalizer. Results were consistently within 1L.
- HQ rods were lowered to a depth calculated to test the target interval and confirmed by measuring the length of rods in the test tubing string and the height above ground surface.
- The packer testing tool was assembled piece by piece as it was lowered into the borehole.
- Packers were positioned by landing the bit stop on the HQ bit at the end of the rods.
- A transducer equipped for real time monitoring was placed in the test tubing.
- Packers were inflated by connecting the packers using 6.35 mm nylon inflation line to the regulator and gradually increasing pressure to the selected pressure. The inflation pressure was selected by calculating hydrostatic pressure at the lowest point on the tool plus the pressure required for the packer to contact the borehole wall (~150 psi), plus the maximum anticipated test differential pressure (typically 20 psi), plus a factor of safety (100 psi), within the recommended operating range by the manufacturer.
- To check for leaks in the nitrogen system following inflation, the nitrogen pressure was monitored for 5 minutes at the surface pressure gauge and checked occasionally throughout the test to ensure little or no loss of pressure.
- Following inflation, a packer circumvention test was conducted by pumping water, typically at a high rate (>30L/min) into the borehole outside of the isolated interval, until the borehole either filled to surface or for an adequate time (typically two minutes) to test the seal of the packers to the borehole wall. During the test, the real time data in the test tubing was monitored to observe if packer bypass was taking place. In cases where packers had not seated properly, a large instantaneous displacement was observed. In some cases, small amounts of gradual bypass took place. These are discussed in more detail later in the report and commented upon in Table F-1.
- Interval pressure stabilization phase - after the packers were fully inflated, 30 minutes of pressure stabilization and recovery was monitored.
- After 30 minutes, typically a 15 L slug of fresh water was inserted into the test tubing as rapidly as possible.

- Slug Injection Recovery (SIR) phase was monitored until full recovery was observed or for a maximum of 30 minutes.
- After 30 minutes of the SIR phase, the % recovery was calculated. If the recovery was 80-100% and there was available depth to water level for a constant rate test, then a Constant Rate Injection (CRI) test was conducted. If recovery was low or there was little depth to water level below top of rods (and therefore a CRI test would overflow the rods and not provide useful data), then an additional 30 minutes of recovery from the SI or until full recovery was observed.
- When a CRI test was performed, it was performed at atmospheric pressure to improve accuracy of pressure and flow rate observations. CRI tests were typically performed for 30 minutes. An initial flow rate was selected for the test based on the speed of the SIR and depth to water. Flow rate was adjusted during the first 10 minutes to maximize displacement in the test tubing, without over topping the rods. Flow rates varied between 1 and 81 L/minute for CRI tests.
  - Because of difficult access routes to most of the testing locations, most tests were limited to the volume of a 1000 L tote. This meant that for some high flow rate tests, the duration was less that 30 minutes.
  - In some cases where finding a flow rate that would not over top the test tubing within the 30 minutes, was difficult, a separate rate finding phase of the test was allowed before the CRI test was started.
- Following each CRI test, recovery was monitored until the water level had recovered to static or a maximum duration of 30 minutes.
- After monitoring recovery, packers were deflated and the tool was removed from the borehole.
- After planned testing on each borehole was complete, either a monitoring well was constructed or the borehole was abandoned in accordance with O.Reg. 903.

Test Analysis

In carbonate rock settings, it is expected that there will be a wide range of possible bulk hydraulic conductivity encountered during testing. For the duration of tests that were completed for this program, it is expected that near borehole conditions dominate the test response. Two flow models were commonly applied to matching the test interval pressure responses:

- Wellbore storage with a homogeneous formation model; and
- Wellbore storage with a two-shell composite model with a change in hydraulic conductivity away from the borehole wall modelled as either a skin (thin inner zone) or a larger inner zone typically representative of a conductive fracture and an outer zone representative of the rock matrix.

In most cases, the approach was to apply wellbore storage with a homogenous flow model as the test response was dominated by undisturbed formation response. Wellbore storage is discussed further below.

Packer test analyses were carried out with HydroBench® (Version 4.7.0.0), an internally-developed software package designed to analyse different types of hydrogeological tests. HydroBench® allows for the analysis of constant rate, variable rate, constant head, pulse, and slug tests. Multi-step superposition is available (e.g., a recovery phase following a variable rate period). In addition, the software includes the pressure deconvolution approach to analyse slug and pulse test data (Chakrabarty and Enachescu 1997). Both homogeneous and composite flow models may be used to interpret the data and the flow geometry may also be matched to infer the local connectivity of a fracture network. HydroBench® also includes the derivative of pressure (i.e., rate of pressure change) with respect to the natural logarithm of time (Gringarten 2008) that has shown to significantly improve the diagnostic and quantitative analysis of slug tests and constant rate pumping tests (Spane and Wurstner 1993). Transmissivity normalised plots (Enachescu et al. 2004) are included in the software package and allow comparing different phases of a hydrogeological test by normalising the pressure response.

The analysis approach followed a systematic, hierarchical workflow to minimize uncertainty:

- Select input parameters.
- Determine static interval pressure by extrapolation of the test interval pressure response during the pressure stabilization phase.
- Review data in transmissivity normalized plots for consistency between phases and for order of magnitude transmissivity.
- Transmissivity was derived by matching on the log-log plot to both the pressure and pressure derivative and semi-log pressure to each test phase and match on the entire simulation plot. Where the pressure and pressure derivative data suggest a transitional period based on the shape and slopes of the log-log derivative of the interval pressure response, HydroBench was set to fit to transmissivity with a borehole skin or a two-shell composite model.

Hydraulic parameters were derived as follows:

- Transmissivity was derived from the pressure match to the extrapolated radial flow acting period of the derivative data on the log-log plot.
- Bulk hydraulic conductivity was estimated by dividing the transmissivity by the interval length.
- Static interval pressure for the purposes of the analyses was derived by the extrapolation of the pressure recovery phase in semi-logarithmic coordinates towards infinite elapsed time in HydroBench.

Input Parameters

Wellbore Storage

Wellbore storage is the response of the test zone to the change in pressure as a result of the compressibility of the fluid in the system (test interval + test tubing), the packer tool, and the rock formation within the interval. Wellbore storage is identified with an early unit slope of the pressure change derivative plotted on the log-log plot.

Wellbore storage C (m^3/Pa) is calculated by the equation below

$$C = \frac{\pi * r_u^2}{\rho * g}$$

where:

r_u is the equivalent test tubing radius = 0.039 m (assuming all boreholes are near vertical)

ρ is the density of water at 10°C = 1000 kg/m^3

g is the earth gravity acceleration = 9.81 m/s^2

Applying these values, C = $5x10^{-7}$ m^3/Pa, which was applied for all slug test analyses.

Skin Zone

Skin is a dimensionless term that is used to quantify the hydraulic properties of the rock around a borehole which may be enhanced by an increased fracturing caused by drilling or reduced by drilling debris and/or mud invasion. The skin magnitude correlates to the ratio of the change in permeability as a factor to the thickness of the skin relative to the borehole diameter. Diagnostic tools are used to identify the hydraulic properties (transmissivity and radial thickness) of the “skin zone” based on the shape and the slopes of the semi-log derivative of the specific drawdown on the log-log plot produced in HydroBench. A negative skin value corresponds to an increase in transmissivity within the skin zone. A positive skin value corresponds to a decrease in transmissivity within the skin zone. The effects of the skin are then separated from the portion of the data that is primarily influenced by the undisturbed rock properties. HydroBench applies skin thickness and magnitude as fitting parameters to the simulation match which influences the shape of the pressure derivative.

Storativity

Storativity is an input parameter in HydroBench, which is directly correlated with skin effect and cannot be uniquely determined from a single hole test. While storativity directly impacts skin, it has less of an impact on the determination of transmissivity.

Storativity is calculated using the following equation:

$$S = \rho * g * \emptyset * c_t * h$$

where:

ρ is the density of water

g is the acceleration of gravity

∅ is the formation effective porosity

c_t is the total compressibility in 1/Pa

h is the length of the test interval in m

A typical range of total porosity for dolostone is 0% to 20% (Freeze and Cherry 1979). Effective porosity in the Study Area was assumed to be within the typical published range of porosity (5 to 10%).

Total compressibility is the compressibility of the formation on a pore volume basis plus the formation water based on the definition above. Total compressibility was assumed at $2x10^{-9}$ 1/Pa, which is approximately the average range of total compressibility for this type of aquifer (Woessner and Poeter 2020). Given these assumptions, a storativity of $2x10^{-5}$ was applied for all tests.

5.4.2 Results

Packer testing summary results are presented in Figures F-2 and F-3 and Table F-1, with detailed results presented in Figures F-4 to F-100. Four plots for each test are presented in the detailed plots, including:

- Pressure Sequence – Plot of pressure versus time.

- Test pressure match plot – Plot of test pressure versus time with the simulation match produced by HydroBench. HydroBench simulates the test pressure response based on the input parameters.
- Transmissivity Normalized Plot – Displays transmissivity versus time in log-log scale as a visual tool for evaluating similar formation responses related to the flow model and enables the comparison of transmissivity from multiple test phases.
- Pressure and pressure derivative log-log plot – Plot of test pressure and pressure derivative versus time on a log-log scale with the simulation match produced by HydroBench.

Hydraulic testing was completed in 97 intervals in 44 boreholes. Four boreholes were not tested because the length of the borehole below the top of bedrock was insufficient for the use of the tool. Transmissivity values were estimated to be in the range of 1 $x10^{-8}$ to $7x10^{-2}$ m^2/s with hydraulic conductivities in the range of $5x10^{-9}$ to $2x10^{--2}$ m/s.

The estimated hydraulic conductivities from the packer testing program are summarized by formation / rock unit in Table 5-5.

Table 5-5: Summary of Packer Test Hydraulic Conductivity Results by Formation / Rock Unit

Formation / Rock Unit	Number of Tests	Minimum k (m/s)	Maximum k (m/s)	Geometric Mean k (m/s)
Gasport	81	$2x10^{-8}$	$2x10^{-2}$	$1x10^{-5}$
Shaley Dolostone	1	-	-	$3x10^{-7}$
Shaley Dolostone / Cabot Head	14	$5x10^{-9}$	$2x10^{-4}$	$8x10^{-7}$
Cabot Head	1	-	-	$5x10^{-8}$

Seventy-nine (79) tests were analyzed using a wellbore storage with a homogeneous formation model and 18 tests were analyzed using a wellbore storage with a two-shell composite model or a homogeneous formation and a borehole skin model to best fit the observed response to each test, as noted in Table F-1. The following observations are made based on the packer testing results:

- Results of packer tests performed in the Gasport Formation varied significantly, ranging from $2x10^{-8}$ m/s to $2x10^{-2}$ m/s. Results ranging by six orders of magnitude demonstrate the heterogeneity of the Gasport Formation in this area. The range of hydraulic conductivities observed in the Gasport Formation are within the range (Freeze and Cherry 1979) of expected values for carbonate rocks, ranging from fine grained unfractured dolostone to weathered, fractured, or vuggy dolostone.
- The results of packer tests performed in the Shaley Dolostone unit and the Cabot Head ranged from $5x10^{-9}$ m/s to $2x10^{-4}$ m/s. The range of hydraulic conductivity results observed in the Shaley Dolostone are generally within the expected range based on their lithology, however, some of the hydraulic conductivity results are higher than expected presumably due to fractures observed in portions of the Shaley Dolostone, which increases its permeability.

- In general, the hydraulic conductivity of the Shaley Dolostone was observed to be approximately one order of magnitude lower than that of the overlying portion of the Gasport Formation.
- Packer test depth (of the center point of the packer test interval) was plotted versus hydraulic conductivity on Figure F-2. While hydraulic conductivity is observed to vary by 5 or more orders of magnitude at a given depth, there is a decreasing trend in hydraulic conductivity with increasing depth below ground surface, which is consistent with expectation that weathering increases the hydraulic conductivity of carbonate rocks.
- Figure F-3 presents a histogram of hydraulic conductivity results, grouped by order of magnitude of results. The hydraulic conductivity of both the Gasport Formation and the Shaley Dolostone conform reasonably well to a normal distribution, which supports conceptualizing the aquifer with a geometric mean hydraulic conductivity and variability (higher and lower hydraulic conductivity in areas).

5.5 Hydraulic Testing - Single Well Response Tests (SWTRs)

Single well response tests are widely used to measure the hydraulic conductivity of subsurface soils and rocks in the vicinity of a well. As part of this assessment, SWRTs were conducted at virtually all the groundwater monitoring wells at the Site (Figure 5-1), including wells screened in the overburden, the upper and lower parts of the Gasport Formation, and the Shaley Dolostone at the base of the Gasport Formation. The testing helped provide good spatial assessment (vertically and laterally) of the hydraulic properties across the Site.

5.5.1 Methodology

The SWRTs were carried out by Golder staff over several events in 2020 and 2021, following monitoring well development. Single well response tests were analyzed to estimate the hydraulic conductivity of each subsurface interval tested.

The SWRTs were conducted in the monitoring wells installed in 2020 (MW20-01 to MW20-28), pumping wells installed in 2021 (PW21-1 to PW21-4), and monitoring wells associated the pumping wells (MW21-1 series to MW21-4 series). The well locations are shown on Figure 5-1.

The methodology for well development and single well response testing is outlined below and was generally as follows.

Monitoring Well Development

- Water was purged from the well using a 13 mm inner diameter Waterra tubing with an inertial foot valve.
- Development was considered complete based on one of the following conditions being met: development water became clear, ten times the volume of water in the monitoring well had been pumped, or the well was pumped dry and allowed to recover (fully or partially depending on recovery speed) and then pumped dry again.

Pumping Well Development

- Well development was completed using the drill rig to flush the borehole with fresh water immediately following drilling.

Single Well Response Testing

- Single well response testing method selection was informed by speed of water level recovery during well development.

- In slow recovering monitoring wells, a logger was deployed near the bottom of the well after the well was pumped dry for the second time. The recovery was monitored using a logger set to a low reading frequency to allow for multiple days of recovery to be recorded if needed and analyzed as a rising head test. The logger was downloaded and the test considered completed when water level recovery exceeded 95%.
- In monitoring wells with an intermediate recovery speed, a Waterra purge rising head test or a physical slug test were performed as described below.
  - Waterra purge rising head test: The monitoring well was allowed to recover following development. Static water levels were confirmed prior the test by measuring manual water levels until the water level had stabilized for 5 minutes (and compared to the water level prior to development). A logger was then placed below the water level and set to a high recording frequency, to optimize the collection of data for a period of minutes or hours. The static water level was monitored for several minutes to observe any minor water level trends. The Waterra pump was then used to rapidly purge the well. The volume purged from the well was measured in a graduated bucket. The Waterra pump was then removed from the monitoring well and recovery was monitored using the logger and manual water levels. The logger was downloaded and the test considered completed when recovery exceeded 95%.
  - Physical slug test: The monitoring well was allowed to recover following development. Static water levels were confirmed prior the test by measuring manual water levels until the water level had stabilized for 5 minutes (and compared to the water level prior to development). A logger was then placed below the water level and set to a high reading frequency, to allow for the collection of data for a period of minutes or hours. The static water level was monitored for several minutes to observe any minor water level trends. A slug of known volume was then lowered quickly to displace the water in the well and a falling head test was monitored using the logger and manual water level measurements. Typically, when recovery exceeded 95%, the slug was rapidly removed from the well and recovery was monitored until 95% was exceeded. Where there was uncertainty if the logger had shifted during the insertion and removal of the slug, the test was repeated.
- Where rapid recovery from well development was identified, a pneumatic displacement rising head test was performed. A pneumatic displacement rising head test was conducted by sealing the top of the riser pipe off with the test apparatus, and then using air pressure to displace groundwater in the riser pipe out through the well screen. The pressure in the system is monitored using pressure transducers at two locations in the riser pipe: in the water column at a known depth, and in the air space above the water column. Typically, pressure in the riser pipe was allowed to equilibrate for 5 minutes. Air pressure is then suddenly released, and the transient response is observed as a rising head test. This test method provided more instantaneous displacement and a better fit with theoretical displacement than traditional tests using a physical slug to displace the water in fast recovering wells. Implementing a pneumatic method is consistent with the Butler's recommendation for testing high k aquifers (1998). In some cases, where the monitoring well recovered rapidly, the well head geometry or a water level in the well screen made it impossible complete a pneumatic rising head test. In these cases, a physical slug test or a Waterra purge rising head test were conducted.
- The method of testing MW20-20B differed from the methods described above, as the well exhibited flowing (artesian) conditions. In this case, the hydrostatic head was measured by tightening the J-plug down to stop flow and allowing the well to pressurize, while monitoring pressure in the well using a transducer at a known depth. The J-plug was then removed and the well was allowed to flow. The flow rate was then measured

using a spout, a graduated bucket, and a stopwatch. During the flow rate measurement, the head was also noted.

- Monitoring well MW20-05B was not tested due to it's water level being consistently below the well screen (i.e., a dry well).

Single Well Response Testing Analysis

Analysis of the single well response tests was performed using the following methodology.

- Monitoring well details were confirmed based construction details to establish the screen length, well diameter, borehole diameter, sand pack length, stick up, and materials used in well construction.
- Field notes and logger files were reviewed and a test hydrograph was plotted.
- A conceptual model of the well was developed, including identifying if the well was confined or unconfined, determining aquifer thickness, and estimating well penetration, based on a review of the borehole log and downhole geophysical data.
- It was assumed that the tested interval was homogenous, isotropic, and no borehole skin affected the test.
- An effective radius correction was applied if the water level entered the sand pack during the test and if the water level was in the well screen interval during the majority of the test.
- These parameters were entered into AQTESOLV (Version 4.50) and an analytical solution was applied to calculate a hydraulic conductivity for the test.
  - Where test results were overdamped (displacement consistently fell toward the static level), the Bouwer Rice (1976) (confined or unconfined, depending on well model) solution was applied.
  - Where test results were underdamped (displacement oscillated around the static level), Springer-Gelhar (1991) solution was applied for unconfined wells and the Butler-Zhan (2004) solution for confined wells.
- As noted above, MW20-20B (Figure G-38) was tested that approximated steady state flow from the well with known drawdown and geometry, which can be analyzed using methods described in Powers (2007).

5.5.2 Results

The single well response tests and results are summarized by formation in Table 5-6 below, with detailed results presented in Appendix G. Appendix G includes a summary table of individual SWRTs (Table G-1), results of the SWRTs by elevation (Figure G-1), a histogram of SWRT results screened in the Gasport Formation (Figure G-2), and SWRT analysis (Figures G-3 to G-77).

Table 5-6: Single Well Response Test Hydraulic Conductivity by Formation / Unit

Formation / Rock Unit	Number of Observations	Minimum K (m/s)	Maximum K (m/s)	Geometric Mean K (m/s)
Overburden	5	$1.4x10^{-6}$	$4.8x10^{-4}$	$1x10^{-5}$
Goat Island	8	$3.5x10^{-8}$	$3.2x10^{-4}$	$6x10^{-6}$
Gasport	46	$1.9x10^{-8}$	$5.1x10^{-4}$	$5x10^{-6}$

Formation / Rock Unit	Number of Observations	Minimum K (m/s)	Maximum K (m/s)	Geometric Mean K (m/s)
Gasport / Shaley Dolostone	3	9.9×10^{-7}	2.4×10^{-5}	7×10^{-6}
Shaley Dolostone	8	7.1×10^{-9}	5.5×10^{-5}	1×10^{-6}
Shaley Dolostone / Cabot Head	4	4.5×10^{-6}	2.4×10^{-5}	1×10^{-5}

The following observations are made with respect to the results of the SWRTs:

- The SWRTs performed on wells screened in the Gasport Formation ranged from 2×10^{-8} m/s to 5×10^{-4} m/s, which is typical of lithologies ranging from a middle value for unfractured dolostone to a middle value of weathered dolostone (Freeze and Cherry 1979). This is consistent with the lithological observations at the Site.
- The eight SWRTs performed in the Goat Island Formation, matched the range and geometric mean of the Gasport Formation very closely. This suggests that the two formations are likely to act as a single hydrogeological unit in the vicinity of the Site.
- The 12 SWRTs performed on wells screen partially or entirely in the Shaley Dolostone (but not in the Gasport Formation), had a geometric mean of 2×10^{-6} m/s, which is similar to, but somewhat lower than, the hydraulic conductivity of the Gasport Formation. This is consistent with the field observation of many horizontal fractures in the Shaley Dolostone which contribute to higher hydraulic conductivity than might otherwise be expected for this unit (Freeze and Cherry 1979).
- The depth below ground surface of the SWRTs varied according to the stratigraphy and variability in the thickness of the overburden and bedrock units. To assess the data for potential trends, SWRT depth was plotted as a function of hydraulic conductivity on Figure G-1. A wide range of hydraulic conductivities were observed for all rock units with no obvious correlation to depth.
- A histogram of hydraulic conductivities for the Gasport Formation is presented on Figure G-2, shows a bi-modal distribution. One group of hydraulic conductivity results is clustered at $\sim 10^{-7}$ m/s responses and the second group is clustered at $\sim 10^{-5}$ m/s, noting that there is considerable overlap. This bi-modal distribution suggests that some wells tested include a hydraulically active feature (such as a fracture or vuggy bed) and others do not, and when not, the well response is representative of the (lower) hydraulic conductivity of relatively intact rock. The short test interval length (a typical screen length of 1.52 m) supports the assertion that some tests capture a hydraulically active feature, while others do not.
- The results of SWRTs in the overburden were generally consistent with published hydraulic conductivities for the soil materials observed during drilling at those locations.

5.6 Hydraulic Testing - Pumping Tests

Once the groundwater monitoring program at the Site and Study Area was established and underway, additional wells were installed in the spring of 2021 in four areas of the Site (see Section 5.1), and pumping tests were conducted in the summer and early fall of 2021.

The objective of the pumping tests was to further assess the hydraulic behavior of these areas, including the degree of connectivity of fractures within the bedrock, the hydraulic connection between aquifer units, and the potential connection to surface water features in the area. Two pumping tests were carried out in the Main Area of the Site (at PW21-1 and PW21-2), one pumping test in the South Area (at PW21-3, using MW21-3 as the pumping well), and one pumping test in the North Area (at PW21-4), at the locations shown on Figure 5-1.

The four tests together provided good spatial coverage across the Site and helped assess the hydraulic properties of the aquifers over a relatively large area in comparison to packer testing and SWRT methods, which inherently provide a more localized measurement.

5.6.1 Methodology

In general, a 96-hour constant rate pumping test was conducted at each location, with each test registered in the MECP Environmental Activity and Sector Registry (EASR). A notification letter was delivered to the private well owners within the potential zone of influence of the test one week prior to the start of each test. The tests were completed at separate times, with non-pumping periods between the tests to allow time for water levels to recover to “static” conditions between successive tests. Pumped water was managed to ensure that it was not “recirculated” back into the local groundwater system during the test. Tracer tests were also conducted by Worthington Groundwater (Worthington) during the pumping tests to support the karst assessment. Results of the tracer testing is provided in Section 5.9.

The well group installed specifically for each pumping test was comprised of a pumping well surrounded by four monitoring wells, positioned as follows relative to the pumping well: one 10 m upgradient, two 30 m cross-gradient, and one 100 m downgradient, with the groundwater gradient inferred from groundwater monitoring data for that area. Note that at the PW21-4 location, the existing borehole BH16 was used as one of the monitoring wells. The wells installed for the pumping tests were advanced through the Gasport Formation and into the top of the Shaley Dolostone, and in some cases, the wells extended through the thin Shaley Dolostone into the Cabot Head Formation. At the test location PW21-3, preliminary testing of the wells indicated that MW21-3-1 was in fact more permeable than the originally planned pumping well, and as such, it was used as the pumping well for that test, in order to maximize the pumping rate achievable.

Groundwater levels were monitored at the pumping well, offset wells, and other monitoring wells in the area using data loggers and manual measurements prior to, during and following the pumping test. For each test, the loggers were set to collect water level measurements every 5 minutes throughout the test. Loggers in wells that were part of the (long-term) monitoring network and proximal to the test area, were temporarily reprogrammed to record water levels at the same 5-minute interval.

The pumping tests were conducted by Ontario Water Well Services Inc. (OWWS), who supplied and operated the equipment to pump and discharge the water. The pumps were equipped with a check valve to ensure water could not flow back into the well. Flow was monitored using a flow meter and totalizer. Discharge water was pumped to a low-lying area away from the pumping well and outside of the expected area of influence of the tests. Upon installation of the pump, a brief test was conducted to identify a proposed flow rate and confirm the selection of pump, and size the discharge hose.

At the start of each constant rate test, the water levels in the pumping well were monitored frequently and adjustments were made to the pumping rate to ensure that the pumping rate was maximized, but to avoid drawdown reaching the pump intake during the tests.

The following mitigation measures were also in place during the testing: in the unlikely event that the aquifer test negatively impacted any nearby private wells, the pumping rate would be reduced, or a temporary water supply would be provided to the impacted parties for the duration of the test; and in the event that erosion or scouring was observed at the discharge point, the flow dissipation system would be modified and the affected area rehabilitated. Neither mitigation measure was required during any of the four pumping tests.

5.6.2 Test Analysis

The constant rate pumping tests were then analyzed following a typical analysis workflow for multi-well aquifer tests. This included a data check and the plotting of hydrographs for each well following the same methodology described in Section 5.3.1. Static groundwater elevations were selected at each well based on an examination of the water levels before and after the constant rate test. These groundwater elevations were used to calculate the observed drawdown at each well.

Flow rates for the constant rate tests were generally very low and close to the minimum flow rate of the pumps available, making it difficult to maintain constant flow rates, and therefore maintain a consistent rate of drawdown. As such, the water level recovery data (i.e., from the point in time when the pump was shut off at the end of the pumping period) was selected for analysis of hydraulic parameters, as it provided a consistent response to the average pumping rate during the constant rate test. Analysis of the recovery part of the test is a very common practice in pumping test assessments, as it typically provides a “cleaner” data set than the drawdown part of the test.

Recovery data versus time was plotted for the pumping well and monitoring wells within 100 m of the pumping well, and the Cooper-Jacob straight line method was implemented to estimate transmissivity, and where possible, storativity (Jacob 1944, Cooper and Jacob 1946, Kruseman and de Ridder 1994), as described below. Where storativity was calculated at multiple monitoring wells, the storativity results are presented as a range. The hydraulic conductivity of the test interval was then calculated by dividing the transmissivity by the aquifer interval length.

A plot of drawdown versus distance, where drawdown was observed at the monitoring wells, was also prepared for each test, to estimate the extent of the zone of influence.

Cooper-Jacob Straight-Line Method

When time is plotted in log scale versus recovery, a straight-line recovery period can be identified. Based on the slope of this line, the bulk transmissivity of the confined bedrock aquifer can be estimated using the Cooper-Jacob (1946) approximation as follows:

$$T=\left(\frac{2.303}{4\pi}\right)\times\left(\frac{Q}{\Delta S}\right)$$

Where:Q = pumping rate (m^3/day)

ΔS = slope of the observed recovery hydrograph per log cycle

The average pumping rate is calculated, and based on a fit to the recovery data, the average bulk transmissivity of the bedrock aquifer is calculated.

Where an unconfined aquifer model is selected, the Cooper-Jacob Straight-Line method can be applied using the modified method proposed by Cooper (1944) and presented by Kruseman and de Ridder (1994). The method addresses two differences in an unconfined aquifer:

1) Change in storage: addressed by selecting a quasi-steady state portion of the aquifer test for analysis, where changes to storage have a minimal affect on observed water levels; and

2) Change in saturated aquifer thickness: addressed using a geometric correction for saturated aquifer thickness (Kruseman and de Ridder 1994).

$$s' = s - \left(\frac{s^2}{2xD}\right)$$

Where: s' = corrected drawdown

s = observed drawdown

D = the initial saturated aquifer thickness

The corrected drawdown or recovery data can then be analyzed using the Cooper-Jacob Straight-Line method, as in a confined case.

Where drawdown is observed at a monitoring well, it is possible to estimate the aquifer storativity (Cooper and Jacob 1946). Based on the slope of the recovery data at the monitoring well in the semilogarithmic recovery plot, the storativity (S) of the bedrock aquifer can be estimated as follows:

$$S = 2.2459T\left(\frac{t}{r^2}\right)$$

Where: T = transmissivity

t/r^2 = time/radius^2 value when observed drawdown = 0 m

When applied with corrected drawdown in an unconfined aquifer, the same method can be applied to estimate specific yield.

5.6.3 Results

The 2021 constant rate pumping test results at the four locations within the Site are summarized in Table 5-7. Hydrographs, drawdown versus distance plots, and recovery versus time plots for the four tests are provided on Figures H-1 to H-10 in Appendix H, as follows:

- Figure H-1 – PW21-1 - Groundwater Elevation Monitoring
- Figure H-2 – PW21-1 - Drawdown Versus Distance
- Figure H-3 – PW21-1 - Recovery Versus Log Time
- Figure H-4 – PW21-2 - Groundwater Elevation Monitoring

- Figure H-5 – PW21-2 - Corrected Recovery Versus Log Time
- Figure H-6 – MW21-3-1 - Groundwater Elevation Monitoring
- Figure H-7 – MW21-3-1 - Drawdown Versus Distance
- Figure H-8 – MW21-3-1 - Corrected Recovery Versus Log Time
- Figure H-9 – PW21-4 - Groundwater Elevation Monitoring
- Figure H-10 – PW21-4 - Corrected Recovery Versus Log Time

5.6.3.1 PW21-1

PW21-1 is located in the northwestern part of the Main Area of the Site. The constant rate pumping test was conducted in this area from September 20 to 24, 2021 and registered under EASR permit 1000140598.

During the first four hours of the test, the pumping rate was adjusted to establish an optimal rate to “stress” the aquifer without drawing the water level down to the pump intake. After noting moderate drawdown in the early portions of the test, the rate was increased from 23 L/min to 34 L/min, then later to 45 L/min. Shortly after the increase to 45 L/min, cascading was observed in the well (when the water level dropped below ~12 mbgs), and the water level began to decline rapidly. The pumping rate was then decreased to 34 L/min, and then further to 23 L/min to prevent the water level from reaching the pump intake, and the pumping rate was maintained at 23 L/s for the reaming duration of the test.

The overall average pumping rate during the test was ~21.7 L/s, and this average rate was used in the analysis of the recovery data. A significant precipitation event (63 mm) occurred on September 21 and 22, 2022 during pumping portion of the test, as indicated on the hydrograph (Figure H-1).

Pumped groundwater from PW21-1 was discharged approximately 320 m southwest of the pumping well in a forested area downgradient of the pumping well, which was approximately 30 m from Tributary #1, to allow for the attenuation of any sediment in the water, should the water eventually reach this stream. Water level monitoring locations during the test included wells and surface water stations within approximately 500 m of the pumping well.

Pumping Well (PW21-1) Response

A water level response to pumping at PW21-1 was observed at MW21-1-1, 2, 3 and 4 and at MW20-15A, B and C. No response to pumping was observed at any surface water stations or mini-piezometers at those stations. The water levels observed at those locations during the test are presented on Figure H-1 in Appendix H.

Drawdown in the pumping well occurred rapidly at the start of the test and increased each time that the pumping rate was increased. Two hydraulic features appear to have controlled the performance of the well (at approximately 12 and 30 mbgs). When the water level declined below ~12 mbgs, cascading was heard in the well and the water level declined rapidly. This is consistent with the dynamic heat pulse flowmeter geophysical logging results for this well (pumped at 4 L/min in the well casing, causing upward flow), which showed that the main water producing zone in this well is a fracture located at ~12 mbgs, and below this elevation the flow is downward to a fracture at ~30 mbgs (see the PW21-2 geophysical logs in Appendix D).

Water levels during the test also showed minor fluctuations due to small fluctuations in the pumping rate; these pumping rate fluctuations were apparently a result of minor sand accumulation in the pump that occurred during the test. The total drawdown observed at the pumping well at the end of the test was 15.4 m.

Bedrock Aquifer Response

The background static water level trends during the aquifer test were influenced by the 63 mm of rainfall during the test on September 21 and 22, 2022 (precipitation recorded at the Georgetown meteorology station). In response to the precipitation event, some bedrock water levels were observed to increase by 1 to 1.5 m during the aquifer test (MW20-14, MW20-16, MW20-17, and MW20-27), while others showed little or no response (0 to 0.5 m) (MW20-11, MW20-12, MW20-15, and BH2). Due to the influence of the precipitation event during the test, static water levels in the pumping well (PW21-1) and nearby monitoring wells (MW21-1-1 to MW21-1-4), were 1.1 m higher, on average, following the pumping test than they were before the test.

A plot of drawdown versus distance for this test is presented on Figure H-2. Observed drawdown in the bedrock aquifer ranged from 2.8 m (at MW21-1-3, 100 m from PW21-1) to 6.7 m (at MW21-1-1, 11 m from PW21-1) (and no drawdown was observed at MW20-15 or BH2). Based on this response, the drawdown cone in the bedrock aquifer during this test is estimated to have extended approximately 210 m from PW21-1, with approximately 1.0 m of drawdown inferred to have occurred at that distance. The drawdown versus distance plot showed some heterogeneity in the bedrock aquifer, as the drawdown at MW21-1-2 was higher than predicted (6.7 m observed, 2.2 m more than expected) and lower than predicted at MW21-1-4 (2.9 m observed, 1.6 m less than expected) based on a straight line projection on the drawdown plot.

Overburden Aquifer Response

No response to pumping at PW21-1 was observed in overburden monitoring wells.

Surface Water Response

No response to pumping at PW21-1 was observed at surface water monitoring stations.

Estimate of Aquifer Properties

As shown on Figure H-3, the recovery water levels at PW21-1, MW21-1-1, and MW21-1-3 plot along a similar slope on the semi-log recovery plot. Based on the slope of this line and an average pumping rate of 21.7 L/min, the average bulk transmissivity of the bedrock aquifer is estimated to be approximately 2 m^2/day.

Based on a test interval thickness of 26.2 m for this well, the estimated hydraulic conductivity of the bedrock in this area is $1x10^{-6}$ m/s, which is close the low end of the range of hydraulic conductivity for fractured or karstic dolostone, and close to the high end of the range of unfractured dolostone (Freeze and Cherry 1979). Water level recovery from the aquifer test varied significantly in the monitoring wells relative to PW21-1. This further suggests there are heterogeneities in the transmissivity of the bedrock aquifer within the area of influence of the test. Based on the slope of the recovery data at MW21-1-1, and MW21-1-3 in the plot, the storativity (S) of the bedrock aquifer is estimated to be between $5x10^{-5}$ to $1x10^{-4}$.

5.6.3.2 PW21-2

PW21-2 is located in the northeastern part of the Main Area of the Site. A constant rate pumping test was conducted in this area from August 10 to 14, 2021 and registered under EASR permit 1000139090.

The average pumping rate during the test was very low, approximately 2.2 L/min. With the pump operating at such a low rate, small variations in the pumping rate caused the water levels in the pumping well to fluctuate significantly during the test. Additionally, during the night of August 12 to 13, 2022, the pump inadvertently shut down, allowing partial recovery.

Pumped groundwater from PW21-2 was discharged approximately 380 m to the southeast of the well, in a forested area downgradient of the pumping well.

Pumping Well (PW21-2) Response

The water levels at the locations monitored during the test are presented on Figure H-4 in Appendix H. Drawdown at PW21-2 occurred rapidly at the start of the test and in response to variations in the pumping rate. Total drawdown at the end of the test was 5.5 m.

Bedrock Aquifer Response

In the area around PW21-2, the aquifer water level was below the top of bedrock and the aquifer is conceptualized as an unconfined aquifer in this area. Static groundwater levels in the area before, during and after the pumping test showed a slow steady decline of about 0.9 cm/day due to dry conditions. No response to pumping was noted any monitoring wells around PW2-2, as seen on Figure H-4.

Overburden Aquifer Response

No response to pumping PW21-2 was noted in overburden monitoring wells.

Surface Water Response

No response to pumping PW21-2 was noted at surface water monitoring stations.

Estimate of Aquifer Properties

The recovery water levels for PW21-2 are shown on Figure H-5. Using an average pumping rate of 2.2 L/min, the bulk transmissivity of the bedrock aquifer is estimated to be 0.2 m^2/day. Based on a test thickness of 19.5 m for this well, the apparent hydraulic conductivity of the bedrock in this area is 9×10^{-8} m/s, which is lower than typically expected for dolostone (Freeze and Cherry 1979).

Since no drawdown was observed any the monitoring wells, the area of influence of the test is likely to be less than 10 m and no estimate of specific storage was possible.

5.6.3.3 MW21-3-1

MW21-3-1 is located in the central part of the South Area of the Site. Based on the single well response testing conducted at PW21-3 and the MW21-3 series wells immediately prior to the pumping test, MW21-3-1 was selected as a better option for the aquifer test in this area due to its more permeable characteristics. The constant rate pumping test was conducted in this area from August 23 to 27, 2021 and registered under EASR 1000137926.

The average pumping rate during the test was very low, approximately 1.7 L/min. With the pump operating at such a low rate, small variations in the pumping rate caused the water levels to fluctuate significantly during the test.

Pumped groundwater from MW21-3-1 was discharged approximately 340 m to the south of the well, in a forested area downgradient of the pumping well.

Pumping Well (MW21-3-1) Response

The water levels at the locations monitored during the test are presented on Figure H-6 in Appendix H, for locations that responded to pumping during the aquifer test. Drawdown occurred rapidly at the start of the test and in response to variations in the pumping rate. Total drawdown at the end of the test was 4.1 m.

Bedrock Aquifer Response

In the area around MW21-3-1, the aquifer water level was below the top of bedrock and as such, the aquifer is conceptualized as an unconfined aquifer in this area. Static water levels in the bedrock aquifer were relatively consistent in the area of the MW21-3-1 during the aquifer test. Responses to the aquifer test were observed in the monitoring wells within 35 m of the pumping well, ranging between 0.49 m (observed at PW21-3, 11 m from MW21-3) and 0.10 m (observed at MW21-3-4, 34 m from MW21-3-1), as shown on Figures H-6 and H-7.

Overburden Aquifer Response

No response to pumping at MW21-1-3 was noted in overburden monitoring wells.

Surface Water Response

No response to pumping at MW21-1-3 was noted at surface water monitoring stations.

Estimate of Aquifer Properties

As shown on Figure H-8, the corrected recovery water levels at MW21-3-1 and PW21-3 plot along a similar slope on the semi-log corrected recovery plot. Based on the slope of this line and an average pumping rate of 1.7 L/min, the average bulk transmissivity of the bedrock aquifer in this area is interpreted to be approximately 2 m^2/day.

Based on a test interval thickness of 12.9 m, the apparent hydraulic conductivity of the bedrock is 1×10^{-6} m/s, which is close the low end of the range of hydraulic conductivity for fractured or karstic dolostone, and close to the high end of the range of unfractured dolostone (Freeze and Cherry 1979).

Based on the slope of the corrected recovery data, the specific yield (Sy) of the bedrock aquifer in this area is estimated to be 4×10^{-3}.

5.6.3.4 PW21-4

PW21-4 is located in the central part of North Area of the Site. A constant rate pumping test was conducted from September 8 and 12, 2021 and registered under EASR 1000140595.

Due to the low yield of this well, an alternate testing method was employed. A float was attached to the pump to cycle pumping on and off and maintain a relatively constant water level, similar to the configuration of a constant head test. The testing resulted in an average pumping rate of 0.12 L/min.

Pumped groundwater from PW21-4 was discharged approximately 300 m to the northeast of the well, in a forested area downgradient of the pumping well.

Pumping Well (PW21-4) Response

Water levels during the test are presented on Figure H-9 in Appendix H, for wells that responded to pumping during the test. Drawdown occurred rapidly at the start of the test and in response to variations in the pumping rate. The drawdown maintained during the test was 7.4 m, with the water level proximal to the base of the Gasport Formation.

Bedrock Aquifer Response

In the area around PW21-4, the aquifer water level was below the top of bedrock and as such, the aquifer is conceptualized as an unconfined aquifer in this area. The bedrock aquifer water levels declined steadily during a dry period in the late summer when the aquifer test was conducted, including in the area of around PW21-4. Water level changes varied by location, with an average decline of 0.9 cm/day during the test in the surrounding monitoring wells (within 100 m). No response to pumping at PW21-4 was noted in the monitoring wells.

Overburden Aquifer Response

No response to pumping at PW21-4 was noted in overburden monitoring wells.

Surface Water Response

No response to pumping at PW21-4 was noted at surface water monitoring stations.

Estimate of Aquifer Properties

The recovery water levels for PW21-4 are shown on Figure H-10. Using an average pumping rate of 0.12 L/min, the bulk transmissivity of the bedrock aquifer is approximately 7×10^{-3} m^2/day. Based on a test interval thickness of 8.8 m, the apparent hydraulic conductivity is 9×10^{-9} m/s, which is lower than typically expected for the observed dolostone lithology (Freeze and Cherry 1979), and lower than the hydraulic conductivity estimated in the Main and South Areas of the site, where the other three pumping tests were conducted.

Since no drawdown was observed in the monitoring wells, the area of influence of the test is likely to be less than 10 m and no estimate of specific storage was possible.

5.6.3.5 Summary

The results of the four 96-hour pumping tests conducted in the late summer and early fall of 2021 in the Main, South and North Areas of the Site are summarized in Table 5-7. Due to the low permeability of the bedrock, the tests could only be conducted at low pumping rates (1.7 to 21.7 L/min), and the permeability of the rock in the North Area was so low, that a constant rate test was not possible, so a constant head test was conducted at an estimated pumping rate of ~0.1 L/min.

The transmissivity estimated from the tests were low, ranging from 7×10^{-3} m^2/day (PW21-4) to 2 m^2/day (PW21-1 and MW21-3-1) and the estimated hydraulic conductivity of the bedrock ranged from 9×10^{-9} m/s (PW21-4) to 1×10^{-6} m/s (PW21-1 and MW21-3-1). The hydraulic conductivity at PW21-4 was lower than all but one of the 97 packer tests and lower than all but one of the 72 SWRTs in bedrock at the Site. These responses highlight the low permeability and heterogeneity of the Gasport Formation.

The pumping test results in conjunction with the other hydraulic tests (packer tests and SWRTs) support the interpretation that while there are local zones of increased permeability in the bedrock on a scale of 10's of metres, these zones are generally not very interconnected and the rock mass as a whole is not very permeable on a scale of hundreds of metres.

Table 5-7: Summary of 2021 Pumping Test Results

Test Location	Pumping Well	Test Pumping Rate (L/min)	Final Drawdown (m)	Estimated Zone of Influence (m)	Aquifer Model	T (m^2/day)	K (m/s)	S / Sy
Main Area (West)	PW21-1	21.7	15.4	210	Confined	2	$1x10^{-6}$	$5x10^{-5}$ to $1x10^{-4}$
Main Area (East)	PW21-2	2.2	5.0	<10	Unconfined	0.2	$9x10^{-8}$	N/D
South Area	MW21-3-1	1.7	4.2	<10	Unconfined	2	$1x10^{-6}$	$4x10^{-3}$
North Area	PW21-4	0.1	7.4	<10	Unconfined	$7x10^{-3}$	$9x10^{-9}$	N/D

An important caveat to the general hydraulic behavior of the bedrock noted above is that a fracture zone was encountered in the upper 1 to 2 m of bedrock during the installation of many of the bedrock wells, requiring that a surface casing be set into the top of the rock in order to allow rock coring to continue. This upper zone and the overburden immediately overlying it forms a “contact aquifer” zone, that is in many instances more permeable than the underlying bedrock.

The presence of a contact aquifer is a commonly recognized as an important hydrogeological unit (Carter et al. 2019) in this hydrogeologic environment, and is a component of regional groundwater flow models in this area. The potential presence of a contact aquifer zone was later assessed during a supplemental investigation conducted in the northwest part of the Main Area in the late summer of 2022 (see Section 5.8), and was incorporated into the numerical groundwater flow model used in this assessment (see Chapter 8).

5.7 Groundwater Quality

The objective of the groundwater quality testing program was to assess groundwater quality on the Site and within the Study area, in order to establish baseline water quality conditions and to assess the potential for water quality issues that may arise when water collected from quarry dewatering is discharged to the environment.

5.7.1 Methodology

The methodology for the groundwater sampling program was as follows.

- All monitoring wells installed as part of the hydrogeologic investigation were developed and completed with dedicated groundwater water sampling equipment (tubing and Waterra foot-valves).
- Each well was purged and then sampled. Field parameters (including pH, electrical conductivity, and temperature) were recorded after each purge volume, to ensure water chemistry had stabilized prior to sampling.
- The water samples were collected in pre-supplied laboratory bottles, placed in ice-packed coolers, and delivered to the Bureau Veritas (BV) Labs in Mississauga following standard Chain of Custody protocols.

- The samples were analysed at BV Labs for the RCAP groundwater suite (which includes general chemistry, nutrients, inorganics and metals), as well as benzene, toluene, ethylbenzene and xylene (BTEX) and petroleum hydrocarbons (PHC) F1 to F4.
- Analytical results were compared to
  - Table 2: Full Depth Generic Site Condition Standards [SCS] in a Potable Groundwater Condition - Coarse Grained Sediments - Residential / Parkland / Institutional Use from the MECP *Soil, ground water and sediment standards for use under Part XV.1 of the Environmental Protection Act*, dated July 1, 2011;
  - Ontario Drinking Water Quality Standards (ODWS) from the MECP *Safe Drinking Water Act*, dated January 1, 2020; and
  - Provincial Water Quality Objectives (PWQO) from *Policies, Guidelines, Provincial Water Quality Objectives of the Ministry of Environment and Energy*, reprinted February, 1999.

Water quality sampling was carried out by Golder field personnel on February 17, 2021, June 21 to 28, 2021 and on July 24, 2021. Groundwater sampling was conducted at monitoring wells MW20-01 to MW20-28 at the locations shown on Figure 5-1.

5.7.2 Results

Water quality results are summarized in Appendix I, Table I-1, with MECP Table 2, ODWS and PWQO criteria presented along side the data for comparison purposes. A full set of analytical results from the laboratory, including chain of custody and certificates of analysis, are provided in Appendix I.

In general, the water quality was in the typical range expected for groundwater in this hydrogeologic setting. There were some exceedances of ODWS and MECP Table 2 criteria, such as total dissolved solids, hardness, aluminum, iron, manganese, and sulphate. There were also a number of occasional exceedances of the PWQO, notably for aluminum and iron, and occasionally for boron, cadmium, cobalt, copper, lead, molybdenum, phosphorous, silver, vanadium, and zinc.

The groundwater samples were analysed for dissolved metals (not total metals) for comparison to MECP Table 2 and ODWS, and as such, the groundwater samples for metals were field filtered. It should be noted that the PWQO are intended to be compared to total metal concentrations, which may be higher than dissolved metal concentrations. The comparison to the PWQO is nonetheless considered to be helpful in understanding the potential water quality of seepage from the Site.

There were also several locations that exhibited one or more elevated parameters presumed to be related to anthropogenic activities, including elevated chloride and sodium (MW20-11B and MW20-15A), elevated PHCs (MW20-17B and MW20-19B) and trace detections of one or more BTEX parameter (MW20-13B, MW20-14B, and MW20-16B).

5.8 Northwest Investigation

Following the completion of the initial field investigations in 2020 and 2021, a supplemental investigation was carried out from July to September of 2022 in the northwest part of the Main Area of the Site proximal to a portion of the Coulterville Wetland Complex near Tributary #1, referred to as the “Northwest Wetland”, as shown on Figure 5-8.

The primary objective of the northwest investigation was to collect additional hydrogeological and hydrologic data to refine the site conceptual model and calibrate the numerical model in that area, thereby increasing confidence in model predictions and in the assessment of potential for hydrogeologic impacts to occur in that area. A secondary objective was to assess the hydraulic characteristics of contact aquifer zone (the uppermost part of the bedrock and overburden immediately overlying it) at the Site.

The northwest investigation included:

- Installation of, and monitoring at additional surface water stations (SW17 – SW20) and mini-piezometers (MP17 – MP20);
- Construction of additional boreholes with downhole geophysical logging, and the construction of additional monitoring wells (MW22-01, MW22-02A/B/C and MW22-03) and another test pumping well (PW22-1);
- Shallow soil coring at SC22-01 to SC22-10, and grain size analysis to assess surficial soil permeability;
- SWRTs in the new monitoring wells; and
- An additional 96-hour constant rate pumping test at PW22-1 in the Northwest Wetland area.

Detailed results and supporting data acquired during the northwest investigation are provided in Appendix J (additional hydrogeologic results) and Appendix L (additional surface water station results are included as an addendum to the Surface Water Flow appendix).

5.8.1 Surface Water Station Installation

5.8.1.1 Methodology

Four additional surface water stations (SW17 – SW20) and mini-piezometers (MP17 – MP20) were installed to support the evaluation of potential impacts of quarry dewatering on water levels and ecological features in the Northwest Wetland, at the locations shown on Figure 5-8. Water level loggers were installed in the mini-piezometers at each of the monitoring locations and programmed to record water levels on a 15-minute interval. Additionally, the previously installed surface water stations SW14 and MP14 were also included in the evaluation as this station sits downstream of SW17/MP17 on Tributary #1 near the Northwest Wetland.

The elevations of the surface water stations (i.e., staff gauges) and mini piezometers were surveyed on October 06, 2020 (SW14 and MP14) September 29, 2022 (SW17 to SW20 and MP17 to MP20) and referenced to the Canadian Geodetic Vertical Datum of 1928 (1978 adjustment) datum. A list of the monitoring stations, their locations and their installation dates are provided in Table 5-8.

Table 5-8: Surface Water Monitoring Locations

Station Name	Zone	Northing (m)	Easting (m)	Installation Date	Measurements
SW14 / MP14 (1)	17	4855098	578165	October 06, 2020 (2)	Water Level
SW17 / MP17 (1)	17	4853803	576488	August 5, 2022 (2)	Water Level
SW18 / MP18 (1)	17	4853993	576396	August 5, 2022 (2)	Water Level
SW19 / MP19 (1)	17	4854106	576226	August 5, 2022 (2)	Water Level

Station Name	Zone	Northing (m)	Easting (m)	Installation Date	Measurements
SW20 / MP20 (1)	17	4853890	576819	August 5, 2022 (2)	Water Level

Notes:

(1) The approximate locations of these monitoring stations are shown on Figure 6-1 described in Section 6 below.

(2) Refers to the installation date for the surface water monitoring stations.

5.8.1.2 Results

The primary objective of groundwater and surface water monitoring performed as part of the Northwest Wetland investigation was to better understand groundwater surface water interaction. The detailed results from these surface water stations are included in the Groundwater - Surface Water Interaction section of this report (Section 6.8), for the available period of record (August to October 2022).

The surface water and shallow groundwater monitoring results at SW14/MP14 to SW20/MP20 are summarized as follows:

- Observed shallow groundwater heads were consistently below the surface water head (when present) and below ground surface during the monitoring period, indicating downward vertical gradients in the shallow subsurface;
- Surface water was not observed at SW18 or SW20; and
- Surface water levels were observed to decline at SW17 and SW19 following installation suggesting the water was evaporating or infiltrating following a 45 mm of rainfall several weeks prior. Both locations did not have consistently present surface water by the end of August and through the remainder of the monitoring period.

In summary, these surface water monitoring locations were either perched or completely dry during the August to October 2022 period of record, and were not supported by groundwater.

5.8.2 Drilling and Well Construction

5.8.2.1 Methodology

Supplemental drilling in the northwest investigation was undertaken between August 2 and August 10, 2022 by CSD under Golder supervision, in a manner similar to that described in Section 5.1.1, noting the following.

- All boreholes were advanced with rotasonic methods through the overburden and into the bedrock, similar to the installation of the PW21 and MW21 series wells.
- Monitoring wells (MW22-01, MW22-02 and MW22-03) were constructed in manner similar to the MW20 series monitoring wells.
- MW22-01 was installed as an offset overburden well to the existing bedrock well nest at MW20-16A/B, located along the southeast part of the Northwest Wetland area, approximately 90 m southwest of SW20/MP20.
- MW22-02A/B/C was installed as a nested bedrock well (MW22-02A/B) and an offset overburden well (MW22-02C) approximately 270 m north of existing well MW20-15A/B and approximately 40 m west of SW17/MP17, on the west side of the Northwest Wetland area.

- MW22-03A/B was installed as a nested overburden well approximately 390 m northwest of MW22-02A/B/C and approximately 30 m west of SW19/MP19, on the west side of the Northwest Wetland Area.
- The new monitoring wells were developed in the same manner as earlier monitoring wells in the program, as described in Section 5.5.1.
- Pumping well PW22-1 was installed adjacent to existing monitoring well MW20-15A/B. PW22-1 was constructed using 4" PVC screen and riser pipe, with filter sand installed around the screen, and bentonite in the remaining annulus. The well screen was designed so that the bottom of screen was aligned with the base of the Shaley Dolostone and the screen spanned entire bedrock aquifer (Shaley Dolostone and Gasport Formation) and the upper contact aquifer zone.
- Pumping well PW22-1 was developed by CSD using an air compressor to air lift water from the well for a period of 4 hours, achieving approximately 5 m of drawdown during development.

5.8.2.2 Results

The stratigraphy encountered during drilling is summarized below and was generally consistent with the earlier drilling at MW20-15A/B and MW20-16A/B. Borehole logs and well completion details for the new wells are provided in Appendix J.

Overburden

- Overburden thickness in the area varied from 10.4 m (at PW22-1) to 19.1 m (at MW22-03).
- The shallow overburden in the area was found to be comprised of variable layers of sediments, primarily sandy silt to silty sands, with dense till layers and gravelly layers in places.
- Below a depth of approximately 6 m, the overburden stratigraphy generally became more consistent and was found to be comprised of silty clay till and sandy silt till to the top of bedrock.
- A gravel lens was encountered at MW22-02 just above the top of bedrock, in the contact aquifer zone.

Bedrock

- The bedrock at PW22-1 and MW22-02 was comprised of the Gasport Formation underlain by the Shaley Dolostone and Cabot Head Formation. The Gasport Formation was found to be 22.56 m thick at PW22-1 and 24.69 m thick at MW22-02.

5.8.3 Downhole Geophysical Logging

Downhole geophysical logging was performed in the open boreholes at PW22-01 (natural gamma, apparent conductivity) and MW22-02 (natural gamma, apparent conductivity, optical televiewer and heat pulse flow meter) in a manner similar to that conducted at earlier boreholes, as described in Section 5.2.1.

The results of the geophysical logging are presented in Appendix J and were used mainly to delineate bedrock stratigraphic contacts between the Gasport Formation, the Shaley Dolostone and the Cabot Head. Additionally, the heat pulse flow meter log at MW22-02 identified a hydraulically active feature in the Gasport Formation at approximately 29 mbgs.

5.8.4 Soil Coring and Grain Size Analysis

The objective of the shallow soil coring program was to assess shallow soil stratigraphy in the wooded wetland area, in order to better understand its hydraulic properties. A total of 10 locations were cored (SC22-01 to SC22-10), as shown on Figure 5-8.

5.8.4.1 Methodology

Soil cores were collected and analyzed using the following methodology.

- Sites were selected to maximize the spatial observations of shallow soils, but avoid coring in areas of ponded water.
- Soil cores were advanced using a 7 cm diameter soil auger with extension rods to a depth of 2.5 mbgs, where possible, or to refusal. Where soil augers reached refusal on gravel or a cobble, a step-off hole was attempted until it reached the target depth or refusal. If two refusals, were encountered within 0.5 mbgs, a third soil core was attempted until it reached the target depth or refusal.
- Soil samples at each test location were described and photographed, and then the samples were bagged by lithology. Where sample quantity permitted, the soil samples were divided in half. Half was submitted to the materials lab for testing and half was retained for future reference. Where soil quantity did not permit the splitting of samples, the sample was retained and not tested.
- Lab analysis included sieve and hydrometer analysis to prepare soil grain size distributions and soil moisture content analysis, as presented in Appendix J. An empirical method suitable for the soil type was applied to the grain size distribution of each sample to provide an empirical estimate of the saturated hydraulic conductivity of the soil. Where a sample was logged as a sand, the Hazen Method (Hazen 1911) was applied and where a finer grained soil sample was observed, the Terzaghi Method was applied (Woessner and Poeter 2020).

5.8.4.2 Results

Results of the soil coring program are summarized in Table 5-9 and hydraulic conductivity based on the Hazen Method (Hazen 1911) are presented in Table 5-10. The following observations are made about of the results of the soil coring program.

- Refusal was encountered at all borehole locations between depths of 0.5 to 1.8 mbgs on cobbles or gravel.
- Observed lithologies included: Sand and Gravel, Sand, Sandy Silt, Silt, and Sandy Clay. These shallow overburden lithologies varied significantly between locations. This variability is consistent with shallow overburden observations in the borehole drilling program (Sections 5.1.2 and 5.8.2.2);
- Till was encountered at four of the 10 soil coring locations; and
- Hydraulic conductivity estimates for the 21 samples analyzed ranged from $1x10^{-8}$ to $3x10^{-5}$ m/s. These values are consistent when compared to literature values for similar lithologies.

Table 5-9 Soil Coring Results - Northwest Investigation
Caledon Pit / Quarry

SC ID	From (mbgs)	To (mbgs)	Description	Sample Number	Comment
SC-01	0.00	0.23	Sandy Silt, Topsoil, no odour, no staining	1	
	0.23	1.04	Sand, some silt, no odour, no staining	2	Refusal on cobble/gravel
	1.04	1.17	medium to coarse sand, trace gravel and silt, no odour, no staining	3	Refusal on cobble/gravel
SC-02	0.00	0.22	Silt, Topsoil, no odour, no staining	1	
	0.22	0.48	Fine to medium Sand, some silt, no odour, no staining	2	Refusal on cobble/gravel x 3, returned with shovel - cobbles in sand
SC-03	0.00	0.30	Silt, Topsoil, no odour, no staining	1	
	0.30	1.19	Fine to medium Sand, some silt, coarsing downward, no odour, no staining	2	Refusal on cobble/gravel x 2
SC-04	0.00	0.33	Sandy Clay, Topsoil, no odour, no staining	1	
	0.33	0.41	Sandy Clay, no odour, no staining	2	
	0.41	0.84	Sand, some clay, trace gavel, coarsing downward, no odour, no staining	2	Refusal on cobble/gravel x 2
SC-05	0.00	0.25	Sandy Silt, Topsoil, no odour, no staining	1	
	0.25	0.69	Fine to medium Sand, some silt, trace gravel, no odour, no staining	2	Refusal on cobble/gravel x 2
SC-06	0.00	0.33	Clay Topsoil, no odour, no staining	1	
	0.33	1.83	Clayey Sand Till, some silt, trace gravel, soft reworked clay, no odour, no staining	2	Refusal on cobble/gravel. Ground past cobble at 0.3m.
SC-07	0.00	0.30	Silty Clay, Topsoil, no odour, no staining	1	
	0.30	0.51	Clay, some Sand, no odour, no staining	2	
	0.51	1.47	Sandy Clay Till, soft reworked clay, no odour, no staining	3	
	1.47	1.57	Sand and Gravel, hard, some clay, no odour, no staining	4	Refusal on cobble/gravel
SC-08	0.00	0.20	Sandy Silt, Topsoil, no odour, no staining	1	
	0.20	0.69	Silt Till, some sand, very dense, no odour, no staining	2	Refusal on cobble/gravel
SC-09	0.00	0.30	Sandy Silt, Topsoil, no odour, no staining	1	
	0.30	0.79	Silt Till, some sand, trace clay and gravel, very dense, no odour, no staining	2	Refusal on cobble/gravel x 2
SC-10	0.00	0.15	Sandy Silt, Topsoil, no odour, no staining	1	
	0.15	1.27	Sand and Silt, dense, silty on top and coarsing downward, becoming trace gravel near bottom, no odour, no staining	2	Refusal on cobble/gravel x 2

Table 5-10: Hydraulic Conductivity Estimates - Northwest Investigation

Borehole Number	Sample Number	Easting (m)	Northing (m)	Ground Elevation (masl)	From (mbgs)	To (mbgs)	D10 (mm)	k (m/s)
SC 22-01	1	576228	4854048	421	0.00	0.23	0.0014	1E-08
	2				0.23	1.04	0.0039	2E-07
	3				1.04	1.17	0.052	3E-05
SC 22-02	1	576331	4853948	421	0.00	0.22	0.0018	2E-08
	2				0.22	0.48	0.0016	3E-08
SC 22-03	1	576423	4853861	420	0.00	0.30	0.0014	1E-08
	2				0.30	1.19	0.01	1E-06
SC 22-04	1	576252	4854147	420	0.00	0.33	0.0014	1E-08
	2				0.33	0.84	0.0014	1E-08
SC 22-05	1	576354	4854102	420	0.00	0.25	0.0014	1E-08
	2				0.25	0.69	0.0016	3E-08
SC 22-06	2	576460	4854012	420	0.33	1.83	0.0096	9E-07
SC 22-07	2	576574	4853921	420	0.30	0.51	0.0014	1E-08
	3				0.51	1.47	0.0014	1E-08
	4				1.47	1.57	0.022	5E-06
SC 22-08	1	576687	4854009	421	0.00	0.20	0.0013	2E-08
	2				0.20	0.69	0.0015	2E-08
SC 22-09	1	576751	4853945	421	0.00	0.30	0.0015	2E-08
	2				0.30	0.79	0.0014	1E-08
SC 22-10	1	576810	4853878	421	0.00	0.15	0.0014	1E-08
	2				0.15	1.27	0.007	5E-07

Notes:
Light grey indicates final weight measurement at 10% - 20%. Therefore, k may be lower than estimated.
Ground surface elevation estimated from 1m SWOOP topography.
Viscosity of water is similar in field and lab testing.
The median value is assumed for the Terzaghi coefficient for particle shape (700) (Woessner and Poeter 2020).
Typical porosity values were assumed: 30% for sand and 40% for dense fine materials (Woessner and Poeter 2020).

5.8.5 Hydraulic Testing (SWRTs)

5.8.5.1 Methodology

Single well response tests were performed at the new monitoring wells MW22-01, MW22-02A/B/C and MW22-03A/B using the same methods described in Section 5.5.1, including Waterra purge rising head tests and pneumatic rising head tests.

To maximize the collection of hydraulic conductivity data in the shallow subsurface, the mini-piezometers MP17 to MP20 were included in the SWRT program. However, the groundwater levels in the mini-piezometers were too low to perform rising head tests, as such a “pour in” falling head test method was used, measuring the static water level and then adding a known quantity of potable water to mini-piezometer to cause a known head increase. Water level recovery was then monitored.

5.8.5.2 Results

Results of the SWRT program are summarized in Table 5-11 and individual test results are presented in Appendix J on Figures J-1 to J10. With reference to these figures and the table, the following observations are noted.

- Three SWRTs were conducted in bedrock wells, and the hydraulic conductivity ranged from $8x10^{-6}$ (at MW22-02B) to $2x10^{-5}$ m/s (at PW22-01 and MW22-02A), consistent with previous bedrock hydraulic conductivity test results.
- The other seven SWRTs were performed on overburden wells or mini-piezometers, and the hydraulic conductivity ranged from $3x10^{-9}$ m/s (at MW22-03B) to $5x10^{-6}$ (at MW22-01). Generally, the overburden tests yielded lower hydraulic conductivity results, with a geometric mean of $8x10^{-8}$, consistent with the range of hydraulic conductivities for the fine grained lithologies encountered.
- It is noted that the three mini-piezometers tested (MP17, MP18 and MP19) were not well developed and had not reached a static water level at the time of testing. Nonetheless, the SWRT results at these locations are considered to be generally indicative of hydraulic conductivity. MP14 and MP20 were found to be dry, and could not be tested.

Table 5-11: Single Well Response Test Results - Northwest Investigation

MW ID	Screen Top (mbgs)	Screen Bottom (mbgs)	Screen Mid-point (masl)	Aquifer Model	Screened Unit	k (m/s)	Comment
PW22-01	10.36	34.14	394.50	Confined	Dolostone	$2x10^{-5}$	
MW22-01	4.11	7.16	415.76	Unconfined	Silty Sand	$5x10^{-6}$	
MW22-02A	34.75	36.27	384.30	Confined	Dolostone	$2x10^{-5}$	
MW22-02B	12.80	15.85	405.48	Confined	Dolostone	$8x10^{-6}$	
MW22-02C	3.96	5.49	415.27	Unconfined	Silty Sand and Gravel Till	$2x10^{-8}$	
MW22-03A	12.80	15.85	407.54	Confined	Silty Sand Till	$2x10^{-7}$	

MW ID	Screen Top (mbgs)	Screen Bottom (mbgs)	Screen Mid-point (masl)	Aquifer Model	Screened Unit	k (m/s)	Comment
MW22-03B	4.57	6.10	416.53	Unconfined	Silty Sand and Gravel Till	$3x10^{-9}$	
MP14				Unconfined	Silty Sand and Gravel Till		Dry
MP17	0.90	1.10	417.88	Unconfined	Silty Sand Till (BH Log MW22-02)	$1x10^{-8}$	Development and overall aquifer trend affected static level during the test.
MP18	1.35	1.55	419.07	Unconfined	Overburden (no BH log)	$1x10^{-7}$	
MP19	1.01	1.21	419.60	Unconfined	Overburden (no BH log)	$2x10^{-7}$	
MP20				Unconfined	Sand, some silt		Dry

5.8.6 Hydraulic Testing - Pumping Test

A 96-hour pumping test was conducted at PW22-1 between August 23 and August 30, 2022, registered under EASR permit 1000187242.

A short duration test was conducted initially on August 23, 2022 to select a suitable pumping rate, followed by the constant rate test beginning on the morning on August 24, 2022. However, an equipment failure led to the pump shutting down on the evening of August 24, 2022. The faulty equipment was replaced, and the test was reinitiated on August 26, 2022.

The pumping rate was increased during the test from an initial rate of 75 L/min to 84 L/min (the maximum rate of the pump). An average pumping rate of 80.4 L/min was assumed in the subsequent analysis. The pump was shut down on August 30, 2022 and recovery was monitored until September 7, 2022.

Pumped groundwater from PW22-1 was discharged approximately 340 m to the southeast of the well and approximately 50 m from Tributary #1, to allow for the attenuation of any sediment in the water before it reached a surface water feature. Soil conditions at the time of the test were very dry and all of the discharged water evaporated or infiltrated. When the pump was shut down on August 30, 2022, the discharge area had wetted an irregular area reaching approximately 30 m toward the Tributary #1 and approximately 20 m in width.

Water level monitoring, as described in Section 5.6, included the wells and surface water locations shown on Figure 5-8.

Water level observations during the test are presented on Figures J-11, J-12 and J-13, showing hydrographs of all wells influenced by the pumping test (J-11), and additionally (to establish background water levels) bedrock wells not influenced by the pumping test (J-12), and surface water and overburden groundwater levels not influenced by the pumping test (J-13).

Pumping Well (PW22-1) Response

- Drawdown in the pumping well occurred rapidly at the start of the test and each time that the pumping rate was increased.
- During the test water levels repeatedly stabilized and, after time, began to recover slowly. This is attributed to the well continuing to develop during the test and becoming more efficient. In response to increasing well efficiency, the pumping rate was repeatedly increased during the test.
- Total drawdown in the pumping well at the end of the test was 26.2 m.

Bedrock Aquifer Response

- Following the typical seasonal trend, bedrock water levels fell steadily during the late summer of 2022 (as discussed in Section 5.3), including in the area of the PW22-1. To quantify this trend, bedrock monitoring wells proximal to PW22-1 but outside of the area of influence of the test were plotted on Figure J-12. A steady and consistent declining trend of 1.2 cm/day was noted from the start of July through the test period observation period in September 2022.
- This trend, superimposed on the affects of the pumping test data and left uncorrected, caused overestimation of drawdown, and underestimation of recovery. The pumping test data was therefore corrected to remove this trend and the corrected data was analysed, as noted in the relevant figures.
- The pumping zone of influence in the bedrock aquifer is estimated to extend approximately 500 m from PW22-1 with approximately 0.2 m of drawdown estimated at that distance (Figure J-14).
- The distance drawdown plot (Figure J-14) shows that the pumping well drawdown plots on a straight line with the drawdown noted in observation wells.
- The drawdown observed in the bedrock aquifer was plotted on Figure J-15 by:
  - Applying a correction for the background aquifer trend;
  - Averaging observations of bedrock drawdown, where drawdown was observed;
  - Assuming that the observed drawdown of 12.02 m at a distance of 11 m from the production well (observed at MW20-15) occurred symmetrically around the pumping well; and
  - Interpolating between that drawdown and surrounding monitoring wells.
- Drawdown in the bedrock aquifer occurred uniformly, with little directional preference. The apparent horizontal hydraulic gradient between the pumping well and the monitoring wells to the northwest (MW22-02), northeast (MW20-16), and east (PW21-1) was very similar.
- Drawdown in the bedrock aquifer observed by monitoring wells ranged from 0.3 m (at MW21-1-3, 408 m away) to 12.5 m (at MW20-15B, 9 m away).
- Water levels in the bedrock well nest MW20-15A/B responded differently to the aquifer test, despite being the equidistant to PW22-1 and within the screen interval of PW22-1. MW20-15B (shallower) responded more quickly to pumping in PW22-1 and had more total drawdown (12.5m versus 11.5m) than MW20-15A (deeper), suggesting a better hydraulic connection to the pumping well. However, MW20-15A recovered significantly

more quickly than MW20-15B, which could be explained by a connection to another hydraulic feature allowing it to recover more quickly. These variable responses reflect the heterogeneity of the bedrock aquifer.

Overburden Aquifer Response

- Water levels in the overburden aquifer system were monitored at nine locations within 670 m of the pumping well during the aquifer test, with water levels shown on the hydrographs on Figure J-13.
- Similar to the bedrock aquifer, a seasonal declining water level trend was observed in the overburden.
- Responses to pumping (changes in water levels) were observed at two locations MW20-15C and MW22-03A. MW20-15C is located 9 m from PW22-01 and showed 1.1 m of drawdown. MW22-03A is located 660 m to the northwest of PW22-01 in a confined portion of the overburden aquifer approximately 3 m above the top of bedrock, where 0.3 m of drawdown was observed.
- Water levels in the remaining overburden monitoring wells, generally shallow wells, showed no response to pumping.
- These observations are overall consistent with a semiconfined aquifer.

Surface Water Response

- Surface water stations SW14, SW18, and SW20 were dry throughout the test period, as shown on hydrograph Figures L-21, L-18, and L-20 in Appendix L, respectively.
- Throughout the observation period, there was a strong downward hydraulic gradient at the surface water locations, and the gradient did not change during the test.
- Surface water stations SW17 and SW19 (shown on hydrograph Figures L-17 and L-19 in Appendix L, respectively) observed low and declining water levels at the start of the observation period, consistent with the trend observed in the bedrock and the overburden. Both surface water stations became dry during the observation period (SW17 on August 27 and SW19 on August 30), but this appears to be due to the aforementioned overall declining water level trends and is not considered to be related to the pumping test.
- Surface water levels during the test did not change in response to pumping.

Estimate of Aquifer Properties

As shown on Figure J-16, the recovery of PW22-1 and MW20-15B plot along a similar slope on the semi-log plot. Based on the slope of this line and an average pumping rate of 80.4 L/min, the bulk transmissivity of the confined bedrock aquifer is interpreted to be approximately 4.5 m^2/day.

Based on an aquifer thickness of 23.8 m, the apparent hydraulic conductivity is $2x10^{-6}$ m/s, which is close the low end of the range of hydraulic conductivity for fractured or karstic dolostone, and close to the high end of the range of unfractured dolostone (Freeze and Cherry 1979).

Notably, the recovery from the aquifer test varied significantly in the monitoring wells (the multiple slopes, steeper and shallower than that of the PW22-1). This suggests significant heterogeneities in the transmissivity of the bedrock aquifer within the area of influence of the aquifer test.

Based on the slope of the recovery data at MW20-15B in the composite plot, the storativity of the bedrock aquifer is estimated to be approximately $1x10^{-4}$.

When compared to the previous pumping tests (summarized in Table 5-7), the results of this aquifer test are fairly consistent with the test performed at PW21-1 in 2021 (320 m to the east of PW22-01). The transmissivity and hydraulic conductivity of PW22-1 are the same order of magnitude as the results of the PW21-1 aquifer test. The storativity calculated based on the MW22-1 aquifer test is $1x10^{-4}$, which is also within the range observed during the PW21-1 aquifer test.

The zone of influence of this pumping test was larger than that of previous tests, which suggest that the contact aquifer is more continuous than the bedrock aquifer and provides a larger zone of aquifer connectivity.

5.8.7 Summary

Key findings of the supplemental groundwater and surface water investigation of the Northwest Wetland area in 2022 are as follows.

- The new surface water / mini-piezometer monitoring stations and existing monitoring stations in this area were found to have perched conditions or were completely dry during the August to October 2022 period of record and were not supported by groundwater.
- Near surface soils were found to be variable in composition but were generally comprised of fine-grained material that yielded low hydraulic conductivity estimates using the Hazen (1911) method.
- Single Well Response Tests in the shallow overburden also yielded low hydraulic conductivities.
- The 96-hour pumping test had a relatively large zone of influence in the bedrock aquifer, presumably due to the connection of the pumping well to the contact aquifer zone at the top of the bedrock. Despite this wide area of connection, surface water monitoring stations and mini-piezometers did not respond to the pumping test.
- Overall, these results suggest that the Northwest Wetland area is a perched water system relative to the deep overburden and bedrock aquifers.

5.9 Karst Assessment

A karst assessment was carried out by Worthington as part of the overall hydrogeologic investigation. The report is provided in Appendix K and included the following tasks:

- An examination of topography and aerial imagery of the Site and Study Area;
- An on-site investigation of closed depressions and surface flows;
- Tracer test investigations during the 2021 pumping tests;
- An evaluation of and correlation with other hydrogeologic data sets; and
- A review of the HGS groundwater-surface water numerical modelling results.

The karst investigation found that the dolostone aquifer on the Site and in the Study Area is typical of carbonate aquifers where there is fairly thin overburden, which allows substantial recharge to enter the bedrock. Such distributed recharge results in pervasive dissolution of fractures, with most enlarged fractures having apertures of 0.1 mm - 3 mm. This results in the aquifer having a predictable response to large-scale stresses such as quarry development. The investigation did not identify any indicators in the data that would suggest the presence of underground dissolution conduits or caves in the Study Area.

Equivalent Porous Media

The results of the hydrogeologic investigation, including core logging, geophysical logging, hydraulic testing at different scales, and the karst assessment, have together demonstrated that the hydrogeologic system at the Site can be adequately represented as an Equivalent Porous Medium (EPM). This EPM representation is considered applicable to the current hydrogeologic environment, as groundwater flow occurs through a combination of overburden soils, and carbonate and shale sedimentary bedrock, in which the scale of flow and groundwater head observations are much greater than the size of individual fractures, where present, within the shales and carbonate rocks of the model domain.

6.0 SURFACE WATER INVESTIGATIONS

6.1 CVC Regulated Area and Floodplain Mapping

According to the CVC geospatial data mapping, the northwestern corner of the Site (i.e., where Tributary #1 crosses into the Site) lies within the "Generic Regulation Mapping" area within the Credit River watershed. The proposed extraction area does not contain any identified water resources on the Region of Peel Schedule A-1 (Water Resources, Systems and Features). However, the proposed licence area includes an identified feature (i.e., Tributary #1) in the northwest corner of the Main Area which is located outside of the extraction area and will be protected.

There is currently no floodplain mapping available from CVC as their geospatial data mapping tool is still in the process of being developed. However, based on available topographic data within the area, the areas nearest to the Credit River range from elevations of 401 – 403 masl while the average bank elevation of the Credit River adjacent to the Site was 378.5 masl. With consideration of the elevation difference as well as a minimum distance of 450 m from the Site to the Credit River, potential impacts due flooding within the Credit River can be considered negligible.

6.2 Hydrology and Hydrologic Setting

The Site is partially located within Sub-watershed 18 (i.e., the Credit River Melville to Forks Sub-watershed; CVC 1999) which is part of the Credit River Watershed, west of the Main Branch of the Credit River near Cataract and Coulterville. It should be noted that Sub-watershed 18 and the surface water station catchments detailed in Section 7 below are not in complete agreement with each other. This is potentially due to a difference in base mapping resolution by OWIT, which was utilized for catchment delineation compared to what was used for the Sub-watershed Plan completed in 1999. There are several surface water features within the vicinity of the Site such as the Credit River which flows directly outside of the northern and eastern property boundaries. There is one tributary of the Credit River Erin Branch in the west corner of the Site, one tributary of the Main Branch sitting directly outside of the northwest portion of the Site, and several unnamed tributaries of the Erin Branch sitting distantly from the west portion of the Site (Figure 6-1). The Coulterville Wetland Complex sits along the north edge of the Site boundary and continues further north away from the Site. Agricultural fields are located throughout the Site, as well as rural residences on all sides of the Site.

As detailed in the "Phase 1 Report – Characterization" (CVC 1999), the streamflow response in the watercourses within sub-watershed 18 can be attributed to dampened sustained flow year-round. The specific characteristics that impose a major influence on the above flow response in sub-watershed 18 include "significant closed drainage systems, limited municipal drainage, significant floodplain storage, high percentage of forest cover, the prevalence of high infiltration soils, and the presence of aggregate extraction activities" (CVC 1999). The combination of limited municipal drainage and presence of hummocky topography, associated with the Singhampton Moraine and large wetland areas, have resulted in large areas with either no surface drainage outlet or restricted outlets. These areas are classified as closed drainage systems and due to the presence of highly permeable soils, a reduction in surface water runoff to flow within the sub-watershed occurs after precipitation due to the high recharge rates to groundwater aquifers (CVC 1999).

Several unnamed tributaries to the Main and Erin Branches of the Credit River are situated within the vicinity of the Site. The following unnamed tributaries (excluding Tributary #1) sit outside the proposed license boundary, as seen in Figure 6-1:

- Tributary #4 originates in a rural pond west of Main Street approximately 0.5 km north of the Site and flows through a culvert under Main Street and reports to the Credit River through the Osprey Valley Golf Course;
- Tributary #5 originates in the Coulterville Wetland Complex approximately 0.78 km north of the Site and flows east into Tributary #4 at the Osprey Valley Golf Course;
- Tributary #6 originates west of Shaws Creek Road approximately 2.1 km west of the Site and flows southeast into Tributary #8 north of Charleston Sideroad;
- Tributary #7 originates in the Coulterville Wetland Complex approximately 1.2 km west of the Site and flows southeast into Tributary #6 at Shaws Creek Road;
- Tributary #8 originates in a rural field approximately 0.5 km southwest of the Site and flows southwest towards the Erin Branch of the Credit River; and,
- Tributary #9 originates in a small wetland west of Shaws Creek Road approximately 1.9 km west of the Site and flows east into Tributary #7.

Tributary #1 originates in the Coulterville Wetland Complex approximately 0.9 km north of the Site and flows through the northwestern corner of the Site. Tributary #1 then follows along the proposed extraction limit before flowing into a residential pond with an adjacent small wetland feature downstream. During periods of low flow, Tributary #1 drains and disappears within this wetland feature while during high seasonal flows, it has been observed that Tributary #1 drains past the wetland feature towards a roadside ditch along Mississauga Road before infiltrating within a local depression east of Mississauga Road, thus, not crossing the roadway. As Tributary #1 flows through the proposed licensed boundary, it was considered a water feature of interest for the potential impact assessment study.

To further identify and characterize the surface water features present on site (i.e., watercourses, waterbodies, and/or drainage features), Ministry of Natural Resources mapping, along with information collected during site visits conducted between May 2020 to December 2021 were reviewed.

6.3 Monitoring Stations

Surface water monitoring stations were installed along various watercourses / drainage pathways around the vicinity of the proposed quarry area.

A list of the monitoring stations, their locations and their installation dates are provided in Table 6-1.

Table 6-1: Surface Water Monitoring Locations

Station Name	Zone	Northing	Easting	Installation Date	Measurements	Description of Monitoring Location
SW1 (1)	17	4853149	573961	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Cobble channel leading to culvert under roadway
SW2 (1)	17	4853750	574434	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Heavily vegetated channel leading to culvert under roadway

Station Name	Zone	Northing	Easting	Installation Date	Measurements	Description of Monitoring Location
SW3 (1)	17	4852964	574761	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Small partially defined channel at roadside ditch with culvert
SW4 (1)	17	4853846	575863	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Wide vegetated floodplain
SW5 (1)	17	4854878	576744	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Small, vegetated channel at culvert
SW6 (1)	17	4851678	576045	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Heavily vegetated roadside ditch channel
SW7 (1)	17	4851688	576055	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Heavily vegetated roadside ditch channel
SW8 (1)	17	4850401	575678	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Wide, deep channel at box culvert
SW9 (1)	17	4850628	579128	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Sand/cobble channel leading to culvert
SW10 (1)	17	4851870	578239	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Ponded feature leading to a culvert
SW11 (1)	17	4854781	576842	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Small, vegetated channel leading to a culvert
SW12 (1)	17	4853488	578154	May 01, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Culvert draining agricultural field with no channel.
SW13 (1)	17	4855098	578165	October 06, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Golf course pond with a siphon discharge structure
SW14 / MP14 (1)	17	4853501	576562	October 06, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Silt/sand channel near wetland feature
SW15 / MP15 (1)	17	4852785	576024	October 06, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Vegetated channel
SW16 / MP16 (1)	17	4851406	576368	October 06, 2020 (2) October 12, 2021 (3)	Water Level and Water Temperature	Wide vegetated floodplain

Station Name	Zone	Northing	Easting	Installation Date	Measurements	Description of Monitoring Location
SW17 / MP17 (1)	17	4853803	576488	August 05, 2022 (2)	Water Level	Wide channel near wetland feature
SW18 / MP18 (1)	17	4853993	576396	August 05, 2022 (2)	Water Level	Wide area of organic deposits
SW19 / MP19 (1)	17	4854106	576226	August 05, 2022 (2)	Water Level	Wide channel in wetland feature
SW20 / MP20 (1)	17	4853890	576819	August 05, 2022 (2)	Water Level	Wide area of organic deposits

Notes:

(1) The approximate locations of these monitoring stations are shown on Figure 6-1.

(2) Refers to the installation date for the water level monitoring stations.

(3) Refers to the installation date for the water temperature monitoring stations.

6.4 Surface Water Levels

Surface water stations (SW1 to SW16) and drive-point piezometers (MP14 to MP16) were installed to assess seasonal streamflow regimes in the watercourses / drainage pathways around the Site. Water level transducer loggers and manual staff gauges were installed at each of these monitoring locations excluding the staff gauges at the drive-point piezometers. The loggers were programmed to record water levels on a 15-minute interval. The elevations of the staff gauges and drive-point piezometers were surveyed on May 1, 2020 (SW1 to SW12) and October 06, 2020 (SW13 to SW16 & MP14 to MP16) and referenced to the Canadian Geodetic Vertical Datum of 1928 (1978 adjustment) datum. Water levels were manually recorded at the staff gauge locations concurrently during each site visit to verify continuous water level measurements recorded with the logger.

The ranges in water levels for monitoring stations are presented in Table 6-2 below. These water level ranges are based on the continuous logger data.

Table 6-2: Maximum and Minimum Water Levels at SW1-SW16 and MP14-MP16

Surface Water Monitoring Stations	Period of Record						
	2020			2021			Range of Water Levels (m)
	Minimum (masl)	Maximum (masl)	Average (masl)	Minimum (masl)	Maximum (masl)	Average (masl)	
SW1 (1)	429.82	429.95	429.85	429.83	430.13	429.90	0.32
SW2 (1)	435.62	435.79	435.66	435.62	435.86	435.72	0.24
SW3 (1)	421.24	421.31	421.28	421.15	421.34	421.26	0.18
SW4 (1)	424.23	424.40	424.25	424.23	424.35	424.26	0.17

Surface Water Monitoring Stations	Period of Record						
	2020			2021			Range of Water Levels (m)
	Minimum (masl)	Maximum (masl)	Average (masl)	Minimum (masl)	Maximum (masl)	Average (masl)	
SW5 [(1)]	400.37	400.56	400.42	400.37	400.74	400.45	0.37
SW6 [(1)]	395.03	395.43	395.08	395.03	395.65	395.20	0.62
SW7 [(1)]	395.12	395.48	395.15	395.12	395.83	395.25	0.71
SW8 [(1)]	392.44	392.87	392.61	392.34	392.88	392.62	0.54
SW9 [(1)]	356.77	356.85	356.79	356.75	356.90	356.82	0.15
SW10 [(1)]	387.87	388.20	387.92	387.87	387.91	387.87	0.33
SW11 [(1)]	399.02	399.18	399.07	399.02	399.21	399.10	0.19
SW12 [(1)]	405.53	405.53	405.53	405.53	405.55	405.53	0.02
SW13 [(1)]	384.14	384.45	384.34	383.83	384.37	384.06	0.62
SW14 [(1)]	415.09	415.21	415.10	415.09	415.32	415.18	0.24
SW15 [(1)]	413.84	413.90	413.87	413.76	413.99	413.89	0.22
SW16 [(1)]	392.73	392.74	392.73	392.73	392.78	392.73	0.05
MP14 [(1)]	414.20	415.17	414.55	414.18	415.31	415.00	1.13
MP15 [(1)]	413.81	414.06	413.96	413.87	414.19	414.02	0.37
MP16 [(1)]	391.79	391.87	391.81	391.79	392.89	391.99	1.10

Note: [(1)] Survey datum is based on Realtime Can-Net Network Observations (UTM Zone 17 CSRS 2010, Elevations are CGVD 1928, 1978 Adjustment).

As detailed in Table 6-2 above, variations in water elevation at the surface water stations were observed to range from 0.02 m to 0.71 m over the period of record, with the minimum and maximum variations occurring at SW12 and SW7, respectively. Variations in subsurface water elevation at the three DP stations were observed to range from 0.37 m to 1.13 m over the period of record, with the minimum and maximum variations occurring at MP15 and MP14, respectively.

Figures L1 to L16 in Appendix L show the continuous water level data for each monitoring station. Generally, water level records at the surface water stations are marked by low water levels during the summer and early fall. Winter water levels generally remained low, marked with high water events likely caused by short melt events. Water levels through the spring were moderate to high following the freshet. Water levels in the fall were marked with responses to large precipitation events.

6.5 Stream Flow

Instantaneous flow measurements were collected at all surface water monitoring stations. The measurements were collected from May 2020 to December 2021. Measurements were collected through standard velocity-area methods, using a wading rod, measuring tape and stream velocity meter. Velocity was measured at 60% of water depth, except when water depth exceeded 0.75 m, in which case velocity was measured at both 20% and 80% of water depth. Instantaneous flow measurements for all stations are summarized in Table 6-3.

Table 6-3: Instantaneous Flow Measurements

Surface Water Station	Flow (L/s)						
	Period of Record						
	May. 01, 2020	Jul. 30, 2020	Dec. 10, 2020	Mar. 16, 2021	Jun. 09, 2021	Sep. 08, 2021	Dec. 14, 2021
SW1	16.12	0.53	11.87	53.38	10.27	8.08	47.31
SW2	0.03	Dry	Stagnant	Frozen	<0.05 [(1)]	Dry	0.34
SW3	0.95	0.07	Stagnant	0.98	0.16	Stagnant	1.74
SW4	Stagnant	Dry	Dry	Dry	Dry	Dry	Stagnant
SW5	5.47	Dry	1.06	9.99	Dry	Dry	14.95
SW6	14.18	Dry	Dry	49.10	Dry	Dry	21.61
SW7	1.40	Dry	Dry	13.94	Dry	Dry	72.21
SW8	14.67	2.56	Frozen	Frozen	4.77	16.29	121.73
SW9	31.67	18.26	19.16	21.21	16.21	27.64	11.12
SW10	0.40	Dry	Dry	Dry	Dry	Dry	Dry
SW11	0.95	Dry	0.96	0.31	0.78	3.58	4.27
SW12	Dry	Dry	Dry	Dry	Dry	Dry	Dry
SW13	- [(3)]	- [(3)]	Frozen	Frozen	- [(2)]	0.25	0.43
SW14	- [(3)]	- [(3)]	Dry	8.41	0.01	Dry	10.64
SW15	- [(3)]	- [(3)]	0.40	1.20	0.71	0.06	2.16
SW16	- [(3)]	- [(3)]	Dry	Dry	Dry	Dry	Dry

Note: L/s = Liters per second
[(1)] On the June 09, 2021 field visit at SW2, the flow in the channel was too shallow to record with the flow meter, so a visual estimate was recorded.
[(2)] On the June 09, 2021 field visit at SW13, no flow was measured due to the configuration of the pond outlet and high water levels in the river.
[(3)] Flow measurement was not recorded as stations had not been installed yet.

The instantaneous flow measurements along Tributaries #1 - #9 or other waterbodies surrounding the Site (SW1-SW16) can be seen in Figures L1 to L16 in Appendix L.

Stage discharge relationships were created for each surface water station using cross-sectional survey data collected by Golder which were incorporated into short-reach hydraulic models (HEC-RAS) to develop theoretical rating curves with the exception of SW4 where no flow was observed and was dry throughout the period. These curves were calibrated using the observed spot flow measurements. The relationships were used to developed continuous flow records for these monitoring stations. Continuous flow estimates above the maximum manually measured flows are reported with lower confidence. Similar to the continuous water level record, the continuous flow record at all stations is marked by low flows during the summer and early fall. Winter flows generally remained low, marked with high flow events likely caused by short melt events. Flows through the spring were moderate to high following the freshet. Flows in the fall were marked with responses to large precipitation events.

Flow at SW13 was difficult to measure depending on the level of the pond. The outlet of SW13, where flow is captured, is situated at the bottom of a slope downstream of an Osprey Valley Golf Course Pond and the water level in the pond is controlled by a siphon discharge structure. The two ponds adjacent to SW13 do not receive substantial surface water runoff and are primarily fed by groundwater inflow. The single flow observed at SW10, captured during installation, was the only time within the period of record that the water level was high enough to cause flow in the culvert that connects the two ponds. At SW10, the staff gauge was installed in the pond at a lower elevation than the culvert invert. Flow conditions between the ponds was observed to be intermittent. Flow conditions at SW12 were usually dry due to the small catchment size contributing to the surface water station as well as the high permeability of the soil within the catchment that resulted in reduced runoff.

6.5.1 Historical Credit River Flow

Historic flows at the Credit River were analyzed to characterize the seasonal trends as well as how the flow within the river has changed over the years. As detailed in Figure 6-2, seasonal trends in the Credit River adjacent to the Site over the last 20 years are marked by low flows during mid summer to mid fall. Winter flows generally remained low but were higher in comparison due to the likely presence of high flow events likely caused by short melt events. Flows through the spring were high following the freshet. Flows in the fall were low to moderate even though large precipitation events were common, which suggests that the influence of precipitation events on flow in the Credit River can vary monthly. Overall, these trends are similar to the trends viewed in the tributaries entering the Credit River adjacent to the Site. Additionally, flows from Island Lake (at the headwaters of the Credit on the west side of Orangeville) are controlled to manage assimilative capacity for Orangeville's WWTP effluent. A summary of the maximum, minimum and average flows over the 20-period are displayed in Table 6-4 below.

Table 6-4: Maximum, Average, and Minimum Historic Flows Measured at the Credit River at Cataract WSC Flow Gauge

Period of Record	Historic Flows Measured at the Credit River at Cataract WSC Flow Gauge			Historical Total Annual Precipitation (mm)
	Minimum (m^3/s)	Maximum (m^3/s)	Average (m^3/s)	
2002	0.82	2.84	1.47	751.7
2003	0.62	1.92	1.26	863.7
2004	1.09	3.65	1.83	902.2

Period of Record	Historic Flows Measured at the Credit River at Cataract WSC Flow Gauge			Historical Total Annual Precipitation (mm)
	Minimum (m^3/s)	Maximum (m^3/s)	Average (m^3/s)	
2005	1.14	4.98	1.97	1013.4
2006	0.93	4.66	2.32	1139
2007	0.83	3.15	1.62	759.1
2008	1.39	5.86	2.43	1405.1
2009	1.39	4.53	2.61	1032.3
2010	1.35	3.57	1.94	1132.2
2011	1.17	4.31	2.21	1075.6
2012	1.21	3.32	1.91	789.7
2013	1.54	5.60	2.47	1071.7
2014	1.50	7.07	2.30	902.5
2015	1.04	2.77	1.59	773.8
2016	1.04	3.89	1.72	727.9
2017	1.56	4.13	2.40	1033.9
2018	1.18	4.81	2.26	1089.8
2019	1.17	4.72	2.27	935.8
2020	1.20	3.57	1.90	951.1
2021	0.93	2.11	1.42	776.2
Average Annual Flow over Period (m^3/s)	**2.0**			**956.3**

As detailed in Figure 6-2 and Table 6-4 above, annual flow within the Credit River remained within +/- 25% of the average annual flow over the 20-year period with various dips and rises over the average annual flow with the lowest annual flow occurring in 2003. Over the last two years, the flow was found to be below the average annual and was the second lowest over the 20-year period in 2021.

As seen in Figure 6-2, there is a strong correlation between average annual precipitation and average annual flow in the Credit River. For the majority of the last 20 years when annual precipitation was above or below the average annual of 956 mm, the average annual flow in the river responded similarly to its average annual flow of 2.00 m^3/s. The only exceptions to this correlation were seen in 2010, 2014, and 2019. It is likely that other factors such as previous years precipitation, localized precipitation events, rates of evaporation due to temperature or fluctuating groundwater recharge were the cause of the exceptions.

6.5.2 Low Flow

The Credit River flows are monitored by the Water Survey of Canada (WSC) and the CVC. These monitoring stations are typically accurate at estimating mid to high flows, however, depending on the channel geometry, low flow estimates can vary. Additional flows were collected by Golder to assess this variance and to confirm the low flow estimates by the WSC and CVC gauges as they represent periods when the river or surrounding surface water system may be vulnerable to impacts caused by changes in stream flow. To evaluate low flows in the Credit River for comparison purposes with the WSC and CVC gauges, low flow measurements were collected during the summer months at three locations of the Credit River within the vicinity of the Site. The following three low flow locations are within the Main Branch of the Credit River and the West Credit River, as seen in Figure 6-3.

- Low Flow Location #1: Situated on the Main Branch of the Credit River, downstream side of the Charleston Sideroad, approximately 0.3 km upstream of the WSC “Credit River at Cataract (Station ID: 02HB001)” flow gauge. This location is approx. 4.5 km upstream of the confluence with the West Credit River.
- Low Flow Location #2: Situated on the Main Branch of the Credit, north side of Forks of the Credit Road, downstream of the Dominion Street bridge along the Credit River, approximately 4.3 km downstream of the WSC “Credit River at Cataract (Station ID: 02HB001)” flow gauge and 0.07 km downstream of the confluence with the West Credit River.
- Low Flow Location #3: Situated on the West Credit River, along the upstream side of the Forks of the Credit Road, approximately 0.32 km upstream of the confluence with the Main Credit River.

Within the vicinity of these low flow locations detailed above, there is one WSC and two CVC flow gauges including the Credit River at Cataract (Station ID: 02HB001), Credit River at The Grange Side Rd. (Station ID: 8200005, located 3.9 km downstream of the confluence with the West Credit River), and the West Credit River at 10th Line (Station ID: 8150006, located 3.5 km west of the confluence with the Main Credit River), respectively. As seen in Figure 6-3, Low Flow Location #1 is nearest to the Credit River at Cataract flow gauge, Low Flow Location #2 sits between the Credit River at Cataract and the Credit River at The Grange Side Rd. flow gauges, and Low Flow Location #3 sits nearest to the West Credit River at 10th Line flow gauge. However, as noted by the CVC upon receiving the data, the dynamics upstream of the Credit River at The Grange Side Rd. station changed at some point during the winter of 2019/2020. They suspect that this occurred as a result of the heavy rain event in January 2020, though they were not certain. The result of this is that a significant amount of flow now moves around this station in a separate braid. Therefore, flows provided at this station represent partial flow for the river.

To perform a comparative analysis of the low flow measurements at the WSC and CVC flow gauges and the WSP low flow locations, flows at each of these gauges will either be prorated to match catchment size of the nearest Low Flow Locations or directly compared to the low flows taken at that time. For the purposes of this study, the flow at Low Flow Location #2 was prorated using the upstream Credit River at Cataract flow gauge due to the partial flow record at the Credit River at The Grange Side Rd. flow gauge. A summary of the catchment areas at each location are provided in Table 6-5 below.

Table 6-5: Summary of Catchment Areas for Each Flow Location

Flow Locations	Catchment Areas (km^2) [1]
"Credit River Near Cataract" Flow Gauge	204.97
"West Credit River at 10th Line" Station Flow Gauge	93.78
"Credit River at the Grange Rd." Flow Gauge	334.53
Low Flow Location #1	204.53
Low Flow Location #2	328.02
Low Flow Location #3	108.95

Note:

(1) Catchment areas were delineated using OWIT.

A comparison of the manual flow measurements captured at each low flow location against the average daily original and prorated discharge measurements from the WSC and CVC flow gauges is summarized in Table 6-6.

Table 6-6: Comparison of Manual Low Flows at Low Flow Locations and Pro-rated Flows at WSC and CVC Flow Gauges

Low Flow Locations	Measured Flows (m^3/s)	Measurement Date	
		August 31, 2020	August 24, 2021
Location #1	Manual Measured Low Flow	1.05	0.78
	Average Daily Discharge at Credit River Near Cataract Flow Gauge [1]	1.06	0.85
	% Difference to Manual Flow	+1	+9
Location #2	Manual Measured Low Flow	1.76	1.49
	Average Daily Discharge at Credit River Near Cataract Flow Gauge [1]	1.06	0.85
	Prorated Average Daily Discharge [2]	1.70	1.36
	% Difference	-4	-9
Location #3	Manual Measured Low Flow	0.61	0.58
	Average Daily Discharge at West Credit River at 10th Line Station Flow Gauge [3]	1.14	0.98
	Prorated Average Daily Discharge [4]	1.32	1.14
	% Difference	+116	+97

Note:

(1) Daily flow data was taken from the WSC "Credit River Near Cataract (ID: 02HB001)" flow gauge (no prorating necessary as catchment difference is less than 1%).

(2) Daily flow data was taken from the WSC "Credit River Near Cataract (ID: 02HB001)" flow gauge and prorated using the relationship between catchment area and flow.

(3) Daily flow data was taken from the CVC West Credit River at 10th Line (ID: 8150006) flow gauge.

(4) Daily flow data was taken from the CVC West Credit River at 10th Line (ID: 8150006) flow gauge and prorated using the relationship between catchment area and flow.

As detailed in Table 6-6, a comparison of manual low flow measurements at Low Flow Locations #1 - #3 to pro-rated daily discharge data from nearby WSC and CVC flow gauges was completed, and it was found that measurements were within +/- 10% of each other with the exception of Low Flow Location #3. For Low Flow Locations #1 and #2, it was considered acceptable to see potential errors in measurements of +/-15%, noting that pro-rating the WSC gauge flow data could also lead to potential error due to the assumption that all areas contribute flow to the channel of the Credit River equally across the entire catch of the gauge station. A +/-10% difference in flows at Low Flow Location #1 and #2 demonstrates that the low flows recorded at the WSC gauge station during August 31, 2020 and August 24, 2021 were representative of actual flows within the reach of the Main Credit River nearest the Site. However, the pro-rated CVC gauge flows at Low Flow Location #3 are 90% greater than the manual flows recorded in August of 2020 and 2021. This indicates that the West Credit River is a potential losing reach between the West Credit River at 10th Line flow gauge and Low Flow Location #3. A comparison of the original (not prorated) flows at the West Credit River at 10th Line flow gauge to the manual flows record by WSP show that the upstream flows are greater than 60% compared to downstream. Additionally, the potential for measurement errors is possible as it is difficult to properly characterize low flow conditions in wide shallow rivers with gravelly substrate due to potential gauge underflow. Due to suspected gauge underflow, shallow bypass channels in the gravelly substrate, and additional measurement discrepancies at Low Flow Location #3 and a changing cross section, all future assessment of low flows along the West Credit River will be based on the measurements taken at a chosen substitute location.

6.5.3 Baseflow

The baseflow at each station was estimated using BFLOW and the results are plotted on Figures L1 to L16 in Appendix L. It is important to note that the BFLOW results are not physically based and represent digital low pass filter results. For the purpose of this assessment, the proportion of runoff to interflow and baseflow as a percentage of the total flow was assumed to be based on the number of low pass filter steps completed. Noting that interflow and baseflow (i.e., the movement of water above and below the groundwater table, respectively), in the context of these calculations, were assumed to be represented by the second and third filter steps in the analysis, respectively. The number of filter steps completed are represented by the suffix number displayed at the end of BFLOW (i.e., BFLOW1 represents a total of one filter step completed for the BFLOW process which will be used as a basis to represent runoff). The proportion of runoff / interflow / baseflow as a percentage of the total flow at each station is summarized in Table 6-7.

Table 6-7: Assumed Proportions of Runoff / Interflow / Baseflow at the Surface Water Monitoring Stations

Surface Water Stations	BFLOW Low Pass Filter Steps					
	BFLOW1 (Runoff)		BFLOW2 (Interflow)		BFLOW3 (Baseflow)	
	Avg. Flow (L/s)	Proportion (%)	Avg. Flow (L/s)	Proportion (%)	Avg. Flow (L/s)	Proportion (%)
SW1	6.5	35.1	4.1	22.5	7.8	42.4
SW2	6.1×10^{-5}	96.2	6.1×10^{-5}	3.7	8.6×10^{-8}	5×10^{-5}
SW3	0.3	51.5	0.2	28.1	0.1	20.4
SW4 [1]	-	-	-	-	-	-

Surface Water Stations	BFLOW Low Pass Filter Steps					
	BFLOW1 (Runoff)		BFLOW2 (Interflow)		BFLOW3 (Baseflow)	
	Avg. Flow (L/s)	Proportion (%)	Avg. Flow (L/s)	Proportion (%)	Avg. Flow (L/s)	Proportion (%)
SW5	2.6	81.7	0.5	17	0.04	1.3
SW6	3.1	47.8	1.8	27.3	1.6	24.9
SW7	2.5	50	1.3	25.9	1.2	24.2
SW8	3.0	23	2.7	21.1	7.2	55.9
SW9	1.5	7.4	1.3	6.4	17.1	86.2
SW10	4.9×10^{-4}	100	0.0	0	0.0	0
SW11	0.9	41.2	0.6	28.8	0.6	30
SW12	6.1×10^{-4}	100	0.0	0	0.0	0
SW13	1.1	17.9	1.7	27.2	3.4	54.9
SW14	1.4	36	0.9	22.7	1.6	41.3
SW15	0.4	51.1	0.2	21.1	0.2	27.8
SW16 [2]	-	-	-	-	-	-

Note:

(1) No flows have been observed at SW4.

(2) Based on the rating curve of SW16 and continuous water level data, there was no flow recorded in the vicinity of the surface water station.

The results of the BFLOW analysis show that the majority of the watercourses surrounding the Site were minorly fed by baseflow through most of the year with runoff playing a larger role in seasonal fluctuations. While many of these watercourses can be classified as drainage paths beside roadways or low-lying areas with high soil permeability as described in Section 3.5, the remaining watercourses (i.e., SW1, SW13, SW14, SW9, SW8) were found to be fed mainly by baseflow with runoff only playing a minor part in seasonal fluctuations. The surface runoff was responsible for the short-lived precipitation responses in the watercourses through the years, as seen in Figures L1 to L16 in Appendix L. Although, many surface watercourses surrounding the site may be only minorly fed by baseflow, the watercourses that produce the more permanent stream flow have a larger contribution of baseflow. Due to the more permanent nature of these watercourses, they produce a larger contribution of flows to the Credit River than the watercourses that respond mainly to large precipitation events. As detailed in the "Phase 1 Report – Characterization" (CVC 1999), the mainstem of Sub-watershed 18 is largely controlled by groundwater flows with a percentage of groundwater versus surface runoff in stream flow being greater than 60%. An analysis of flows recorded at the WSC "Credit River at Cataract" flow gauge using BFLOW showed that 69% of the flow within the river between 1998 – 2021 was contributed by baseflow. Evidence of this can be seen at the surface water stations detailed above. As a note, the period of the BFLOW analysis was limited to 2020 and 2021, therefore, the proportion of runoff to interflow and baseflow may vary from year to year.

6.6 Water Temperature

Water temperature tidbit loggers were installed at each of the surface water monitoring stations. The continuous water temperature data is displayed on Figures M1-M4 in Appendix M for each surface water monitoring station over the period of October 2021 to October 2022. Water temperatures at SW1-SW16 followed a typical seasonal trend, where temperatures warm through the spring as air temperatures consistently remain above 0 °C. This warming continues until mid-summer when daily air temperatures begin to drop. The temperatures drop rapidly through the fall and remain around 0 °C through the winter until the spring freshet.

The instantaneous maximum and daily average maximum recorded at each surface water monitoring station and are summarized in Table 6-8 below.

Table 6-8: Instantaneous and Daily Average Maximum Water Temperatures at SW1-SW16

Surface Water Monitoring Stations	Surface Water Temperatures (°C)	
	Instantaneous Maximum (°C)	Daily Average Maximum (°C)
SW1 (1)	21.62	19.64
SW2 (1)	26.52	22.06
SW3 (1)	23.87	21.01
SW4 (1)	25.51	22.85
SW5 (1)	22.73	19.99
SW6 (1)	32.05 (2)	21.89
SW7 (1)	27.82	22.52
SW8 (1)	23.89	23.47
SW9 (1)	22.08	22.87
SW10 (1)	23.69	19.32
SW11 (1)	23.87	21.32
SW12 (1)	34.76	22.70
SW13 (1)	28.84	27.08
SW14 (1)	26.82	21.88

Surface Water Monitoring Stations	Surface Water Temperatures (ºC)	
	Instantaneous Maximum (ºC)	Daily Average Maximum (ºC)
SW15 (1)	22.97	19.01
SW16 (1)	28.83	23.28

Note:

(1) Instantaneous and daily average maximum temperature readings were measured over the period of October 2021 to October 2022.

(2) Instantaneous maximum temperature reading at SW6 likely represents a dry event where air temperature was measured.

These instantaneous maximum water temperature measurements at the surface water stations occurred during June to August. As seen on Figure M4, the surface water station at Osprey Valley Golf Course (SW13) displays the greatest fluctuation in temperature throughout the year, particularly summer 2022, while SW15, just west of the Site displays the narrowest range of temperatures. Given that SW13 is a pond with a relatively slow discharge rate, it is expected that SW13 would exhibit more temperature fluctuations as the water is stagnant for much of the year. SW15 remains relatively dry throughout most of the year and is encompassed by heavy ground vegetation that may result in shading.

A comparison of daily averaged air temperatures over the same period, as seen on Figures M1-M4, showed that the majority of water temperature at surface water stations would be below or similar to air temperatures during the summer, spring, and fall months and then slightly above freezing during the winter. SW13 was the only surface water station that showed water temperatures over the average daily air temperatures during the summer of 2022. SW13 is a large pond with minimal canopy cover so it is more likely to act as a heat sink.

6.7 Water Quality Monitoring Program

Surface water quality was collected at five surface water monitoring locations within the various tributaries of the Main and Erin Branches of the Credit River surrounding the Site.

A list of the surface water quality collection locations and the conditions at sampling are provided in Table 6-9.

Table 6-9: Surface Water Quality Collection Locations and Sampling Conditions

Station Name	Zone	Northing	Easting	Condition at Sampling			
				June 8, 2021	September 8, 2021	December 14, 2021	March 24, 2022
SW8	17	4851688	576054	Sampled	Sampled	Sampled	Sampled
SW9	17	4850400	575677	Sampled	Sampled	Sampled	Sampled
SW10	17	4850628	579128	Sampled	Dry	Dry	Sampled
SW11	17	4851869	578238	Sampled	Sampled	Sampled	Sampled
SW13	17	4853488	578153	Sampled	Sampled	Sampled	Sampled

The approximate locations of these monitoring stations are shown on Figure 6-1.

The surface water quality monitoring program has been conducted at the five surface water monitoring stations listed above for four quarterly events for the analysis of metals, nutrients, and general chemistry.

These five stations were selected from a subset of the stream flow monitoring stations in an attempt to maximise the value of each monitoring station by selecting stations downstream of the proposed quarry that were either isolated (i.e., no other station sits on the same watercourse) or were the furthest downstream station on a shared watercourse. These stations were also selected because they typically have surface water present through a large portion of the year.

An overview of the water quality samples collected on a quarterly basis at locations SW8 – SW11 and SW13 over the year of monitoring is provided in the section below. The water quality parameters being tested for the program are provided in the list below.

- Hardness ($CaCO_3$)
- In-Situ General Chemistry (i.e., pH, temperature, conductivity, dissolved oxygen, turbidity)
- Total Ammonia-N
- Total Phosphorus
- Alkalinity (Total as $CaCO_3$)
- Dissolved Chloride (Cl^-)
- Nitrite (N)
- Nitrate (N)
- Nitrate + Nitrite (N)
- Total Kjeldahl Nitrogen (TKN)
- Total Suspended Solids
- Total Oil & Grease
- Total Metals

6.7.1 Water Quality Results

The sampling results for the parameters outlined above are shown in Table N1 in Appendix N. The analyzed parameters were compared to the PWQO. Laboratory certificates of analysis are provided in Appendix O.

The water quality results are summarized as follows:

- pH was found to be consistently within the PWQO range of 6.5 – 8.5 at each station during the monitoring period with the exception of an exceedance of pH (8.7) at SW9 during the September 8, 2021 monitoring event.

- Concentrations of total phosphorus were found to be slightly elevated above the PWQO value of 0.03 mg/L during the monitoring period at SW8 during the June 8, 2021 and September 8, 2021 monitoring events and at SW11 during each monitoring event.

- Similarly, concentrations of total iron were found to be slightly elevated above the PWQO value of 300 µg/L during the monitoring period at SW8 during the June 8, 2021 and September 8, 2021 monitoring events and at SW11 during the June 8, 2021 monitoring event.

- All other parameter concentrations were below the PWQO.

6.8 Groundwater – Surface Water Interaction

Groundwater and surface water interaction forms an important part of water movement on the Site and in the Study Area. The combined groundwater-surface water monitoring network (Figure 6-4) has collected valuable data to support the observation of groundwater-surface water interaction at key locations within the Study Area. Focus areas for the observation of groundwater-surface water interaction are discussed in the subsections below, include:

- The Provincially Significant Wetlands (PSW) located in the south part of the South Area (SW10 / MW20-03);
- The Coulterville Wetland Complex proximal to the Site including the Northwest Wetland and Tributary #1 area located to the northwest and west of the Main Area (SW4 / MW20-27, SW14/MP14, SW17/MP17, SW18/MP18, SW19/MP19 and SW20/MP20);
- The area immediately east of the South Area (SW12 / MW20-08); and
- The area to the west and southwest of the Main and South Areas along several tributaries that ultimately report to the Credit River (SW15/MP15 / MW20-21 and SW16/MP16 / MW20-23).

At each location the head of the surface water feature, surface water feature elevation, and nearby groundwater heads are plotted, as presented on Figures 6-5 to 6-9. Additionally, field observations provide some additional insight into groundwater-surface water interaction in the Study Area.

In August 2022, a supplemental investigation was carried out in the Northwest Wetland, which is located directly northwest of the Main Quarry on Tributary #1, where additional surface water monitoring stations were installed, and additional monitoring began. The additional monitoring locations include the installation of surface water stations SW17/MP17 to SW20/MP20, instrumented with staff gauges and mini-piezometers (August to October 2022 data are presented in Figures L-17 to L-20). Surface water and shallow groundwater locations in this area were influenced by 45 mm of precipitation in seven days in mid July, shortly before the start of monitoring at these locations (as reported at Mono Centre, ON, EC Climate ID#6157000).

Groundwater-Surface Water Interaction at SW10

As noted in Section 6.5, SW10 is installed at the culvert between two surface water features, mapped as PSW. Surface water head and nearby groundwater heads are plotted on Figure 6-5. The following observations were made:

- It was noted during field visits that the ground surface at the culvert where SW10 was installed is somewhat higher than the lowest ground surface in either pond, and as a result, this culvert does not capture the lower water levels in the wetlands;
- It was noted during field visits that surface water is present in the wetland features more often than it was measurable at SW10, but water levels were very low during periods of particularly low precipitation;
- MW20-02 is located approximately 40 m northeast of SW10, approximately cross-gradient to groundwater flow and is screened 14 m below the surface water feature; and
- Groundwater head observed at MW20-02 is typically 2 m lower than the observed surface water head, when surface water could be observed. In the portion of the wetland near SW10, surface water is infiltrating and

groundwater does not support this surface water feature (i.e., the wetland feature is supported by a localized perched water table).

Groundwater-Surface Water Interaction at SW14

Surface water station SW14 is located on Tributary #1, downstream of the Northwest Wetland. Groundwater head is monitored in the shallow subsurface by a mini-piezometer (MP14). Groundwater head is also monitored by the well nest at MW20-15 approximately 50 m away from SW14, and deeper in the aquifer system, however this data is too deep in the aquifer system to be comparable with the data collected at SW14. The data are plotted on Figure 6-6 and the following observations are noted:

- Throughout the observation period, when surface water levels were present, the surface water levels were higher than the groundwater levels, except for a period in April and May of 2021;
- When surface water is present, shallow groundwater levels are consistently within 5cm of the surface water levels;
- When Tributary #1 is dry, shallow groundwater levels fall below ground surface, typically by 0.5 to 1 m; and,
- These observations suggest that in this location, Tributary #1 is not often supported by groundwater, particularly during the driest portions of the year.

Groundwater-Surface Water Interaction at SW17

Surface water station SW17 is located approximately 230 m to the northwest of the Site and adjacent to the Northwest Wetland. Groundwater head is monitored in the shallow subsurface by a mini-piezometer (MP17). The data are plotted on Figure L-17. The following observations are noted:

- Surface water was present during the beginning of the investigation, following significant precipitation in July. Surface water levels declined, and the feature became dry, from the end of August 2022 onward;
- Shallow groundwater head observed at MP17 ranged from 1.4 – 1.9 m lower than the observed surface water level, when surface water could be observed; and
- In this area, surface water is infiltrating and the surface water feature is not supported by groundwater during the observation period.

Groundwater-Surface Water Interaction at SW18

Surface water station SW18 is located approximately 420 m to the northwest of the Site and within the Northwest Wetland. Groundwater head is monitored in the shallow subsurface by a mini-piezometer (MP18). The data are plotted on Figure L-18. The following observations are made:

- Surface water was not observed during the observation period; and
- Shallow groundwater head ranged from 0.3 – 1.4 mbgs;
- Shallow groundwater head responded rapidly to a rain event in late September, showing rapid groundwater recharge in this area; and
- In this area, the surface water feature is not supported by groundwater discharge, during the observation period.

Groundwater-Surface Water Interaction at SW19

Surface water station SW19 is located approximately 620 m to the northwest of the Site and within the Northwest Wetland. Groundwater head is monitored in the shallow subsurface by a mini-piezometer (MP19). The data are plotted on Figure L-19. The following observations are noted:

- Surface water was present during the beginning of the investigation, following significant precipitation in July. Surface water levels declined, and the feature became dry, from the middle of August 2022 onward (with the exception of small amounts of standing surface water that coincide with late August rainfall);
- Shallow groundwater head observed at MP19 ranged from 0.2 – 0.5mbgs; and
- In this area, surface water infiltrates and the surface water feature is not supported by groundwater discharge, during the observation period.

Groundwater-Surface Water Interaction at SW20

Surface water station SW20 is located approximately 80m from the Site and within the easternmost portion of the Northwest Wetland. Groundwater head is monitored in the shallow subsurface by a mini-piezometer (MP20). The data are plotted on Figure L-20. The following observations are made:

- Conditions at SW20 were dry during the whole monitoring period with no significant response to any precipitation events;
- Shallow groundwater head observed at MP20 was typically 1.3 mbgs; and,
- In this area and during this observation period, the absence of surface water and groundwater head below ground surface show that there is no groundwater supported surface water feature at this location.

Groundwater-Surface Water Interaction at SW4

Surface water station SW4 is located on Tributary #8, directly west of the Northwest Wetland, on Mississauga Road and sits within an evaluated wetland feature. No nearby overburden groundwater head observation point is available. The nearest groundwater monitoring point is MW20-27B, approximately 120 m southeast and screened 34 mbgs, in the shallow bedrock, which is not comparable with surface water for purposes of assessing groundwater surface water interaction. SW4 data are plotted on Figure L-4. The following observations are noted:

- Surface water is intermittent at this location. During the monitoring period, it was present from spring (May to early June 2020 and late March to late April 2021) as well as in winter (early December 2021 to January 2021); and
- The infrequent presence of surface water suggests that Tributary #8 is likely not supported by groundwater in this area.

Groundwater-Surface Water Interaction at SW12

As noted in Section 6.5, SW12 is located at a culvert along the edge of the proposed licensed boundary of the South Quarry adjacent to Main Street. This culvert drains a small portion of the surrounding farmland and exhibits no channelization of flow downstream. Surface water head and nearby groundwater levels are plotted on Figure 6-7. The following observations are made:

- Surface water is rarely present at this location, exhibiting dry conditions for the entirety of the year with the exception of pooling near the culvert following large precipitation or snow melt events. During the monitoring period, surface water was only present briefly following precipitation events during winter (early January 2021 to March 2021);
- For the entirety of the period, groundwater levels were below the ground surface in the area of SW12. Whenever surface water is present there is a downward gradient, suggesting infiltration takes place;
- This supports the assessment of low runoff potential in the area; and
- These observations suggest that at this location, SW12 is not supported by groundwater.

Groundwater-Surface Water Interaction at SW15

Surface water station SW15 is located southwest of the Main Quarry on Tributary #8 downstream of an evaluated wetland feature. Surface water and shallow groundwater head are plotted on Figure 6-8. It is noted that:

- Surface water is continuously present in this location throughout the monitoring period;
- Shallow groundwater head is consistently greater than surface water head in this area, typically by approximately 0.1 m; and
- It is possible that groundwater discharge at this location supports Tributary #8.

Groundwater-Surface Water Interaction at SW16

Surface water station SW16 is located northwest of the intersection of Charleston Sideroad and Shaws Creek Sideroad. Surface water and shallow groundwater levels are plotted on Figure 6-9. It is noted that:

- Measurable surface water was rarely observed at this location during the monitoring period;
- Groundwater was typically approximately 1 m below ground surface at this location;
- Certain precipitation and melt events (such as late March 2021 and early December 2021) cause rapid increases in groundwater levels and brief presence of surface water at these locations;
- The rapid increases in groundwater head suggest event based rapid groundwater recharge is taking place in this area; and,
- Based on the groundwater levels generally below ground surface and the infrequent presence of surface water, groundwater does not support a surface water feature at this location.

Tributary #1 Infiltration

As discussed in Section 6.2, Tributary #1 (Trib. 1) is an ephemeral feature, noted to be flowing at times and dry at others. Downstream of SW14, when Tributary #1 is flowing, it travels 500 m southeast to Trib. 1 Pond, as shown on Figure 6-4. During field visits, Trib. 1 Pond was frequently observed to flow into the Trib. 1 Wetted Feature 10 m to the southeast of the pond. During site visits during times of the year with higher surface water levels, flow was observed from the Trib. 1 Wetted Feature through approximately 450 m of ditches along Mississauga Road to the Local Depression where it infiltrated. Further, it is noted that there is no culvert in this area to convey surface water from the northeast side of Mississauga Road to the southwest side and there is no channelized feature to the southwest of Mississauga Road. Groundwater monitoring wells (MW20-17B and MW20-18) screened in the shallow bedrock in this area showed greater water level increases associated with event-based groundwater recharge. These observations suggest that a significant portion of the surface water in Tributary #1 infiltrates in this part of the Study Area and contributes to groundwater recharge.

Surface Water Losses

Observations during field investigations over the period of record as well as surface water flow estimates detailed in the hydrographs suggests that the surface water features in the vicinity of the Site are experiencing a loss in runoff volumes due to the presence of high infiltration soils as detailed in the "Phase 1 Report – Characterization" (CVC 1999). These observations are supported by the loss of flow between surface water stations on the same tributaries or drainage features as well as minimal to no channelization of drainage features. A summary of average monthly and annual flows of the surface water stations along the same tributaries, drainage features, or watersheds is provided in Table 6-10 below.

Table 6-10: Average monthly and annual flow estimates within the surrounding Tributaries.

Month	Average Monthly and Annual Flow Estimates (L/s) (1)							
	Tributary #6		Tributary #7 & #9			Tributary #1 and #8		
	SW1 (2)	SW7 (3)	SW2 (2)	SW3 (2)	SW6 (3)	SW14 (2)	SW15 (2)	SW16 (3)
January	29.0	1.0	0.03	0.80	1.70	2.38	0.28	0.00
February	67.0	0.00	0.01	0.65	12.3	2.32	0.46	0.00
March	66.0	20.0	0.09	1.89	66.4	10.0	0.75	0.00
April	29.0	2.00	0.06	0.59	21.3	3.24	0.72	0.00
May	11.0	1.00	0.03	0.18	4.78	0.51	0.77	0.00
June	3.00	0.00	<0.01	0.13	0.05	0.00	0.52	0.00
July	4.00	0.00	0.01	0.31	0.00	0.90	0.75	0.00
August	1.00	0.00	0.00	0.60	0.00	0.01	0.14	0.00
September	3.00	0.00	0.01	1.01	0.00	0.48	1.03	0.00
October	12.0	1.00	0.03	0.72	1.10	4.80	1.40	0.00
November	17.0	6.00	0.05	0.47	0.08	5.05	1.06	0.00
December	43.0	34.0	0.09	1.21	14.6	8.75	1.49	0.00
Annual	**23.8**	**5.42**	**0.03**	**0.71**	**10.2**	**3.21**	**0.78**	**0.00**

Note:

(1) Flows are based on continuous logger data in conjunction with the stage-discharge curves developed for each station.

(2) Denotes the furthest upstream surface water stations including SW2, SW3, SW14, and SW15 which are all the furthest upstream station on their respective tributaries or drainage features.

(3) Denotes the furthest downstream surface water station.

Within Tributary #6, similar observations were detailed between upstream and downstream surface water stations as SW1 showed an average annual flow of 23.4 L/s with consistent standing water while further downstream, SW7 showed a smaller average annual flow of 5.42 L/s with stretches of dry conditions during from summer to winter of 2020 and the summer of 2021. Flow conditions in SW1 and SW7 also showed similar responses to high precipitation and freshet events, however, during periods of low volume events, SW1 showed consistent flow while SW7 went dry.

As seen in Figure 7-2, SW14 and SW15 both sit within the catchment of SW16, based on OWIT delineations, and are shown to receive moderate flow through the year, however, SW16, which is characterized by a wide vegetated valley, shows dry conditions over the period of record. As detailed above, Tributary #1 disappears before Mississauga Road at two locations including the Trib. 1 Wetted Feature or a local depression further downstream depending on the season while consistent flow from SW15 has been observed to drain into Tributary #8 within the vicinity of SW16 before infiltrating into the wide floodplain.

Within Tributary #7, the aforementioned losing response between upstream and downstream conditions was not observed. SW6 showed an average annual flow of 10.2 L/s and exhibited periods of dry conditions from June to December in both 2020 and 2021. SW2 showed a lower average annual flow of 0.03 L/s and showed periods of dry conditions during similar periods to SW6. While SW3 showed an average annual flow of 0.71 L/s and was only dry once during the fall of 2021. While all stations showed similar responses to precipitation and freshet events, SW6 saw a substantially higher contribution of flow, which is to be expected as SW2 and SW3 are much further upstream than SW6 and collect less drainage area.

Additionally, the lack of channelization in various areas near the Site suggests that surface runoff from the Site is either internally draining (infiltrating) or flowing un-channelized, overland across the drainage area before contributing to the Credit River. Areas such as these include the catchment of SW12 and sections of the proposed North, South, and Main quarries that do not drain to an identified drainage feature. As evidenced by the dry conditions seen at SW12 throughout the period of record, the majority of surplus is understood to infiltrate and report as baseflow to surrounding surface water features (e.g., the Credit River).

Springs and Seeps

Initial reconnaissance visits to the Site were made by Golder personnel from February to April 2020, to assess site conditions and property access points, to finalize proposed drilling, monitoring well, and surface water station locations, and to assess the Study Area for the potential presence of springs and seeps. Areas assessed for springs and seeps included the Site, portions of the Coulterville Wetland Complex to the northwest proximal to the Site, and the Niagara escarpment immediately south of the community of Cataract, which was accessed via the network of walking trails in and around Forks of the Credit Provincial Park. The Niagara escarpment area east of the Site was also assessed for springs and seeps by Golder personnel in June 2022, which was accessed via Osprey Valley Golf Course Lands, and the network of walking trails.

No seeps or springs were identified on any areas of the Site, or the Coulterville Wetland Complex, either during initial reconnaissance visits, or subsequent trips to site to perform surface water and / or groundwater monitoring.

The Niagara escarpment east of the Site does not exhibit a well-defined crest, as the Gasport Formation thins and then pinches out to the east of Site, and the underlying Cabot Head shales are more susceptible to erosion and have formed a relatively gentle soil-covered slope down towards the Credit River in that area. No seeps or springs were identified in this area during the June 2022 site reconnaissance visit.

Reconnaissance of the Niagara escarpment area south of Cataract was initially made on March 5, 2020 via the walking trail network, to observe geologic, hydrologic and hydrogeologic conditions, and assess the area for springs and seeps. One seep was identified along the walking trail at the location noted on Figure 6-10 as Waypoint #263, in a location where a concrete box culvert had been installed under the former rail bed, suggesting that this was a persistent seepage location along the escarpment. The flow rate of the seep at the time of the initial visit was low, <1 L/min. No other seeps were identified during this initial reconnaissance visit.

A follow-up reconnaissance visit was recently made on December 12, 2022 and covered generally the same areas as the initial visit. The trails walked and observation stations (Waypoints) along the route are shown on Figure 6-10. Observations from this visit are summarized as follows.

- Conditions were ideal for spotting ground seeps, as there was no leaf canopy to obscure views, there was a light snow cover of 2 to 5 cm, air temperatures were near freezing, making seeps readily visible as areas where (relatively warm) groundwater seepage had melted snow on the ground. Additionally, groundwater levels in December are generally at or very near seasonal high levels.
- There were several points along the trail that allowed for excellent views of the south face of the escarpment, as shown in the photographs on Figure 6-11. Based on a review of topographic mapping for the area and available borehole data, the approximate positions of geologic units have been projected on the escarpment photographs, which provides geologic context, as seepage is most likely to occur at the base of the Gasport Formation and then deeper in the gorge, from within the Manitoulin / Whirlpool Formations.
- The walking trail is at an elevation of about 390 masl in this area, which corresponds generally to the expected elevation of the base of the Gasport Formation in this area. The escarpment exposed above the trail was comprised of limestone with a near-vertical slope, consistent with exposure of the Gasport Formation.
- Below the walking trail, the slope was less steep and based on elevation, this portion of the escarpment is inferred to be the outcrop of the Shaley Dolostone / Cabot Head Formation, down to an elevation of approximately 370 masl (the approximate elevation of the current rail line). Below 370 masl to 350 masl at the base of the gorge, is inferred to be the outcrop of the Manitoulin and Whirlpool formations.
- The same seep observed previously in March 2020 was again identified as shown in the photographs on Figure 6-12 and was flowing at a similarly low rate of <1 L/min. There was no evidence of seepage flowing down the face of the Gasport exposure in this area, so it is presumed that the seepage was originating from the base of the Gasport, at trail level.
- There were no other seeps noted from the Gasport Formation along the trails walked, but a 100 mm steel pipe buried beneath the walking trail was observed at Waypoint #259 and a 300 mmm steel culvert was observed buried beneath the old rail bed at Waypoint #266 (observed from Waypoint #264), as shown in the photographs on Figure 6-13. Both pipes appeared to be drains installed in the former rail bed to facilitate surface water runoff when the old rail line was active.
- Some seepage was also observed at the base of the gorge from within the Manitoulin and Whirlpool Formations, below the rapids and just above the level of the river, as seen from the bridge (Waypoint #270). This area of the gorge was not accessible to the public for safety reasons.

7.0 SURFACE WATER BALANCE

Ten surface water balance assessments related to the 262-ha pit / quarry development were carried out to assess the potential hydrological impacts of the proposed quarry development with respect to loss in surplus, including potential impacts to downstream surface water features. The assessment included the existing, operational (i.e., Phases 1-7), and rehabilitated conditions within the site boundary as well as the quarry's impact on six of the surface water monitoring station watershed areas as well as three internally draining catchments that overlap with the Site. The three internally draining catchment areas do not report to any channelized surface water features in the area and either internally drain or flow across the surrounding surfaces towards the Credit River. These catchments focus solely on the remaining area within the license boundary.

7.1 Methodology

The Meteorological Service Data Analysis and Archive division of Environment Canada (EC) provides monthly water budget summaries for meteorological stations with greater than 20 years of meteorological data. These water budgets include monthly values for all parts of the water budget (rainfall, snowmelt, potential evaporation, etc.) for each of the years in the historic record, as well as average monthly values over the entire record.

The water balance assessment presented herein is based on composite meteorological data from the EC Thornthwaite water budgets (Environment Canada Orangeville – Mono Centre station [ID 6155790] between 1961 – 2021), watershed boundaries, land use data, and the existing soil types. The meteorological data set used in this assessment was derived by combining daily observations of Orangeville MOE (6155790, 1961 – 2015) and Mono Centre (6157000, 2015 – 2021).

The Thornthwaite method describes water flux in a unit area of soil on a monthly basis based on a balance of precipitation (rainfall and snowmelt), evapotranspiration (ET), soil storage, and surplus.

The water budget can be summarized as follows:

$$P = S + ET + R + I$$

Where: P = precipitation;

S = change in soil water storage;

ET = evapotranspiration;

R = surface runoff; and,

I = infiltration (infiltration below the root zone and available for groundwater recharge).

The various water budget components associated with catchment areas are typically presented in millimetres (mm) per time step over their respective sub-catchments and represent the amount of water per unit of watershed area.

The water budget model combines accumulated rainfall and snowmelt to estimate total precipitation. Rainfall represents precipitation when monthly mean temperatures are greater than 0 °C. Snowmelt is initiated when snow is on the ground and monthly mean temperatures are greater than 0 °C. Hence, snowmelt is based on the depletion of snow storage (accumulated precipitation during periods of sub-zero temperatures). Composite precipitation data collected at the Orangeville – Mono Centre monitoring station (1961 – 2021) indicated a mean annual precipitation (P) of 899 mm/year.

The potential or maximum ET is estimated, in this case, by the empirical Thornthwaite equation (using average monthly temperature and hours of daylight) and represents the amount of water that would be evaporated or transpired under saturated soil-water scenarios. The actual ET is the total evapotranspiration for the period of study based on evapotranspiration demand, available soil-water storage, and the rate at which soil water is drawn from the ground (as defined by an established drying curve specific to the soil type). Winter-time sublimation was not considered in any of the scenarios (including existing conditions) in the water balance analysis, however, we have estimated that the sensitivity of the water balance results to our assumption of no sublimation is minimal. The mean annual potential ET for the Site is approximately 582 mm/year based on data provided by EC.

Annual water surplus is the difference between P and the actual ET assuming year to year changes in soil moisture storage are negligible. The water surplus represents the total amount of water available for either surface runoff (R) or groundwater infiltration (I) on an annual basis. On a monthly basis, surplus water remains after actual evapotranspiration has been removed from the sum of rainfall and snowmelt, and maximum soil or snowpack storage is exceeded. Maximum soil storage is quantified using a Water Holding Capacity (WHC) specific to the soil type and land use. WHC is defined as the difference is soil moisture content between the field capacity and wilting point and is assigned across the site based on soil type and vegetation cover.

7.2 CVCA – Meteorological Comparison

In a letter addressed to Golder from July 9, 2021, the Credit Valley Conservation Authority (CVC) reviewed the proposed TOR (Golder, June 2021) for the CBM Caledon Quarry and provided comments for consideration in the Water Report. It was recommended that the meteorological data received from Environment Canada Orangeville MOE meteorological station be verified using the CVC Waste Management Facility meteorological station at 1795 Quarry Drive, Town of Caledon. The precipitation and temperature data from both stations were compared over their available shared record (i.e., 2004 – 2020, only including data on days both stations were reporting) and the average monthly results are provided below in Table 7-1. A correlation plot between both stations is shown on Figure 7-1.

Table 7-1: Comparison of MET Data Collected by CVC and EC at Nearby Stations (2004 – 2020)

Month	CVC Caledon (2004 – 2020)		EC Orangeville MOE - Mono Centre (2004 – 2020)		Missing Days Shared Between Stations
	Temperature (°C)	Precipitation (mm)	Temperature (°C)	Precipitation (mm)	
Jan	-7.1	11	-7.3	31	26
Feb	-6.2	9	-6.4	21	23
Mar	-1.5	17	-1.6	26	24
Apr	4.8	40	4.9	49	13
May	12.5	72	12.3	73	1
Jun	17.3	64	17.2	78	1
Jul	20.2	64	20.0	82	2
Aug	18.8	55	18.8	71	3
Sep	15.0	57	15.1	65	2
Oct	8.2	67	8.3	71	4
Nov	2.3	41	2.5	52	8
Dec	-3.5	14	-3.6	39	25
Total	**6.7 Avg.**	**512**	**6.7 Avg.**	**657**	**132**

Note: [(1)] The average shared missing days per month between the CVC Waste Management Facility and the EC Orangeville MOE – Mono Centre stations daily precipitation records were estimated over the period of 2004 -2020.

Table 7-1 above displays the average monthly air temperatures within the vicinity of the Site between 2004 and 2020 which yielded almost identical results. However, the total annual precipitation observed at both stations showed a difference of 145 mm. As seen on Figure 7-1, the majority of precipitation points between both stations are similar in value, however, larger precipitation events were recorded at the EC meteorological station which may consist of isolated precipitation events. In total, 132 days on average per year were missing from the shared precipitation record of data. It is possible that precipitation events that occurred over two or more days were not accounted for in the above analysis as both stations needed to have data recorded on the same day. Regardless of this, the usage of the Orangeville MOE – Mono Centre meteorological station is sufficient for the purposes of the surface water balance.

7.2.1 Catchment Delineation

The water balance evaluation was performed for the CBM owned property as a whole, including the area of proposed extraction and licensed quarry areas. Additionally, water balance evaluations were performed for each surface water monitoring station catchment that crossed the Site as well as internally draining catchments within the proposed licensed quarry areas using watersheds delineated by OWIT, available topographic mapping, and site boundary data as seen on Figures 7-2 (i.e., existing catchments) and 7-3 (i.e., operational catchments). Land uses under existing, operational (i.e., Phases 1-7), and rehabilitated conditions were taken from desktop delineations using SOLRIS V3, estimates from the Operational Mine Plan drawings by phase, and the *Final Rehabilitated Landform and Ecological Enhancement Areas* figure prepared by MHBC.

7.2.2 Surface Water Balance Scenarios

Under existing conditions, the Site catchment is composed of sections of wetlands/marshes along the east side of Mississauga Road within the Main Quarry with sections of forest along Charleston Sideroad between the Main and South quarry, along the west side of Main Street adjacent to the Main quarry, and along the east side of the North quarry. A small area of rural development is located near the southeast corner of the Main quarry and the south corner of the South quarry. Sections of moderately rooted agriculture, pasture, and meadow dominate the remaining sections of the Site. Additionally, the downstream surface water feature watersheds are composed of forests, wetlands, ponds, roadways, moderately rooted agricultural fields, pasture/meadow, rural development, and existing aggregate sites.

Under operational conditions (i.e., Phases 1 – 7), the portions of the Site designated for aggregate extraction will be untouched, stripped, blasted, and/or backfilled to form the proposed quarry as seen on Figure 2-1. This will leave sections of setbacks between the quarry and Tributary #1/Northwest Wetland to the west/northwest as well as between various residential buildings to the southwest, southeast, and east. The operational condition considers only the quarry extraction areas at each phase to be dewatered. For the purpose of the surface water balance, groundwater inflow from upgradient locations and groundwater flow to downgradient locations were not considered in the analysis, however, these elements are a part of the groundwater and surface water model detailed in Section 8.0.

Rehabilitated conditions were also considered in this study to determine the water surplus after quarry operations have ceased and the quarry is decommissioned. The rehabilitated condition is based on the *Final Rehabilitated Landform and Ecological Enhancement Areas* figure prepared by MHBC and considers the majority of the quarry area to be flooded as a lake with additional sections of wetland, islands, meadow, woodlands, grasslands, and forested swamps.

7.2.3 Surface Water Balance Parameters

Soils at the site are primarily silty sand and sandy silt for the site area. Fine sandy loam was assumed to be the operational conditions soil type for the proposed quarry based on existing borehole results for the Site. Surrounding land uses within the nearby watersheds will also use silt loam as the soil type for water balance purposes. The maximum soil storage is quantified using a Water Holding Capacity (WHC) that is based on guidelines provided in Table 3.1 of the Ministry of the Environment (MOE) Stormwater Management Planning and Design Manual (MOE 2003), (MOE manual). The WHC represents the total amount of water that can be stored in the soil capillaries and is defined as the water content between the field capacity and wilting point (the practical maximum and minimum soil water content, respectively).

WHCs are specific to the soil type and land use, whereby values typically range from approximately 10 mm for bedrock to 400 mm for mature forest over silt loam. For temperate region watersheds, soil storage is typically relatively stable year-round, remaining at or near field capacity with the exception of the typical mid- to late-summer dry period. As such, the change in soil storage is a minor component in the water budget, particularly at an annual scale. Surplus water remains in the system after actual ET has been removed (ET demand is met) and the maximum WHC is exceeded (soil-water storage demand is met).

The surplus data obtained from ECCC for the respective water holding capacities was split into an infiltration component by first applying an infiltration factor based on Table 3.1 from the MOE *SWM Manual* (MOE 2003) and then infiltration was subtracted out of surplus to obtain the runoff component. The infiltration factors were based on a sum of site-specific topography, surficial soil type and vegetative cover factors as presented in Table P-1 of Appendix P.

The water balance analyses were developed under the following assumptions:

- WHCs were chosen based on Table 3.1 in the MOE *SWM Manual* (2003) corresponding to the fine sandy loam soil type, existing land uses and operational/rehabilitation conditions for the Site-Wide, surface water station, and internally draining catchment water balances.
  - Forested Swamp (Wetland / Mature Forest): 250 mm WHC with a null (i.e., 0%) infiltration factor due to observed standing water in the area during the majority of the year resulting in a negligible drawdown, or upward gradient (existing, operational, and rehabilitation conditions).
  - Forested Area (Mature Forest): 300 mm WHC and 0.70 infiltration factor (existing, operational, and rehabilitation conditions).
  - Moderately Rooted Agricultural Land / Meadow (Tilled / Pasture & Shrubs): 150 mm WHC and a 0.65 infiltration factor (existing and operational conditions)
  - Impervious Built-Up Areas (Roadways): 3 mm WHC with a null (i.e., 0%) infiltration factor (existing, operational, and rehabilitation conditions).
  - Quarry Extraction Area (Dewatered Quarry): 10 mm WHC with a null (i.e., 0%) infiltration factor due to upward gradients and dewatering.
  - Till / Rehab Area (Stripped Area): 100 mm WHC and a 0.70 infiltration factor (operational conditions)

- Post-Agricultural Land / Meadow / Grassland (Pasture & Shrubs): 150 mm WHC and a 0.65 infiltration factor (rehabilitation conditions)
- Pervious Built-Up Area (Urban Lawn): 75 mm WHC and a 0.70 infiltration factor (existing, operational, and rehabilitation conditions).

- For the open water areas (lake, local pond, quarry sump, wet meadow, and marsh), it was assumed surplus equals the difference between the annual precipitation and annual lake evaporation, which was estimated using the NOAA-GLERL Great Lakes Evaporation Model by the National Oceanic and Atmospheric Administration (NOAA) for Lake Ontario (664 mm) over the same period as the water budget (1961 – 2020) (NOAA 2021). With the unavailability of recent pan evaporation data from local meteorological stations, lake evaporation estimates from Lake Ontario were deemed to be representative of evaporation conditions within the region.
- Net surplus was estimated by multiplying the estimated monthly surplus (mm/month) for the assumed WHC by the associated drainage area. Annual evapotranspiration and surplus values were obtained from the meteorological data from the Orangeville MOE – Mono Centre ECCC Meteorological Station based on the WHC assigned to each land use area.
- Runoff was calculated as the difference between surplus and infiltration.

7.3 Surface Water Balance Results

Average annual water balance assessments were carried out on i) a site-wide basis; for the portions of the site contributing to ii) the SW8 sub-watershed, iii) the SW10 sub-watershed, iv) the SW11 sub-watershed, v) the SW12 sub-watershed, vi) the SW14 sub-watershed, vii) the SW16 sub-watershed, viii) the South Area Internally Draining Catchment (SQ), ix) the Main Area Internally Draining Catchment (MQ), x), and the North Area Internally Draining Catchment (NQ). The results for the existing, operational (i.e., Phases 1 – 7), and rehabilitated scenarios are presented in this section for each of the ten assessments.

7.3.1 Existing Conditions

Based on the results of the assessment, the average annual existing water balance was estimated on a site-wide and watercourse/internally draining sub-watershed basis as summarized in Table 7-2, and as detailed in Tables P-2 to P-11, Appendix P.

Table 7-2: Existing Average Annual Water Balance Results – Site Wide & Watercourse / Internally Draining Catchments

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Average Annual Volume m^3/yr				
	Precipitation (P)	Evapotranspiration (ET)	Surplus (S)	Infiltration (I)	Runoff (R)
Site-Wide (1)	2,352,590	1,461,890	891,630	579,245	312,385
SW8	15,622,150	9,429,920	5,868,160	3,420,735	2,447,425
SW10	237,040	147,870	89,070	52,185	36,885

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Average Annual Volume m^3/yr				
	Precipitation (P)	Evapotranspiration (ET)	Surplus (S)	Infiltration (I)	Runoff (R)
SW11	254,740	159,560	95,135	61,295	33,840
SW12	57,110	34,640	22,460	12,700	9,760
SW14	1,268,060	805,270	461,030	222,140	238,890
SW16	5,331,290	3,273,410	2,001,720	1,138,370	863,350
South Area	103,800	64,270	39,530	25,695	13,835
Main Area	417,730	260,020	157,600	104,015	53,585
North Area	271,560	168,560	102,970	67,305	35,665

Note: (1). Site-wide refers to the whole proposed license boundary (i.e., the proposed extraction area + setbacks) as seen in Figure 6-1.

Based on the ten assessments, the proportion of evapotranspiration, infiltration, and runoff to precipitation for each assessment is summarized in Table 7-3 below for the existing condition.

Table 7-3: Existing Average Annual Water Balance Precipitation Breakdown – Site Wide & Watercourse / Internally Draining Catchments

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Precipitation Breakdown		
	% Evapotranspiration	% Infiltration	% Runoff
Site-Wide (1)	62	25	13
SW8	60	22	16
SW10	62	22	16
SW11	63	24	13
SW12	61	22	17
SW14	64	18	19
SW16	61	21	16
South Area	62	25	13
Main Area	62	25	13
North Area	62	25	13

Note: (1). Site-wide refers to the whole proposed license boundary (i.e., the proposed extraction area + setbacks) as seen in Figure 6-1.

7.3.2 Operational Conditions (Phases 1 – 7)

Based on the results of the assessment, the average annual operational (at the end of phase 7) water balance was estimated on a site-wide and watercourse/internally draining sub-watershed basis as summarized in , and as detailed in Tables P-2 to P-11, Appendix P. A summary of the water balance results for phases 1 – 7 is detailed in Table P-12 in Appendix P.

Table 7-4: Operational (Phase 7) Average Annual Water Balance Results – Site Wide & Watercourse / Internally Draining Catchments

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Average Annual Volume m^3/yr				
	Precipitation (P)	Evapotranspiration (ET)	Surplus (S)	Infiltration (I)	Runoff (R)
Site-Wide (1)	2,352,590	1,304,250	1,049,025	281,245	767,780
SW8	14,092,340	8,798,100	5,284,800	3,046,595	2,238,205
SW10	444,640	265,070	179,245	81,535	97,710
SW11	254,450	159,380	95,025	61,220	33,805
SW12	21,320	12,480	8,830	3,840	4,990
SW14	1,252,610	795,700	455,145	218,315	236,830
SW16	3,801,470	2,379,670	1,418,360	764,230	654,130
South Area	30,140	18,660	11,480	7,460	4,020
Main Area	57,650	35,790	21,840	14,370	7,470
North Area	127,700	79,430	48,240	31,685	16,555

Note:

(1) Site-wide refers to the whole proposed license boundary (i.e., the proposed extraction area + setbacks) as seen in Figure 6-1.

Based on the ten assessments, the proportion of evapotranspiration, infiltration, and runoff to precipitation for each assessment is summarized in Table 7-5 below for the operational condition.

Table 7-5: Operational Average Annual Water Balance Precipitation Breakdown – Site Wide & Watercourse / Internally Draining Catchments

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Precipitation Breakdown		
	% Evapotranspiration	% Infiltration	% Runoff
Site-Wide (1)	55	12	33
SW8	62	22	16
SW10	60	18	22

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Precipitation Breakdown		
	% Evapotranspiration	% Infiltration	% Runoff
SW11	63	24	13
SW12	59	18	23
SW14	64	17	19
SW16	63	20	17
South Area	62	25	13
Main Area	62	25	13
North Area	62	25	13

Note:

(1) Site-wide refers to the whole proposed license boundary (i.e., the proposed extraction area + setbacks) as seen in Figure 6-1.

7.3.3 Rehabilitated Conditions

Based on the results of the assessment, the average annual rehabilitated water balance was estimated on a site-wide and watercourse/internally draining sub-watershed basis as summarized in Table 7-6, and as detailed in Tables P-2 to P-11, Appendix P.

Table 7-6: Rehabilitated Average Annual Water Balance Results – Site Wide & Watercourse / Internally Draining Catchments

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Average Annual Volume m^3/yr				
	Precipitation (P)	Evapotranspiration (ET)	Surplus (S)	Infiltration (I)	Runoff (R)
Site-Wide (1)	2,352,590	1,587,740	764,925	628,000	136,925
SW8	14,092,340	8,798,100	5,284,800	3,046,595	2,238,205
SW10	444,640	266,090	178,565	81,145	97,420
SW11	254,450	159,380	95,025	61,220	33,805
SW12	21,320	12,480	8,830	3,840	4,990
SW14	1,252,610	795,700	455,145	218,315	236,830
SW16	3,801,470	2,379,670	1,418,360	764,230	654,130
South Area	30,140	19,030	11,095	7,745	3,350

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Average Annual Volume m^3/yr				
	Precipitation (P)	Evapotranspiration (ET)	Surplus (S)	Infiltration (I)	Runoff (R)
Main Area	57,650	36,640	20,970	14,315	6,655
North Area	127,700	79,970	47,680	31,650	16,030

Note:

(1) Site-wide refers to the whole proposed license boundary (i.e., the proposed extraction area + setbacks) as seen in Figure 6-1.

Based on the ten assessments, the proportion of evapotranspiration, infiltration, and runoff to precipitation for each assessment is summarized in Table 7-7 below for the rehabilitated condition.

Table 7-7: Rehabilitated Average Annual Water Balance Precipitation Breakdown – Site Wide & Watercourse / Internally Draining Catchments

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Precipitation Breakdown		
	% Evapotranspiration	% Infiltration	% Runoff
Site-Wide (1)	67	27	6
SW8	62	22	16
SW10	60	18	22
SW11	63	24	13
SW12	59	18	23
SW14	64	17	19
SW16	63	20	17
South Area	63	26	11
Main Area	64	25	12
North Area	63	25	13

Note:

(1). Site-wide refers to the whole proposed license boundary (i.e., the proposed extraction area + setbacks) as seen in Figure 6-1.

7.3.4 Summary of Surface Water Balance Results

A summary of the annual water balance assessments considering surplus, infiltration, and runoff for the existing, operational, and rehabilitated conditions is provided in Table 7-8 and Table 7-9.

Table 7-8: Water Balance Summary - Surplus

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Scenarios Considered		
	Surplus (m³/yr)		
	Existing Conditions	Operational Conditions (End of Phase 7)	Rehab Conditions
Site-Wide (1)	891,630	1,049,025	764,925
SW8	5,868,160	5,284,800	5,284,800
SW10	89,070	179,245	178,565
SW11	95,135	95,025	95,025
SW12	22,460	8,830	8,830
SW14	461,030	455,145	455,145
SW16	2,001,720	1,418,360	1,418,360
South Area	39,530	11,480	11,095
Main Area	157,600	21,840	20,970
North Area	102,970	48,240	47,680

Note:

(1) Site-wide refers to the whole proposed license boundary (i.e., the proposed extraction area + setbacks) as seen in Figure 6-1.

Table 7-9: Water Balance Summary – Infiltration and Runoff

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Scenarios Considered					
	Existing Conditions		Operational Conditions (End of Phase 7)		Rehab Conditions	
	Infiltration (m^3/yr)	Runoff (m^3/yr)	Infiltration (m^3/yr)	Runoff (m^3/yr)	Infiltration (m^3/yr)	Runoff (m^3/yr)
Site-Wide (1)	579,245	312,385	281,245	767,780	628,000	136,925
SW8	3,420,735	2,447,425	3,046,595	2,238,205	3,046,595	2,238,205
SW10	52,185	36,885	81,535	97,710	81,145	97,420
SW11	61,295	33,840	61,220	33,805	61,220	33,805
SW12	12,700	9,760	3,840	4,990	3,840	4,990
SW14	222,140	238,890	218,315	236,830	218,315	236,830
SW16	1,138,370	863,350	764,230	654,130	764,230	654,130

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Scenarios Considered					
	Existing Conditions		Operational Conditions (End of Phase 7)		Rehab Conditions	
	Infiltration (m^3/yr)	Runoff (m^3/yr)	Infiltration (m^3/yr)	Runoff (m^3/yr)	Infiltration (m^3/yr)	Runoff (m^3/yr)
South Area	25,695	13,835	7,460	4,020	7,745	3,350
Main Area	104,015	53,585	14,370	7,470	14,315	6,655
North Area	67,305	35,665	31,685	16,555	31,650	16,030

Note:

(1) Site-wide refers to the whole proposed license boundary (i.e., the proposed extraction area + setbacks) as seen in Figure 6-1.

Under operational conditions (at the end of phase 7), Site-wide surplus is anticipated to increase by 18% – representing a decrease in evapotranspiration due to land use changes as well as the dewatering of the quarry extraction area. For analysis purposes, the Site-wide water balance only accounted for evaporation of ponded water within the quarry sump and the remainder of the extraction area was modeled as dry rock. It is assumed precipitation on these areas will drain by gravity towards the quarry sump. Evapotranspiration will decrease as a result of the large area now covered by exposed rock with very reduced capacity to store water for evaporation, and most surplus represented as runoff. Infiltration is expected to decrease to 281,245 m^3 per year as the surplus from the quarry will be pumped to a sump pond and won't be infiltrated. This will effectively increase the total runoff from the Site to 767,780 m^3/yr. It is important to note that under operational conditions, the increase in runoff is not due to the addition of new water, instead, it represents a change in the path the water takes to the receiver (i.e., the Credit River). Under existing conditions, infiltration contributes to local groundwater, which discharges to the Main and Erin Branches of the Credit River. Under operational conditions that water is captured in the quarry dewatering system, treated to remove TSS and then will be discharged to the Credit River or one of its branches. Therefore, the only change in total surplus is attributed to relatively minor differences in evapotranspiration from the different land uses.

Under rehabilitated conditions, the components of the water balance will continue to function very similarly to operational conditions, however the non-backfilled sections of the quarry will be flooded and the newly vegetated features such as islands, wetlands, grasslands, woodlands, and meadow will be added. Existing lands outside of this rehabbed area will either remain or become pasture and shrubs. Surplus on the Site is projected to a decrease by 14% (compared to existing). Site runoff is expected to be conveyed to the lake and will outlet to the Credit River through proposed culverts within the North Quarry or leave the Site as either evaporation or recharge to the ground water system. The infiltration is expected to increase to 628,000 m^3/yr and the runoff will decrease to 136,925 m^3/yr.

A summary of the changes compared to existing conditions in surplus on a site-wide and surface water station / internally draining watershed basis under operational and rehabilitated conditions is detailed in Table 7-10 below.

Table 7-10: Water Balance Changes in Surplus Due to Catchment and Land Use Change

Site / Surface Water Monitoring Stations / Internally Draining Catchments	Scenarios Considered	
	Operational Conditions (Phase 7)	Rehabilitated Conditions
	Surplus (%)	
Land Use Changes		
Site Wide [(1)]	+18	-14
Catchment Loss & Land Use Changes		
SW8	-10	-10
SW10	+101	+100
SW11	-0.12	-0.12
SW12	-61	-61
SW14	-1.3	-1.3
SW16	-29	-29
South Area	-71	-72
Main Area	-86	-87
North Area	-53	-54

Note:

(1) Site-wide refers to the whole proposed license boundary (i.e., the proposed extraction area + setbacks) as seen in Figure 6-1.

7.4 Potential Discharge Location

The potential discharge location for quarry dewatering from the combined extraction parcels of the Caledon Quarry is the Credit River via Discharge Location #1, as seen in Figure 7-4. this discharge location was chosen as a possible option for the main discharge route that will convey the majority of the quarry dewatering. Under this proposed plan, the discharge of quarry water to the Credit River would be accomplished by pumping water collected from the sumps on the quarry floor to the northeastern quarry land parcel, where it will be conveyed to the Credit River via an armoured channel, as shown in Figure 7-4. This channel is proposed to convey water from the northeast edge of the northeast quarry parcel through an existing concrete box culvert beneath the rail line south of the Osprey Valley Resort (the Resort) and ultimately to the Credit River, noting that the lands northeast of the rail line to the banks of the Credit River are owned by the CVC. CBM will work closely with the CVC to obtain all necessary approvals before implementation of the proposed discharge route to the Credit River.

With this proposed discharge route in mind, preliminary estimates for the maximum discharge to the Credit River were found to range from 33,000 – 1,334,000 m^3/year over the expected period of the quarry operations. The maximum average water discharge rate over the quarry life is expected to be approx. 40 – 42 L/s which is 2.2 - 2.4% of the average annual flow rate in the Credit River at this location. Discharge rates could potentially range from 0 – 200 L/s depending on precipitation and season, as such, it is proposed that part of the northeastern quarry could be used for additional storage to mitigate peak flows directed to the discharge route. If applicable, limits to quarry discharge volumes may vary my season. Potential discharge limits will be identified and approved in consultation with the MECP through a future Industrial Sewage Works (ISW) Environmental Compliance Approval (ECA).

Additional discharge locations may be developed to supplement water levels in wetted areas in the north and south of the extraction areas. These discharge locations will have a limited volume with prescribed timing and flow rates, strictly to support the natural environment and will not be used as the main discharge location. Any additional discharge location will be identified and approved in consultation with the MECP through a future Industrial Sewage Works (ISW) Environmental Compliance Approval (ECA.

8.0 GROUNDWATER AND SURFACE WATER MODELLING

A fully integrated numerical groundwater-surface water model was used to assess the potential effect of the proposed Caledon Pit / Quarry on local and regional groundwater and surface water conditions. This includes changes in groundwater elevations and flow rates in nearby surface features during the various stages of quarry development and rehabilitation, relative to background conditions. Given the emphasis on the potential for either groundwater and surface water impacts, a coupled surface water/groundwater (SW/GW) modelling approach was applied. A detailed description of the groundwater-surface water modelling assessment is provided in Appendix Q.

The model was constructed using HydroGeoSphere (HGS), a finite element modelling package developed jointly by the Universities of Waterloo and Laval, and Aquanty (Aquanty, 2016). This entails constructing a 3D numerical model of the proposed pit / quarry and surrounding regional groundwater flow system, with the addition of a 2D grid that represents the surface flow domain (which is coincident with the top of the 3D model domain). In addition to its basis as a fully integrated, groundwater / surface water code, HGS was selected for this modelling simulation given its capabilities to efficiently discretize local features around the Site and Study Area, within a larger footprint around the Site in order to calibrate to water elevations and water balances within the surrounding region.

The 3D model domain is regional in scale and encompasses three sub-watersheds (No.15, No.17, No.18) within the larger Credit Valley watershed (Figure 8-1). The constructed based on the hydrogeologic conceptual model presented in Section 3.0, and the generalized hydrostratigraphy for the project area is described in Section 3.7 and illustrated schematically on Figures 4-5 and 4-6. To represent this hydrostratigraphy within the HGS model, a total of 26 numerical layers were used. Whereas this is greater than the number of hydrostratigraphic units present in the model domain, the additional number of layers was adopted to allow for increased resolution of vertical hydraulic heads within the model domain, as well as to capture vertical variability in the overburden sequence. The distribution of hydrostratigraphic units within these layers and the hydraulic conductivity values applied to each unit described in Appendix Q.

The model was calibrated to average, long-term hydraulic heads observed at Site monitors, MECP water wells, and long-term average flow rates at surface water monitoring stations for the current condition. The model was also calibrated transiently to the four-day constant rate pumping test conducted as part of the Northwest investigation in the fall of 2022. The calibrated model served as a basis for predictive model simulations to assess the potential impacts of proposed pit/ quarry development on groundwater levels and surface water flows. Eight predictive model simulations were completed, each representing a different phase of pit / quarry development (including the final rehabilitation). The main findings of these predictive simulations are described in the sections below.

8.1 Simulated Head and Drawdown

The simulated hydraulic head and drawdown in the overburden (shallow and deep), the Gasport Formation, and the Whirlpool / Manitoulin Formations for Operational Phases 1 to 7 and post-Rehabilitation are shown on Figures 8-2A to H, and Figures 8-3A to H respectively.

The general simulated groundwater flow direction across the Site in each unit remained consistent with the current condition; groundwater flow is southeast across the Site toward the Credit River and bedrock valley. The greatest drawdown occurs in the Gasport Formation and the deep overburden as extraction proceeds through Phases 1 to 7.

The least drawdown occurs in the upper overburden, in particular to the northwest, north and east of the Site where fine grained material is present, which provides a significant degree of hydraulic isolation between the shallow overburden and the underlying deep overburden and Gasport Formation layers, where dewatering mainly occurs during operations.

Drawdown in the upper overburden during later stages of quarry operation (Phase 6 and 7) as extraction proceeds into the southwest corner of the Main Area and South Area is more extensive, and propagates to the southwest, owing to the lack of fine grained soils in that area, and the dominance of sand and gravel in the overburden, but is relatively small in actual magnitude.

The progressive rehabilitation of the pit / quarry walls during operation provides further hydraulic isolation between the pit / quarry operation and the surrounding environment, helping to minimize drawdown and dewatering requirements. In particular, the south part of the pit / quarry wall in the Main Area and the pit / quarry walls of the South Area will be backfilled with fine grained soil that will be placed in lifts and compacted to achieve a low hydraulic conductivity upon rehabilitation.

There is also drawdown observed in the Whirlpool / Manitoulin Formations, which extends into a significant area as extraction proceeds, but is relatively small in magnitude. The drawdown beyond the Site is predicted to reach a maximum of approximately 4 m, however, given the depth of that formation, it represents only a fraction of the available water column in wells screened in that aquifer, as discussed in Section 9.3.

Upon rehabilitation, the residual change in groundwater heads within all of the subsurface units predicted to be affected by pit / quarry dewatering beyond the limits of the Site is typically less than +/- 1 m.

Further discussion of the potential impact to bedrock and overburden aquifers during pit / quarry operations and upon rehabilitation is found in Section 9.2 and 9.3.

8.2 Surface Flow

A summary of the simulated changes in surface water flow at the 16 surface water monitoring stations for Phases 1-7 and the Rehabilitation phase is shown on Figure 10. Surface water stations SW1 to SW9 generally experience simulated reduction in flows of less than 10% of the current conditions (largest reduction is 8% at SW8 during Phase 6 of quarry development). SW14 experiences a reduction in simulated flow of up a 23% (during Phase 7). The largest percentage of simulated reduction in flows occurs at SW16; however, only 1.0 L/s of flow was simulated under current conditions at this location, and no surface flow has been observed at that location.

8.3 Pit / Quarry Inflow

The steady state simulated groundwater inflow during Phase 1 to 7 of operation, for each area (Main, North, South) is summarized in Table 8-1 below.

Overall, the total simulated inflow to all areas of the pit / quarry during operations ranges from 9.6 L/s to 29.8 L/s. The majority of the simulated inflow is in the Main area of the pit / quarry, with inflows up to 27.3 L/s during Phase 5 of the operation. There is a slight reduction in the simulated inflow to each area during Phase 7 of operation, due to the placement of lower hydraulic conductivity (compacted) backfill material along the southern wall of the Main Area and the perimeter of the South Area as progressive rehabilitation occurs.

Upon post-rehabilitation, there will be an overflow from the Main Pond at an approximate elevation of 400 masl that will be directed to the North Pond, and an outlet from the North Pond at an approximate elevation of 399 masl that is directed to the Credit River. The simulated steady state outflow from the Main and North Ponds to the Credit River is estimated to be approximately 13 L/s.

Table 8-1: Simulated Pit / Quarry Inflow at Each Phase of Development

Phase	Main Area Simulated Groundwater Inflow (L/s)	North Area Simulated Groundwater Inflow (L/s)	South Area Simulated Groundwater Inflow (L/s)	Total Groundwater Inflow (L/s)
1	9.6	0.0	0.0	9.6
2	13.0	1.9	0.0	14.9
3	12.3	2.0	0.0	14.3
4	17.7	2.0	0.0	19.7
5	27.3	2.0	0.0	29.3
6	26.1	2.0	1.7	29.8
7	20.1	1.8	1.3	23.2

1.The inflows account for groundwater contributions only. Direct precipitation applied to the pit would be in addition to these estimates.

9.0 IMPACT ASSESSMENT

This section provides an assessment of the potential for impacts to water resources as a result of the proposed Caledon Pit / Quarry project, including surface water resources, groundwater resources, and water users in the Study Area. As this ARA licence is for below water table extraction of aggregates, there is potential for water resources impacts to occur. In addition to meeting the MNRF requirements, this assessment also considers the applicable provisions of the Greenbelt Plan, Source Water Protection, and the Caledon Official Plan, as well as how the proposed development may be affected by climate change.

The impact assessment also includes a proposed groundwater and surface water monitoring plan, as well as a complaints response plan, should a water-related compliant be received by a neighbouring water user.

9.1 Surface Water Resources

9.1.1 Potential Impacts to Surface Water

The Site sits within the catchments of several tributaries to the Credit River (Erin and Main Branches) and drainage courses including Tributaries #1, #4, and #8 (SW14, SW11, and SW8/SW16, respectively) as well as the catchment areas of SW10 and SW12. The total catchments of these tributaries and drainage features as well as their change in catchment area due to pit / quarry operations is detailed in Table 9-1 below.

Table 9-1: Surface Water Station / Internally Draining Catchment Losses

Surface Water Monitoring Stations / Internally Draining Catchments	Scenarios Considered		
	Existing Conditions	Operational / Rehab Conditions	
	Catchment Area (km^2) (1)		% Change in Catchment Area
SW8	17.397	16.542	-5
SW10	0.264	0.495	+88
SW11	0.284	0.283	-0.11
SW12	0.064	0.024	-63
SW14	1.412	1.398	-1.0
SW16	5.937	4.051	-32
South Quarry	0.116	0.034	-71
Main Quarry	0.465	0.064	-86
North Quarry	0.302	0.142	-53
Erin Branch of the Credit River	108.739	107.381	-1.2
Main Branch of the Credit River	218.421	219.779	+0.6

Note:

(1) Catchment areas were delineated using OWIT and were manipulated based on available topography data and site boundary data.

As seen in Table 9-1 above, the quarry extraction will remove approximately 1 - 63% of each tributary/drainage catchment area at the monitoring stations with the exception of the SW10 catchment at the end of Phase 7. Under the assumption that a perimeter berm and/or ditches would be placed along the licence extraction boundary during full quarry development, flow from the southeastern portion of the catchment of SW8/SW16 (Tributary #8) near Cataract (as seen on Figures 7-2 and 7-3) would be intersected by the berm and contribute to the catchment of SW10. Therefore, the catchment of SW10 is expected to increase by 0.231 km^2 (approximately 88%). Minimal changes were found to occur at Tributary #4 (SW11) as only a small section of the catchment will be lost due to quarry excavations. Minimal changes were found to occur within Tributary #1 (SW14) due to catchment loss. Significant decreases in catchment area were noted at SW12 due to quarry excavation, however, this area is typically dry for the majority of the year and directs small amounts of flow away from the agricultural fields within the property. Changes were also seen in Tributary #8 (SW8 and SW16) with one of the highest losses in catchment area. The internally draining catchment areas of the three small sections within the quarry, that have no channelized flow or culverts for draining purposes, were seen to have significant decreases in catchment area during operations. The loss in infiltration within these catchments will eventually be mitigated under rehab conditions when the lake and surrounding areas will recharge the surrounding groundwater levels.

As detailed in Table 9-1 above, the total catchment of the Erin and Main Branches of the Credit River downstream of the Site, before their confluence, was found to be 108.739 km^2 and 218.421 km^2, respectively, provided by OWIT, and under full extraction, the quarry as a whole would divert approximately 1.36 km^2 from the catchment of the Erin Branch to the Main Branch through the capture of runoff within the quarry and the discharge of effluent to the east. The quarry area accounts for approximately 0.8% of the catchment of the Main Branch of the Credit Rivers at the confluence with the Erin Branch (with a total catchment area of 327.160 km^2). Ultimately, all surplus within these tributaries and drainage features will report to the Credit River through surface or sub-surface pathways.

Similar to the changes in catchment area detailed above, the water balance assessments on surface water station catchment basis suggest that overall, there is a decrease in water surplus going to Tributaries #1, #4, and #8 with exception of an increase in surplus to SW10, under operational conditions. Additionally, as detailed in Table P-12 in Appendix P, changes and impacts to each catchment will differ with respect to the operational phases. For instance, the surface water station catchments of SW8, SW14, and SW16 as well as the main and north quarry internally draining catchments will begin to experience a decrease in water surplus within Phase 1 while SW11 will experience a loss in Phase 2, SW12 and the south quarry internally draining catchments in Phase 5, and ultimately, SW10 in Phase 7.

On a site wide basis, average annual surplus will increase by approximately 18% from 891,630 to 1,049,025 m^3 per year for the site under operational conditions (noting that this additional surplus will be conveyed to the Credit River through the quarry dewatering). On a site-wide basis, rehabilitated conditions are expected to have a lower annual surplus compared to existing conditions with a decrease of 14%. Although, the quarry area is expected to detain the runoff to the Credit River and its tributaries by capturing various amounts of their catchments, the surplus from the quarry area is expected to be maintained, and will report to the Credit River and its tributaries via quarry dewatering (operational) or groundwater inputs and lake outflows (rehabilitation). Also, during large flooding events, the storage available in the excavation under operational conditions and the relatively slow dewatering rate range, described above, will favourably reduce the peak flow in the Credit River by a small percentage.

Additionally, there are no key hydrologic features located within the proposed extraction area, however, a 0.1 ha key hydrologic feature (i.e., a small wetland near the north corner of the Main Area) will be affected by the construction of the proposed berm and this feature is permitted to be removed in accordance with applicable policies. There are also key hydrologic features (i.e., an evaluated wetland and Tributary #1) in the northwest corner of the Main Area and these features will be protected. Taking into consideration the rehabilitation plan, there are 4.8 ha of wetland to be created and 158.3 ha lake to be created resulting in 163 ha of new key hydrologic features that will compensate any lost habitat. Additionally, the Credit River is classified as a cold-water fishery and thus, any discharge to the river will be monitored for TSS and temperature to mitigate any negative impacts to the fishery. If quarry effluent is discharged to any other water features in the area, similar TSS and temperature monitoring will be conducted at those outlets to proactively identify any potential negative impacts to the surrounding water features and aquatic life. Overall, adverse impacts predicted for surface water features in the surrounding area will be minimal. Limits to the quarry discharge to protect the Credit River will be approved by the MECP as part of the future Industrial Sewage Works (ISW) Environmental Compliance Approval (ECA) application.

9.1.2 Flow Reduction at Each Surface Water Station

As detailed in Section 8.0, the results of the groundwater and surface water model yielded overall predicted percent changes in flow over the operational and rehabilitation period. The changes in flow at each station over the period are detailed in Table 9-2 below.

Table 9-2: Predicted Changes to Flow at Surface Water Stations

Surface Water Monitoring Stations (1)	Existing Flow (L/s)	Maximum Predicted Change in Average Annual Flow Over Operational Period		Predicted Change in Average Annual Flow Over Rehabilitation Period	
		(%)	(L/s)	(%)	(L/s)
SW1	23.75	0	0.00	0	0.00
SW2	0.03	-1	-3.4E-04	0	0.00
SW3	0.71	0	0.00	0	0.00
SW4	0.00	-4	0.00	-1	0.00
SW5	3.63	-5	-0.18	-1	-0.04
SW6	10.19	-4	-0.41	-2	-0.20
SW7	5.42	-4	-0.22	-2	-0.11
SW8	11.66	-8	-0.93	-3	-0.35
SW9	19.78	-6	-1.19	-2	-0.40
SW10	0.00	0	0.00	0	0.00
SW11	2.33	-24	-0.56	-4	-0.09
SW12	0.00	0	0.00	0	0.00
SW13	5.22	-15	-0.78	-13	-0.68

Surface Water Monitoring Stations [1]	Existing Flow (L/s)	Maximum Predicted Change in Average Annual Flow Over Operational Period		Predicted Change in Average Annual Flow Over Rehabilitation Period	
		(%)	(L/s)	(%)	(L/s)
SW14	3.21	-23	-0.74	-21	-0.67
SW15	0.78	-13	-0.10	-3	-0.02
SW16	0.00	-100	0.00	-95	0.00

Note:

(1) Surface water stations and their respective catchments can be seen on Figure 6-1.

The extraction of aggregates under the 7 operational phases as well as the creation of quarry ponds at the Site upon rehabilitation is not predicted to have adverse impacts on the local surface water hydrology with respect to loss in flow (i.e., a result of groundwater drawdown and overall surplus reduction) at surface water stations SW1-10 and SW12 as maximum operational reductions in flow are predicted to be less than 10% of the existing flows. Additionally, these stations will also experience a recovery of flow under rehabilitation conditions that will return predicted flows to within 5% of existing flows.

Tributary #1 (i.e., SW14) is predicted to see maximum localized impacts to flow during Phase 7 of operations at a total flow reduction of 23%, compared to existing conditions. The water feature will experience reductions in flow beginning in Phase 1 of operations that will continue until the rehabilitation stage and further into the future. As described in Section 6.0 above, Tributary #1 can be characterized as an intermittent water feature that sits within a perched wetland and showed periods of dry conditions over the available record. This reduction in flow is predicted to partially alter the observed wetted period within Tributary #1.

SW11, situated directly north of the Main Area, is predicted to see maximum localized impacts to flow during Phase 2 of operations at a total flow reduction of 24%, compared to existing conditions. This drainage course only experiences such a large reduction in flow during Phase 2 and quickly recovers in Phase 3 with a flow reduction of 9%. This flow reduction continues to decrease until rehabilitation with a flow reduction of 4% compared to existing conditions. This drainage course is an ephemeral feature and does not support regular flow, therefore impacts will be minimal.

Tributary #8 (i.e., SW15 and SW16) is predicted to see maximum localized impacts to flow during Phase 4 of operations at a total flow reduction of 13% and 100%, respectively, compared to existing conditions. At SW16, the groundwater / surface water model simulated minor flows at this station, however, manual field flow and continuous flow measurements recorded and/or estimated zero flow throughout the year. The 100% and 95% decrease in flow is what the groundwater / surface water model estimated. At SW15, annual flow will experience a small recovery after Phase 6 with a flow reduction of 9% and in rehab with a flow reduction of 3%, both compared to existing conditions. SW15 is supported by groundwater inflow so this predicted change is expected to have a slight effect on water levels in this part of Tributary #8. At SW16, there was no surface water flow captured within the wide valley area, therefore, any reduction in flow will have no impact on local surface water hydrology at that station. For these reasons, the predicted impacts to Tributary #8 can be considered minimal, as further downstream, SW8 also shows a low flow reduction during the operational and rehabilitated scenarios.

The two golf course ponds situated adjacent to SW13 are predicted to experience maximum localized impacts to flow during Phase 7 of operations at a total flow reduction of 15% compared to existing conditions. This reduction in flow to SW13 will begin during Phase 2 and last until rehabilitation. As described above, SW13 outlets to the Credit River, however, the reduction in flow to SW13 and ultimately the Credit River will be compensated by the quarry dewatering/discharge to the Credit River during operations and rehabilitation.

It should be noted that flows at SW13 may also be potentially influenced by irrigation activities on the golf course, which is permitted to pump up to 4,546 to 5,910 L/min (1,000 from 1,300 igpm) from each of two irrigation ponds and a Credit River intake and distribute that water within this area.

9.2 Groundwater Aquifers

9.2.1 Potential Impacts during the Operational Period

The potential impact to aquifers during the operational period was assessed by examining the predicted drawdown in the shallow overburden (upper sand), deep overburden (lower sand), Gasport Formation and Manitoulin / Whirlpool Formation relative to current conditions, for each of the seven phases of pit/quarry operations (Figure 2-1) as follows:

- Figure 8-3A: Phase 1 Simulated Drawdown
- Figure 8-3B: Phase 2 Simulated Drawdown
- Figure 8-3C: Phase 3 Simulated Drawdown
- Figure 8-3D: Phase 4 Simulated Drawdown
- Figure 8-3E: Phase 5 Simulated Drawdown
- Figure 8-3F: Phase 6 Simulated Drawdown
- Figure 8-3G: Phase 7 Simulated Drawdown

These figures, when viewed sequentially, present the predicted changes in drawdown within these aquifer units over time, and have been used to identify where, when and to what extent impacts to these aquifers is expected to occur during the operational period.

Predicted Impacts to Bedrock Aquifers

- Phase 1 – At the end of Phase 1, the drawdown in the Gasport Formation is primarily within the footprint of the Phase 1 operational area, with drawdown of ~1 m in head observed in a wider area, but generally within the Site footprint. A small area of minor drawdown is also predicted to be observed in the Manitoulin / Whirlpool Formation over a vary localized area at the end of Phase 1.
- Phase 2 – At the end of Phase 2, the drawdown in the Gasport Formation is primarily within the footprint of the Phase 2 operational area, with drawdown of ~1 m in head observed in a wider area to the south and west of the Main Area, but generally still within the Site footprint. A slightly larger area of minor drawdown is also predicted to be observed in the Manitoulin / Whirlpool Formation over a localized area at the end of Phase 2.
- Phase 3 – At the end of Phase 3, the extent of drawdown in the Gasport Formation has not changed significantly since the end of Phase 2, as extraction advances southwesterly with drawdown of ~1 m in head

observed in a similar sized area to the south and west of the Main Area, but generally still within the Site footprint. A very similar sized area of minor drawdown is again predicted to be observed in the Manitoulin / Whirlpool Formation shifting slightly southward the end of Phase 3, relative to its position at the end of Phase 2.

- Phase 4 – At the end of Phase 4, the extent of drawdown in the Gasport Formation has increased to the southwest and the northwest since the end of Phase 3, as extraction advances southwesterly with drawdown of ~1 m in head observed in a larger area to the south, west and northwest of the Main Area. The area of minor drawdown becomes larger in the Manitoulin / Whirlpool Formation shifting further southward the end of Phase 4, relative to its position at the end of Phase 3.
- Phase 5 – At the end of Phase 5, the extent of drawdown in the Gasport Formation has not changed significantly since the end of Phase 4, as extraction advances southward with drawdown of ~1 m in head observed in a slightly larger area to the south of the Main Area. The area of minor drawdown becomes slightly larger in the Manitoulin / Whirlpool Formation to the south the end of Phase 5, relative to its position at the end of Phase 4.
- Phase 6 – At the end of Phase 6, the extent of drawdown in the Gasport Formation has changed slightly since the end of Phase 5, as extraction advances into the eastern part of the South Area, with drawdown of ~1 m in head observed in a slightly larger area to the east of the Main and South Areas. The area of minor drawdown becomes slightly larger in the Manitoulin / Whirlpool Formation to the east at the end of Phase 6, relative to its position at the end of Phase 5. This is the maximum extend of drawdown in the bedrock observed during operations.
- Phase 7 – At the end of Phase 7, the extent of drawdown in the Gasport Formation has slightly decreased since the end of Phase 6, as extraction is completed in the South Area, with drawdown of ~1 m in head observed in a slightly decreasing to the west and south of the Main Area. The area of minor drawdown becomes slightly decreased in the Manitoulin / Whirlpool Formation at the end of Phase 7, relative to its position at the end of Phase 6.

Predicted Impacts to Overburden Aquifers

- Phase 1 – At the end of Phase 1, the drawdown in the shallow overburden is very slight and almost entirely within the footprint of the Phase 1 operational area. A larger area of minor drawdown is predicted to be observed in the deep overburden, focussed to the south, where the overburden is primarily comprised of (more permeable) sand and gravel material.
- Phase 2 – At the end of Phase 2, the drawdown in the shallow overburden is again very slight primarily and almost entirely within the footprint of the Phase 2 operational area. A larger area of minor drawdown is predicted to be observed in the deep overburden, focussed to the south, where the overburden is primarily comprised of (more permeable) sand and gravel material, and to the west, where sand and gravel underlies the (less permeable) fine grained till separating the upper and lower overburden aquifer units.
- Phase 3 – At the end of Phase 3, the drawdown in the shallow overburden is again very slight primarily and almost entirely within the footprint of the Phase 3 operational area. The area of minor drawdown predicted to be observed in the deep overburden is similar in extent to that observed in Phase 2, again focussed to the south, where the overburden is primarily comprised of (more permeable) sand and gravel material, and to

the west, where sand and gravel underlies the (less permeable) fine grained till separating the upper and lower overburden aquifer units.

- Phase 4 – At the end of Phase 4, the drawdown in the shallow overburden is observed to expand to the south of the Main and South Areas beyond the footprint of the Phase 4 operational area. The area of minor drawdown predicted to be observed in the deep overburden is slightly larger in extent than that observed in Phase 3, again focussed to the south, where the overburden is primarily comprised of (more permeable) sand and gravel material, and to the west, where sand and gravel underlies the (less permeable) fine grained till separating the upper and lower overburden aquifer units.
- Phase 5 – At the end of Phase 5, the drawdown in the shallow overburden is observed to expand slightly to the south of the Main and South Areas beyond the footprint of the Phase 5 operational area. The area of drawdown predicted to be observed in the deep overburden is larger in extent than that observed in Phase 4, again focussed to the south, where the overburden is primarily comprised of (more permeable) sand and gravel material, and to the west, where sand and gravel underlies the (less permeable) fine grained till separating the upper and lower overburden aquifer units.
- Phase 6 – At the end of Phase 6, the drawdown in the shallow overburden is observed to expand to the south of the Main and South Area beyond the footprint of the Phase 6 operational area. The area of drawdown predicted to be observed in the deep overburden is only slightly larger in extent than that observed in Phase 5, again focussed to the south, where the overburden is primarily comprised of (more permeable) sand and gravel material, and to the west, where sand and gravel underlies the (less permeable) fine grained till separating the upper and lower overburden aquifer units. This is the maximum extend of drawdown in the bedrock observed during operations.
- Phase 7 – At the end of Phase 7, the drawdown in the shallow overburden is observed to decrease slightly relative to that of Phase 6. The area of drawdown in the deep overburden is also observed to decrease slightly relative to that of Phase 6.

It is noted that while the Cataract Southwest PSW is located approximately 430 m from the area of extraction, no direct impacts (i.e., removal) to the PSW as a result of the proposed extraction are anticipated. Golder has simulated a steady state drawdown depth of 1 m near this PSW based on conservative assumptions that have been incorporated into the integrated numerical groundwater/surface water model for the Study Area. The model was constructed in a manner that provides a conservative estimate of groundwater influence in this area and note that the aggregate pit pond (Licence #6524, Section 3.9), located approximately 375 m west of the PSW, has not been represented in the model. The pit pond currently stores a large volume of water, and is expected to have a dampening effect on the shallow overburden drawdown, limiting the influence of the proposed Caledon Pit / Quarry in the South Area. Furthermore, groundwater levels immediately west of the Site will be monitored allowing hydrogeologic and water-related ecological conditions in the area to be further assessed as extraction proceeds.

9.2.2 Potential Impacts upon Post-Rehabilitation

The potential impact to aquifers upon post-rehabilitation, once dewatering activities have ceased and the Main, North and South areas are allowed to fill with water, was assessed by examining the predicted post-rehabilitation groundwater levels in the overburden and bedrock aquifer units, presented on the following figures:

- Figure 8-2H: Rehabilitation Simulated Head

- Figure 8-3H: Rehabilitation Simulated Drawdown

These figures present the predicted changes in final water levels and show residual drawdown within these aquifer units in the post-rehabilitation scenario and have been used to identify where and to what extent impacts to these aquifers are expected to occur post-rehabilitation.

Predicted Impacts to Bedrock Aquifers

Upon rehabilitation, there are very minor changes predicted to water levels in the bedrock aquifers relative to current conditions, so no impacts are predicted to either the Gasport or underlying Manitoulin / Whirlpool Formations.

Predicted Impacts to Overburden Aquifers

Similarly, upon rehabilitation, there are very minor changes predicted to water levels in the shallow and deep overburden aquifers relative to current conditions, so no impacts are predicted.

9.2.3 Potential Impacts to Springs and Seeps

With respect to the seeps observed along the Niagara escarpment south of Cataract, the maximum predicted drawdown in the bedrock (both the Gasport and the Manitoulin / Whirlpool Formations) in this area during any phase of operation is <1 m and post-rehabilitation, the residual drawdown is negligible. As such, there is no predicted impact to springs and seeps along the escarpment in this area.

9.3 Water Users

9.3.1 Water Supply Wells

To assess the potential for impacts to water well users identified in Section 3.8, a screening process was developed and applied to identify any wells in the Study Area that had the potential to have their static water level reduced by 10% or more AND have <10 m of remaining available water column for use, as a result of the proposed aggregate extraction operations.

- Any wells that met the criteria of >10% predicted water column reduction and <10 m of water column remaining were included for further consideration in the impact assessment.
- Those wells for which the predicted water column reduction was less than 10% and/or had >10 m of predicted water column remaining were removed from further consideration.

The methodology used and conservative assumptions made in predicting the potential water column reduction at these wells is provided in Appendix R, and a table detailing the calculations and results of the screening process is presented in Table R-1. In additional to the wells identified in Section 3.8, three additional properties close to the Site, designated A, B and C (see Figure 9-1), for which there was no well record were also added to the screening process, assuming that these properties likely had a (non-registered) water well for domestic use.

Results

As shown on Figure 9-1, of the approximately 100 water supply wells and property locations considered in the assessment, more than 75% of the wells have a negligible likelihood to be impacted by the proposed pit / quarry operation.

The screening process also identified 23 water wells that have potential to be impacted, as they are within the predicted zone of drawdown at one or more phases of the pit / quarry operation, are relatively shallow and / or have relatively little available water column from which to draw water. The maximum predicted drawdown at these wells mainly occurred during the later stages of operation (either Phase 6 or Phase 7). These wells are summarized in Table 9-3 and shown on Figure 9-1.

Table 9-3: Water Well Impact Assessment Results

Well ID	Well Use	Distance from Site (m)	Well Depth (m)	Static Water Level (m)	Water Column (m)	Aquifer Unit	Predicted Max Drawdown (m)	Reduction During Operation	Reduction Post-Rehab	Potential for Well Impact
4905228	Domestic	85.0	8.5	6.3	2.2	Gasport Fm	2.6	100%	79%	Significant
4908162	Domestic	2.3	15.2	8.5	6.7	Gasport Fm	6.4	96%	33%	Significant
4907244	Domestic	69.0	20.1	12.7	7.4	Gasport Fm	6.0	82%	24%	Significant
4906547	Domestic	124.9	22.6	9.0	13.6	Gasport Fm	6.3	46%	15%	Significant
4900947	Domestic	147.7	12.8	3.7	9.1	Gasport Fm	3.3	36%	18%	Significant
4900879	Domestic	50.0	13.7	9.6	4.1	Gasport Fm	1.3	31%	19%	Significant
4900878	Domestic	91.8	15.2	9.7	5.5	Gasport Fm	1.1	19%	11%	Significant
4900946	Domestic	367.3	15.8	14.3	1.5	Overburden	1.3	89%	64%	Moderate
4901027	Domestic	835.9	12.2	4.2	8.0	Gasport Fm	4.7	59%	20%	Moderate
4907246	Domestic	69.2	24.7	12.7	12.0	Gasport and Lower	6.1	51%	15%	Moderate
4903132	Domestic	321.5	10.1	7.0	3.1	Gasport Fm	1.5	49%	35%	Moderate
4903189	Domestic	459.8	15.2	11.4	3.8	Gasport and Lower	1.8	47%	27%	Moderate
4906026	Domestic	57.0	23.5	9.6	13.9	Gasport and Lower	6.5	47%	12%	Moderate
4903338	Domestic	600.8	16.2	2.0	14.2	Gasport Fm	4.7	33%	14%	Moderate
4907589	Domestic	94.7	15.2	4.1	11.1	Gasport and Lower	3.6	32%	15%	Moderate
4900948	Domestic	214.1	13.7	2.9	10.8	Gasport and Lower	3.0	28%	14%	Low
4903810	Domestic	269.1	13.1	4.2	8.9	Gasport and Lower	2.4	27%	17%	Low
4905365	Domestic	341.3	29.9	21.9	8.0	Gasport and Lower	1.7	22%	14%	Low
4905272	Domestic	341.3	13.7	5.9	7.8	Gasport and Lower	1.6	21%	15%	Low
4904297	Domestic	467.2	32.0	25.5	6.5	Below Gasport	1.1	17%	7%	Low
4905439	Commercial	587.1	12.8	7.4	5.4	Overburden	0.6	11%	4%	Low
4904054	Domestic	354.2	16.8	10.0	6.8	Gasport and Lower	0.7	11%	5%	Low

Well ID	Well Use	Distance from Site (m)	Well Depth (m)	Static Water Level (m)	Water Column (m)	Aquifer Unit	Predicted Max Drawdown (m)	Reduction During Operation	Reduction Post-Rehab	Potential for Well Impact
4906635	Domestic	156.1	21.6	10.6	11.0	Gasport Fm	1.1	10%	8%	Low

Notes:

1. Well ID - as identified in the WWIS.
2. Well Use - as identified in the WWIS.
3. Distance from Site (m) - measured from the reported well location to the nearest Site boundary.
4. Well Depth (m) - well depth as reported in the WWIS.
5. Static Water Level (m) - inferred water level based on the HGS numerical groundwater model calibrated to current conditions.
6. Water Column (m) - height of water column in the well based on the static water level and well depth.
7. Aquifer Unit - aquifer(s) from which the well draws groundwater from.
8. Predicted Max Drawdown (m) - maximum predicted drawdown in the well during any phase of operation.
9. Reduction During Operation – predicted maximum % reduction in the static water level in the well during any phase of operation.
10. Reduction Post-Rehab – predicted maximum % reduction in the static water level in the well post-rehabilitation.
11. Potential for Well Impact – assessment of the potential for impact to the water user based on the predicted reduction in static water level.
12. The assumed potential wells at properties A, B and C were assumed to be typical of the most common design of water supply wells in this area: fully penetrating wells screened across the Gasport Formation and the Manitoulin/Whirlpool Formations aquifers.

The 23 wells initially identified by the screening process as having the potential to be impacted and were further assessed based on their well geometry, formation from which they draw water, available drawdown, and predicted drawdown as a result of pit / quarry operations. Based on this well-specific assessment, their potential for impact was further classified as significant, moderate or low, as shown on Table 9-2 and Figure 9-1. These categories of wells are discussed further below.

Significant Potential

There are seven wells drawing water from the upper bedrock (Gasport Formation) that are within 150 m of the site (see Figure 9-1) and have significant potential to be impacted. Under existing conditions, these wells are inferred to have on average only 7 m of available water column, and are predicted to experience, on average, 4 m of drawdown during Phases 6 or 7.

- Three of the wells are located south of the South Area (ID 4907244, 4906547, and 4908162), which is an area predicted to experience approximately 6 m of maximum drawdown in the Gasport Formation during Phase 6 and 7.
- Two of the wells are located in Coulterville at the intersection of Main Street and Charleston Sideroad (ID 4900878 and 4900879), proximal to the South Area, where there is predicted to be a maximum drawdown in the Gasport Formation of approximately 1 m during Phase 7.
- Two of the wells are located in north east limits of Cataract closest to the extraction limit, immediately to the east of the South Area (ID 4900947 and 4905228), where there is predicted to be a maximum drawdown in the Gasport of approximately 3 m during Phase 6.

Moderate Potential

There are eight wells considered to have a moderate potential for impact; four are in Cataract, two are south of the South Area, and two are southwest of the South Area. These wells draw water from either the overburden or the bedrock (Gasport Formation and underlying bedrock), as noted in Table 9-2.

- Water wells 4903189, 4903132, and 4907589 are located in the northeastern portion of Cataract. These range in depth from 10 to 15 m, are screened in the upper bedrock (Gasport Formation), and are predicated to experience a maximum drawdown in the Gasport Formation of 1.5 to 3.6 m in this area during Phase 6.
- Water well 4900946, is located in the southern portion of Cataract. It is 15.8 m deep and screened in the overburden. The modelled existing groundwater surface at this location yields a static water level of 14.3 mbgs, suggesting this well currently has only 1.5 m of available water column, which is significantly different than the static water level reported on the water well record (SWL of 5.5 m; water column of 10.3 m). It is possible that this well is positioned in the wrong location in the WWIS database and because of the steep terrain in this area, a positioning error would explain this mismatch between the observed and modelled static water level. As such, the potential for impact to this well may be much lower than predicted by this screening process.
- Two wells located to the south of the South Area were initially assessed to have a moderate potential for impact (ID 4906026 and 4907246). They are located 60 and 70 m (respectively) from the South Area. In this area, a maximum potential drawdown of approximately 6 m is expected during Phase 6; however, these wells are deep (23.5 and 24.7 m, respectively) and fully penetrate the Gasport Formation and lower aquifer, so they maintain significant water columns (5.9 and 7.4 m, respectively). Because the screening method considered head changes in both bedrock aquifers and assumed the maximum drawdown predicted in either of the two aquifers (see methodology in Appendix R), it is probable that the actual drawdown in these fully penetrating wells will be less, and the wells are not as likely to be impacted as the conservative screening method predicts.
- Water wells 4903338 and 4901027 are located 600 and 840 m respectively, to the southwest of the Site, along Charleston Sideroad. Both wells are screened in the Gasport Formation and are predicted to experience a maximum drawdown of approximately 4.7 m and a reduction in their water column during Phase 6 of the extraction, and may be impacted by pit / quarry operations.

Low Potential

- There are eight remaining wells that met the initial assessment screening criteria: 4900948, 4903810, 4905365, 4905272, 4904297, 4905439, 4904054, and 4906635, but upon further assessment have a low potential for impact as a result of pit / quarry operations. These wells are between 150 and 600 m from the Main and South Area and are predicted to only lose 20 to 30% of their current available water column under predicted maximum drawdown. Seven of the wells are located in Cataract and experience their minimum water levels during Phase 6. The eighth well is located to the northwest of the Main and North Areas, on Osprey Valley Golf Course owned lands, and is not in use.

Post-Rehabilitation

Post-rehabilitation, all of the wells identified by the impact assessment screening and subsequent well-specific assessment will see a significant recovery in static water levels once dewatering has ceased and static groundwater levels rise to their long-term levels. As such, there is expected to be no long-term impact to water users post-rehabilitation.

9.3.2 Well Interference and Complaints Response

Of the approximately 100 water supply wells evaluated in this assessment, 15 wells are considered to have significant or moderate potential to be impacted during operations by the proposed pit / quarry development. These 15 wells are susceptible to impacts due to their location relative to the predicted zone of influence of the Site, and their relatively shallow well construction in comparison to other wells in the area. In all cases, these wells could be deepened to the depth of other wells in the surrounding area to restore the water supply, if the proposed pit / quarry operations is found to have resulted an unacceptable decline in their water level. A well complaints response plan, presented in Appendix R, will be implemented by CBM to address well interference issues.

The assessment was based on well information available from the MECP's WWIS, and used conservative assumptions to ensure the impact assessment was protective of groundwater users. A door-to-door private well survey was also conducted in July 2021 in an effort to supplement and help verify the MECP WWIS information. However, there was no public participation in the survey. In an effort to further ensure this assessment was protective of groundwater users, three residential properties near the Site but for which there were no water well records (locations A, B and C on Figure 9-1) were also screened in this assessment, in order to consider their probable groundwater use.

A follow-up private well survey within 1,000 m of the licence area is proposed upon licence approval and prior to the initiation of aggregate extraction, to confirm details regarding individual water well users. Survey participation will again be voluntary. The objective of the survey would be to confirm water use and well construction details with individual property owners, confirm the static water level in the well, and potentially monitor groundwater levels in the well, if agreed by the property owner.

9.3.3 Other Wells

The WWIS database search also identified 25 wells with purposes other than water supply, including 14 monitoring wells, nine recharge (or injection) wells, and two unused dewatering wells (excluding wells installed by CBM from 2020 to 2022 for the purposes of this Water Resources Assessment). The function of dewatering and recharge wells will not be affected quarry dewatering, so no impact is predicted. Twelve of the 14 monitoring wells are expected to continue to be able to observe the groundwater levels throughout the predicted scenarios. Two of the monitoring wells, located at the snow dump on Charleston Sideroad, between the Main Quarry and South Quarry, are predicted to be above the groundwater level throughout extraction (all Phases 1 to 7), and become operable again once the Site has been rehabilitated. If monitoring groundwater levels and chloride below the snow dump is required, it is predicted that these will be adversely impacted.

9.3.4 Osprey Valley Golf Course – PTTW 1807-AC9P9J (Active)

There are no predicted impacts to the water supply well at the Osprey Valley Golf Course, as the maximum predicted drawdown in their supply well during dewatering operations (conservatively estimated) is negligible, about 2% of the available water column and less than 0.5 m.

There are also no predicted impacts to water quantity at their intake along the Credit River, which is outside of the area of influence of quarry dewatering.

9.3.5 AquaTerra Corporation – PTTW 7541-72ZM8Z (Expired)

There are no impacts predicted to the two wells that are on the AquaTerra property that are inferred to be part of this expired PTTW, noting the following:

- Well #4905439 has a maximum predicted drawdown of 0.60 m during Phase 6 of operation and was initially flagged as “low” impact potential in our WWR screening process as it was predicted to retain 89% of its available water column (just met the >10% loss screening criteria). An examination of the WWR indicates the static water level in this well at the time of construction was 2.4 m higher than the modelled current SWL, suggesting there is likely more available drawdown than conservatively modelled in the impact assessment, making the potential for impact “negligible”.
- Well #4903950 has a maximum predicted drawdown of 0.52 m during Phase 6 of operation and had adequate drawdown so this well was initially screened as having “negligible impact potential in our WWR screening process as it was predicted to retain 94% of its water column. An examination of the WWR indicates the static water level in this well at the time of construction was 3.1 m higher than the modelled current SWL, suggesting there is likely more available drawdown than conservatively modelled in the impact assessment.
- Since installed and monitored in 2020, monitoring well MW20-03 (located ~250 m east of these wells) has never observed a change in water level that suggested either of these wells were actively being pumped (noting that their permitted rate is 455 L/min or 100 Igpm), but if they were, their zone of influence did not reach this monitoring well nest.

As previously noted, Golder has requested information about this PTTW from the MECP through the Freedom of Information (FOI) process and are awaiting a response to confirm hydrogeological information about this water taking, if it is still active.

9.4 Source Water Protection

The proposed Caledon Pit / Quarry is within the Credit Valley Source Protection Area but is not located in a WHPA or IPZ and as such there will be no impacts to municipal water supplies.

The proposed extraction area does not contain any identified water resources on the Region of Peel Schedule A-1 (Water Resources, Systems and Features). The proposed licence area includes an identified feature in the northwest corner of the Main Area and this feature is located outside of the extraction area and will be protected.

A small portion of Main Area, a very small portion of the North Area and the majority of the South Area is mapped as a Highly Vulnerable Aquifer on the Region of Peel Schedule A-2 (Highly Vulnerable Aquifers). Almost all of the Rural Area in the Region of Peel including the Main Area, North Area and South Area are mapped as a Significant Groundwater Recharge Area on the Region of Peel Schedule A-3 (Significant Groundwater Recharge Area). This is very common for mineral aggregate resource areas, and based on the design of the operation, and the implementation of the recommendations contained in this report, the proposed Caledon Pit / Quarry does not result in additional risk to the aquifer and the groundwater recharge function of the area (i.e., providing flow to the Credit River) will be maintained, and will report to the Credit River and its tributaries via quarry dewatering (operational) or groundwater inputs and lake outflows (rehabilitation).

9.5 Greenbelt Plan

The scope of this Water Report Level 1 /2 is considered to meet the requirements set forth in the Greenbelt Plan (2017) as summarized in the table below.

Table 9-4: Greenbelt Plan Requirement Checklist

Greenbelt Plan Requirement	Caledon Pit / Quarry Project
4.3.2 Non-Renewable Resource Policies For lands within the Protected Countryside, the following policies shall apply: 1. Non-renewable resources are those non-agriculture-based natural resources that have a finite supply, including mineral aggregate resources. Aggregates, in particular, provide significant building materials for our communities and *infrastructure*, and the availability of aggregates close to market is important for both economic and environmental reasons. 2. Activities related to the use of non-renewable resources are permitted in the Protected Countryside, subject to all other applicable legislation, regulations and official plan policies and by-laws. The availability of mineral aggregate resources for long-term use shall be determined in accordance with the PPS, except as provided below. 3. Notwithstanding the policies of section 3.2, within the Natural Heritage System, *mineral aggregate operations* and wayside pits and quarries are subject to the following: a) No new *mineral aggregate operation* and no new wayside pits and quarries, or any ancillary or accessory use thereto, shall be permitted	Meets requirement as a valuable non-renewable aggregate resource close to market (Water Report Section 4).
3.2.4 Key Hydrologic Areas *Key hydrologic areas* are areas which contribute to the *hydrologic functions* of the Water Resource System. These areas maintain ground and surface water quality and quantity by collecting, storing and filtering rainwater and overland flow, recharge aquifers and feed downstream tributaries, *lakes*, *wetlands* and discharge areas. These areas are also sensitive to contamination and feed *key hydrologic features* and drinking water sources. *Key hydrologic areas* include: • *Significant groundwater recharge areas*; • *Highly vulnerable aquifers*; and • *Significant surface water contribution areas*. For lands within a *key hydrologic area* in the Protected Countryside, the following policies apply: 1. *Major development* may be permitted where it has been demonstrated that the *hydrologic functions*, including groundwater and surface water quality and quantity, of these areas shall be protected and, where possible, improved or restored through: a) The identification of planning, design and construction practices and techniques;	Meets requirement, as hydrogeologic functions are protected and where possible, improved or restored (Water Report Sections 5 to 11).

Greenbelt Plan Requirement	Caledon Pit / Quarry Project
b) Meeting other criteria and direction set out in the applicable *watershed planning* or *subwatershed plan*; and c) Meeting any applicable provincial standards, guidelines and procedures. 2. Section 3.2.4.1 does not apply to *major development* that is a new or expanding building or structure for *agricultural uses*, *agriculture-related uses* or *on-farm diversified uses* where the total impervious surface does not exceed 10 per cent of the lot.	

9.6 Caledon Official Plan

The scope of this Water Report Level 1 / 2 is considered to meet the requirements set forth in the Town of Caledon Official Plan (2018) as summarized in the table below.

Table 9-5: Caledon Official Plan Requirement Checklist

Town of Caledon Official Plan Requirement	Caledon Pit / Quarry Project
5.11.2.4.15 - The Water Resources Study required by Section 5.11.2.4.2(g) shall identify all sources of water and their functions and analyze and assess the impact of the application on each of those water resources and shall satisfactorily demonstrate that there will not be unacceptable impacts and shall address the following: *a) The quantity and quality of mineral aggregate resource located below the water table;* *b) That the removal of the mineral aggregate resource and the subsequent rehabilitation of the lands will satisfy the applicable performance measures in Sections 3.2.5.13 and 5.11.2.2.6 of this Plan;* *c) That measures to protect water resources will be implemented in the design and operation of fuel storage and handling systems, machinery storage and servicing and the use and storage of potential contaminants on the site. The storage of fuel and other potential contaminants on-site may be restricted if necessary to protect water resources; and,* *d) That an appropriate monitoring program will be implemented and that the results of this monitoring program will be provided to the Town of Caledon, the Region of Peel, the Niagara Escarpment Commission where applicable and the applicable Conservation Authorities.*	Requirements met through Impact Assessment and Conclusions (Water Report Section 9 and 11.1). a) Met through Aggregate Resource Assessment (Water Report Section 4). b) 3.2.5.13 Met through Water Resource Assessment (Water Report Sections 5 through 9). 5.11.2.2.6 met through Natural Environment Report (under separate cover) c) Met through Recommendations (Water Report Section 11.2). d) Met through Monitoring Plan (Water Report Section 9.8).

Town of Caledon Official Plan Requirement	Caledon Pit / Quarry Project
5.11.2.4.16 - The Water Resources Study required by Section 5.11.2.4.2(h) shall identify all sources of water and their functions and analyze and assess the impact of the application on each of those water resources and shall satisfactorily demonstrate that there will be no unacceptable impacts and shall address the following: *a) That the removal of the mineral aggregate resource and the subsequent rehabilitation of the lands will satisfy the applicable groundwater performance measures in Sections 3.2.5.13 and 5.11.2.2.6 of this Plan;* *b) That measures to protect water resources will be implemented in the design and operation of fuel storage and handling systems, machinery storage and servicing and the use and storage of potential contaminants on the site. The storage of fuel and other potential contaminants on-site may be restricted if necessary to protect water resources; and,* *c) That an appropriate monitoring program will be implemented and that the results of this monitoring program will be provided to the Town of Caledon, the Region of Peel, the Niagara Escarpment Commission where applicable and the applicable Conservation Authorities.*	Requirements met through Impact Assessment and Conclusions (Water Report Section 9 and 11.1). a) 3.2.5.13 Met through Water Resource Assessment (Water Report Sections 5 through 9). 5.11.2.2.6 met through Natural Environment Report (under separate cover) b) Met through Recommendations (Water Report Section 11.2). c) Met through Monitoring Plan (Water Report Section 9.8).

9.7 Climate Change Considerations

Canada's Changing Climate Report (Bush and Lemmen 2019), identifies climate change as one of the defining challenges of the 21st century, and summarizes the story of Canada's changing climate in the following key messages:

- Canada's climate has warmed and will warm further in the future, driven by human influence.
- Both past and future warming in Canada is, on average, about double the magnitude of global warming.
- Oceans surrounding Canada have warmed, become more acidic, and less oxygenated, consistent with observed global ocean changes over the past century.
- The effects of widespread warming are evident in many parts of Canada and are projected to intensify in the future.
- Precipitation is projected to increase for most of Canada, on average, although summer rainfall may decrease in some areas.
- The seasonal availability of freshwater is changing, with an increased risk of water supply shortages in summer.
- A warmer climate will intensify some weather extremes in the future.

- The rate and magnitude of climate change under high versus low emission scenarios project two very different futures for Canada.

Taking Action on Climate Change in Toronto Region (TRCA 2022) provides specific insight on how climate change is expected to change the hydrologic cycle in the GTA over the lifetime of the proposed Caledon Pit / Quarry project, by increasing mean annual temperature, mean annual precipitation, hot and cold extremes and dry weather.

Mean annual temperature is projected to increase from 7.3°C (1971-2000) to a range of 9.8°C to 15.8°C under high emissions scenario (TRCA 2022). These temperature increases are expected to increase across all seasons. These changes in temperature will not only increase the temperature of surface waters, but they will also increase the potential evapotranspiration in the Study Area. This will increase the water losses to the atmosphere and dry up seasonal surface water features more quickly and potentially for longer durations.

Changes to mean precipitation are projected to increase from 986 mm (1971-2000) to a projected range of 1,015 to 1,292 mm under the high emissions scenario (TRCA 2022). These changes to mean precipitation will reintroduce water back into the surface water systems, however these increases will likely not be distributed evenly over the year or even typical precipitation events. Precipitation increases will most likely be realized through more frequent and intense storms that may cause flooding and reduce overall infiltration and soil water storage because available surface waters may have less time to infiltrate or be absorbed.

The number of extreme heat days (above 30°C and 35°C) are expected to increase from around 11 days and 1 day (1971-2000), respectively, to 52 and 14 days, respectively, under a high emissions scenario. While the number of days below -20°C is expected to decrease from around 10 days (1971-2000) to 0 to 3 days under high emissions scenario (TRCA 2022). These changes to dry and cold periods will likely cause more surface water features to dry or experience extreme lows, while warmer winter weather may produce drier spring freshets, limiting aquatic environments that rely on spring snow melt water levels.

In general, the Project may not see significant mean average changes to their water handling, since increased precipitation may be balanced but increased evaporation (annually). However, the frequency and intensity of the wet and dry events may significantly change the water handling throughout the year, with increased precipitation events that are capable of flooding or the increase of extended dry periods.

Based on this information, the Project has the potential to benefit the receiving water system by containing large precipitation events and controlling the release of these waters over a prolonged period. This can be accomplished when an intense rainfall event falls on the operating or flooded quarry and the water volumes are pumped out or drain by gravity (through flooded quarry outlets or infiltration) over a period of weeks or months. This has the potential to decrease peak flows and increase typical or low flows in the receiving water system.

Another potential benefit of the Project with respect to mitigation of extreme precipitation events as a result of climate change is the control / stability of local groundwater levels that the Project will create, both during operations and upon post-rehabilitation. The dewatering of the pit / quarry during operations will inherently stabilize the local groundwater table, and during a period of high precipitation events, may help maintain infiltration capacity in the shallow subsurface, allowing precipitation in infiltrate, rather than cause flooding.

Upon post-rehabilitation, the Main and North Ponds will have engineering water level controls, which will help prevent an excessive rise in the groundwater table, that could again lead to flooding during high precipitation events. While the South Pond does not have an outlet structure, groundwater modelling has demonstrated that the South Pond water level is effectively controlled by the water level in the Main Pond, and as such, the South Pond also helps control and stabilize the local water table and has sufficient retention capacity to contain major precipitation events.

In summary, the proposed Caledon Pit / Quarry project will not be adversely impacted as a result of climate change and may in fact be beneficial in mitigating the potential climate change impacts of extreme precipitation events, as the Project will provide a degree of hydraulic control on the surface water and groundwater systems in the Study Area, both during operations and post-rehabilitation.

9.8 Proposed Monitoring Program

The proposed groundwater and surface water monitoring program is summarized in Table 9-6 (on-site locations) and Table 9-7 (off-site locations). It is comprised of monitoring wells and well nests (MW), surface water stations (SW), and surface water / mini-piezometer stations (SW/MP); mainly of wells and stations that are part of the current monitoring program and Site investigations, but additional locations have been added in areas where enhanced monitoring will augment the understanding of hydrogeological and hydrologic conditions on the Site and in the Study Area. The locations of the various monitors are presented on Figure 9-2, a described further in the subsections below.

9.8.1 On-Site Monitoring

The proposed on-site groundwater monitoring program is comprised of the on-site monitoring wells installed during the 2020 hydrogeologic investigation and part of the current monitoring program. These wells are within the proposed setback area, so they would remain in place for the duration of the pit / quarry operations, if needed.

Additionally, a monitoring well from each of the four pumping test areas (two in the Main Area, one in the North Area and one in the South Area, will be added to the program, with the understanding that these wells would be decommissioned and removed during the operational period, as aggregate extraction proceeds, as they are within the planned extraction area. These wells are already in place and the additional water level data collected there will enhance the monitoring of hydrogeologic conditions as aggregate extraction advances. Also to be added to the on-site program are the wells installed during the 2022 supplemental investigation in the Northwest Wetland area; these wells are located within the planned setback area, so they would remain in place for the duration of the pit / quarry operations, if needed.

The proposed on-site surface water monitoring locations include existing station SW14/MP14, located in the proposed setback on the west side of the Main Area, as well as two new stations in that area SW22/MP22 and SW23/MP23 at the pond and wetted feature associated with Tributary #1.

Lastly, a new surface water station, SW26 will be installed at a future point in time at the planned outlet of the proposed Settling Pond, where water will be conveyed via an armoured discharge channel to the Credit River, once the pond and discharge channel have been permitted, constructed and is operational. Specific monitoring requirements of the water discharged from the Settling Pond will be as approved by the MECP based on the PTTW and ECA to be obtained by the Applicant prior to the initiation of any off-site discharge, and is expected to include water quality, temperature, and flow.

Additional information regarding scope and frequency for each type of monitor is provided in the table notes below.

Table 9-6: On-Site Groundwater and Surface Water Monitoring Program

Name	Type	Easting	Northing	Monitoring Scope
MW20-01 A/B	Mon Well	577459	4852268	Water level[1]
MW20-07 A/B	Mon Well	578360	4853250	Water level[1]
MW20-08 A/B	Mon Well	578010	4853575	Water level[1]
MW20-09	Mon Well	578344	4854157	Water level[1]
MW20-10 A/B	Mon Well	577838	4854407	Water level[1]
MW20-11 A/B	Mon Well	577672	4853921	Water level[1]
MW20-12 A/B	Mon Well	577272	4854321	Water level[1]
MW20-14 A/B	Mon Well	577576	4853100	Water level[1]
MW20-15 A/B	Mon Well	576577	4853544	Water level[1]
MW20-15 C	Mon Well	576577	4853544	Water level[1]
MW20-16 A/B	Mon Well	576785	4853807	Water level[1]
MW20-17 A/B	Mon Well	576752	4852966	Water level[1]
MW20-18	Mon Well	577058	4852659	Water level[1]
MW21-1-1	Mon Well	576882	4853485	Water level[1,4]
MW21-2-1	Mon Well	577279	4854021	Water level[1,4]
MW21-3-1	Mon Well	577872	4852814	Water level[1,4]
MW21-4-1	Mon Well	577793	4854211	Water level[1,4]
MW22-01	Mon Well	576782	4853808	Water level[1]
MW22-02 A/B	Mon Well	576478	4853794	Water level[1]
MW22-03 A/B	Mon Well	576201	4854078	Water level[1]
PW22-01	Mon Well	576574	4853535	Water level[1]
SW14/MP14	SW/MP	578165	4855098	Water level and temperature[2]
SW22/MP22	SW/MP	576800	4853125	Water level and temperature[2]
SW23/MP23	SW/MP	576840	4853050	Water level and temperature[2]
SW26	SW	578155	4854320	To be determined by MECP PTTW and ECA Approvals[3]

Notes:

1. Groundwater level to be monitored by logger set to record on 15-min intervals, with quarterly logger downloads and quarterly manual measurements.
2. Surface water level and temperature to be monitored by logger set to record on 15-min intervals, with quarterly logger downloads and quarterly manual measurements.
3. Water discharge from the Settling Pond to be monitored as per requirements to be approved by the MECP based on the Permit to Take Water and Environmental Compliance Approval to be obtained by the Applicant prior to the initiation of any off-site discharge.
4. These wells only need to be monitored until they are required to be decommissioned in accordance with MECP requirements to allow for on-site operations

9.8.2 Off-Site Monitoring

The proposed off-site groundwater monitoring program is comprised of 15 of the 19 off-site monitoring well nests that were installed during the 2020 hydrogeologic investigation and are currently part of the existing groundwater monitoring program. These off-site locations encompass all existing well nests that are within approximately 1,500 m of the Site. The current groundwater monitoring program and predictive modelling for the operational and post-rehabilitation period indicates that these wells will provide very good spatial coverage within the Study Area, and will allow to the licensee to monitor baseline conditions and assess the potential for any impacts to groundwater as a result of the proposed Caledon Pit / Quarry development. These well nests are all located on lands owned or under the control of the licensee.

The proposed off-site surface water monitoring locations include nine existing surface water stations installed in 2002 as part of the surface water investigations (SW4, SW5, SW8, SW10, SW11, SW12, SW13, SW15/MP15 and SW16/MP16), as well as four new surface water stations that were installed in the summer of 2022 as part of the supplemental investigation in the Northwest Wetland area (SW17/MP17, SW18/MP18, SW19/MP19 and SW20/MP20), which are to be added to the long-term monitoring network to enhance the monitoring of this wetland area.

To further enhance monitoring in the vicinity of the PSW area to the northwest of SW10, station SW21/MP21 (a surface water station / mini piezometer pair) is proposed to be installed in a deep portion of the wetland feature and at the wetland’s edge, respectively, to enhance long term monitoring in that area.

Two additional stations, SW22/MP22 and SW23/MP23 (surface water station / mini piezometer pair) are also proposed to be installed in the pond and wetted feature along Tributary #1 immediately west of the Main Area downstream of SW14/MP14, to further enhance monitoring of these features.

New surface water monitoring is also proposed along and proximal to the alignment of the discharge channel from the proposed Storm Water Pond to the Credit River. Specifically, SW24 is a surface water station proposed to be installed at the box culvert under the rail line east of the North Area, and SW25/MP25 is proposed to be installed in the wetted feature east of the rail line, both on CVC controlled-lands. The installation of these monitors will allow for the collection of baseline hydraulic data to assist in optimizing the channel, and help ensure that water is discharged in a manner that minimizes potential impacts to receptors.

Lastly, it is proposed that a baseline water quality monitoring station be set up at SW-CR to help establish baseline water quality in the Credit River, prior to the planned discharge of water from the Pit / Quarry operation. Together, these monitoring enhancements will allow for improved understanding of the flow regime, surface water and groundwater interactions in the receiving stream and waters associated with the dewatering channel pathway.

Additional information regarding scope and frequency for each type of monitor is provided in the table notes below.

Table 9-7: Off-Site Groundwater and Surface Water Monitoring Program

Name	Type	Easting	Northing	Monitoring Scope
MW20-02	Mon Well	577900	4852138	Water level[1,3]
MW20-03	Mon Well	578244	4851907	Water level[1,3]
MW20-04	Mon Well	578265	4852313	Water level[1,3]
MW20-05 A/B	Mon Well	578423	4852713	Water level[1,3]
MW20-06 A/B	Mon Well	578474	4852973	Water level[1,3]
MW20-13 A/B	Mon Well	576873	4854473	Water level[1,3]
MW20-13 C	Mon Well	576873	4854473	Water level[1,3]
MW20-19 A/B	Mon Well	576907	4852000	Water level[1,3]
MW20-20 A/B	Mon Well	576476	4852468	Water level[1,3]
MW20-20 C	Mon Well	576476	4852468	Water level[1,3]
MW20-21 A/B	Mon Well	576014	4852840	Water level[1,3]
MW20-22 A/B	Mon Well	575785	4851966	Water level[1,3]
MW20-23 A/B	Mon Well	576206	4851556	Water level[1,3]
MW20-23 C	Mon Well	576206	4851556	Water level[1,3]
MW20-27 A/B	Mon Well	575954	4853770	Water level[1,3]
SW4	SW	574760	4852963	Water level and temperature[2,4]
SW5	SW	575863	4853846	Water level and temperature[2,4]
SW8	SW	576054	4851688	Water level and temperature[2,3]
SW10	SW	579128	4850628	Water level and temperature[2,3]
SW11	SW	578238	4851869	Water level and temperature[2,4]
SW12	SW	576842	4854781	Water level and temperature[2,4]
SW13	SW	578153	4853488	Water level and temperature[2,3]
SW15/MP15	SW/MP	576562	4853501	Water level and temperature[2,3]
SW16/MP16	SW/MP	576024	4852785	Water level and temperature[2,3]
SW17/MP17	SW/MP	576488	4853803	Water level and temperature[2,3]
SW18/MP18	SW/MP	576396	4853993	Water level and temperature[2,3]
SW19/MP19	SW/MP	576226	4854106	Water level and temperature[2,3]
SW20/MP20	SW/MP	576819	4853890	Water level and temperature[2,3]
SW21/MP21	SW/MP	578215	4851865	Water level and temperature[2,3]

Name	Type	Easting	Northing	Monitoring Scope
SW24	SW	578193	4854455	Water level and temperature[2,4]
SW25/MP25	SW/MP	578138	4854525	Water level and temperature[2,4]
SW-CR	SW	578350	4854700	Water quality[4,5]

Notes:

1. Groundwater level to be monitored by logger set to record on 15-min intervals, with quarterly logger downloads and quarterly manual measurements.
2. Surface water level and temperature to be monitored by logger set to record on 15-min intervals, with quarterly logger downloads and quarterly manual measurements.
3. Located on lands / owned controlled by the licensee.
4. Located on public lands and monitoring to be completed subject to permission by the applicable public authority.
5. Water quality to be sampled and monitored in the Credit River 2x / year (April and September) for: Hardness (CaCO3), General Chemistry (i.e., pH, temperature, conductivity, dissolved oxygen, turbidity), Total Ammonia-N, Total Phosphorus, Alkalinity (Total as CaCO3), Dissolved Chloride (Cl-), Nitrite (N), Nitrate (N), Nitrate + Nitrite (N), Total Kjeldahl Nitrogen (TKN), Total Suspended Solids, Total Oil & Grease, Total Metals.

10.0 CUMULATIVE EFFECTS ASSESSMENT

A cumulative effects assessment was completed for the proposed Caledon Pit / Quarry generally following the guidance provided in *Cumulative Effects Assessment (Water Quality and Quantity) Best Practices Paper for Below-Water Sand and Gravel Extraction Operations in Priority Subwatersheds in the Grand River Watershed* (GRCA 2010). This guidance document provides a framework by which a technical study may meet the best-practices of a cumulative effects assessment, which has been followed herein, and is considered to be applicable to both pits and quarries.

Based on the assessment of cumulative effects outlined below, the proposed Caledon Pit / Quarry Project is not predicted to have a significant cumulative effect on the subwatershed, Erin Branch or Credit River Watershed.

10.1 Initial Assessment

The following initial assessment has been completed for the proposed Caledon Pit / Quarry Project.

Table 10-1: Initial Assessment to Evaluate Potential for Cumulative Effects

Initial Assessment	Caledon Pit / Quarry Project
Proximity to licenced above- and below-water aggregate extraction operations and the potential for overlapping cumulative effects including changes to surface water drainage patterns and water balance.	There are two pits located above the Niagara escarpment approximately 600 m southwest and downgradient of the Site. The potential for a significant overlapping cumulative effect is low. There are six pits located east of the Study Area and east of the Credit River, which are outside of the subwatershed. There is no potential for overlapping cumulative effects with these other aggregate sites east of the Credit River.
Proximity to licence applications for proposed above- and below- water extraction operations	The authors are not aware of other aggregate licence applications proximal to the Study Area.
Degree of environmental degradation existing within the subwatershed, if available (e.g., ground water/surface water quantity and quality, impacts on natural features and functions, ecosystem health)	The impact assessment (Section 9) did not identify significant environmental degradation within the subwatershed.
Potential impacts on the level of stress that the proposed below-water aggregate extraction operation may have on the subwatershed.	The impact assessment (Section 9) did not identify an unacceptable increase in stress to the subwatershed as a result of this proposed aggregate extraction.
Proximity to municipal water wells and intakes, if the information is available	The Site is within the Credit Valley Source Protection Area but is not located in a wellhead protection area (WHPA) or an intake protection zone (IPZ), therefore the Project will not impact municipal water supplies.

Initial Assessment	Caledon Pit / Quarry Project
Vulnerability of the groundwater resources in the subwatershed and the potential impact that the proposed below-water aggregate extraction operation may have on vulnerability (if any).	A small portion of Main Area, a very small portion of the North Area and the majority of the South Area is mapped as a Highly Vulnerable Aquifer on the Region of Peel Schedule A-2 (Highly Vulnerable Aquifers). Based on the design of the operation, and the implementation of the recommendations contained this Report, the proposed Caledon Pit / Quarry does not result in additional risk to the aquifer. Almost all of the Rural Area in the Region of Peel including the Main Area, North Area and South Area are mapped as a Significant Groundwater Recharge Area on the Region of Peel Schedule A-3 (Significant Groundwater Recharge Area). Based on the design of the operation, and the implementation of the recommendations contained in this report, the groundwater recharge function of the area (i.e., providing flow to the Credit River) will be maintained, and will report to the Credit River and its tributaries via quarry dewatering (operational) or groundwater inputs and lake outflows (rehabilitation).
Other activities or features in the study area that could significantly affect or rely on groundwater resources.	Osprey Valley Golf Course (commercial / irrigation) – PTTW 1807-AC9P9J (Active) – The proposed pit /quarry is not considered to have a cumulative effect on this water taking, as the two activities (i.e. water taking upstream from the Credit River for irrigation and dewatering the pit / quarry southwest of the golf course and discharging collected water to the Credit River) do not appear to have overlapping zones of influence. AquaTerra Corporation (bottled water) – PTTW 7541-72ZM8Z (Expired) – The proposed pit /quarry is not considered to have a cumulative effect on this water taking, as the two activities do not appear to have an overlapping zone of influence.

10.2 Local Scale Cumulative Effects

The following potential for local scale cumulative effects have been considered and assessed for the Caledon Pit / Quarry Project.

Table 10-2: Local Scale Cumulative Effects

Local Scale Cumulative Effects	Caledon Pit / Quarry Project
Characterize the existing conditions at the site and in the vicinity of the site, and during the extractive and rehabilitation stages.	The Water Report meets the required characterization scope.
Assess the potential impacts to groundwater and surface water resources from the proposed below water sand and gravel extraction operation relative to the impacts of existing above - and below water sand and gravel extraction operations for all development stages.	The Water Report meets the required impact assessment scope (Section 9)
Establish monitoring requirements to identify and distinguish between individual and cumulative effects.	The Water Report includes a proposed monitoring program (Section 9.8) and recommends a follow-up Private Well Survey be conducted prior to the start of aggregate extraction operations (Section 11.2).
Establish a mitigation and implementation plan, as appropriate.	The impact assessment (Section 9) does not predict significant cumulative impacts to water resources.
The cumulative impact assessment should consider impacts from both a spatial and a temporal perspective.	This Water Report considered temporal and spatial impacts on the Local Scale and did not predict significant impacts to water resources (Section 9).
Temporal impacts may occur where potential operations overlap in time and duration. The applicant should assess cumulative effects resulting from existing conditions and potential impacts that could reasonably be expected to occur in the future due to other aggregate operations.	This is discussed in Section 10.3.

10.3 Watershed / Subwatershed Cumulative Effects

The following potential for Watershed/Subwatershed cumulative effects have been considered and assessed for the Caledon Pit / Quarry Project.

Table 10-3: Watershed/Subwatershed Scale Cumulative Effects

Watershed/Subwatershed Scale Cumulative Effects	Caledon Pit / Quarry Project
The appropriate scale for this assessment is typically the quaternary-level watersheds. A broader scale approach may be encouraged if the proposed aggregate operation drains directly to a higher-level watershed or if reasonably-anticipated potential cumulative effects are likely to occur at a broader scale.	The groundwater modelling (Section 8) carried out as part of the Water Report used an appropriate scale to assess potential effects, and the Impact Assessment (Section 8) did not predict there to be impacts at the that scale during any phase of proposed operation.
Through a hydrogeological assessment, each successive applicant for a below-water extraction licence or licence amendment, will be encouraged to provide information and analyses that will place the impacts of their proposal into the subwatershed context.	The Impact Assessment (Section 9) and Cumulative Effects Assessment (Section 10) satisfies this requirement.

11.0 CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

Based on this water resources assessment, present for following conclusions regarding the proposed Caledon Pi / Quarry project.

- The proposed Caledon Pit / Quarry is within the Credit Valley Source Protection Area but is not located in a wellhead protection area (WHPA) or an intake protection zone (IPZ) and there will be no impacts to municipal water supplies.
- Of the approximately 100 water supply wells evaluated a majority of the wells are located at a depth below the proposed pit / quarry floor and they will not be impacted. There are 15 residential wells that have the potential to be impacted during operations by the proposed pit / quarry development. These 15 wells are susceptible to water quantity impacts due to their location relative to the predicted zone of influence of the Site, and their relatively shallow well construction in comparison to other wells in the area.
- In all cases, these wells could be deepened to the depth of other wells in the surrounding area to restore the water supply. In the event of a water well complaint there is an established procedure that the licensee must follow which requires an immediate investigation and supply of temporary water if required. In the event, any well was impacted by the proposed pit / quarry operation it is the licensee's responsibility to restore the water supply, at their expense.
- As part of the operation there will be an extensive on-site and off-site groundwater monitoring program and annual reports that will be submitted to the government agencies and publicly available. As a result of the proposed design of the quarry, the comprehensive groundwater monitoring and reporting requirements and the water well complaint procedure, it is concluded that water supply wells in the surrounding area will be protected.
- The proposed extraction area does not contain any identified water resources on the Region of Peel Schedule A-1 (Water Resources, Systems and Features). The proposed licence area includes an identified feature in the northwest corner of the Main Area and this feature is located outside of the extraction area and will be protected.
- A small portion of Main Area, a very small portion of the North Area and the majority of the South Area is mapped as a Highly Vulnerable Aquifer on the Region of Peel Schedule A-2 (Highly Vulnerable Aquifers). This is very common for mineral aggregate resource areas, and based on the design of the operation, and the implementation of the recommendations contained this Report, the proposed Caledon Pit / Quarry does not result in additional risk to the aquifer.
- Almost all of the Rural Area in the Region of Peel including the Main Area, North Area and South Area are mapped as a Significant Groundwater Recharge Area on the Region of Peel Schedule A-3 (Significant Groundwater Recharge Area). This is very common for mineral aggregate resource areas, and based on the design of the operation, and the implementation of the recommendations contained in this report, the groundwater recharge function of the area (i.e., providing flow to the Credit River) will be maintained, and will report to the Credit River and its tributaries via quarry dewatering (operational) or groundwater inputs and lake outflows (rehabilitation).

- There are no key hydrologic features located within the proposed extraction area. There is a 0.1 ha key hydrologic feature (i.e., wetland) that will be impacted for the construction of the proposed berm and this feature is permitted to be removed in accordance with applicable policies. There are also key hydrologic features (i.e., wetland and tributary) in the northwest corner of the Main Area and these features will be protected. Taking into consideration the rehabilitation plan, there are 4.8 ha of wetland to be created and 158.3 ha lake to be created resulting in 163 ha of new key hydrologic features.
- The extraction of aggregates and creation of ponds at the Site upon rehabilitation is not predicted to have adverse impacts on the local surface water hydrology of the Credit River or the surrounding tributaries/water features with the exception of Tributary #1, Tributary #8, and the golf course ponds at SW13, via land use changes, surface water drainage alterations and / or quarry operation. The decrease in surplus and increase in groundwater drawdown, over the operational period, to the remaining adjacent tributaries/water features is predicted to have minor localized impacts to flow that will see a total decrease in flow of less than 9% of existing flows. The decrease in surplus and increase in groundwater drawdown, over the operational period, at Tributaries #1 and #8 as well as the two golf course ponds situated adjacent to SW13 is predicted to have minor localized impacts to flow that will see a total decrease in flow of less than 25% of existing flows.
- Compared to existing conditions, average annual surplus over the Site footprint area increases under operational conditions by approximately 18%, while under rehabilitated conditions the surplus decreased by approximately 14%.
- Compared to existing conditions (579,245 m^3/yr), average annual infiltration decreases over the Site footprint area under operational and increases under rehabilitated conditions to 281,245 m^3/yr and 628,000 m^3/yr, respectively.
- Compared to existing conditions (312,385 m^3/yr), average annual on-Site runoff increases under operational conditions to 767,780 m^3/yr and decreases under rehabilitated conditions to 136,925 m^3/yr.
- The application includes detailed monitoring and reporting requirements to ensure adjacent sensitive groundwater features and sensitive surface water features will be assessed as extraction proceeds to help ensure these features will be protected, improved or restored.
- With the implementation of the recommendations in this Report, sensitive surface water features and sensitive groundwater features will be protected, improved and restored during operations.
- Taking into account rehabilitation, there will be a long-term enhancement to the water resources system and features.

11.2 Recommendations

The results of this assessment provide the basis for the following technical recommendations to be included in the Aggregate Resources Act Site Plans for the proposed Caledon Pit / Quarry.

Operational Plan

- The Aggregate Resources Act Site Plans shall identify the maximum groundwater table elevation based on groundwater levels monitored over a 12 month period from January to December 2021, as illustrated on Figure 5-6 and described below:
  - Main Area – ranges from 420.7 to 393.5 masl (north to southwest)

- North Area– ranges from 407.0 to 397.3 masl (northwest to southeast)
- South Area– ranges from 405.3 to 391.0 masl (northeast to south)

- Prior to below water extraction, the licensee shall complete a follow-up door-to-door survey of private wells for properties within 1,000 m of the licence area, to supplement and verify the MECP WWIS information, to confirm neighbouring water users and confirm baseline conditions prior to below water extraction commencing. Landowner participation in this private well survey is voluntary.
- Prior to below water extraction, the licensee shall obtain and operate in accordance with a Permit To Take Water and Environmental Compliance Approval under the Ontario Water Resources Act to permit the water management activities needed to operate the pit / quarry. These activities include:
  - Pumping, collection, storage and discharge of pit / quarry water; and
  - Construction and operation of an aggregate wash plant.
- The approved monitoring programs defined in the Permit to Take Water and/or Environmental Compliance Approval shall, at a minimum, include all groundwater and surface water monitoring requirements as outlined below:
  - On-site monitoring shall include the wells, surface water stations and mini-piezometers listed in Table 9-6, and shall include the scope and frequency specified in Table 9-6; and
  - Off-site monitoring shall include the wells, surface water stations and mini-piezometers listed in Table 9-7, and shall include the scope and frequency specified in Table 9-7, subject to landowner approval.
- In the event of a well complaint (domestic / farm wells) the licensee shall implement the Well Complaint Response Protocol as specified in Appendix R.
- The licensee shall submit an annual water resources monitoring report to MNRF, MECP, Town of Caledon and CVC. The annual report shall also include a summary of any water related complaint and the actions taken by the licensee to address the issue.
- During operations, the sump in each pit / quarry area shall be located near the lowest point of elevation on the current pit / quarry floor. The position of the sump at a given point in time will be dictated by direction of extraction and elevation of the base of the current pit / quarry floor within each quarry area, and shall generally be as follows:
  - Main Area - the sump shall be located in the most southwestern area of the current pit / quarry floor, at the point of lowest elevation;
  - North Area - the sump shall be located in the most southwestern area of the current pit / quarry floor, at the point of lowest elevation; and
  - South Area - the sump shall be located in the most southeastern area of the current pit / quarry floor, at the point of lowest elevation.
- Excess water collected in the sump(s) shall be pumped to a settling pond located on the east side of the North Area, from which water will flow by gravity for off-site discharge to the Credit River.

- Subject to an agreement with CVC, the licensee shall install an armoured channel with rip rap on lands owned by CVC to convey the water from the settling pond to the east towards the Credit River.
- Subject to an agreement with the Region of Peel the licensee shall construct piping under Main Street and Charleston Sideroad for the transfer of water from the Main and South Areas to the North Area.
- An aggregate washing operation may be established in the Main Area utilizing up to a 1 to 2 ha sized pond for the storage of wash water in a closed-loop system. Wash water will be sourced from the pit / quarry sump, and top-up water will be added to the wash pond as needed during operations, in order to maintain sufficient water for the operation. Aggregate washing operations shall be completed in accordance with the Permit To Take Water and Environmental Compliance Approval under the Ontario Water Resources Act.
- All fuel storage and handling on site shall be completed in accordance with applicable TSSA Standards. The on-site storage and servicing of machinery shall be carried out in accordance with established best practices and is protective of the environment. The use and storage of hazardous substances shall follow applicable workplace hazardous materials regulations, including O.Reg. 860/93, as amended.

Rehabilitation Plan

- Once operations in the North Area, South Area and Main Area have been completed and the rehabilitated landform has been created, pumping will cease and allowed to flood and form the Main, North and South ponds. The Main, North and South pond water levels post-rehabilitation are predicted to reach a level of approximately ~400, ~399 and ~392 masl, respectively.
  - The South pond would be self contained and not require an overflow outlet;
  - The Main pond overflow shall be directed via a culvert under Main Street to the North pond with its outlet invert at ~400 masl; and
  - The North pond overflow shall be directed via main outlet to the Credit River with its outlet invert at ~399 masl.
- All rehabilitated pond levels and outlets will be passive and not require pumping;

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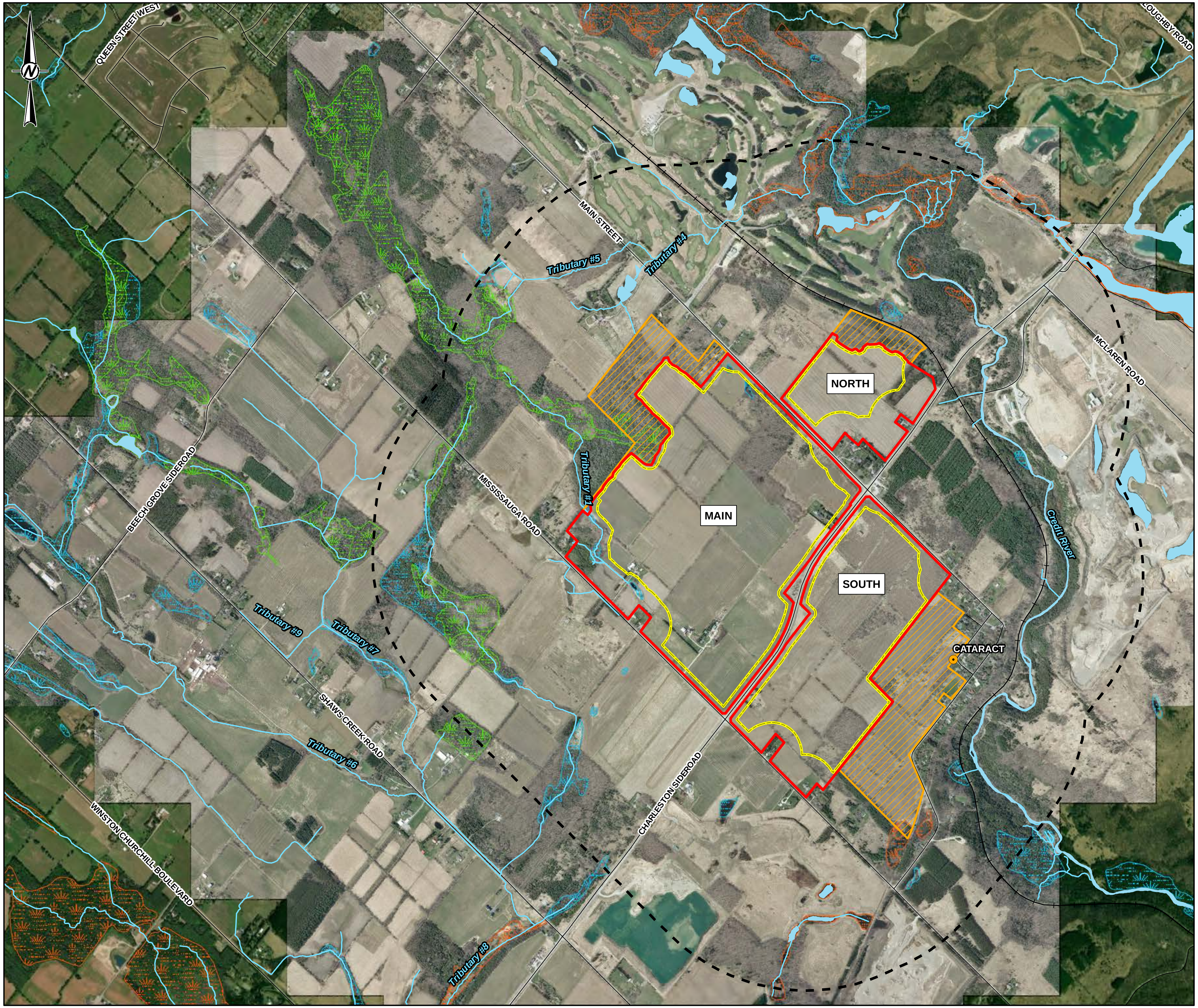
https://golderassociates.sharepoint.com/sites/114392/project files/6 deliverables/ph 2300-hydrogeology/300 water resources report/19129150 rpt caledon water report r3c (final live copy).docx

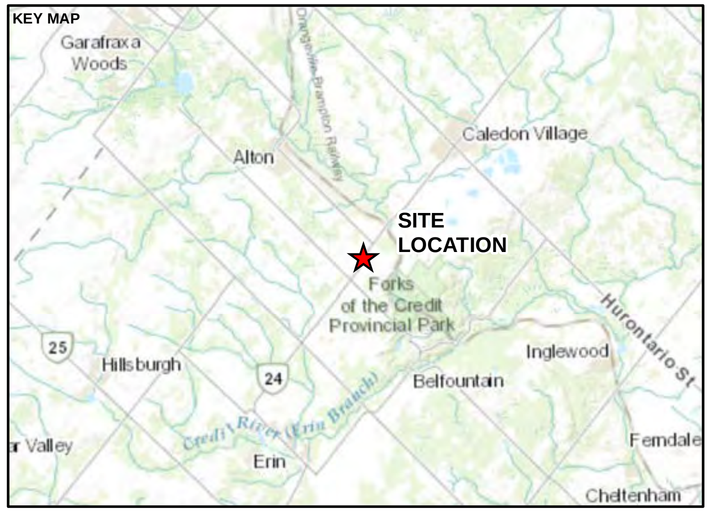
FIGURES



LEGEND

- TOWN/VILLAGE
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- 1 km LICENCE BOUNDARY BUFFER
- LIMIT OF EXTRACTION
- LICENCE BOUNDARY
- ADDITIONAL LANDS OWNED / CONTROLLED BY CBM

KEY MAP



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REFERENCE(S)

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2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
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4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

TITLE
STUDY AREA

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	SO
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
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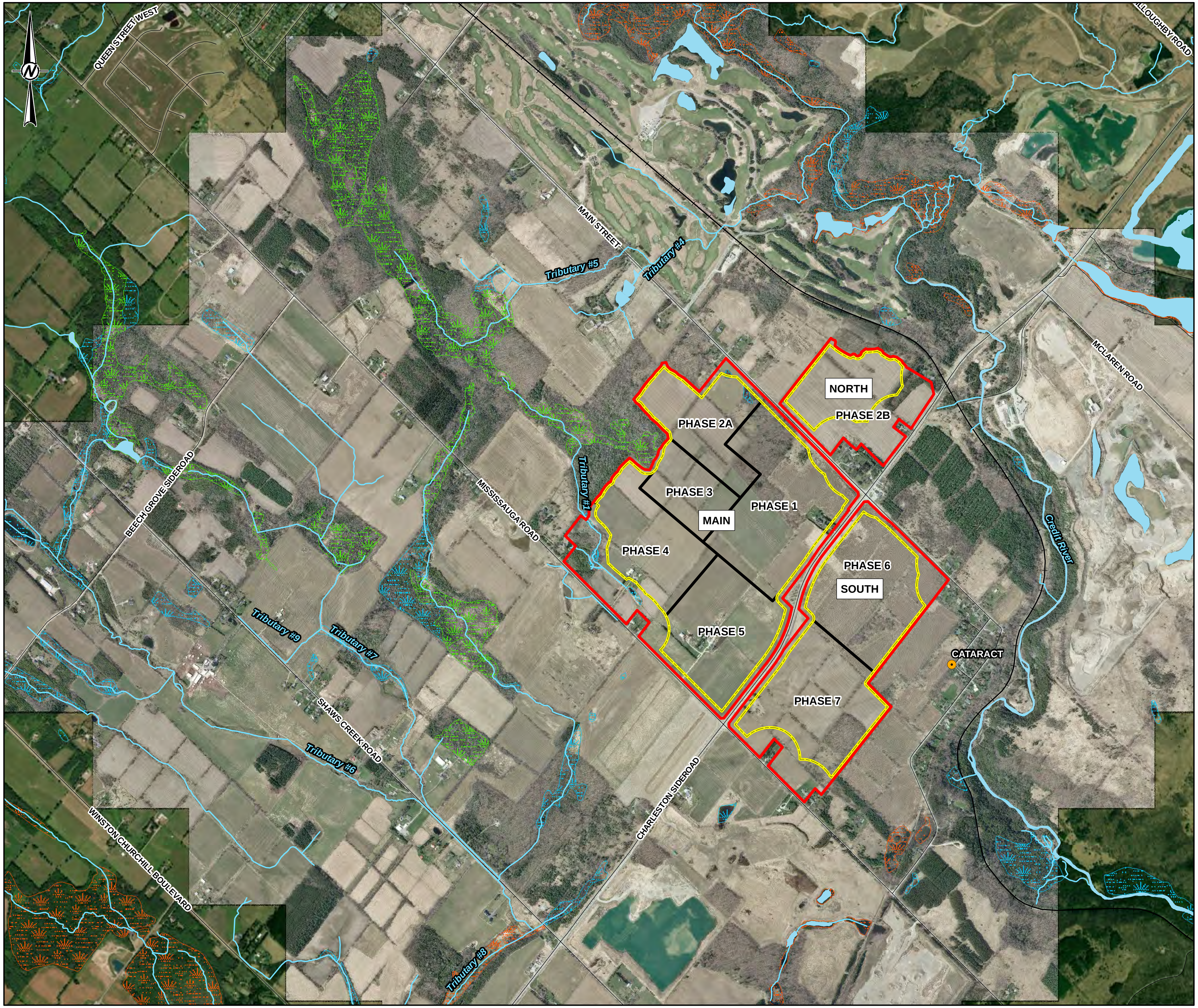

LEGEND

- TOWN/VILLAGE
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- EXTRACTION PHASE

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REFERENCE(S)

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3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

TITLE
OPERATIONAL PHASES

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-15
DESIGNED	SO
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
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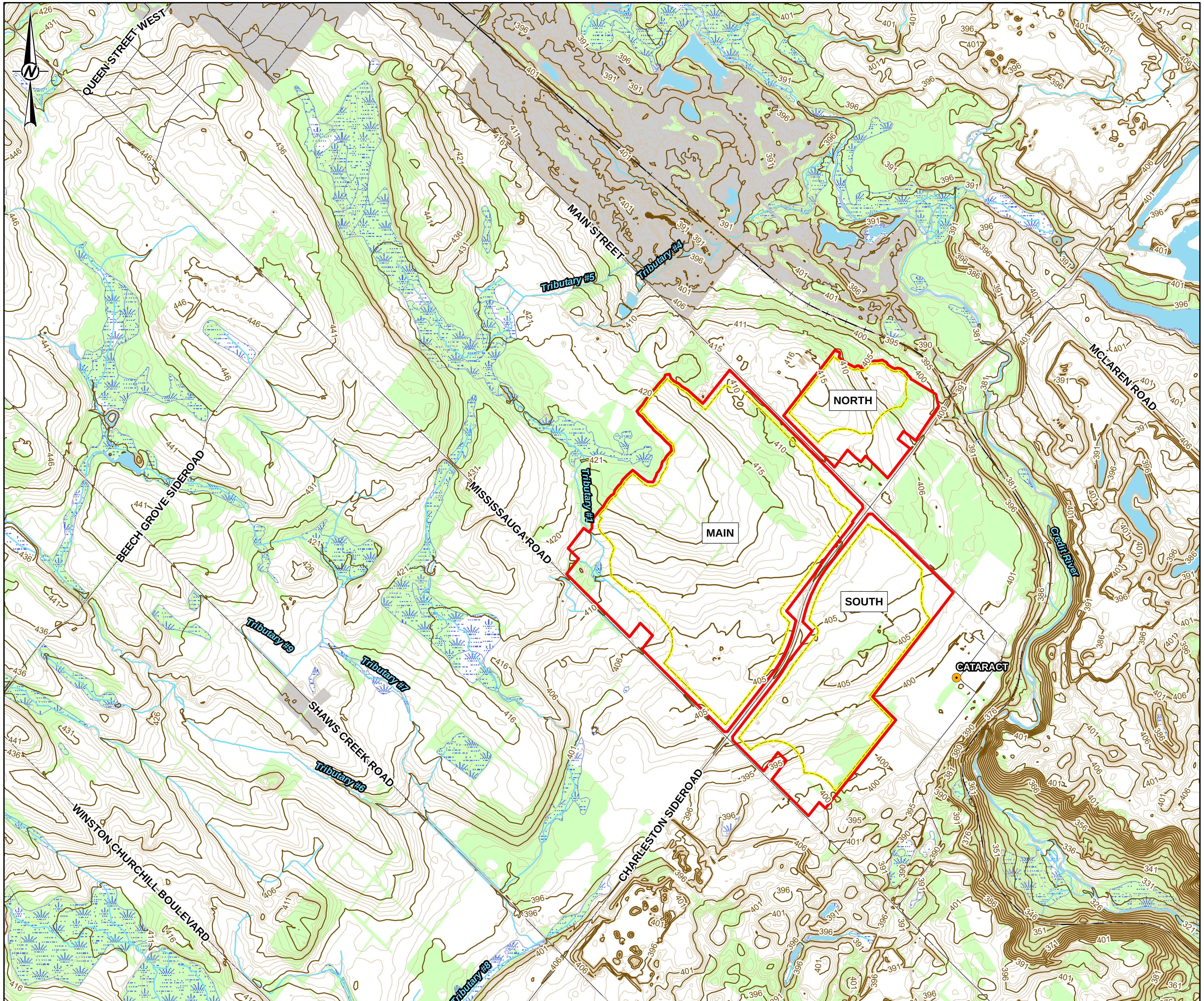

LEGEND

- TOWN/VILLAGE
- ROAD
- RAILWAY
- CONTOUR (5 m INTERVAL)
- CONTOUR (1 m INTERVAL)
- WATERCOURSE
- WATERBODY
- WETLAND
- WOODED AREA
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

0 500 1,000

1:20,000 METRES

REFERENCE(S)
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4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

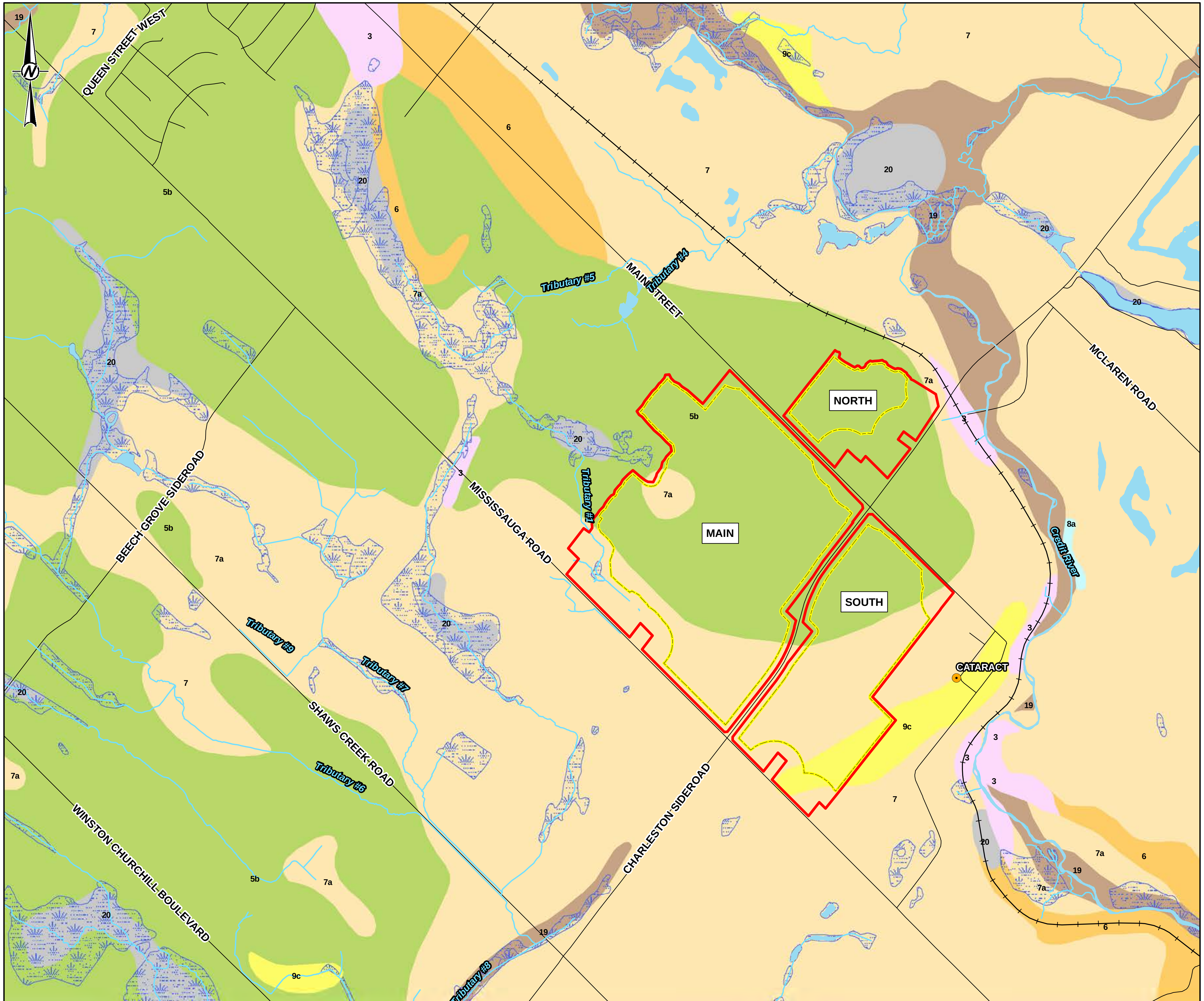
TITLE
TOPOGRAPHY AND DRAINAGE

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-15
DESIGNED	SO
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	3-1



LEGEND

- TOWN/VILLAGE
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

SURFICIAL GEOLOGY

- 3: PALEOZOIC BEDROCK
- 5B: STONE-POOR, CARBONATE-DERIVED SILTY TO SANDY TILL
- 6: ICE-CONTACT STRATIFIED DEPOSITS
- 7: GLACIOFLUVIAL DEPOSITS
- 7A: SANDY DEPOSITS
- 8A: MASSIVE-WELL LAMINATED
- 9C: FORESHORE-BASINAL DEPOSITS
- 19: MODERN ALLUVIAL DEPOSITS
- 20: ORGANIC DEPOSITS

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASEDATA MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. ONTARIO GEOLOGICAL SURVEY 2003: MRD128-SURFICIAL GEOLOGY OF SOUTHERN ONTARIO, (MNDM)
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

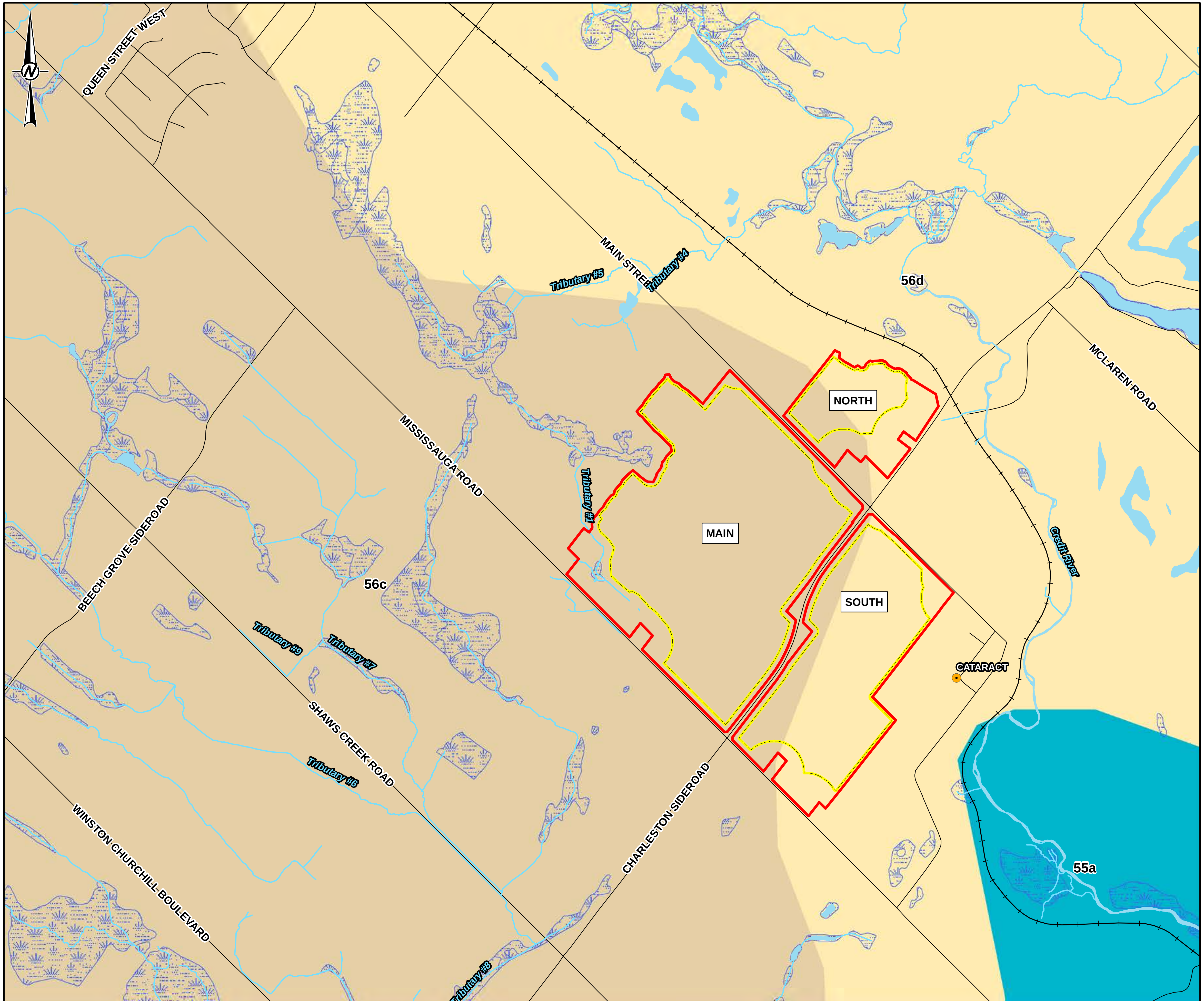
TITLE
SURFICIAL GEOLOGY FROM OGS (2003)

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	SO
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	3-2



LEGEND

- TOWN/VILLAGE
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

BEDROCK GEOLOGY

- 56C GASPORT FM
- 56D FOSSIL HILL FM / CABOT HEAD FM / MANITOULIN FM / WHIRLPOOL FM
- 55A QUEENSTON FM

0 500 1,000
1:20,000 METRES

REFERENCE(S)

1. BASEDATA MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. ONTARIO GEOLOGICAL SURVEY 2011: MRD126-REV1-BEDROCK GEOLOGY OF ONTARIO, (MNDM)
4. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

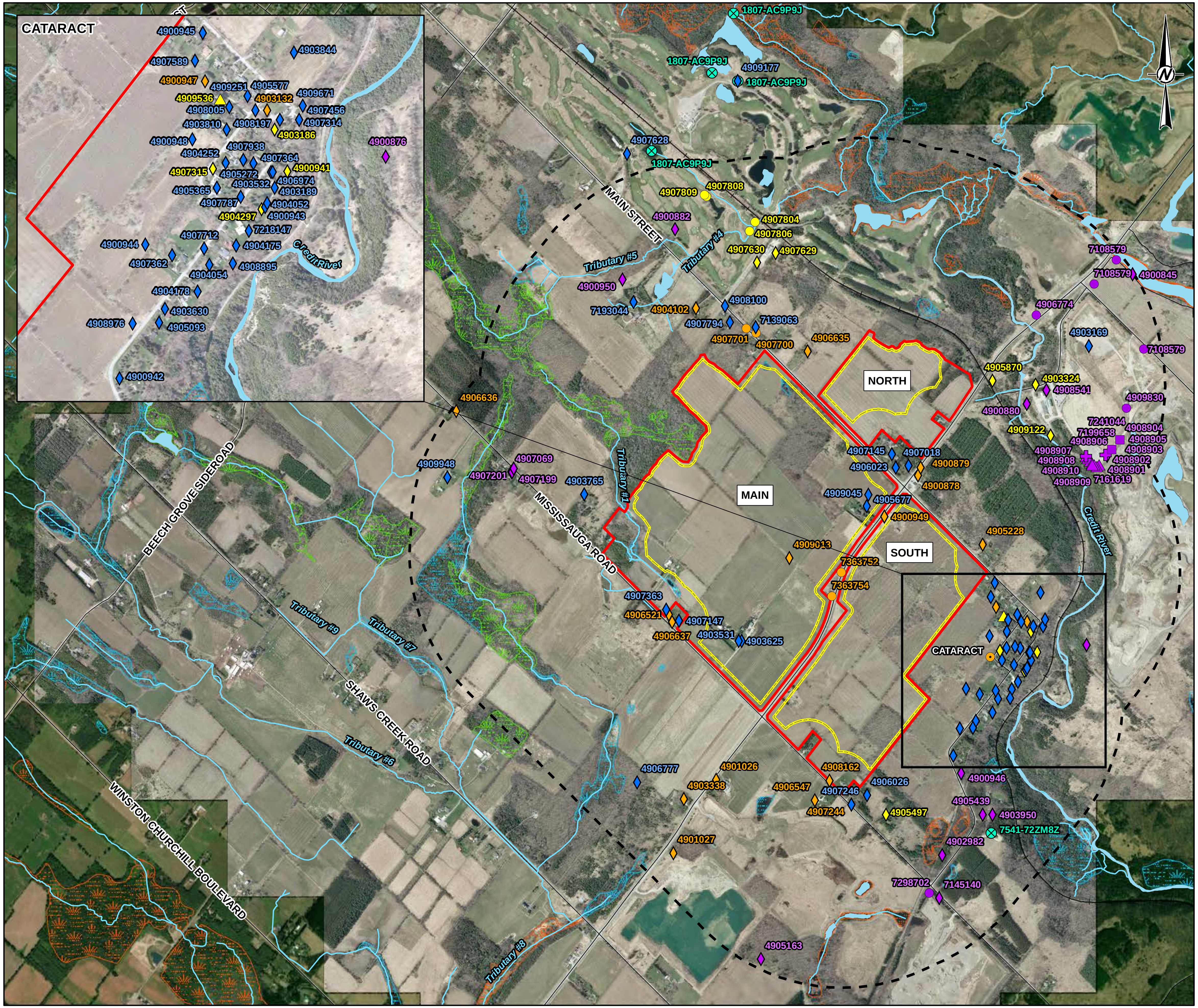
TITLE
BEDROCK GEOLOGY FROM OGS (2011)

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	SO
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	3-3



LEGEND

- TOWN/VILLAGE
- PERMIT TO TAKE WATER

WATER WELL RECORD BY AQUIFER CLASSIFICATION

BEDROCK (BELOW GASPORT)
- Observation Wells
- Recharge Well
- Water Supply

BEDROCK (GASPORT AND LOWER)
- Water Supply

BEDROCK (GASPORT)
- Observation Wells
- Water Supply

OVERBURDEN
- Dewatering
- Observation Wells
- Other Status
- Recharge Well
- Water Supply

- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- WOODED AREA
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- 1 km LICENCE BOUNDARY BUFFER

REFERENCE(S)

1. BASEDATA MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

TITLE
WATER WELL RECORDS AND PERMITS TO TAKE WATER

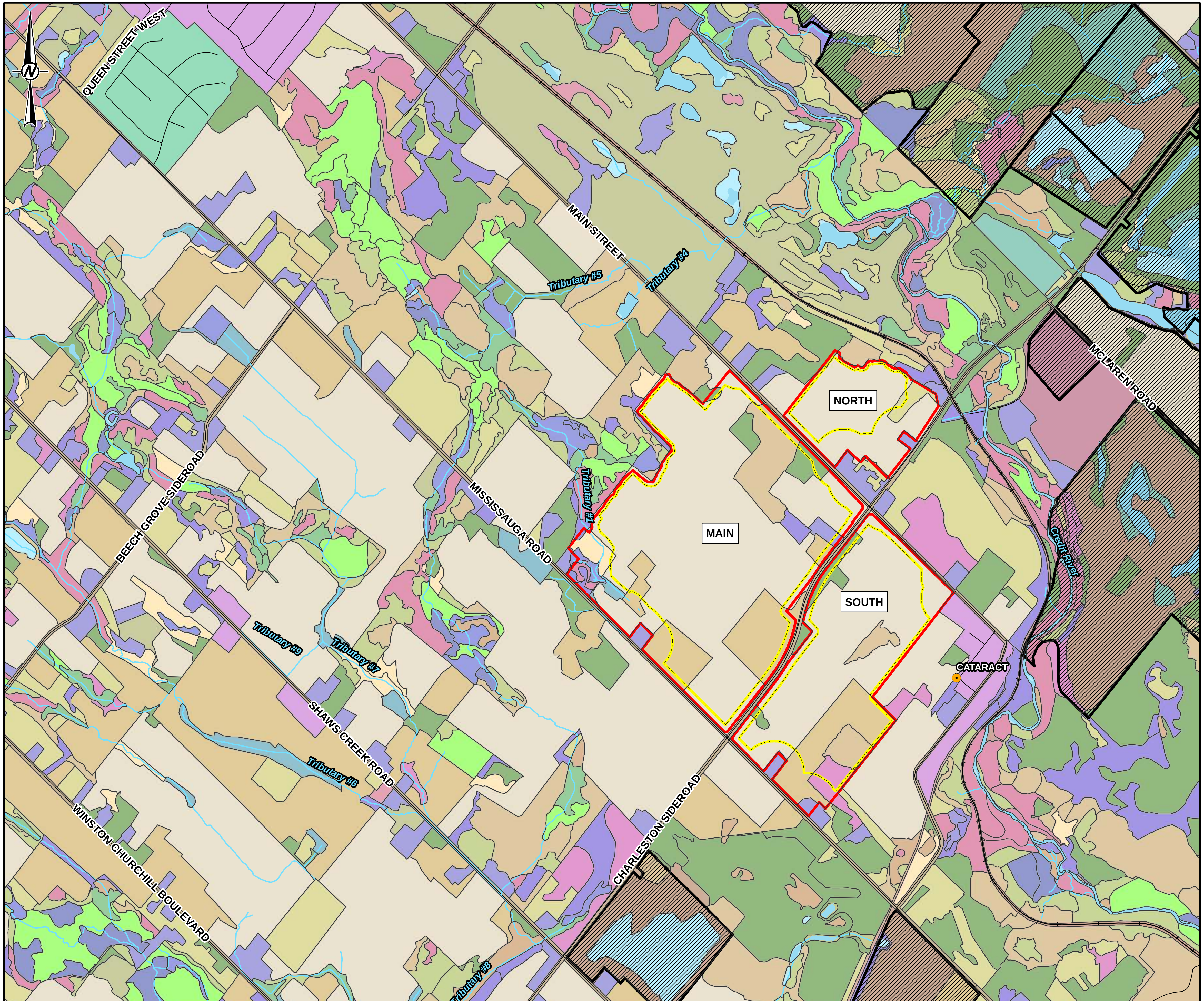
CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	SO
PREPARED	SO
REVIEWED	VP
APPROVED	GWS

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	3-4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm



LEGEND

- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- ACTIVE AGGREGATE SITE

LAND USE

- ACTIVE AGGREGATE
- CONIFEROUS FOREST
- CONIFEROUS PLANTATION
- CONIFEROUS SWAMP
- CONSTRUCTION
- CULTURAL MEADOW
- CULTURAL SAVANNAH
- CULTURAL THICKET
- CULTURAL WOODLAND
- DECIDUOUS FOREST
- DECIDUOUS SWAMP
- FLOATING-LEAVED SHALLOW AQUATIC
- GENERAL URBAN
- INACTIVE AGGREGATE
- INTENSIVE AGRICULTURE
- LANDFILL
- MAJOR TRAIL
- MANICURED OPEN SPACE
- MARSH
- MIXED FOREST
- MIXED PLANTATION
- MIXED SWAMP
- NON-INTENSIVE AGRICULTURE
- OPEN AQUATIC
- RAILROAD
- REGIONAL ROAD
- RURAL DEVELOPMENT
- SHRUB FEN
- SUBMERGED SHALLOW AQUATIC
- THICKET SWAMP
- TREED BLUFF
- WET MEADOW

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASEDATA MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3, LANDUSE OBTAIANED FORM THE CREDIT VALLEY CONSERVATION AUTHOIRTY OPEN DATA PORTAL NOVEMBER 2022.
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

TITLE
NEIGHBOURING LAND USES / OTHER AGGREGATE SITES

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	SO
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	3-5

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

25mm 0

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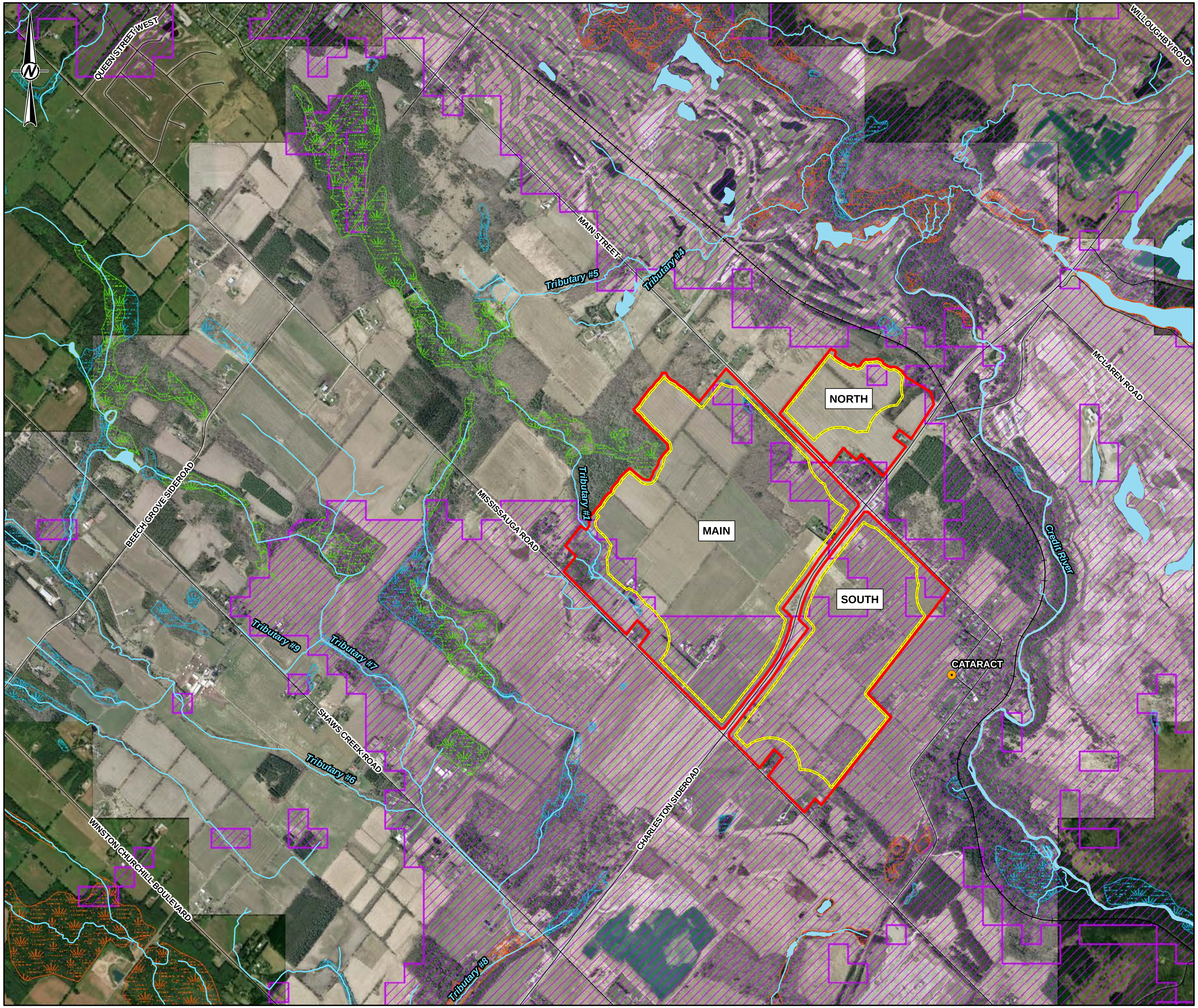

LEGEND

- TOWN/VILLAGE
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- HIGHLY VULNERABLE AQUIFERS

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASEDATA MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

TITLE
HIGHLY VULNERABLE AQUIFERS

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	SO
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	3-6

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

25mm

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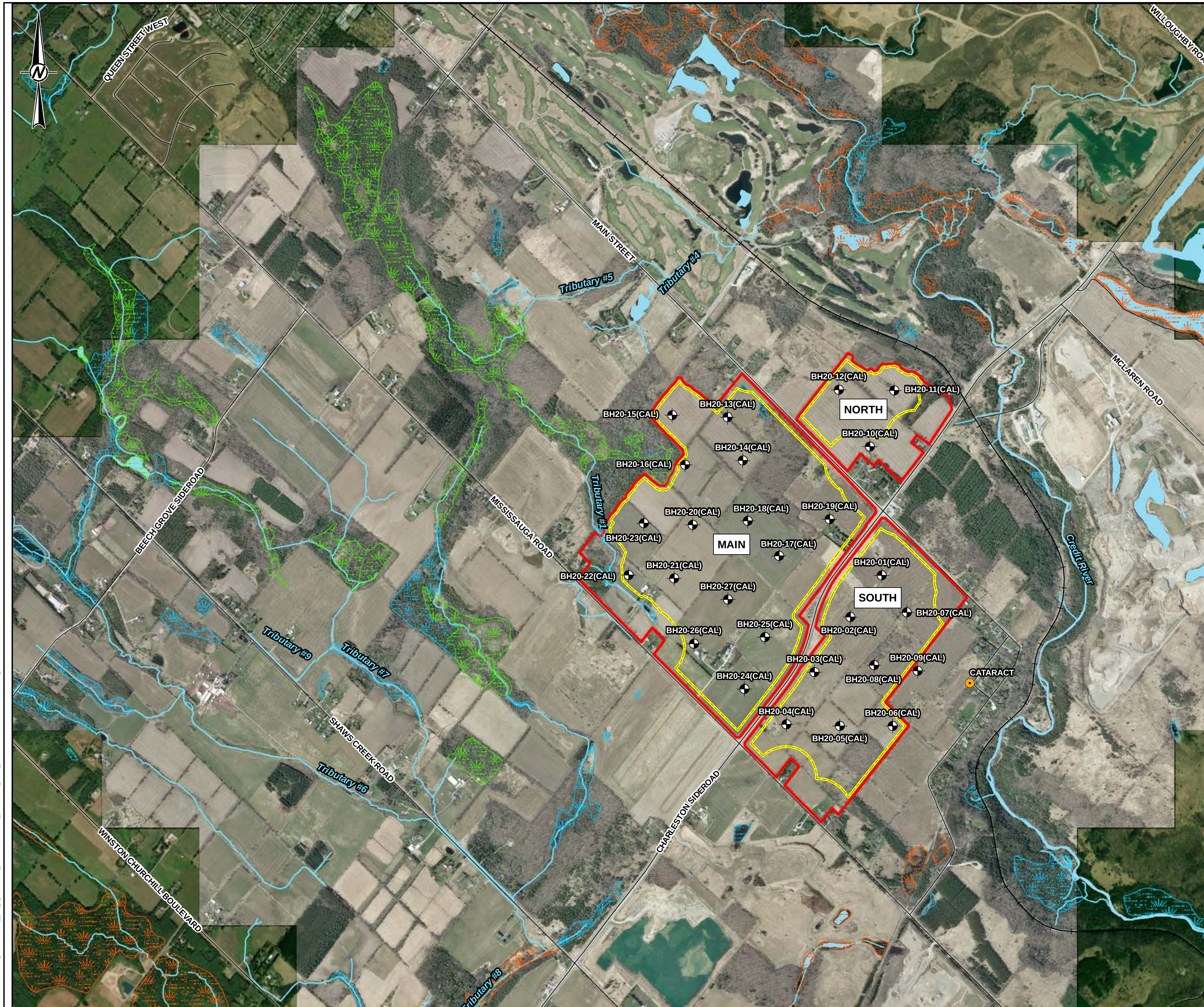

LEGEND

- TOWN/VILLAGE
- BOREHOLE
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
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SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
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5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

TITLE
BOREHOLE LOCATIONS - RESOURCE DRILLING

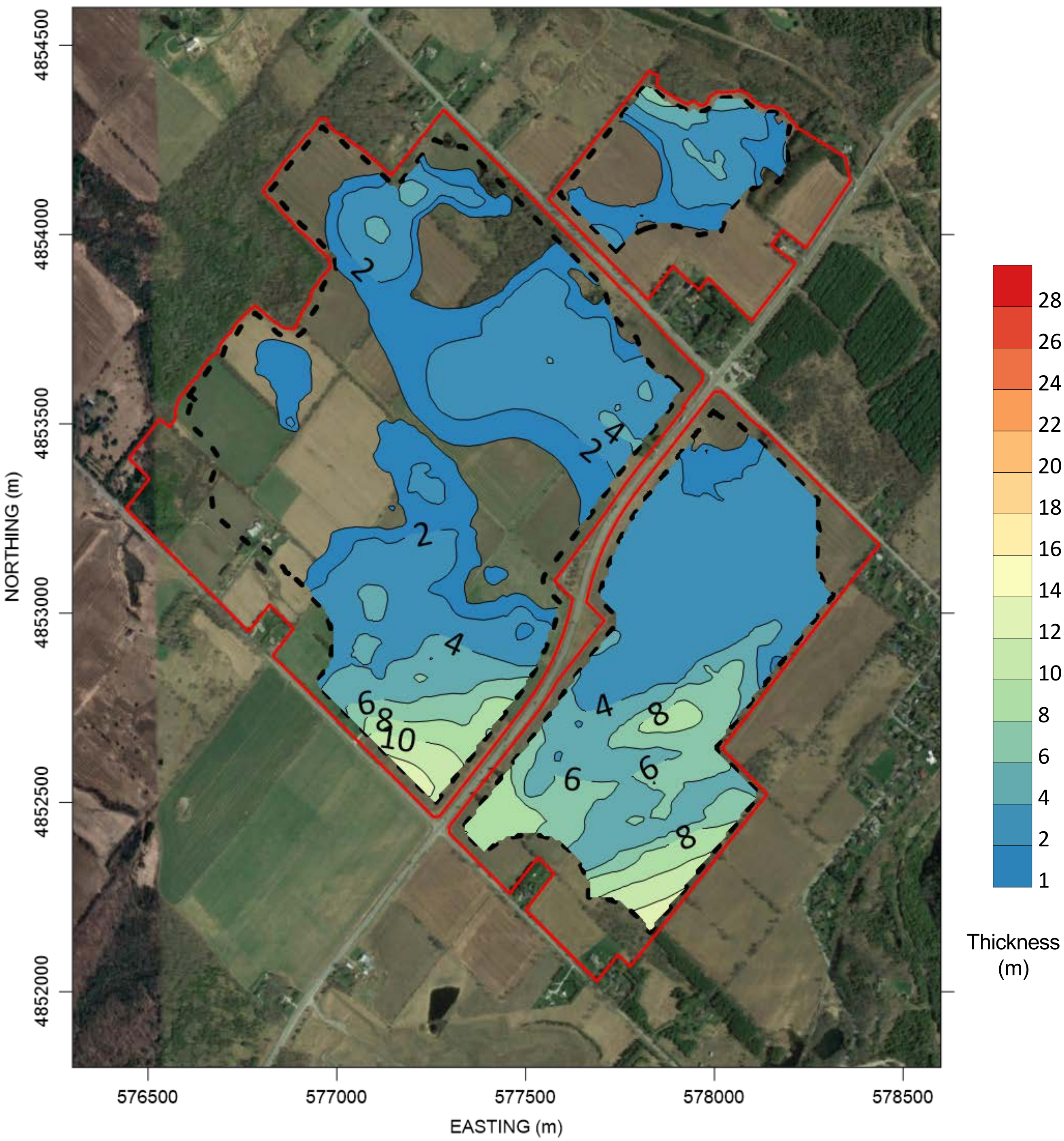
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	4-1

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

25mm 0



LEGEND

NOTE

CLIENT
CBM Aggregates, a division of St. Marys Cement Inc. (Canada)

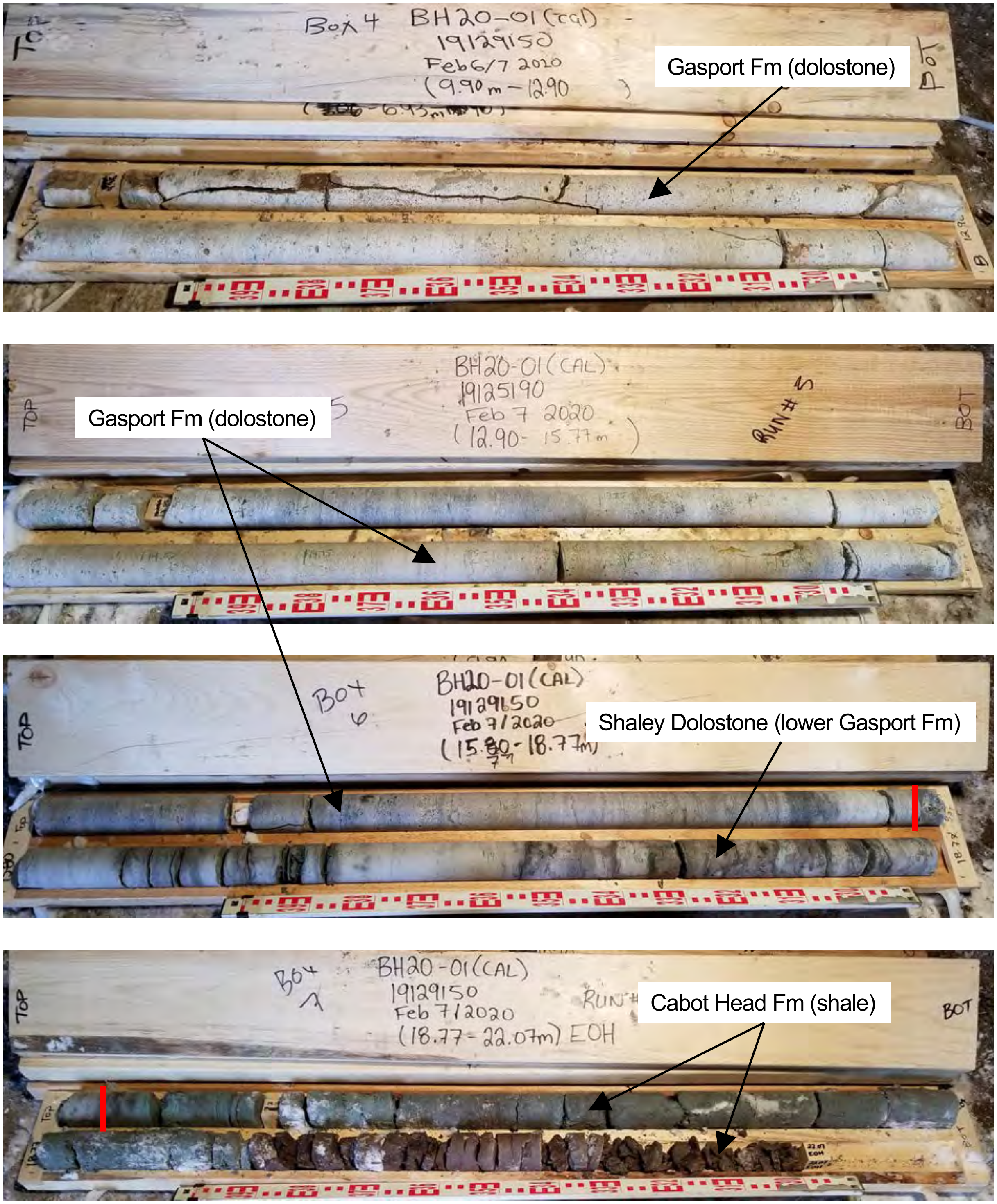
PROJECT
Caledon Pit / Quarry
Water Resources Report

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-11-12
PREPARED	HW
DESIGN	GWS
REVIEW	GRP
APPROVED	GWS

TITLE
Inferred Sand and Gravel Thickness
Determined from Resource Borehole Drilling

PROJECT No. **19129150** Rev. **A** FIG. **4-2**



LEGEND

Geologic Contact

NOTE

1. Borehole drilled February 6-7, 2020
2. Logged and photographed by Golder field staff

CLIENT
CBM Aggregates, a division of St. Marys Cement Inc. (Canada)

PROJECT
Caledon Pit / Quarry
Water Resources Report

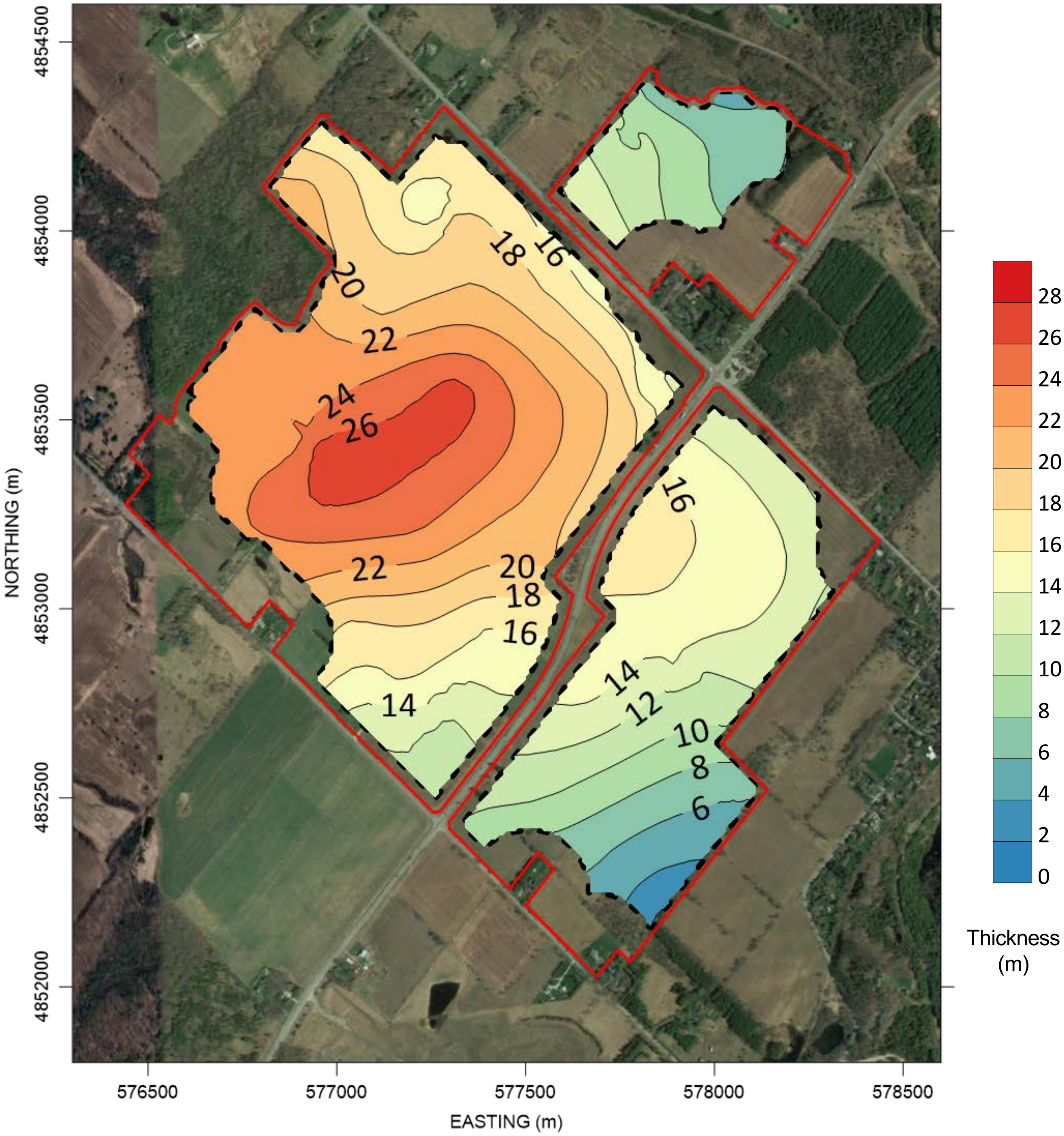
CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-11-12
PREPARED	AL
DESIGN	GWS
REVIEW	GRP
APPROVED	GWS

TITLE
Example HQ Rock Core
Caledon Borehole BH20-01(CAL)

PROJECT No.	Rev.	FIG.
19129150	**A**	**4-3**



LEGEND

NOTE

CLIENT
CBM Aggregates, a division of St. Marys Cement Inc. (Canada)

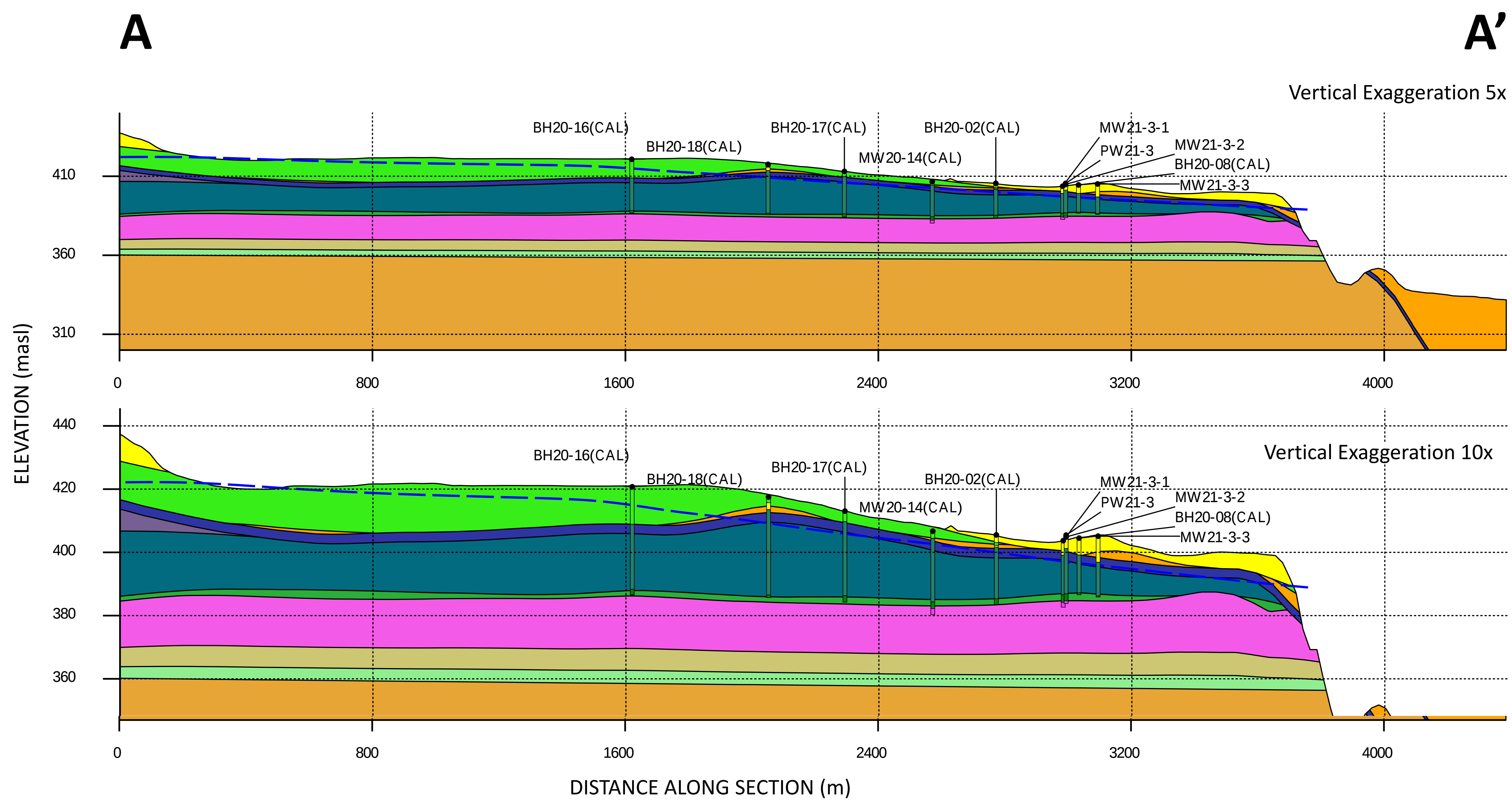
PROJECT
Caledon Pit / Quarry
Water Resources Report

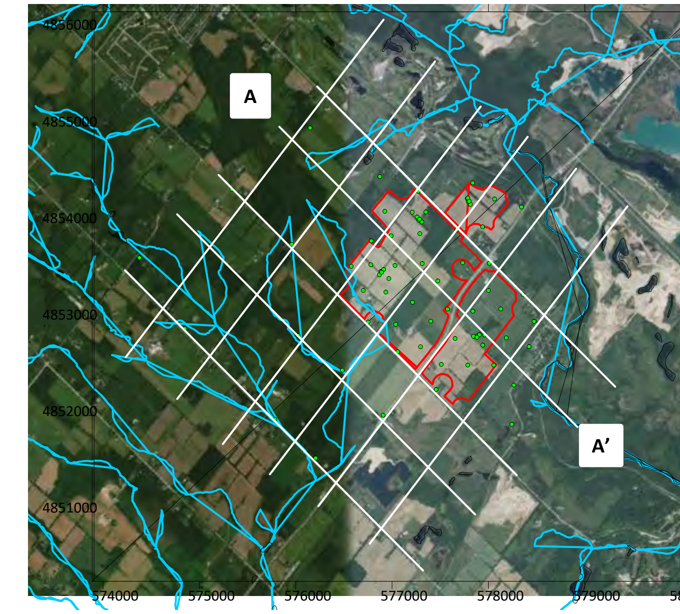
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-11-12
PREPARED	HW
DESIGN	GWS
REVIEW	GRP
APPROVED	GWS

TITLE
Inferred Gasport Formation Thickness
Determined from Resource Borehole Drilling

PROJECT No.	Rev.	FIG.
19129150	**A**	**4-4**





LEGEND

- Eramosa Formation (Dolostone)
- Goat Island Formation (Dolostone)
- Gasport Formation (Dolostone)
- Shaley Dolostone
- Cabot Head Formation (Shale)
- Manitoulin Formation (Shaley Dolostone)
- Whirlpool Formation (Sandstone)
- Queenston Formation (Shale
- Lower Sand/ Channel Sediment
- Till
- Upper Sand
- Weathered Bedrock
- Average Water Level (Site Wells)

CLIENT
CBM Aggregates, a division of St. Marys Cement Inc. (Canada)

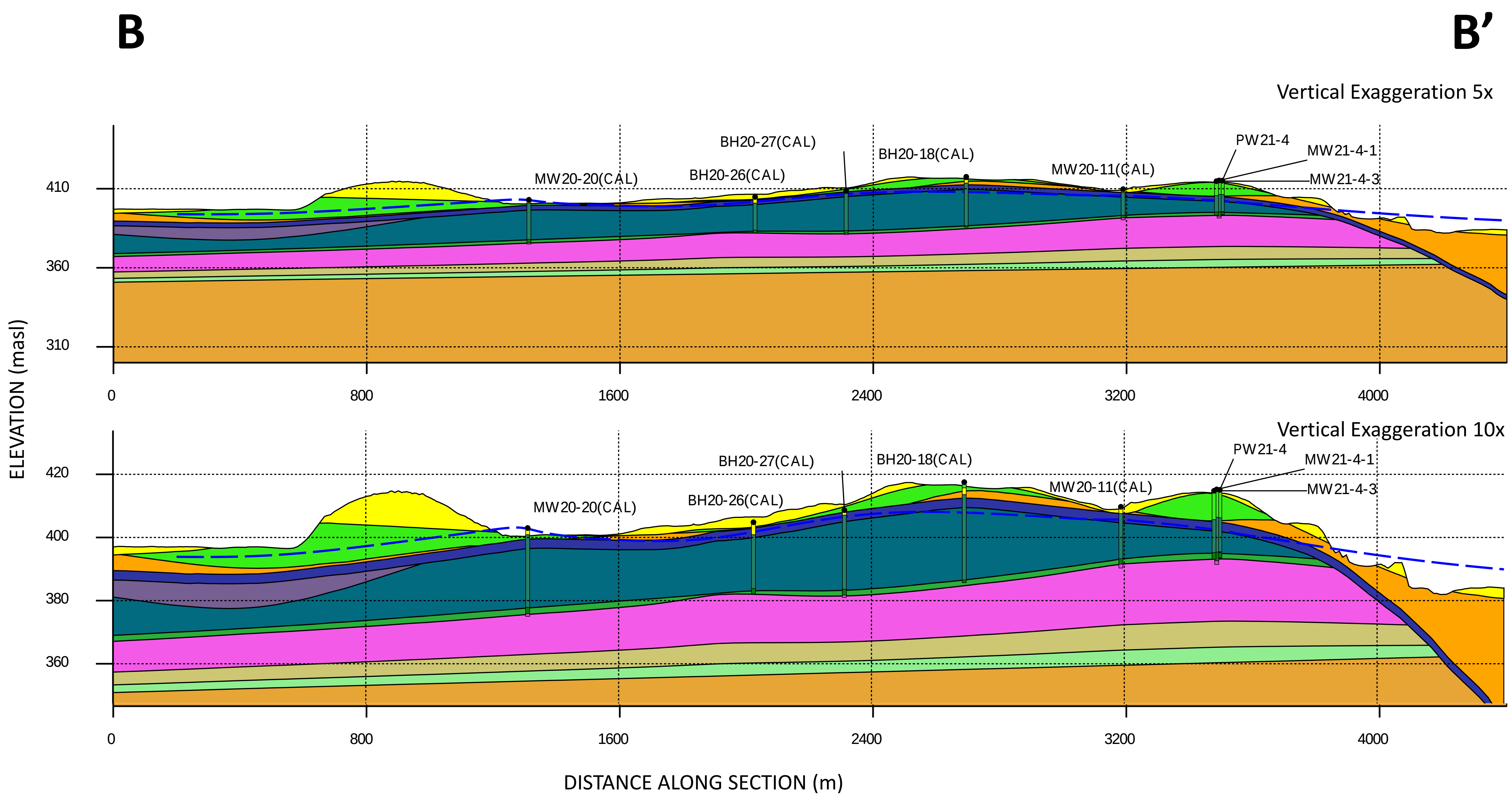
CONSULTANT
GOLDER
MEMBER OF WSP

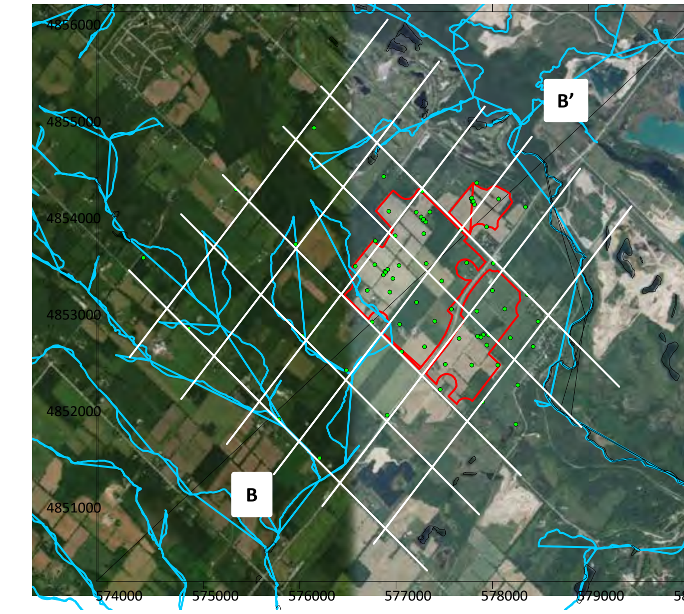
YYYY-MM-DD	2022-11-12
PREPARED	HW
DESIGN	GWS
REVIEW	GRP
APPROVED	GWS

PROJECT
Caledon Pit / Quarry
Water Resources Report

TITLE
Northwest - Southeast Cross-section
Caledon Pit / Quarry Geologic Model

PROJECT No.	Rev.	FIG.
19129150	A	4-5





LEGEND

- Eramosa Formation (Dolostone)
- Goat Island Formation (Dolostone)
- Gasport Formation (Dolostone)
- Shaley Dolostone
- Cabot Head Formation (Shale)
- Manitoulin Formation (Shaley Dolostone)
- Whirlpool Formation (Sandstone)
- Queenston Formation (Shale
- Lower Sand/ Channel Sediment
- Till
- Upper Sand
- Weathered Bedrock
- Average Water Level (Site Wells)

CLIENT
CBM Aggregates, a division of St. Marys Cement Inc. (Canada)

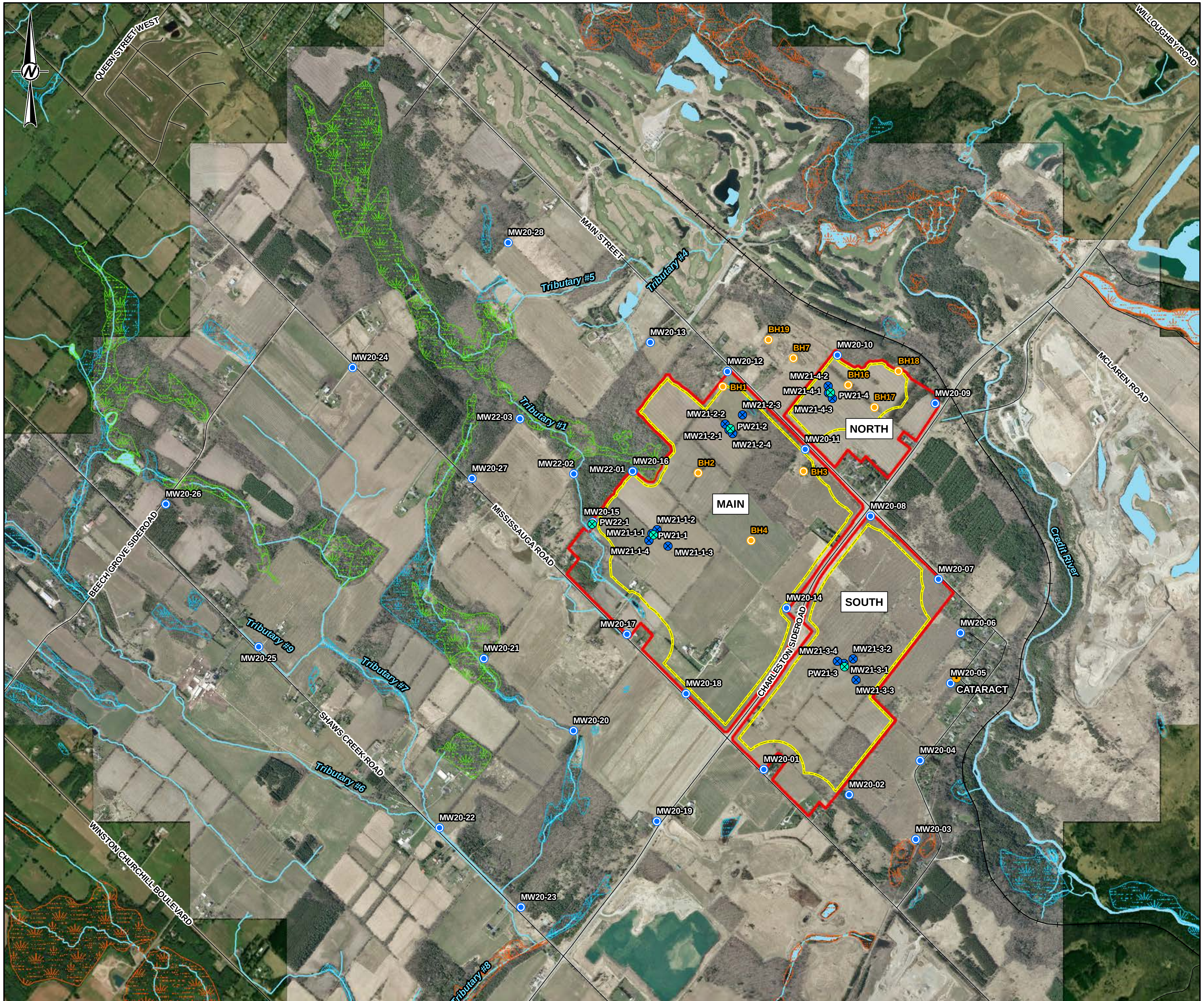
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-11-12
PREPARED	HW
DESIGN	GWS
REVIEW	GRP
APPROVED	GWS

PROJECT
Caledon Pit / Quarry
Water Resources Report

TITLE
Southwest – Northeast Cross-section
Caledon Pit / Quarry Geologic Model

PROJECT No.	Rev.	FIG.
19129150	A	4-6



LEGEND

- TOWN/VILLAGE
- MONITORING WELL
- MONITORING WELL (PUMPING TEST)
- TEST WELL
- HISTORICAL MONITORING WELL
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT
CALEDON PIT / QUARRY

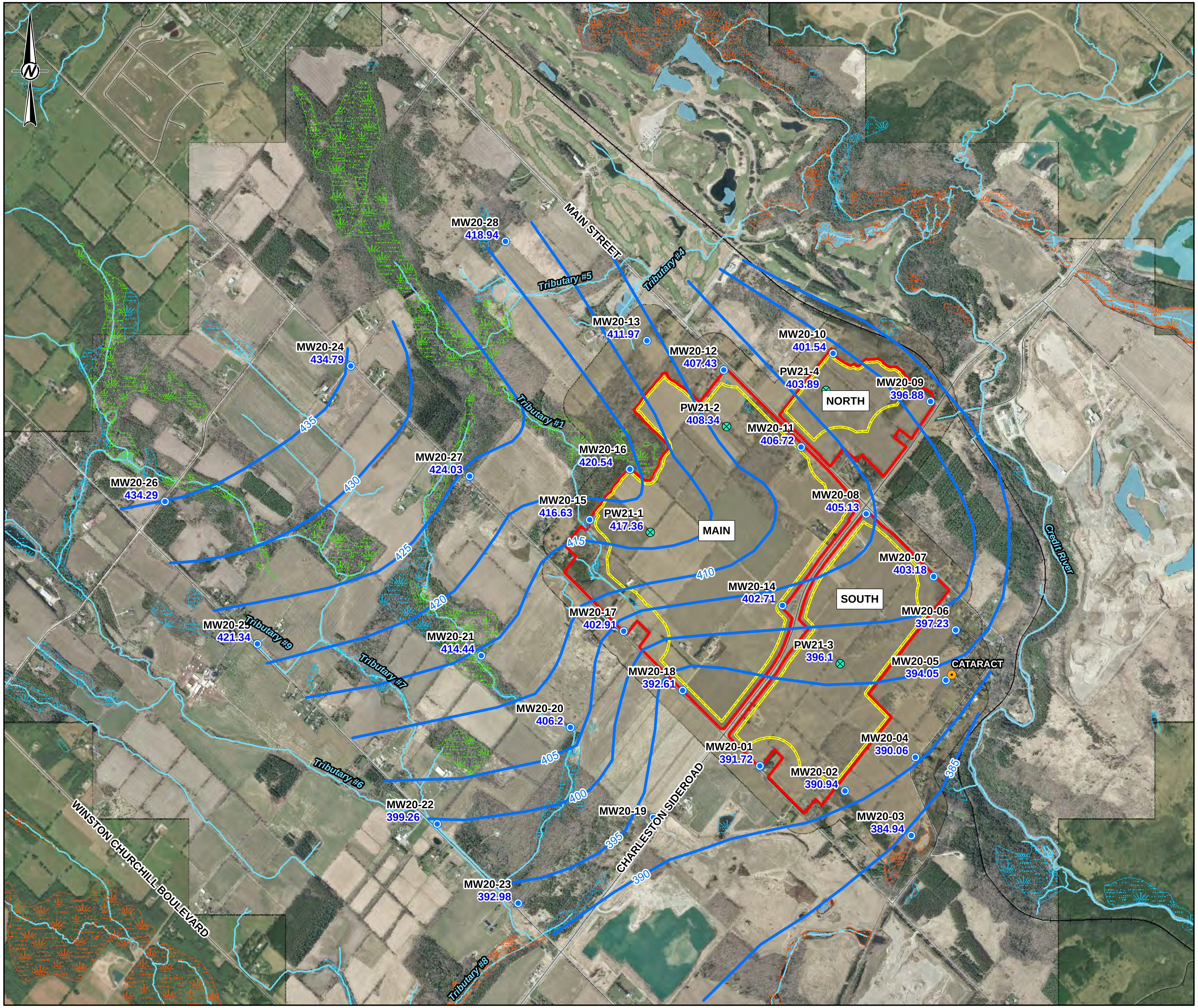
TITLE
WELL LOCATIONS - GROUNDWATER MONITORING AND AQUIFER TESTING PROGRAM

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	5-1

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



LEGEND

- TOWN/VILLAGE
- MONITORING WELL
- TEST WELL
- GROUNDWATER CONTOUR
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- 434.26 WATER LEVEL GASPORT FORMATION

0 500 1,000

1:20,000 METRES

REFERENCE(S)
1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
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4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT
CALEDON PIT / QUARRY

TITLE
GROUNDWATER ELEVATIONS APRIL 2021 - GASPORT FORMATION

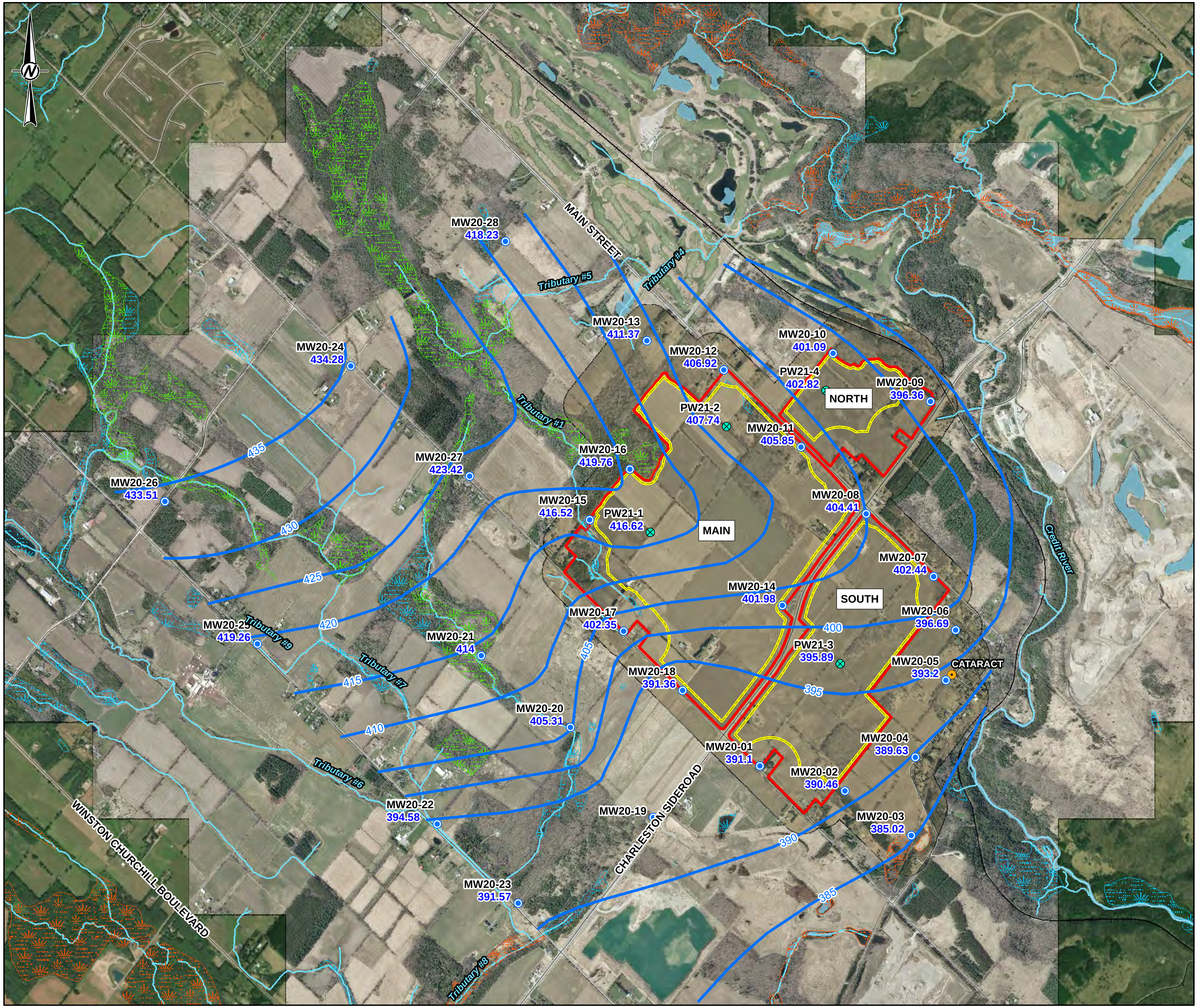
CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-15
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	5-2

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

25mm



LEGEND

- TOWN/VILLAGE
- MONITORING WELL
- TEST WELL
- GROUNDWATER CONTOUR
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- 434.26 WATER LEVEL GASPORT FORMATION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2021, SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT

CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT

CALEDON PIT / QUARRY

TITLE

GROUNDWATER ELEVATIONS JUNE 2021 - GASPORT FORMATION

CONSULTANT

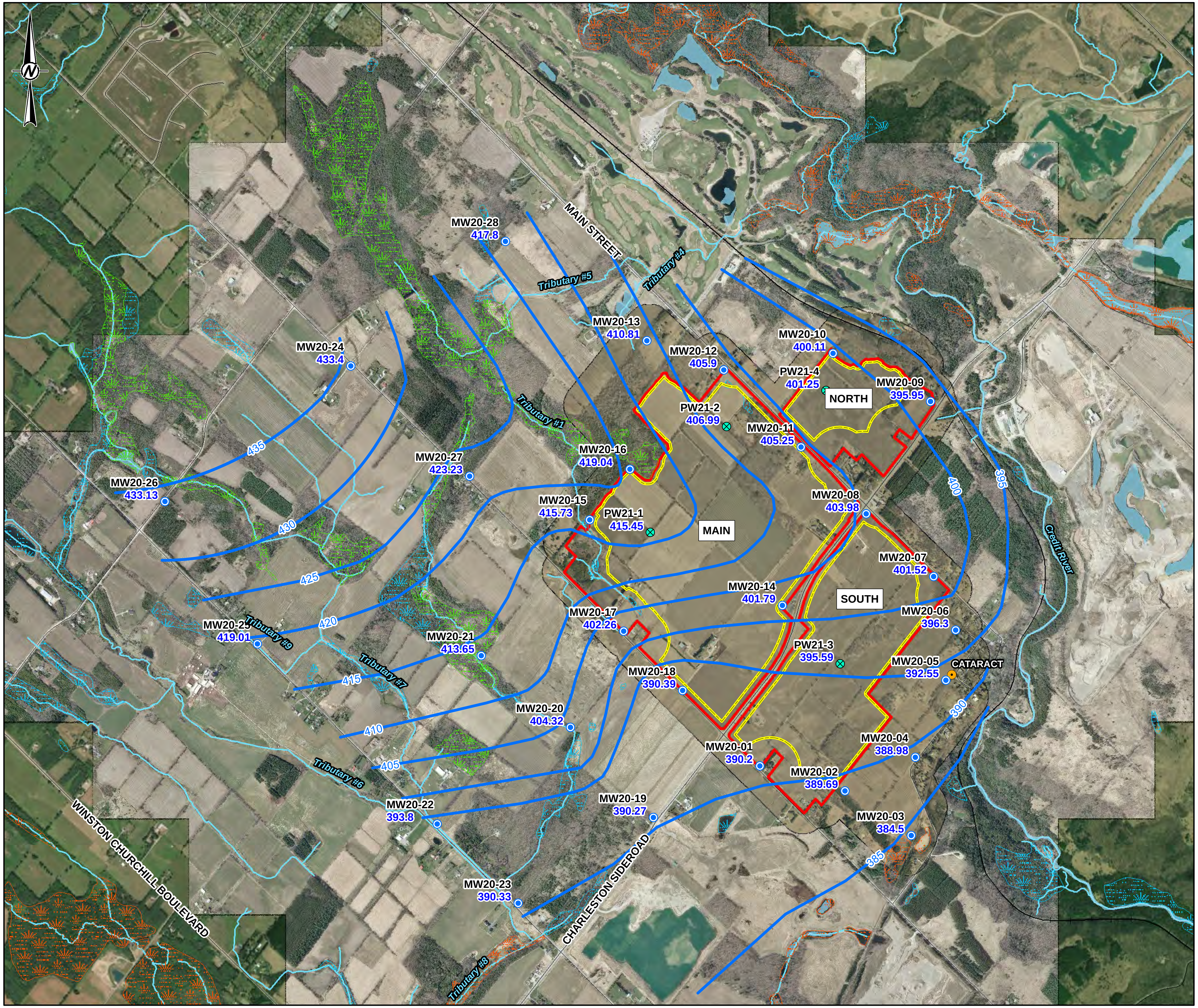
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-15
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	5-3

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

PATH: S:\Clients\Votorantim_Cimentos\Long_Par_5_Caledon\99_PROJ\19129150\40_PROD\0036_Water_Resources\19129150-0036-CH-0005_3.mxd PRINTED ON: 2022-12-15 AT: 10:31:24 AM



LEGEND

- TOWN/VILLAGE
- MONITORING WELL
- TEST WELL
- GROUNDWATER CONTOUR
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- 434.26 WATER LEVEL GASPORT FORMATION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
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4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT

CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT

CALEDON PIT / QUARRY

TITLE

GROUNDWATER ELEVATIONS SEPTEMBER 2021 - GASPORT FORMATION

CONSULTANT

GOLDER MEMBER OF WSP

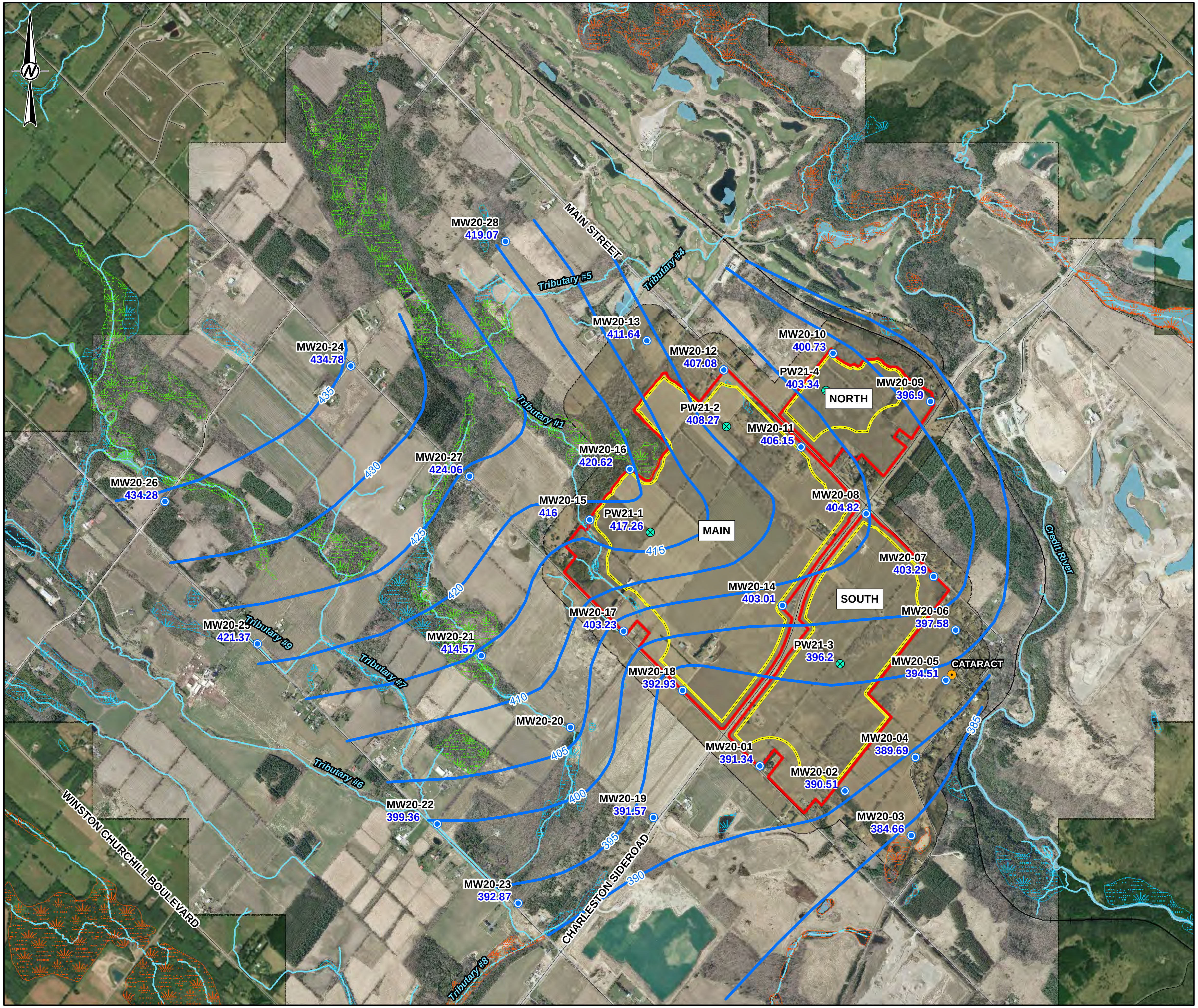
YYYY-MM-DD	2022-12-15
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	5-4

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

25mm

0



LEGEND

- TOWN/VILLAGE
- MONITORING WELL
- TEST WELL
- GROUNDWATER CONTOUR
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- 434.26 WATER LEVEL GASPORT FORMATION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2021, SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT

CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT

CALEDON PIT / QUARRY

TITLE

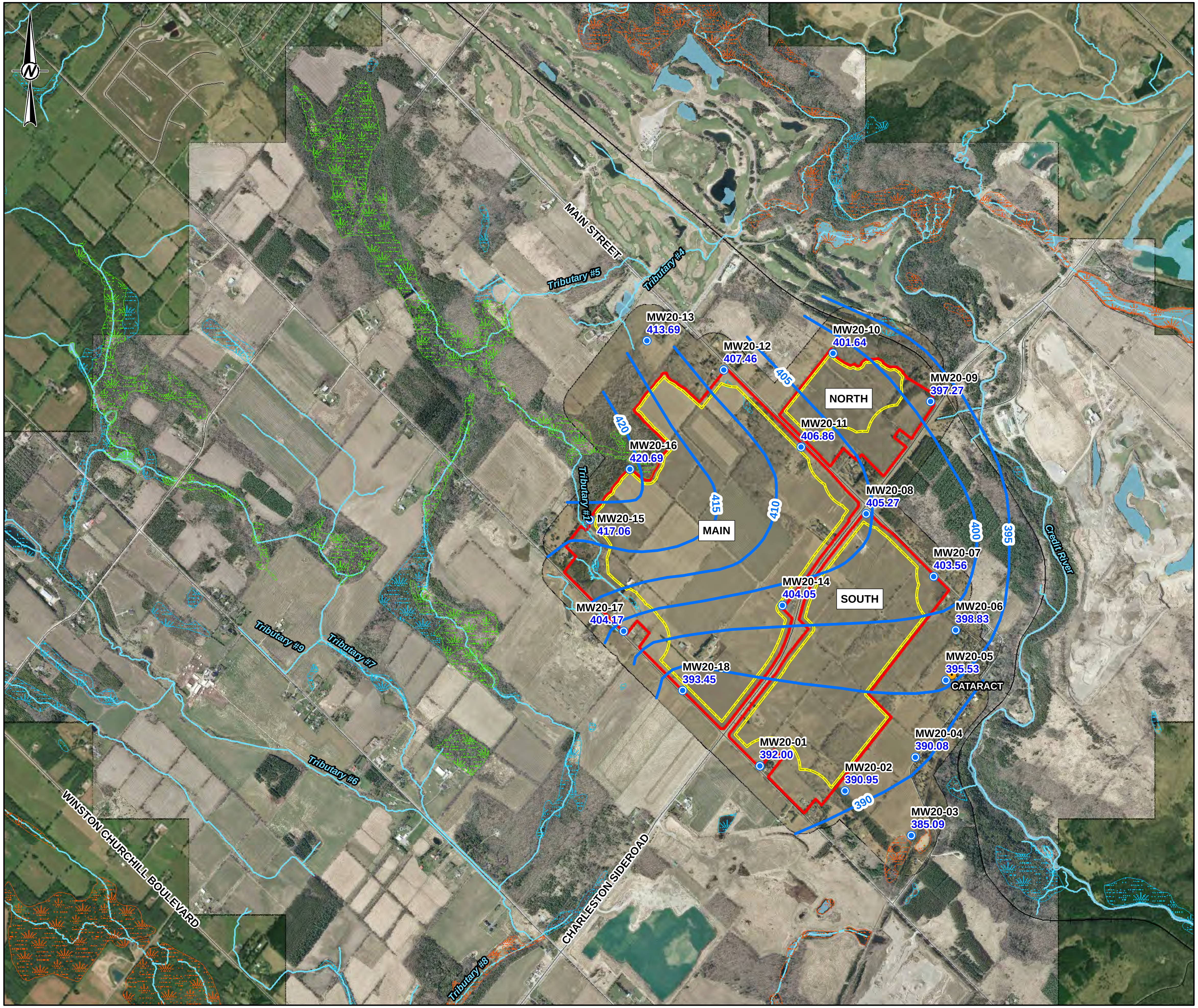
GROUNDWATER ELEVATIONS DECEMBER 2021 - GASPORT FORMATION

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-15
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	5-5



LEGEND

- TOWN/VILLAGE
- MONITORING WELL
- 2021 MAXIMUM GROUNDWATER HEAD
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- 434.26 MAXIMUM PREDICTED WATER TABLE ELEVATION

0 500 1,000

1:20,000 METRES

NOTE(S)

1. HIGH WATER TABLE PREPARED BASED ON THE MAXIMUM GROUNDWATER HEAD OBSERVATION AT EACH MONITORING WELL NEST DURING THE 2021 GROUNDWATER MONITORING PROGRAM. FIGURE TO BE READ WITH ACCOMPANYING REPORT.

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2021, SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT

CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT

CALEDON PIT / QUARRY

TITLE

MAXIMUM PREDICTED WATER TABLE

CONSULTANT

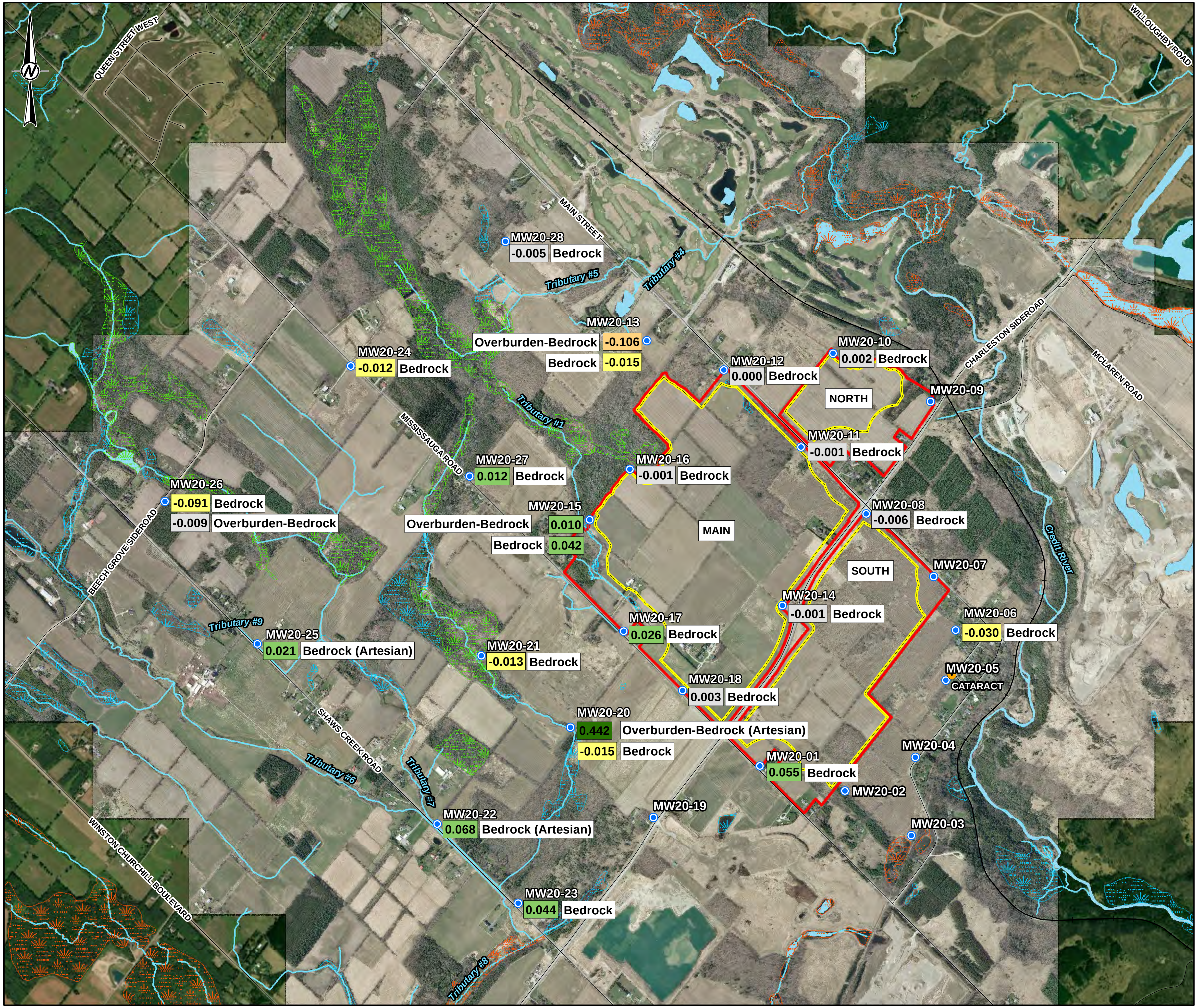
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-15
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	5-6

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

25mm



LEGEND

- TOWN/VILLAGE
- MONITORING WELL
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

VERTICAL HYDRAULIC GRADIENTS

- -0.015 DOWNWARD GRADIENT < -0.100 m/m
- -0.001
- 0.055 NEUTRAL GRADIENT > -0.01 AND < 0.01 m/m
- 0.442
- UPWARD GRADIENT > 0.100 m/m

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT
CALEDON PIT / QUARRY

TITLE
TYPICAL 2021 VERTICAL HYDRAULIC GRADIENTS

CONSULTANT

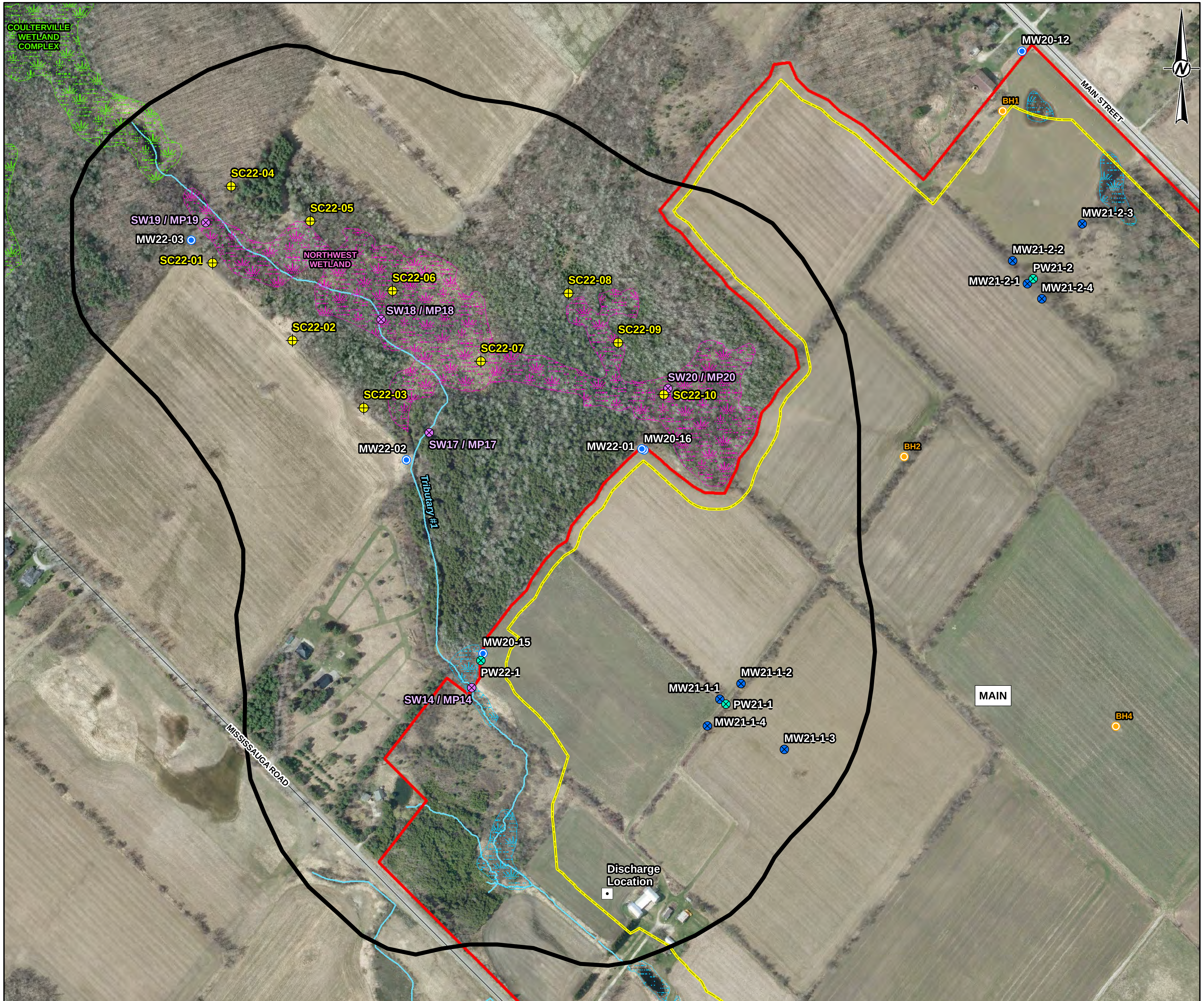
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0006	0.0	5-7

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

25mm



LEGEND

- MONITORING WELL
- MONITORING WELL (PUMPING TEST)
- TEST WELL
- DISCHARGE LOCATION
- HISTORICAL MONITORING WELL
- SOIL CORE LOCATIONS
- SURFACE WATER LOCATIONS
- WATERCOURSE
- ROAD
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- NORTHWEST WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- NORTHWEST INVESTIGATION AREA

0 100 200 300

1:5,000 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT
CALEDON PIT / QUARRY

TITLE
NORTHWEST INVESTIGATION AREA

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-06
DESIGNED	CGE
PREPARED	SO
REVIEWED	PM
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0006	0.0	5-8

LEGEND

- TOWN/VILLAGE
- SURFACE WATER STATION
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASEDATA MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT/ QUARRY

TITLE
SURFACE WATER LOCATIONS

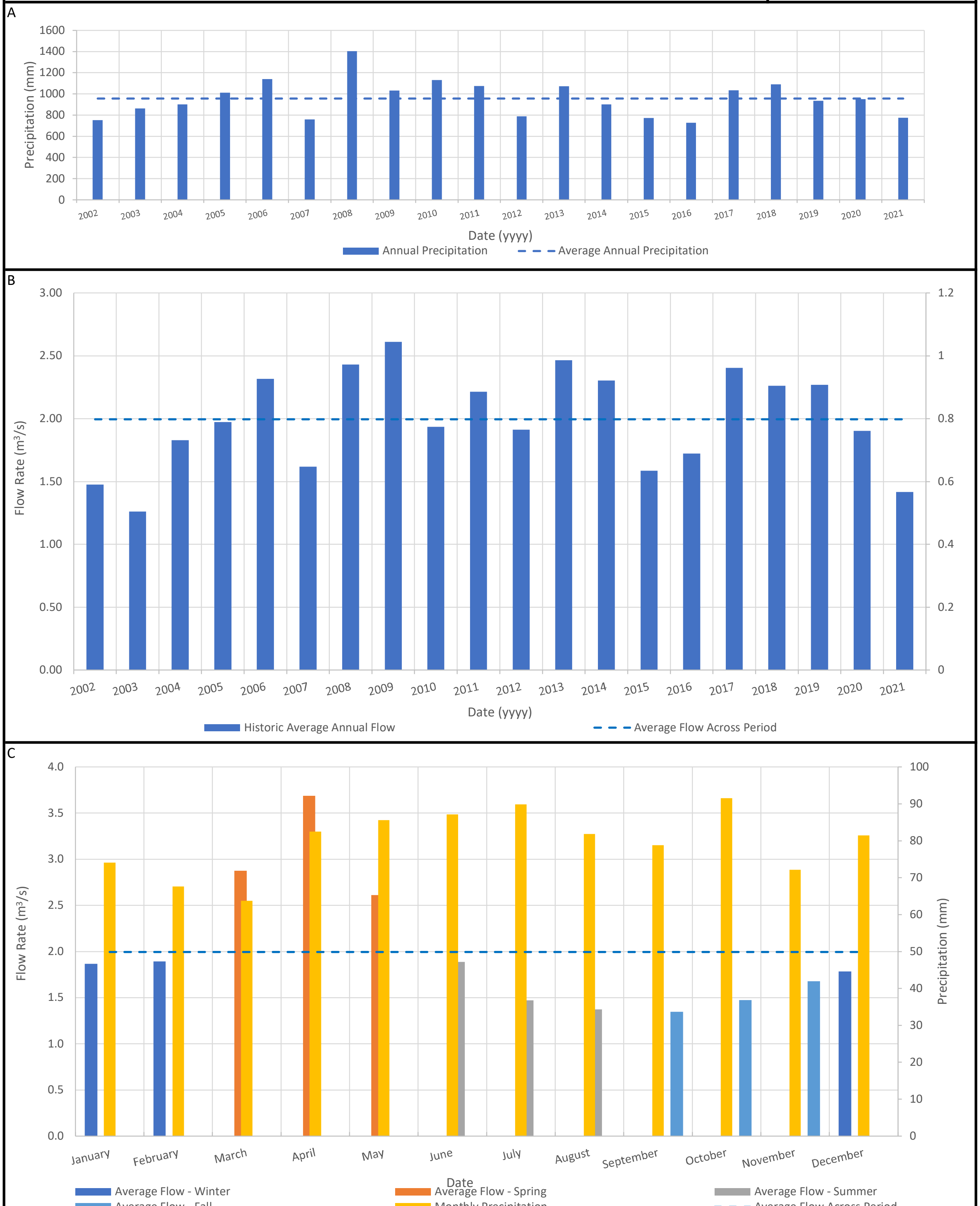
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	SO
PREPARED	SO
REVIEWED	MR
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	6-1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25mm
0

Historical Flows at the EC Credit River at Cataract Flow Gauge Adjacent to VCNA Caledon Quarry (2002 - 2021) | FIGURE 6-2



A. Total Daily Precipitation (Orangeville - Mono Centre, ON, EC Climate ID#6157000) **B. Annual Flow Rate** **C. Seasonal Flow Rate**

PROJECT: 19129150
DATE: December 2022

GOLDER
MEMBER OF WSP

DRAWN: MR
CHECK: CDV

LEGEND

- TOWN/VILLAGE
- LOW FLOW STATION
- CVC FLOW GAUGE
- EC FLOW GAUGE
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

0 500 1,000 1,500

1:30,000 METRES

REFERENCE(S)

1. BASEDATA MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

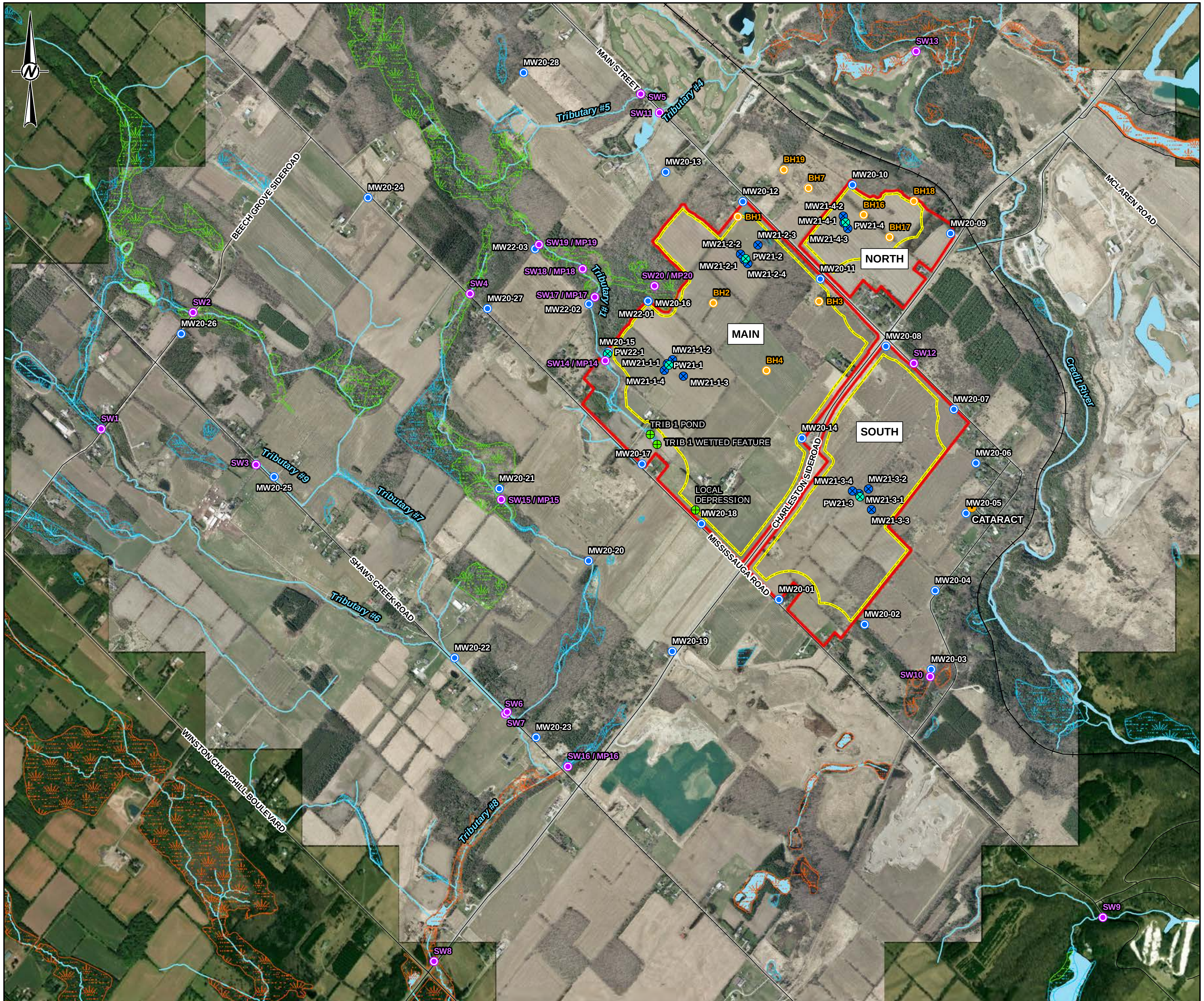
PROJECT
CALEDON PIT/ QUARRY

TITLE
SURFACE WATER LOW FLOW STATION LOCATIONS

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	SO
PREPARED	SO
REVIEWED	MR
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	6-3



LEGEND

- TOWN/VILLAGE
- MONITORING WELL
- MONITORING WELL (PUMPING TEST)
- TEST WELL
- HISTORICAL MONITORING WELL
- SURFACE WATER STATION
- TRIBUTARY #1 ANNOTATION
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
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SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT
CALEDON PIT / QUARRY

TITLE
GROUNDWATER SURFACE WATER MONITORING NETWORK

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	6-4

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

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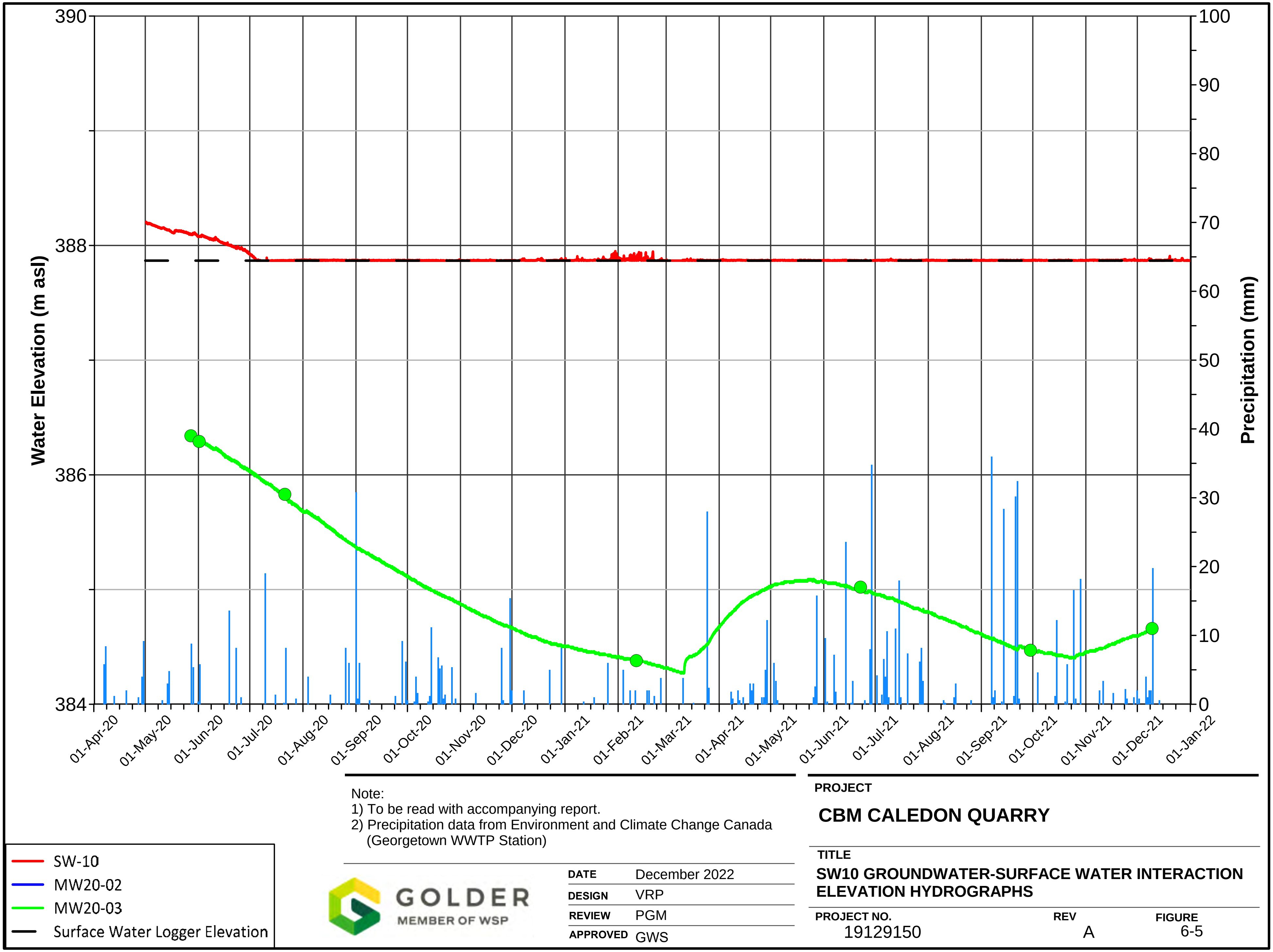


Note:
1) To be read with accompanying report.
2) Precipitation data from Environment and Climate Change Canada (Georgetown WWTP Station)

GOLDER
MEMBER OF WSP

DATE	December 2022
DESIGN	VRP
REVIEW	PGM
APPROVED	GWS

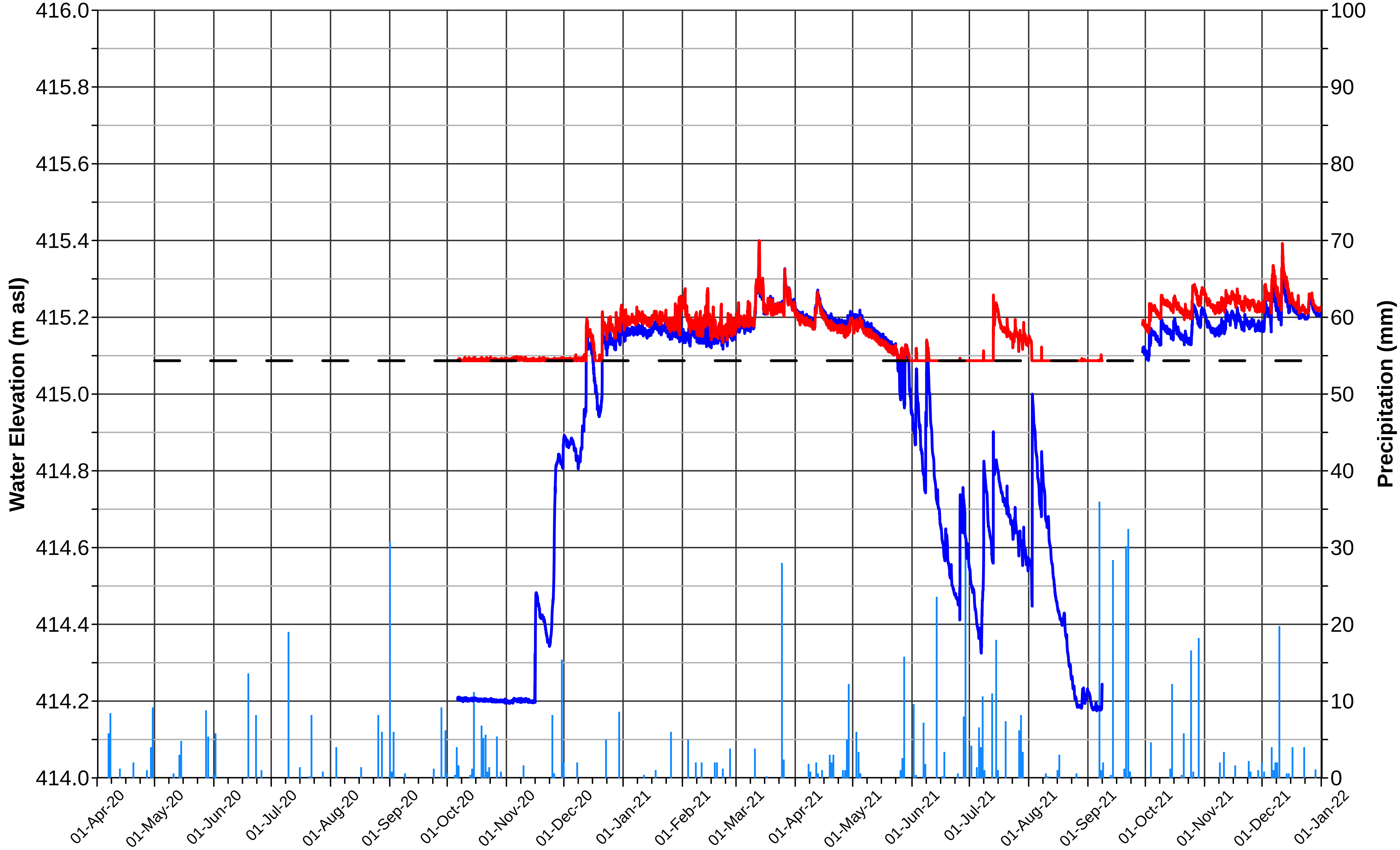
PROJECT

CBM CALEDON QUARRY

TITLE

SW10 GROUNDWATER-SURFACE WATER INTERACTION ELEVATION HYDROGRAPHS

PROJECT NO.	REV	FIGURE
19129150	A	6-5



Note:
1) To be read with accompanying report.
2) Precipitation data from Environment and Climate Change Canada (Georgetown WWTP Station)

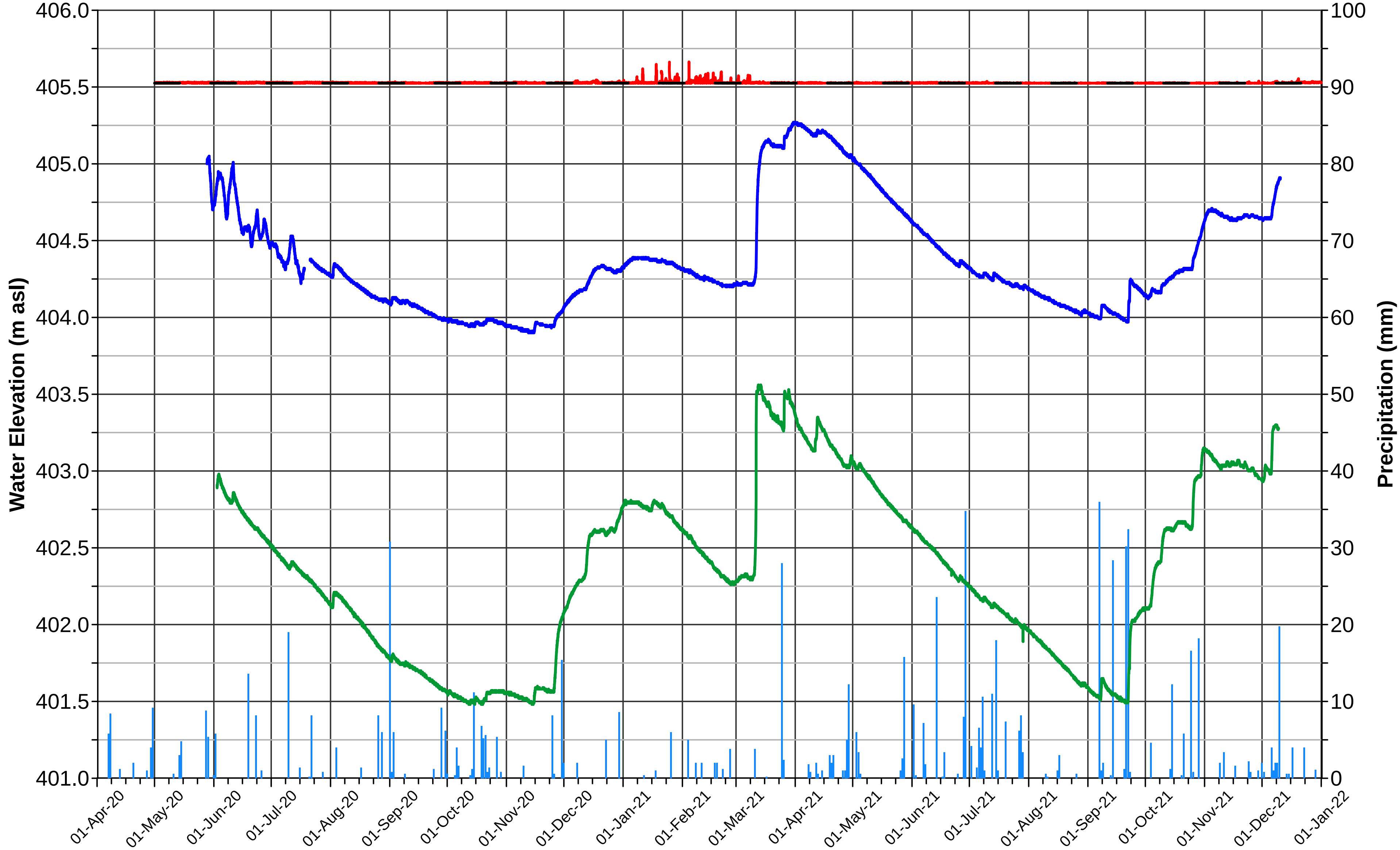
GOLDER
MEMBER OF WSP

DATE	December 2022
DESIGN	VRP
REVIEW	PGM
APPROVED	GWS

PROJECT
CBM CALEDON QUARRY

TITLE
SW14 GROUNDWATER-SURFACE WATER INTERACTION ELEVATION HYDROGRAPHS

PROJECT NO.	REV	FIGURE
19129150	A	6-6



Note:
1) To be read with accompanying report.
2) Precipitation data from Environment and Climate Change Canada (Georgetown WWTP Station)

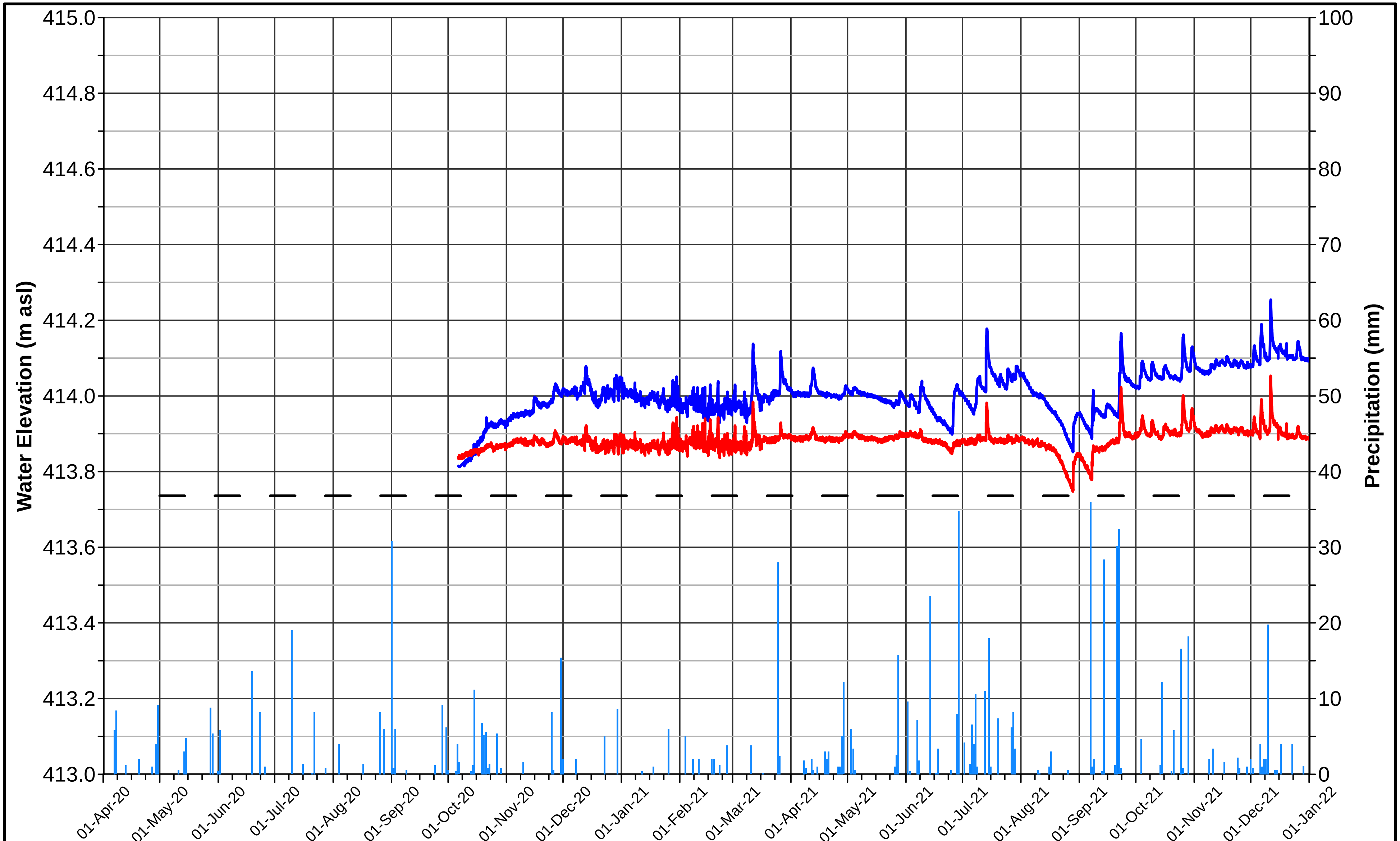
GOLDER
MEMBER OF WSP

DATE	December 2022
DESIGN	PGM
REVIEW	GWS
APPROVED	GWS

PROJECT
CBM CALEDON QUARRY

TITLE
SW12 GROUNDWATER-SURFACE WATER INTERACTION ELEVATION HYDROGRAPHS

PROJECT NO.	REV	FIGURE
19129150	A	6-7



Note:
1) To be read with accompanying report.
2) Precipitation data from Environment and Climate Change Canada
(Georgetown WWTP Station)

GOLDER MEMBER OF WSP

DATE	December 2022
DESIGN	VRP
REVIEW	PGM
APPROVED	GWS

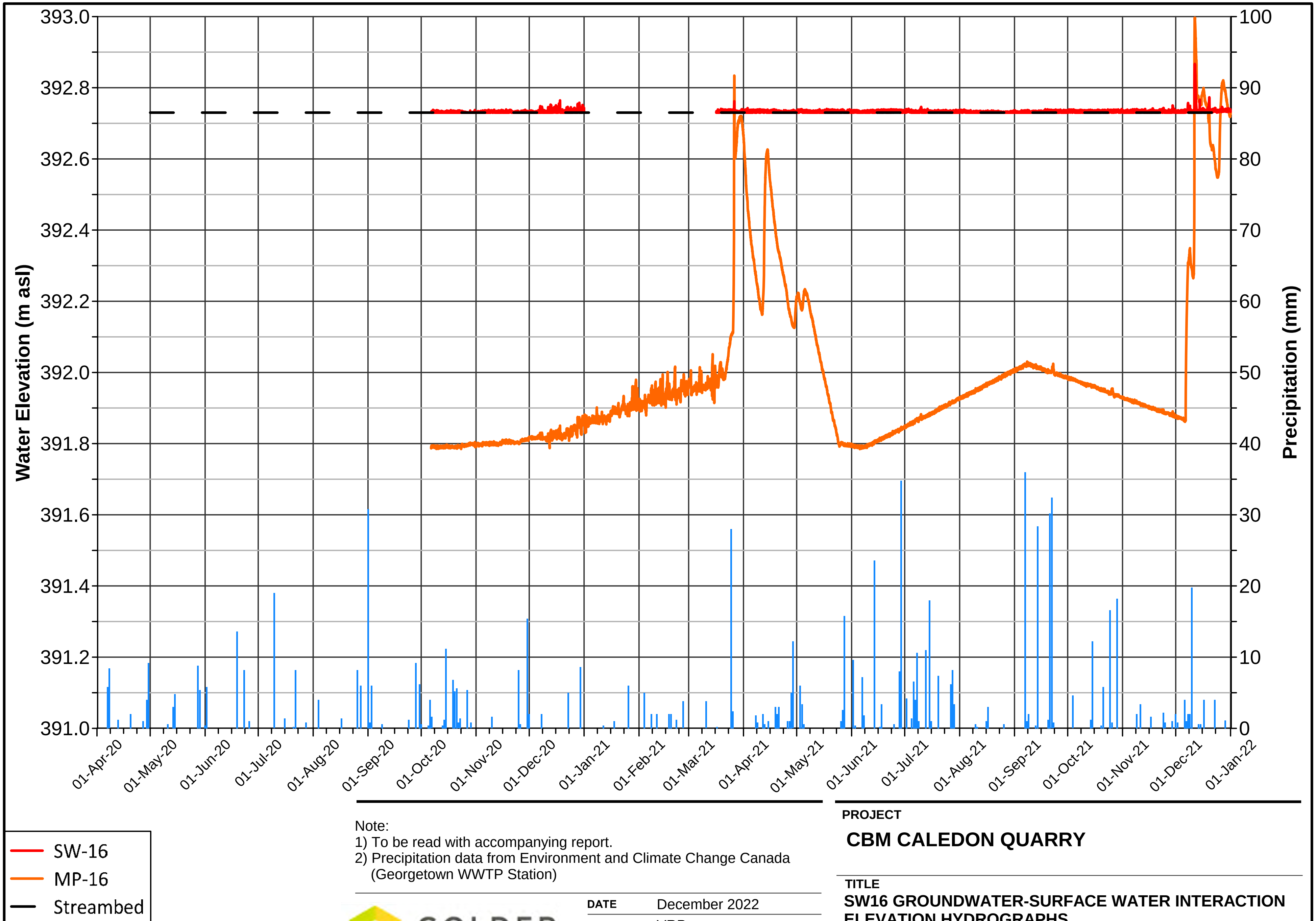
PROJECT

CBM CALEDON QUARRY

TITLE

SW15 GROUNDWATER-SURFACE WATER INTERACTION ELEVATION HYDROGRAPHS

PROJECT NO.	REV	FIGURE
19129150	A	6-8



Note:
1) To be read with accompanying report.
2) Precipitation data from Environment and Climate Change Canada (Georgetown WWTP Station)

GOLDER MEMBER OF WSP

DATE	December 2022
DESIGN	VRP
REVIEW	PGM
APPROVED	GWS

PROJECT
CBM CALEDON QUARRY

TITLE
SW16 GROUNDWATER-SURFACE WATER INTERACTION ELEVATION HYDROGRAPHS

PROJECT NO.	REV	FIGURE
19129150	A	6-9

LEGEND

NOTES

Traverse #1 completed on March 5, 2020
Traverse #2 completed on December 12, 2022

CLIENT

CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-11-xx
PREPARED	GWS
DESIGN	GWS
REVIEW	PGM
APPROVED	GRP

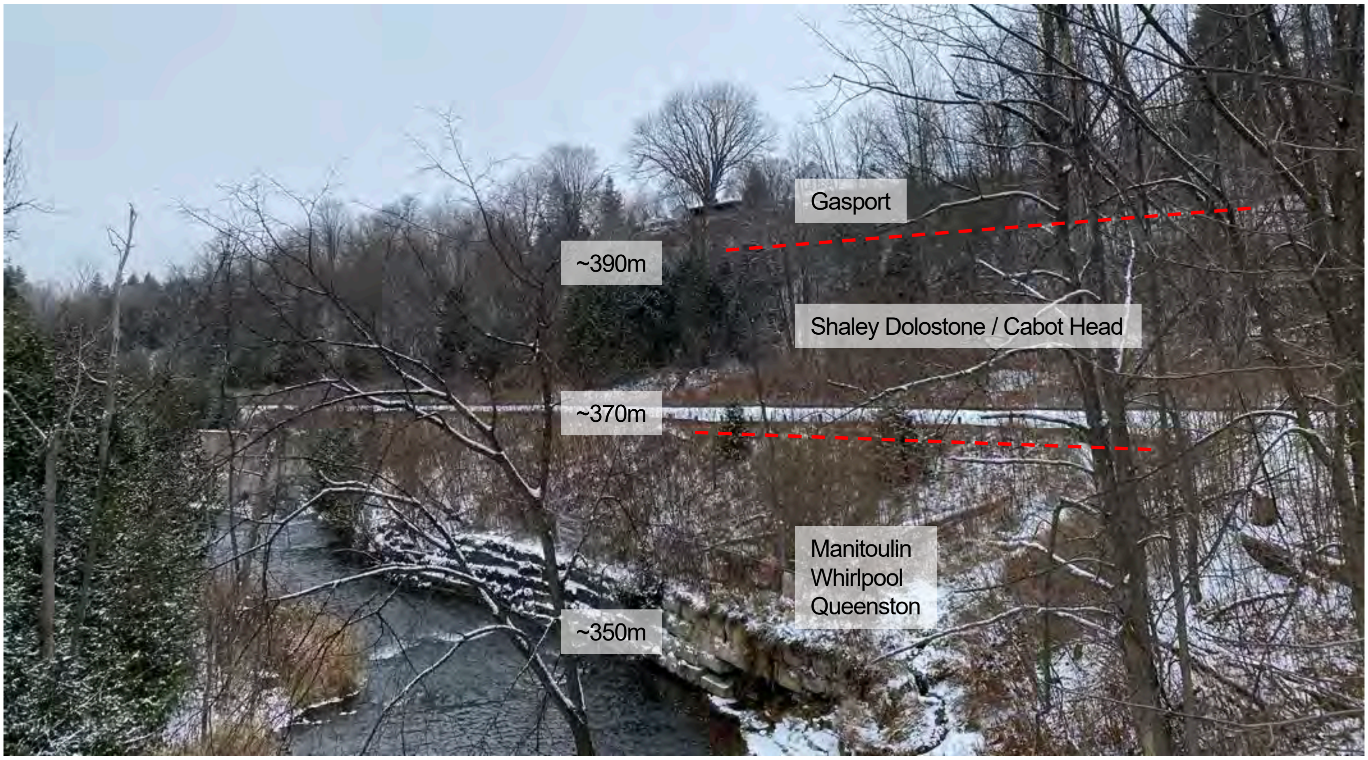
PROJECT

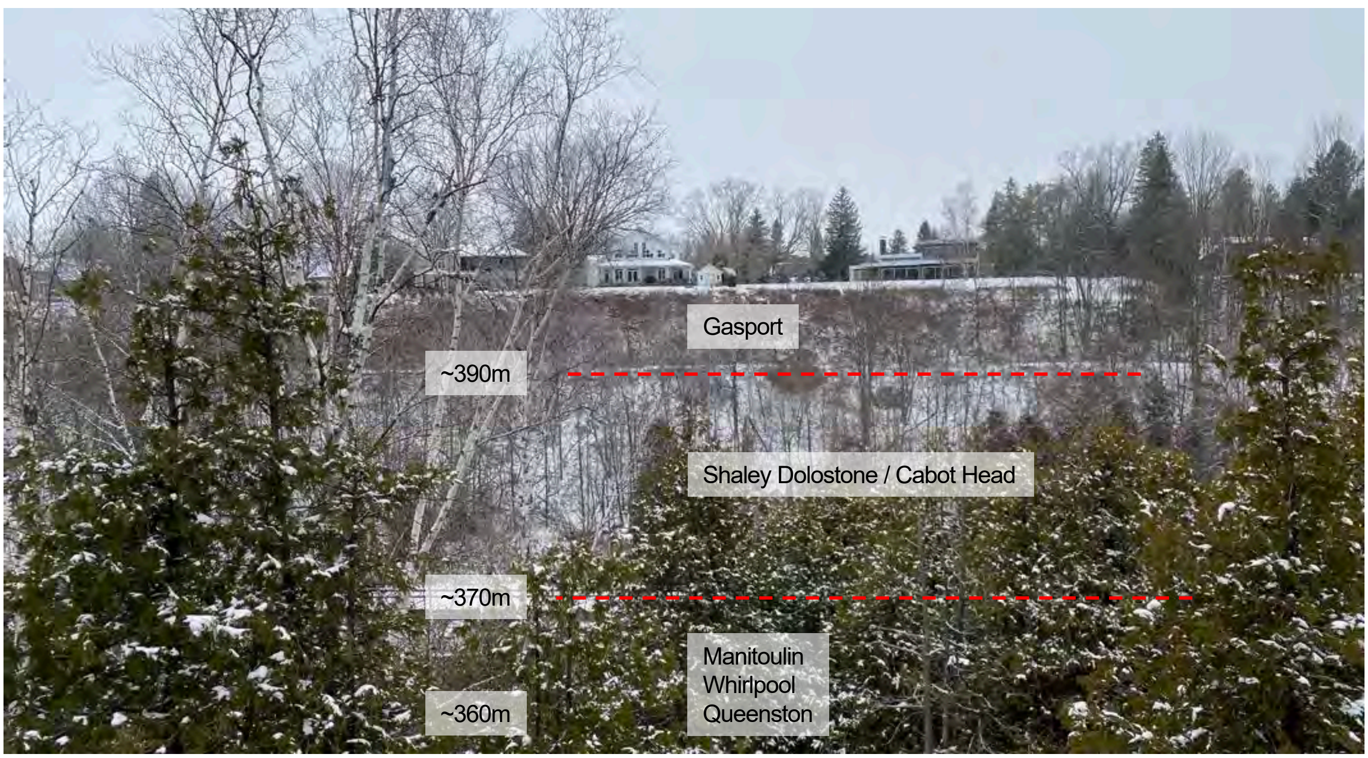
CALEDON PIT AND QUARRY

TITLE

CATARACT SEEP RECONNAISSANCE - TRAVERSE ROUTE AND WAYPOINTS

PROJECT No.	Rev.	FIGURE
19129150	0	6-10





LEGEND

- - - Approximate Geologic Contact

NOTE

Approximate geologic contacts are projected from borehole drilling and water well record data from the Site and Cataract area

CLIENT

CBM Aggregates, a division of St. Marys Cement Inc. (Canada)

PROJECT

Caledon Pit / Quarry

Water Report Level 1 / 2

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-12
PREPARED	GWS
DESIGN	GWS
REVIEW	GRP
APPROVED	GRP

TITLE

Cataract Seep Reconnaissance

Bedrock Geology

PROJECT No.	Rev.	FIG.
19129150	**0**	**6-11**

LEGEND

- - - Approximate Geologic Contact

NOTE

CLIENT
CBM Aggregates, a division of St. Marys Cement Inc. (Canada)

PROJECT
Caledon Pit / Quarry
Water Report Level 1 / 2

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-12
PREPARED	GWS
DESIGN	GWS
REVIEW	GRP
APPROVED	GRP

TITLE
Cataract Seep Reconnaissance
Seepage from base of Gasport at Waypoint #263

PROJECT No.	Rev.	FIG.
19129150	**0**	**6-12**

LEGEND

- - - Approximate Geologic Contact

NOTE

Approximate geologic contacts are projected from borehole drilling and water well record data from the Site and Cataract area

CLIENT
CBM Aggregates, a division of St. Marys Cement Inc. (Canada)

PROJECT
Caledon Pit / Quarry
Water Report Level 1 / 2

CONSULTANT

GOLDER
MEMBER OF WSP

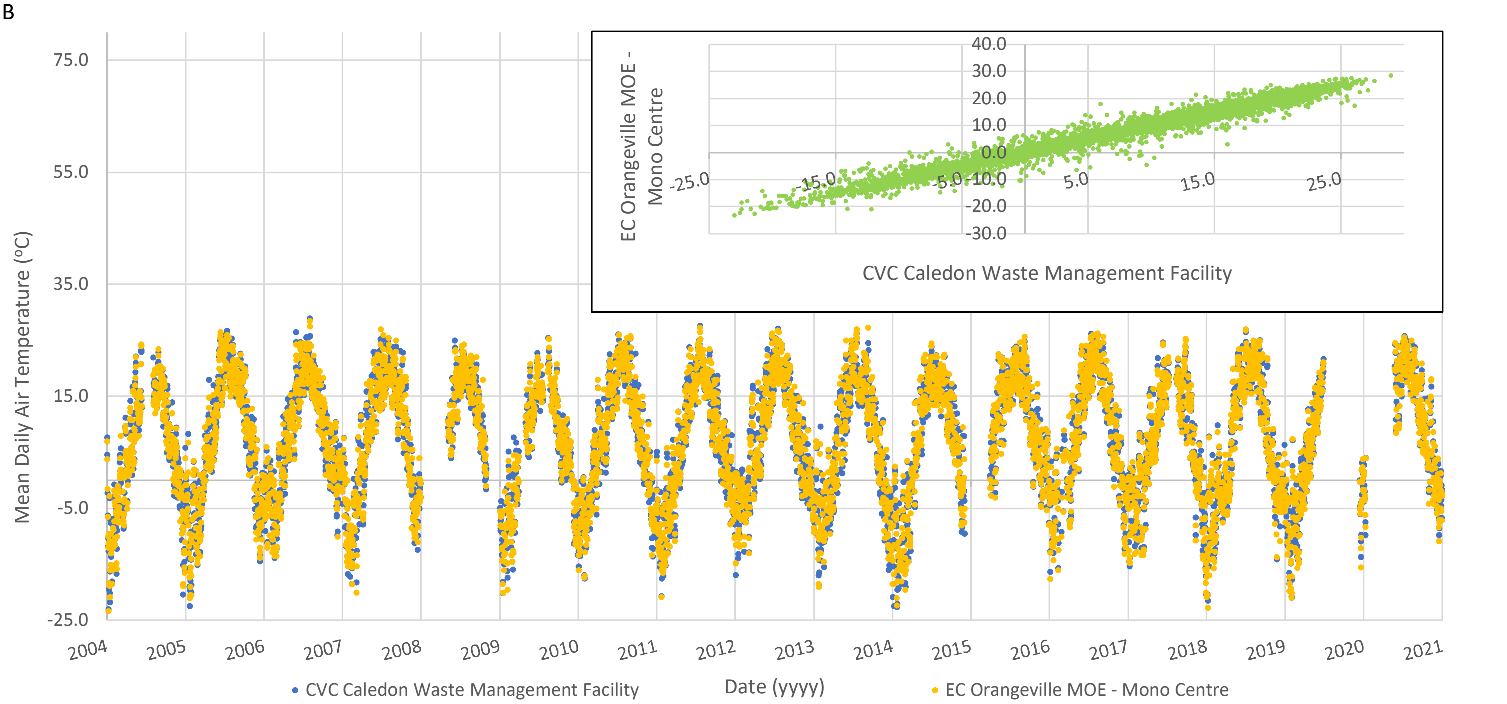
YYYY-MM-DD	2022-12-12
PREPARED	GWS
DESIGN	GWS
REVIEW	GRP
APPROVED	GRP

TITLE
Cataract Seep Reconnaissance
Pipe Observed at Waypoint #259 and Culvert at Waypoint #266

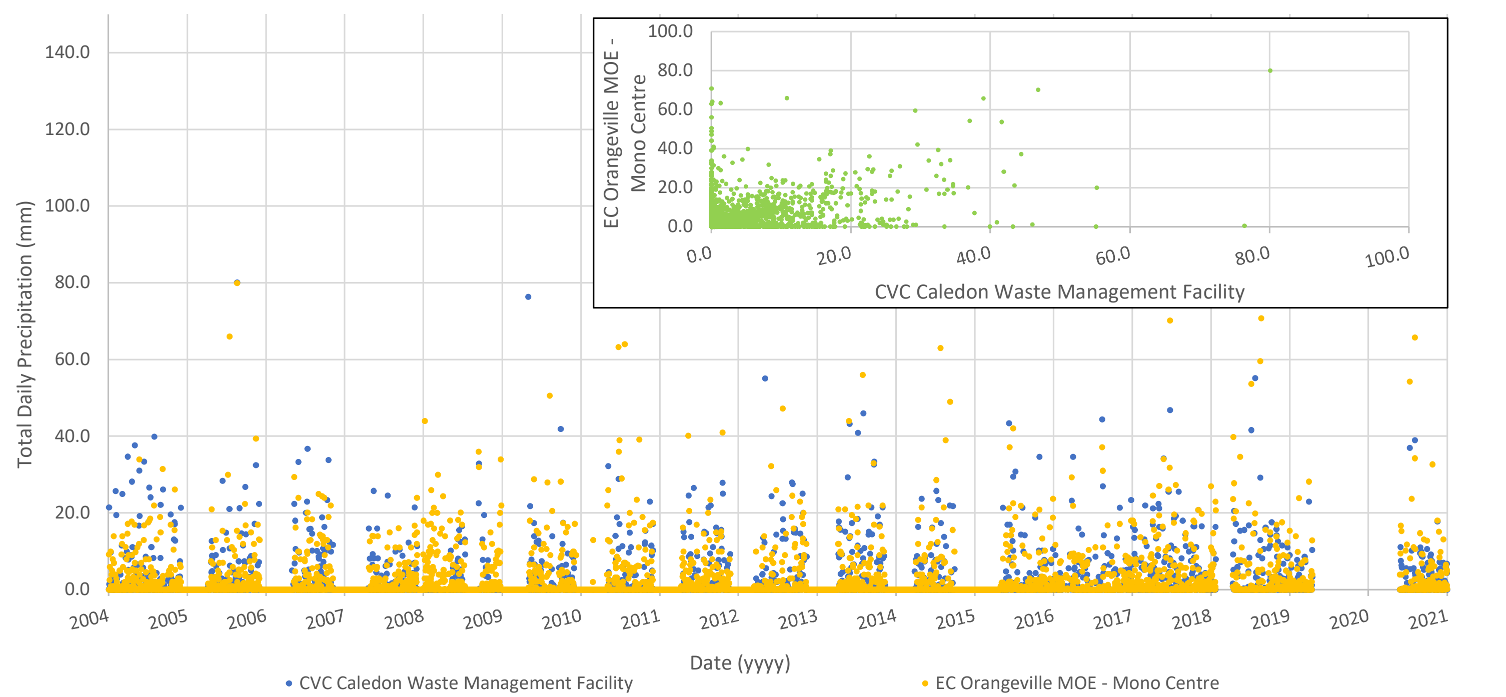
PROJECT No.	Rev.	FIG.
19129150	**0**	**6-13**

Meterological Correlation Plot Between the CVC Caledon Waster Management Facility and EC Orangeville MOE / Mono Centre MET Stations (2004 - 2020)	FIGURE 7-1

B



C

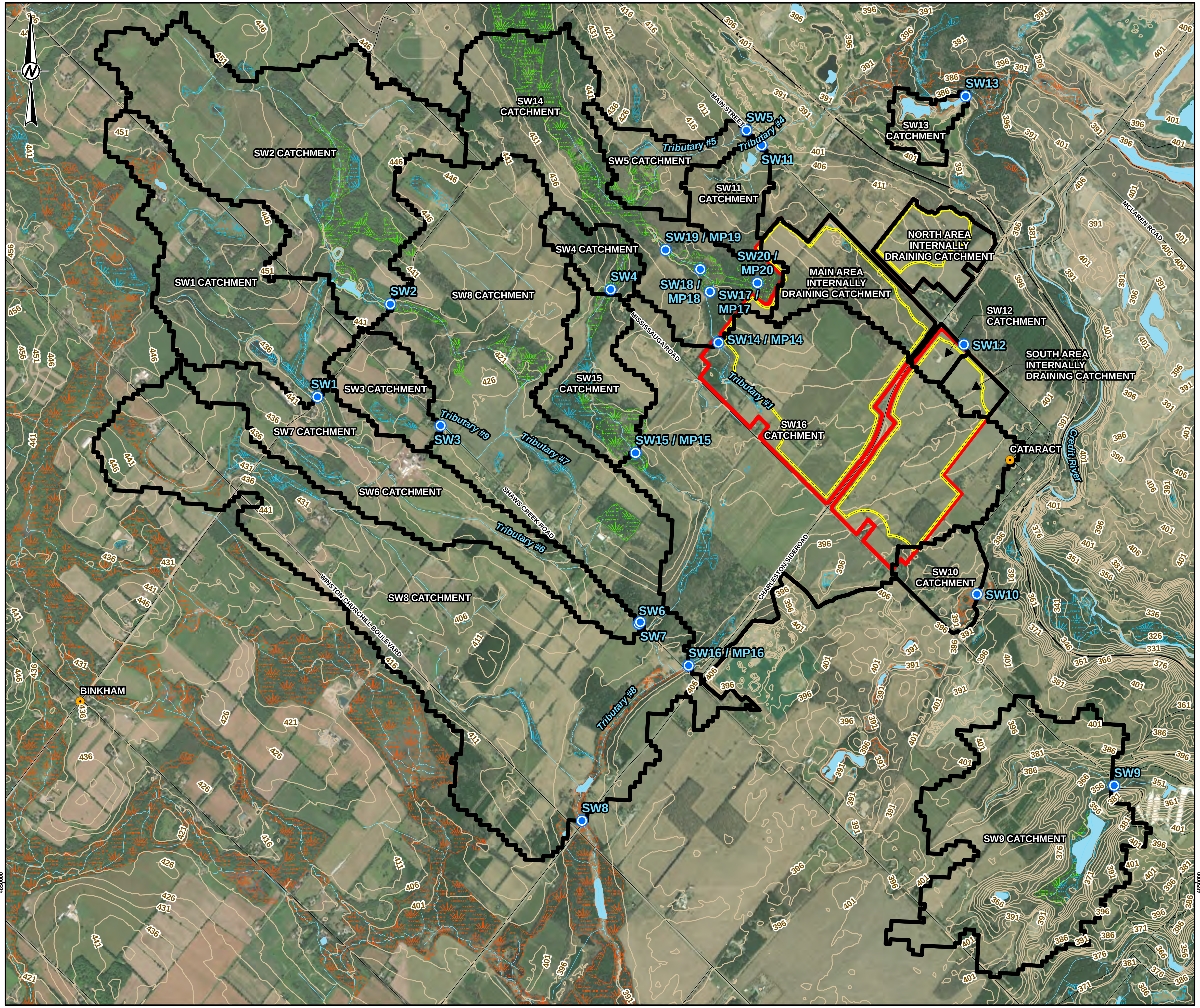


A. Mean Daily Air Temperature **B. Total Daily Precipitation**

PROJECT: 19129150
DATE: December 2022

GOLDER MEMBER OF WSP

DRAWN: MR
CHECK: CDV



LEGEND

- TOWN/VILLAGE
- SURFACE WATER STATION
- CONTOURS (5 m INTERVAL)
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- CATCHMENT AREA

0 500 1,000 1,500

1:25,000 METRES

REFERENCE(S)

1. BASEDATA AND TOPOGRAPHY MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

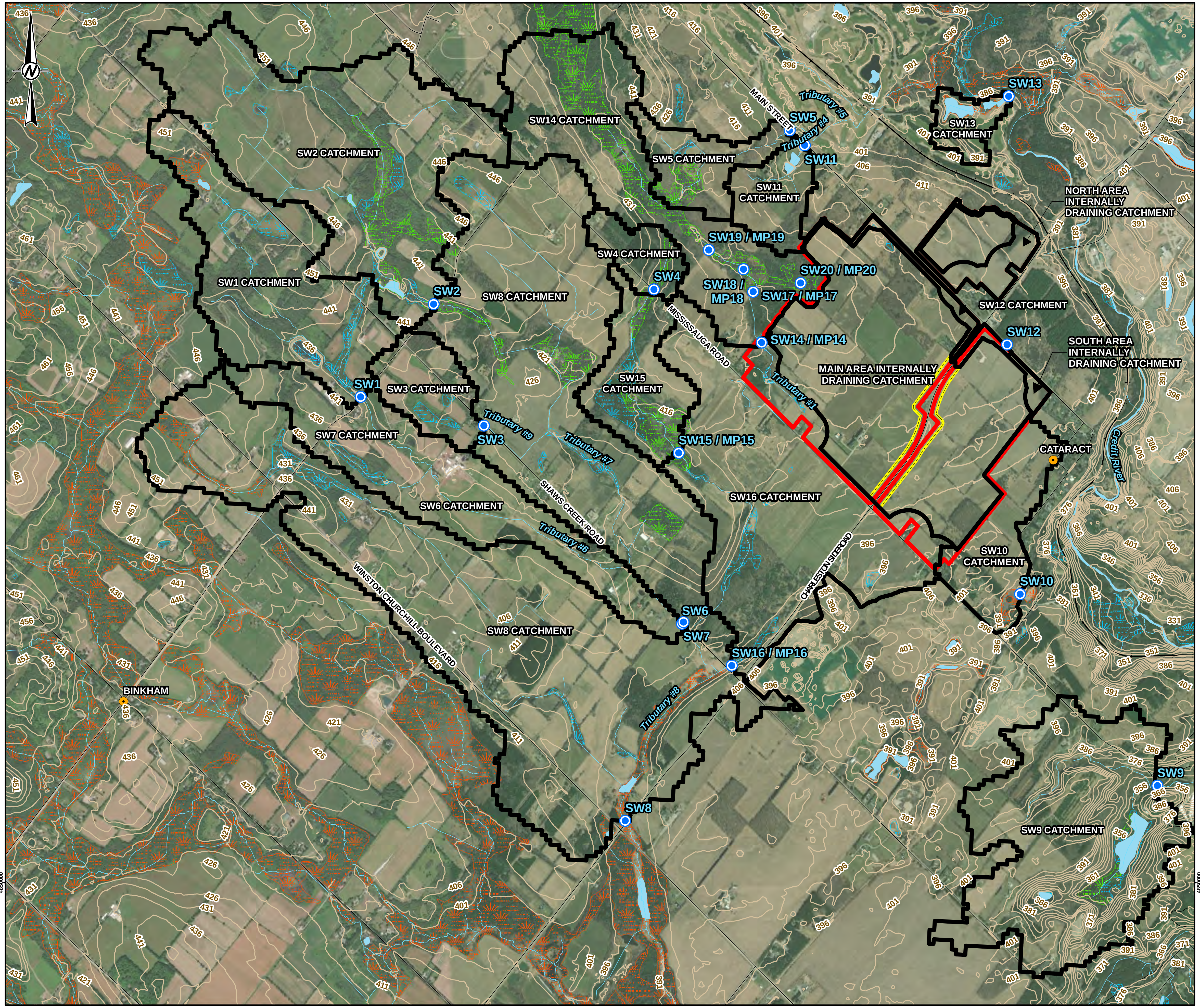
TITLE
SURFACE WATER STATION CATCHMENTS AND TOPOGRAPHY - EXISTING

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-15
DESIGNED	SO
PREPARED	SO
REVIEWED	MR
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	7-2

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



LEGEND

- TOWN/VILLAGE
- SURFACE WATER STATION
- CONTOURS (5 m INTERVAL)
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION
- CATCHMENT AREA

0 500 1,000 1,500

1:25,000 METRES

REFERENCE(S)

1. BASEDATA AND TOPOGRAPHY MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

TITLE
SURFACE WATER STATION CATCHMENTS AND TOPOGRAPHY - OPERATIONAL

CONSULTANT

GOLDER
MEMBER OF WSP

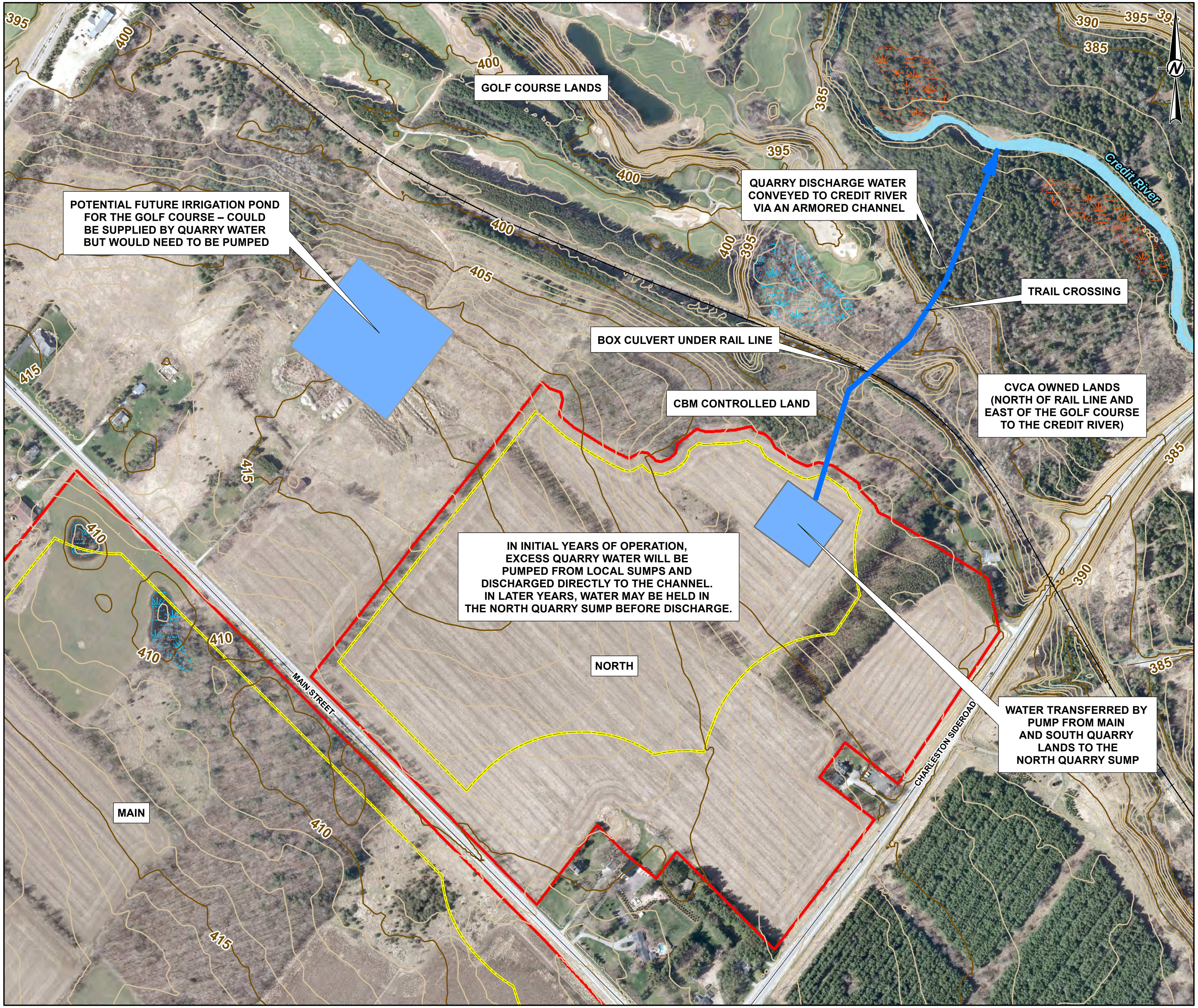
YYYY-MM-DD	2022-12-15
DESIGNED	SO
PREPARED	SO
REVIEWED	MR
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	7-3

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

25mm

PATH: S:\Clients\Votorantim_Cimentos\Caledon\99_PROJ\19129150\40_PROD\0036_Water_Resources\19129150-0036-GH-0007_3.mxd PRINTED ON: 2022-12-15 AT: 9:45:54 PM



LEGEND

- ROAD
- RAILWAY
- CONTOUR 5 m INTERVAL
- CONTOUR 1 m INTERVAL
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

0 100 200
1:4,500 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT
CALEDON PIT / QUARRY

TITLE
POTENTIAL DISCHARGE LOCATION

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-06
DESIGNED	CGE
PREPARED	SO
REVIEWED	PM
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0006	0.0	7-4

25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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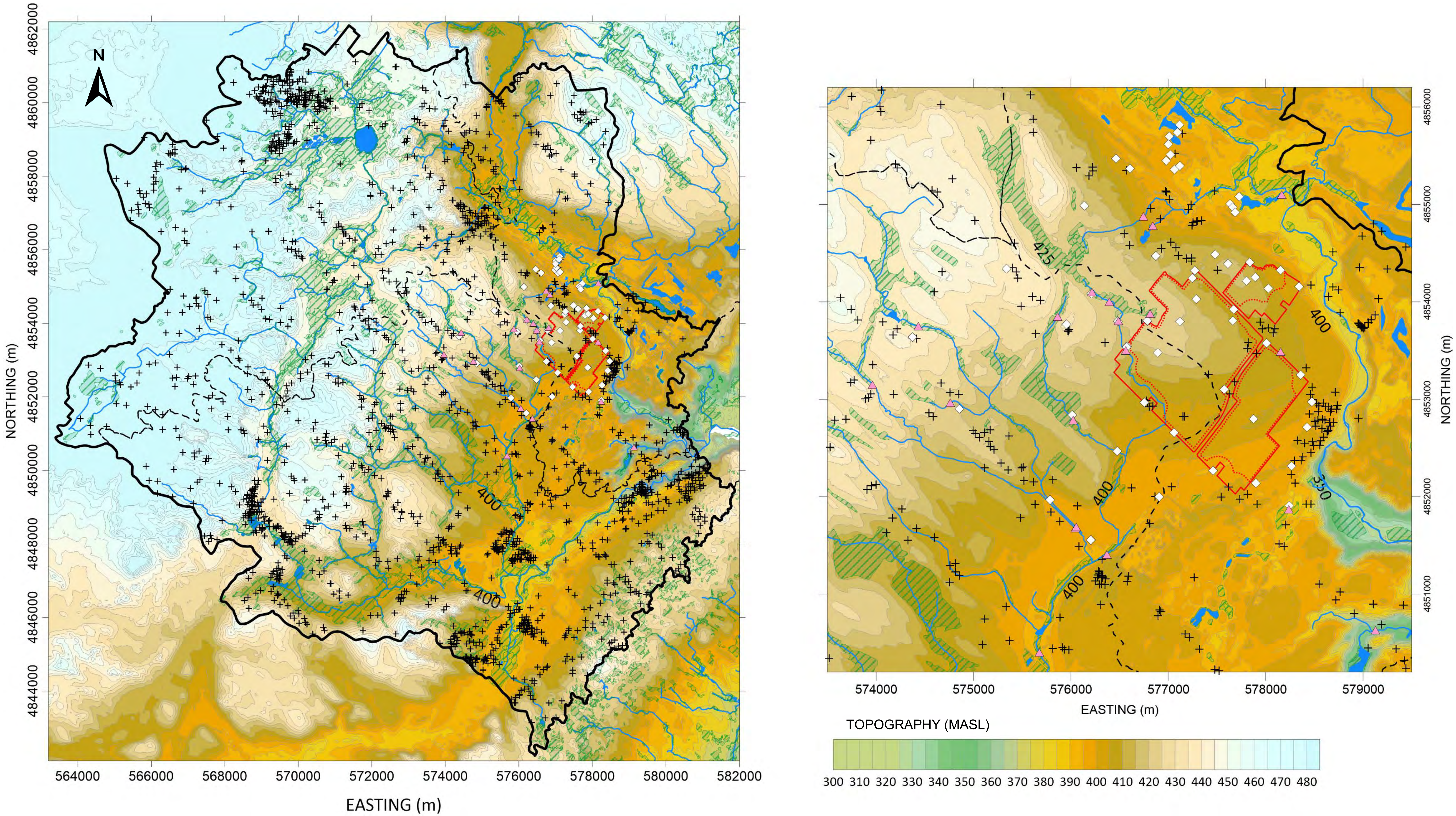


LEGEND

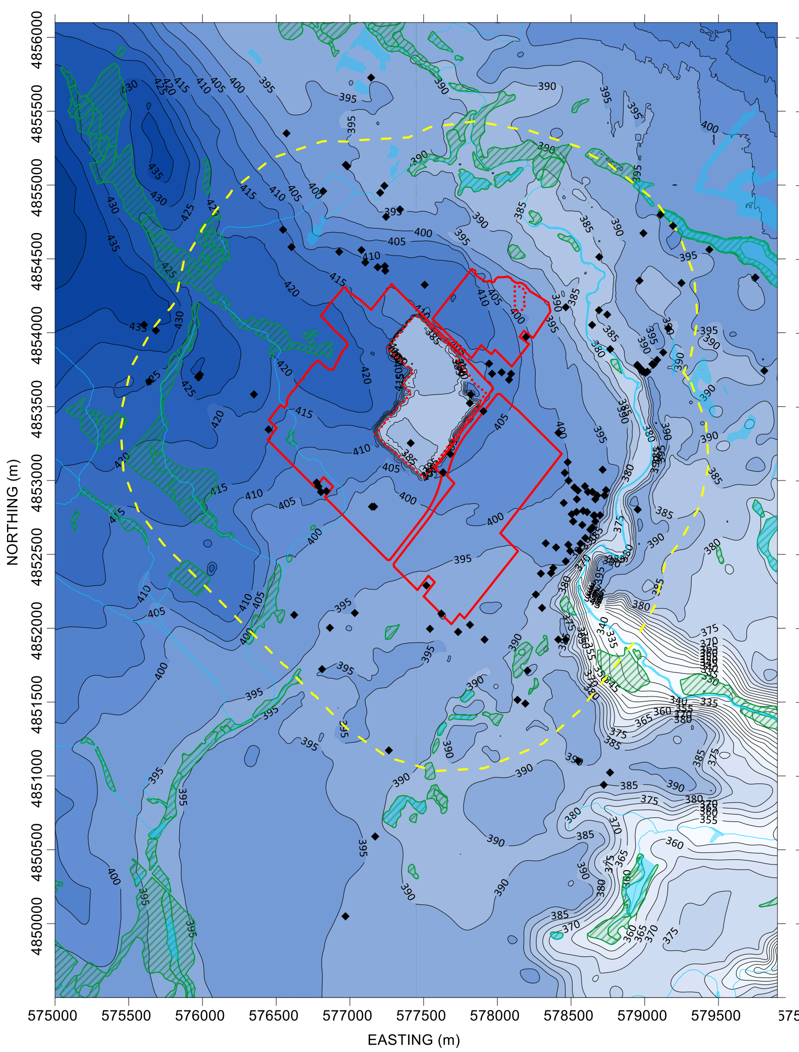
- LAKES
- RIVERS/ STREAMS
- WETLAND
- MODEL DOMAIN
- CVC SUBWATERSHED
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- MECP WWR WELL LOCATION
- SITE GROUNDWATER MONITORING LOCATION
- SITE SURFACE WATER MONITORING LOCATION

NOTES

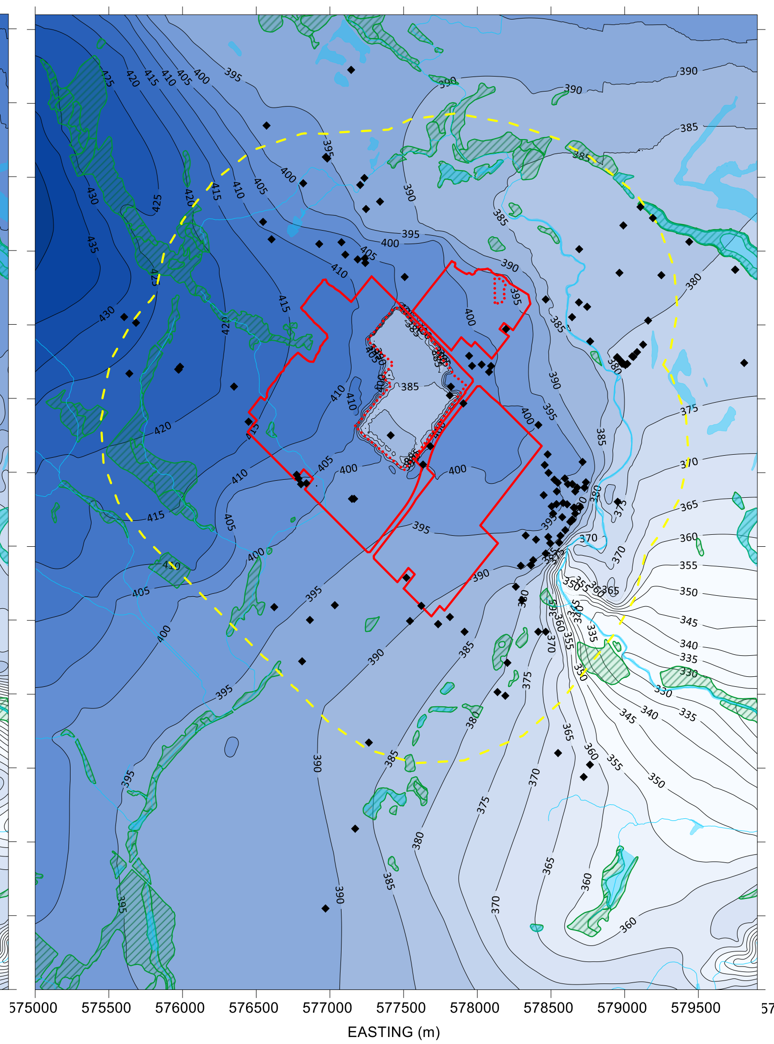
1. Source of spatial mapping of watercourses, waterbodies, and wetlands: Land Information Ontario (MNRF, 2018)
2. Source of Regional Topography dataset Ontario Ministry of Natural Resources and Forestry (MNRF) Southwestern Ontario Orthophotography (SWOOP) 2019
3. Source of Site Topography dataset provided by Firstbase Solutions (Spring 2021)
4. Ministry of Environment Conservation and Parks (MECP) Water Well Information System Database (MECP, 2020).
5. Quarry license and limit of extraction provided by MHBC (2022)

CLIENT	CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)
PROJECT	CALEDON PIT AND QUARRY NUMERICAL MODELLING
CONSULTANT	GOLDER MEMBER OF WSP
YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS
TITLE	STUDY AREA AND MODEL DOMAIN
PROJECT No.	19129150
Rev.	0
FIGURE	8-1

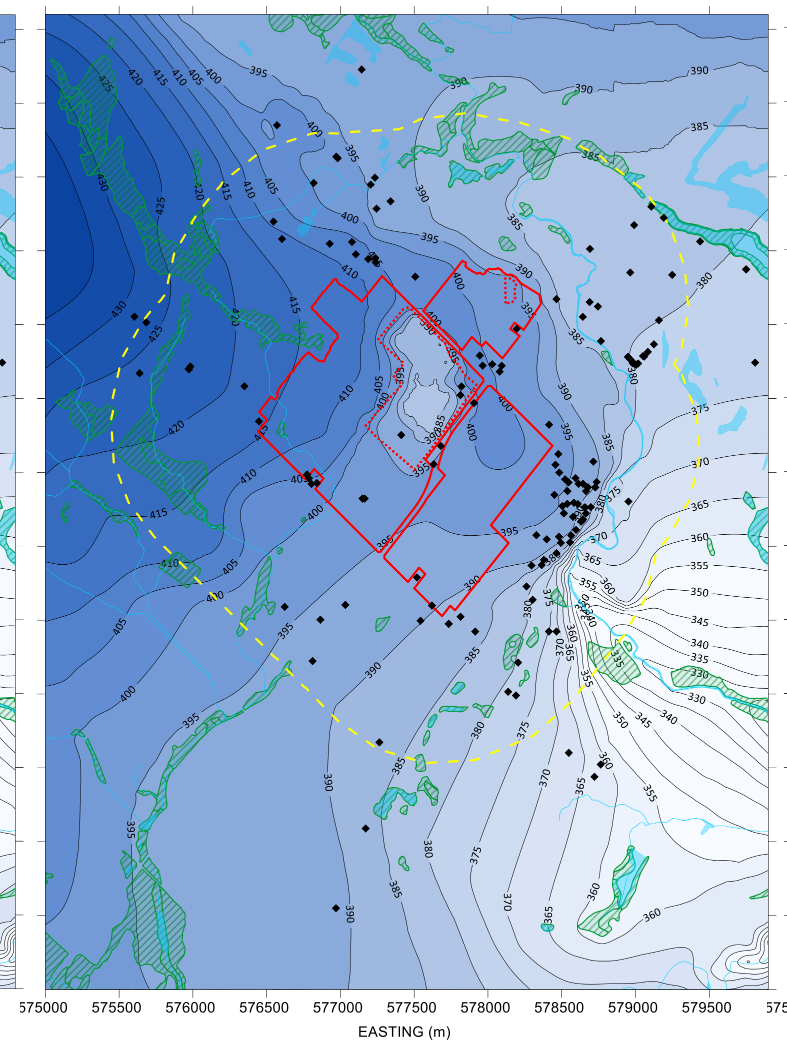
1. SHALLOW OVERBURDEN



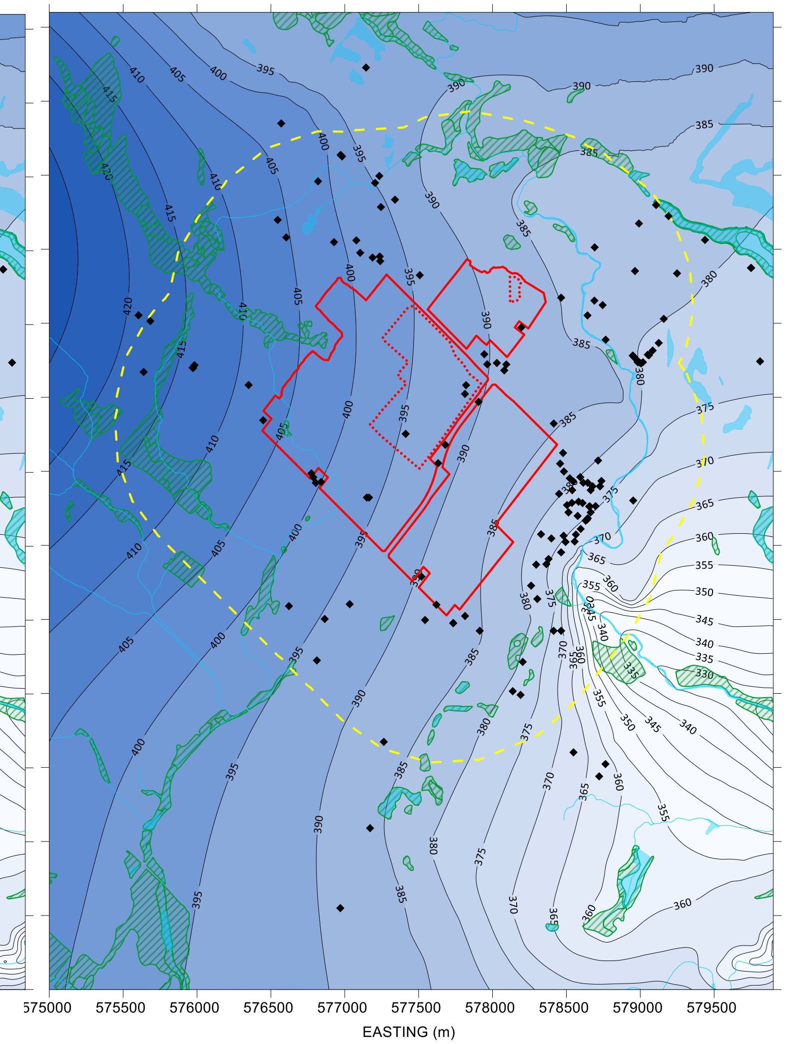
2. DEEP OVERBURDEN



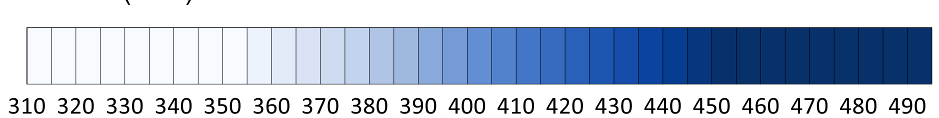
3. GASPORT FORMATION



4. MANITOULIN/ WHIRLPOOL FORMATION



HEAD (masl)



LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
3	14 to 18
4	18 to 23
5	23 to 29
6	27 to 33
7	33 to 37

NOTES

1. Simulated hydraulic head is shown at a contour interval of 5m
2. Gasport formation head extracted from model slice 22 (base of Gasport)
3. Manitoulin/ Whirlpool formation head extracted from model slice 25
4. Shallow overburden head extracted from model slice 2 (top of overburden sequence in model)
5. Deep overburden head extracted from model slice 12 (base of overburden sequence in model)
6. Source of spatial mapping of watercourses, waterbodies, and wetlands: Land Information Ontario (MNRF, 2018)
7. Private wells shown are from the Ministry of Environment Conservation and Parks (MECP) Water Well Information System Database (MECP, 2021).

CLIENT
CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

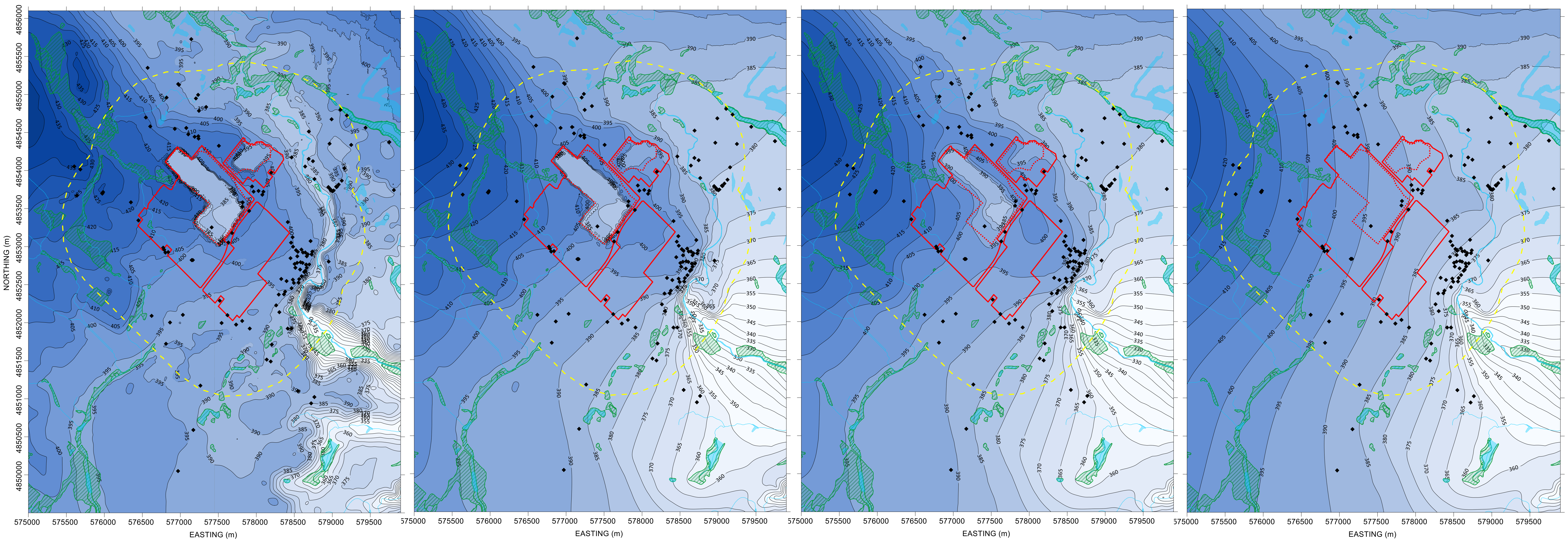
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

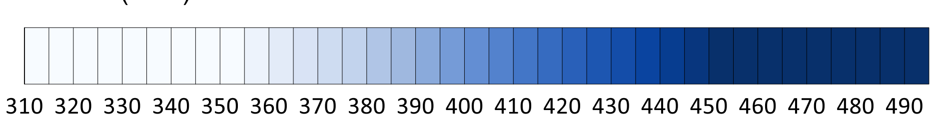
TITLE
PHASE 1 SIMULATED HEAD

PROJECT No.	Rev.	FIGURE
19129150	0	8-2A

1. SHALLOW OVERBURDEN 2. DEEP OVERBURDEN 3. GASPORT FORMATION 4. MANITOULIN/ WHIRLPOOL FORMATION



HEAD (masl)



LEGEND

LAKES

RIVERS/ STREAMS

SITE PROPERTY BOUNDARY

EXTRACTION EXTENTS

WETLAND

1KM BUFFER AROUND PROPERTY

MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
3	14 to 18
4	18 to 23
5	23 to 29
6	27 to 33
7	33 to 37

NOTES

1. Simulated hydraulic head is shown at a contour interval of 5m
2. Gasport formation head extracted from model slice 22 (base of Gasport)
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4. Shallow overburden head extracted from model slice 2 (top of overburden sequence in model)
5. Deep overburden head extracted from model slice 12 (base of overburden sequence in model)
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7. Private wells shown are from the Ministry of Environment Conservation and Parks (MECP) Water Well Information System Database (MECP, 2021).

CLIENT
CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

CONSULTANT
GOLDER
MEMBER OF WSP

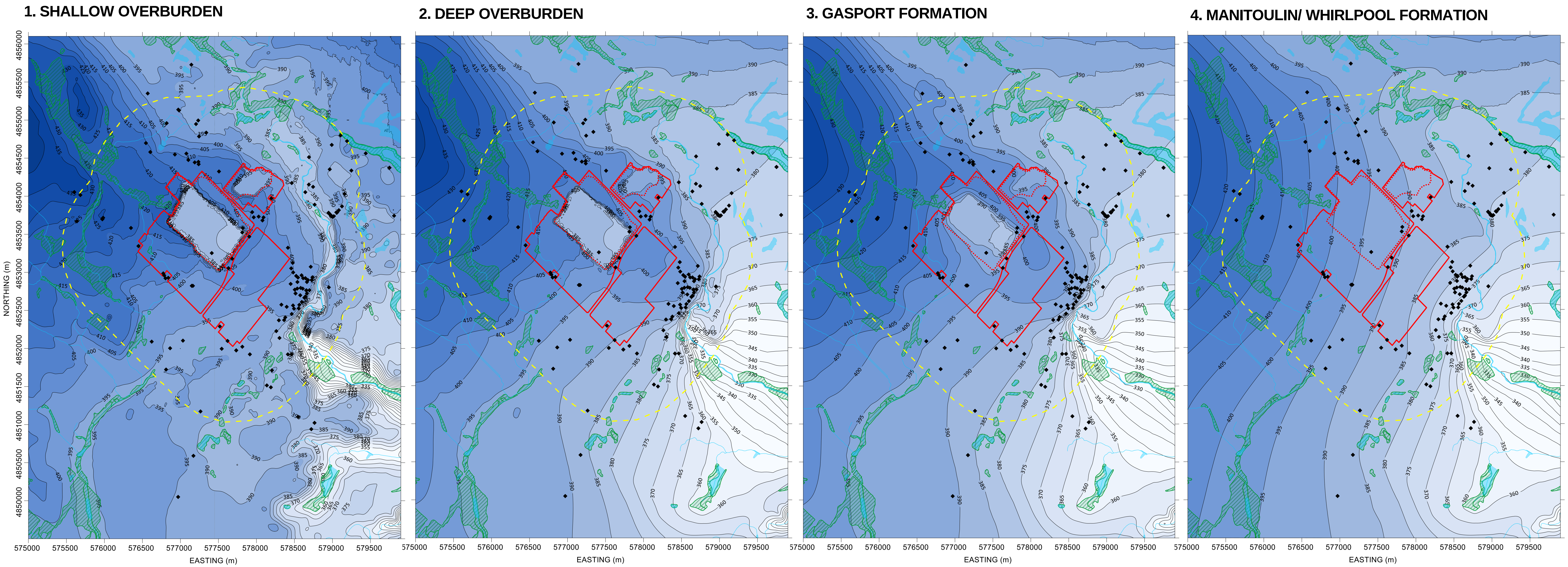
YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

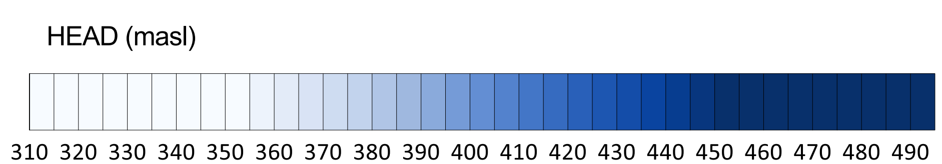
PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

TITLE
PHASE 2 SIMULATED HEAD

PROJECT No. 19129150
Rev. 0
FIGURE 8-2B

1. SHALLOW OVERBURDEN 2. DEEP OVERBURDEN 3. GASPORT FORMATION 4. MANITOULIN/ WHIRLPOOL FORMATION





LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
3	14 to 18
4	18 to 23
5	23 to 29
6	27 to 33
7	33 to 37

NOTES

1. Simulated hydraulic head is shown at a contour interval of 5m
2. Gasport formation head extracted from model slice 22 (base of Gasport)
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4. Shallow overburden head extracted from model slice 2 (top of overburden sequence in model)
5. Deep overburden head extracted from model slice 12 (base of overburden sequence in model)
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7. Private wells shown are from the Ministry of Environment Conservation and Parks (MECP) Water Well Information System Database (MECP, 2021).

CLIENT
CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

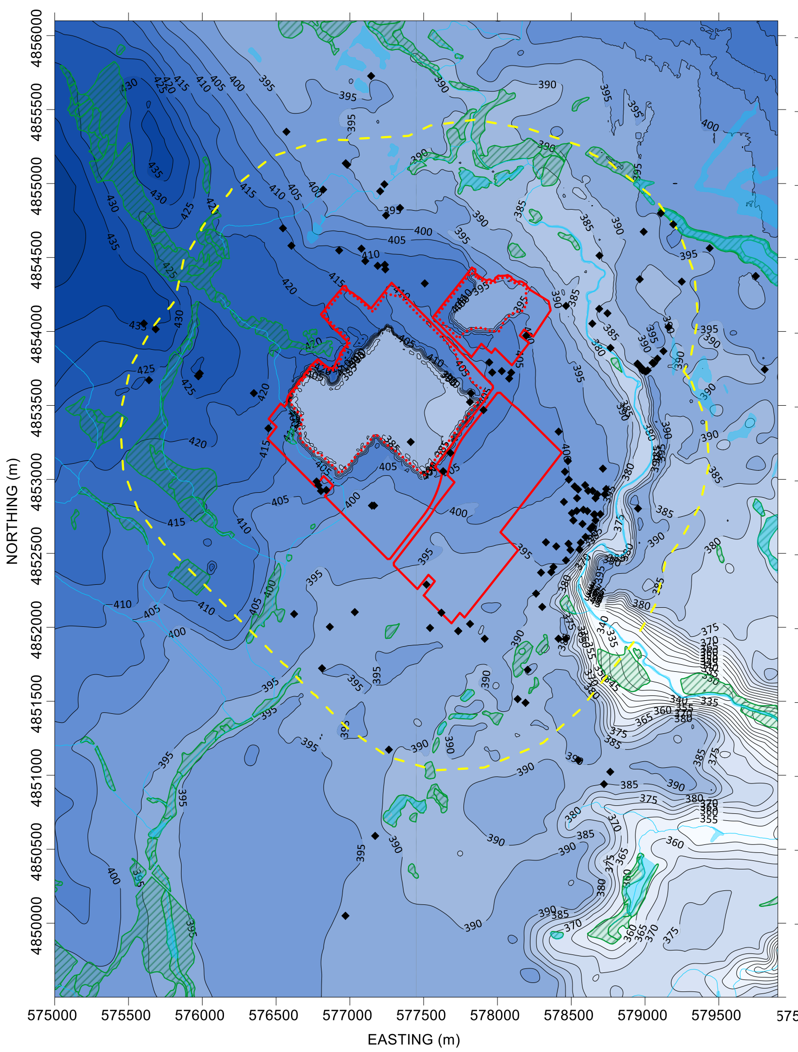
CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

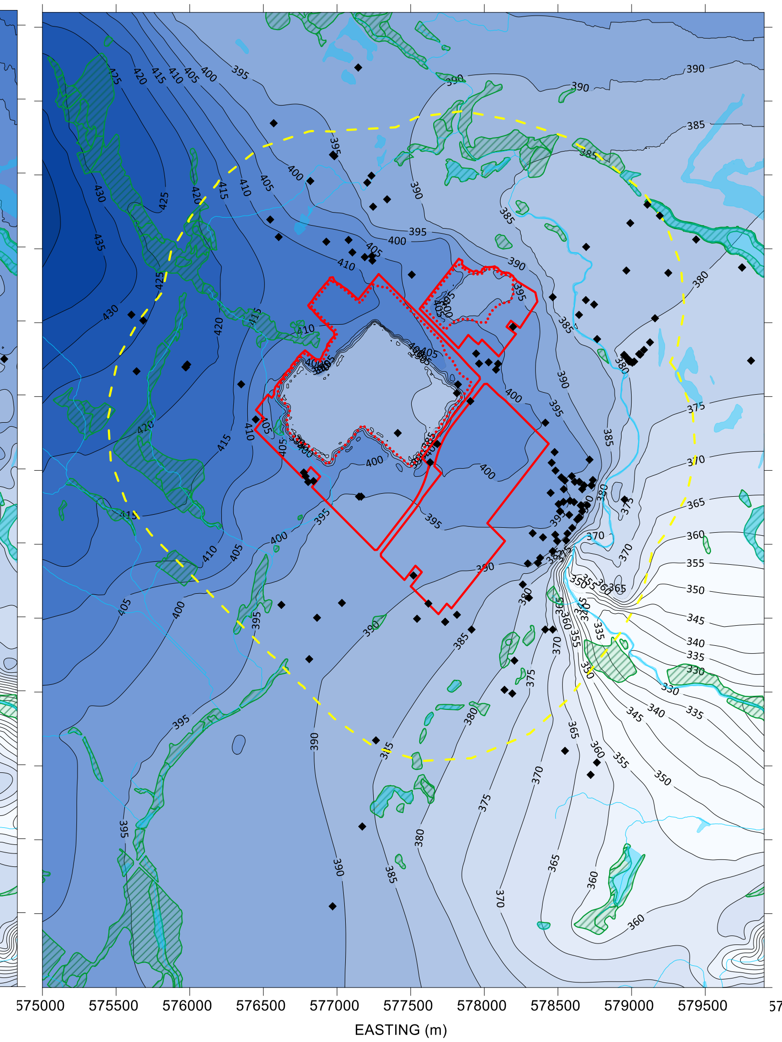
TITLE
PHASE 3 SIMULATED HEAD

PROJECT No. 19129150 | Rev. 0 | FIGURE 8-2C

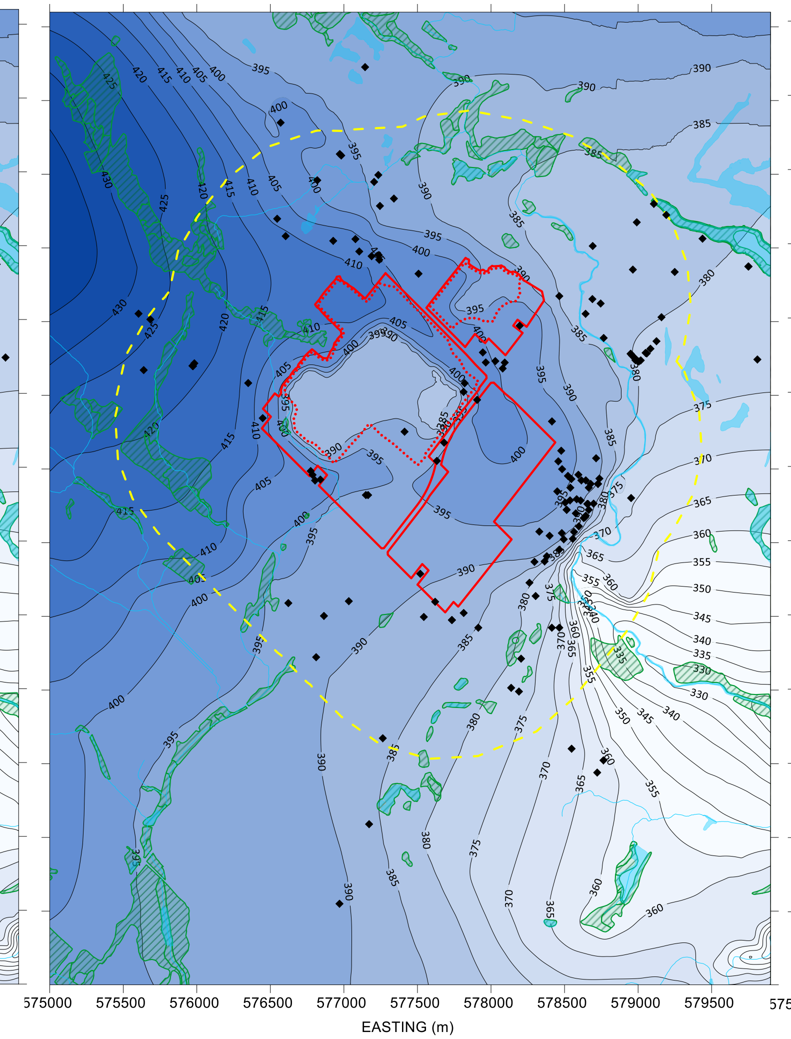
1. SHALLOW OVERBURDEN



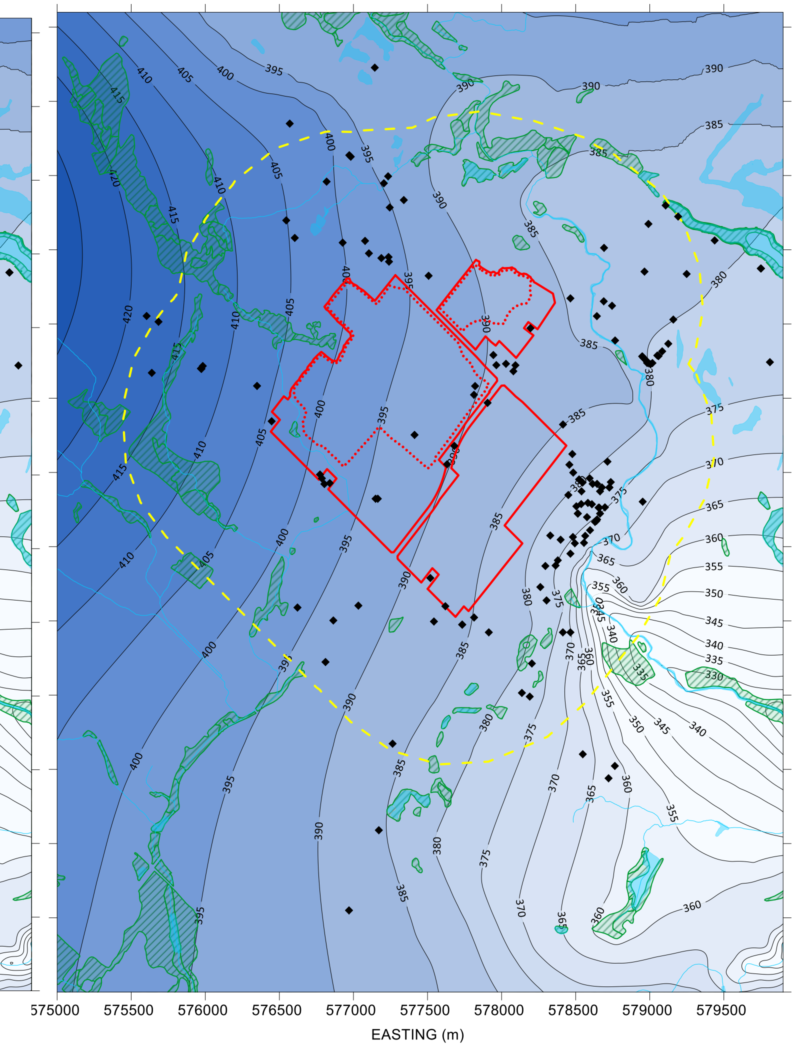
2. DEEP OVERBURDEN



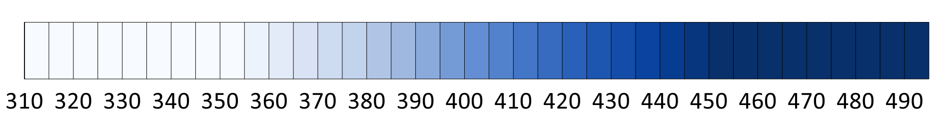
3. GASPORT FORMATION



4. MANITOULIN/ WHIRLPOOL FORMATION



HEAD (masl)



LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
3	14 to 18
4	18 to 23
5	23 to 29
6	27 to 33
7	33 to 37

NOTES

1. Simulated hydraulic head is shown at a contour interval of 5m
2. Gasport formation head extracted from model slice 22 (base of Gasport)
3. Manitoulin/ Whirlpool formation head extracted from model slice 25
4. Shallow overburden head extracted from model slice 2 (top of overburden sequence in model)
5. Deep overburden head extracted from model slice 12 (base of overburden sequence in model)
6. Source of spatial mapping of watercourses, waterbodies, and wetlands: Land Information Ontario (MNRF, 2018)
7. Private wells shown are from the Ministry of Environment Conservation and Parks (MECP) Water Well Information System Database (MECP, 2021).

CLIENT
CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

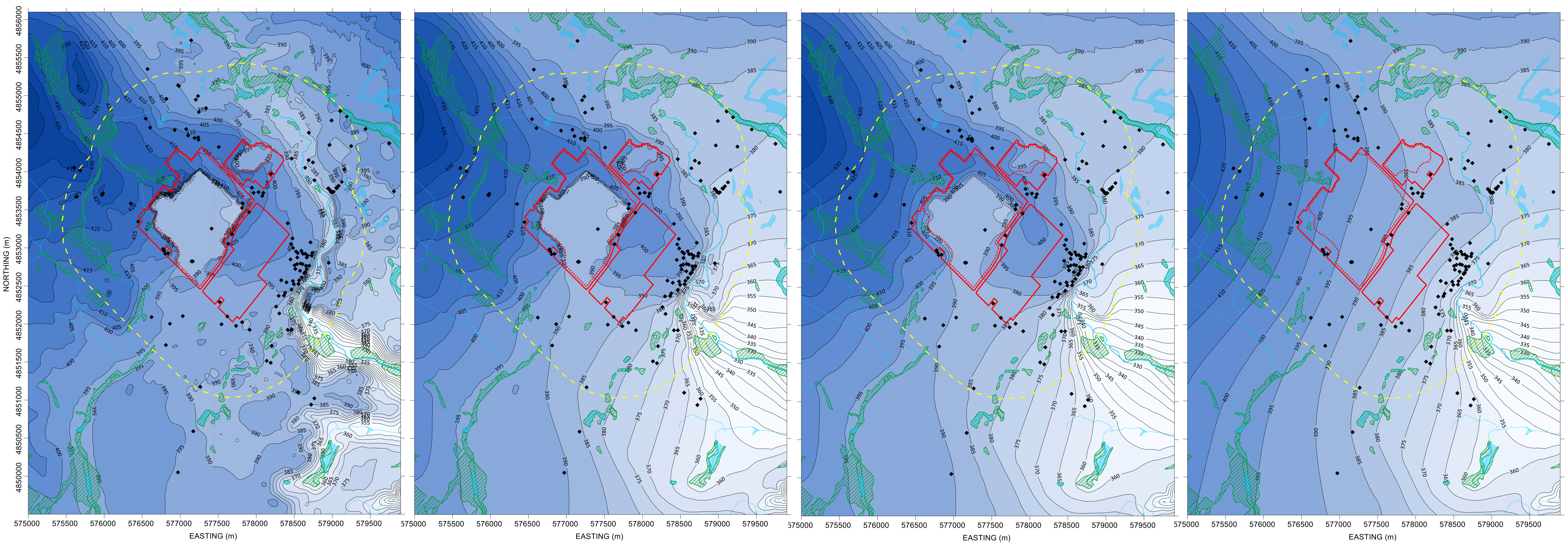
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

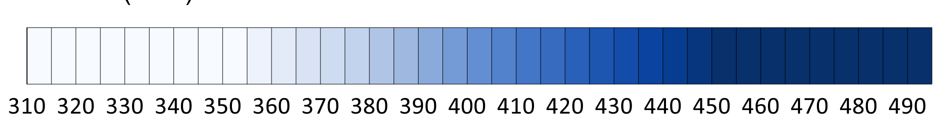
TITLE
PHASE 4 SIMULATED HEAD

PROJECT No.	Rev.	FIGURE
19129150	0	8-2D

1. SHALLOW OVERBURDEN **2. DEEP OVERBURDEN** **3. GASPORT FORMATION** **4. MANITOULIN/ WHIRLPOOL FORMATION**



HEAD (masl)



LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
3	14 to 18
4	18 to 23
5	23 to 29
6	27 to 33
7	33 to 37

NOTES

1. Simulated hydraulic head is shown at a contour interval of 5m
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4. Shallow overburden head extracted from model slice 2 (top of overburden sequence in model)
5. Deep overburden head extracted from model slice 12 (base of overburden sequence in model)
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7. Private wells shown are from the Ministry of Environment Conservation and Parks (MECP) Water Well Information System Database (MECP, 2021).

CLIENT
CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

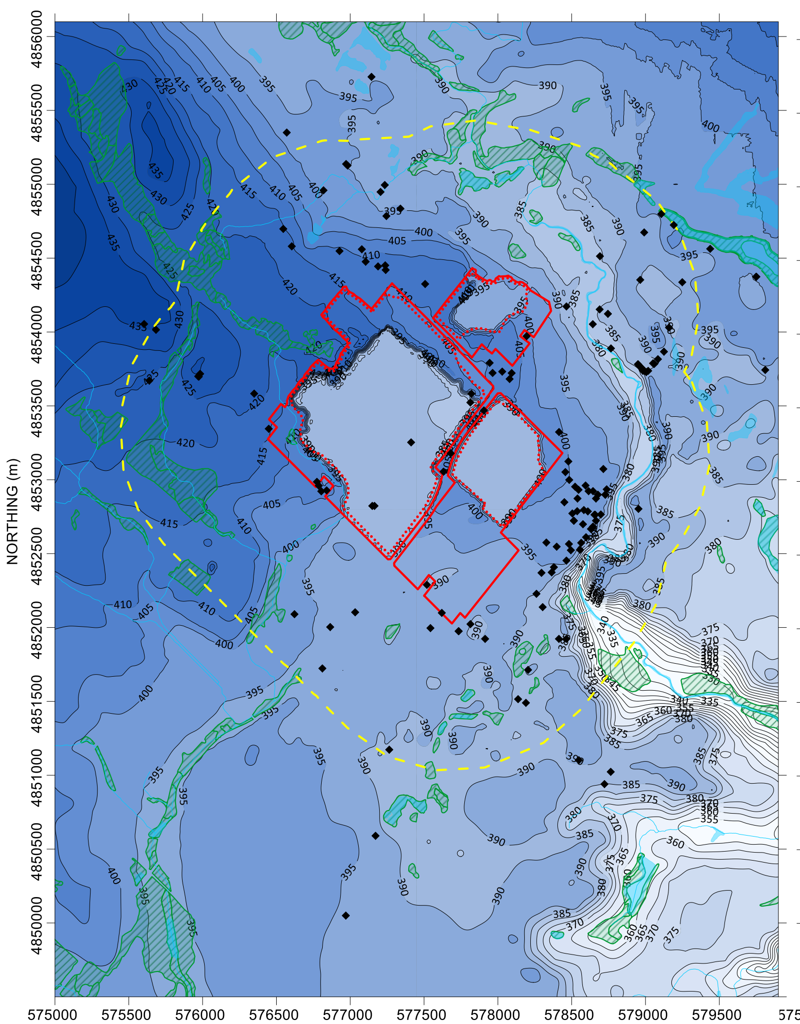
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

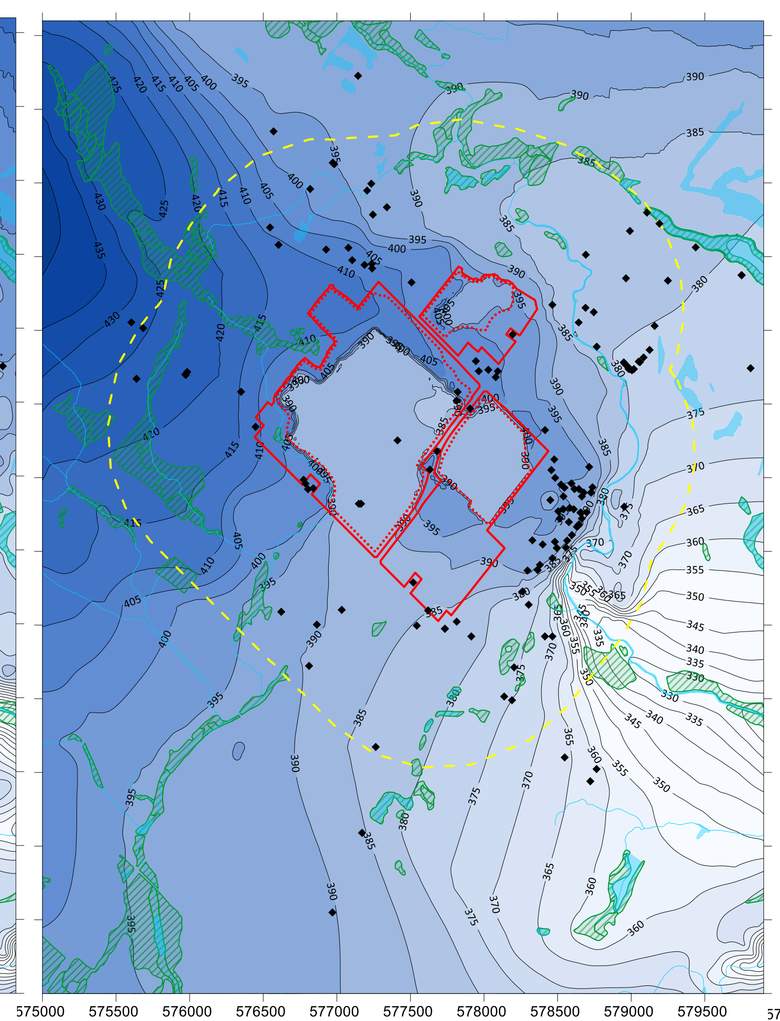
TITLE
PHASE 5 SIMULATED HEAD

PROJECT No.	Rev.	FIGURE
19129150	0	8-2E

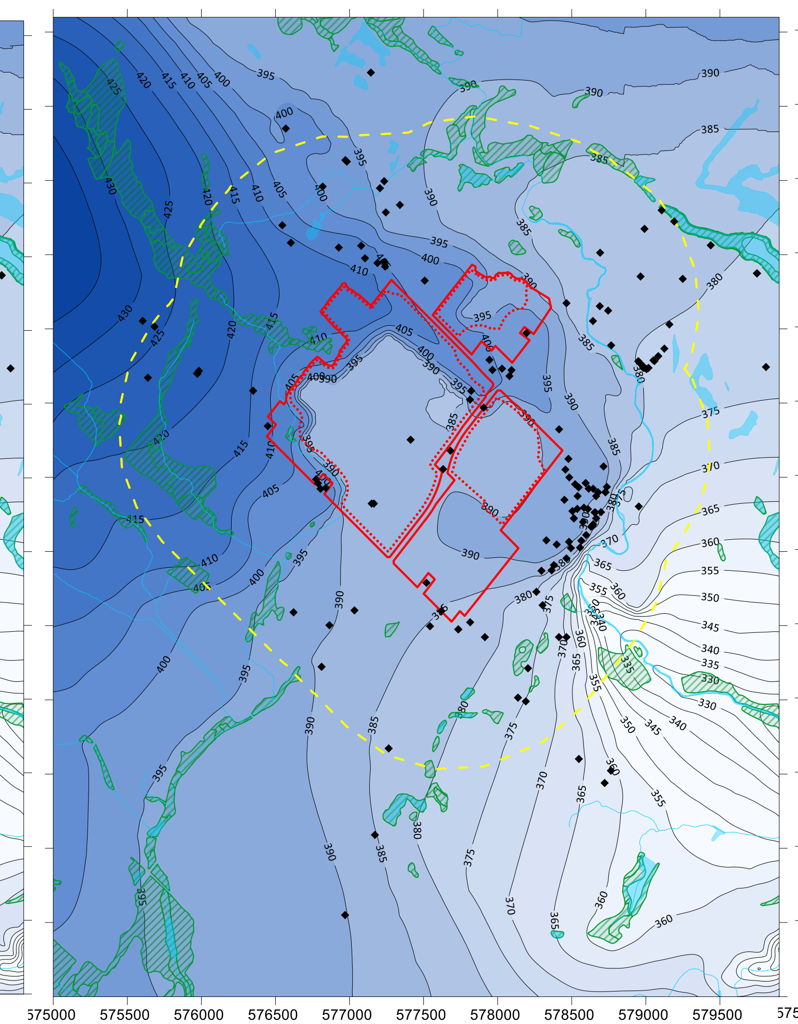
1. SHALLOW OVERBURDEN



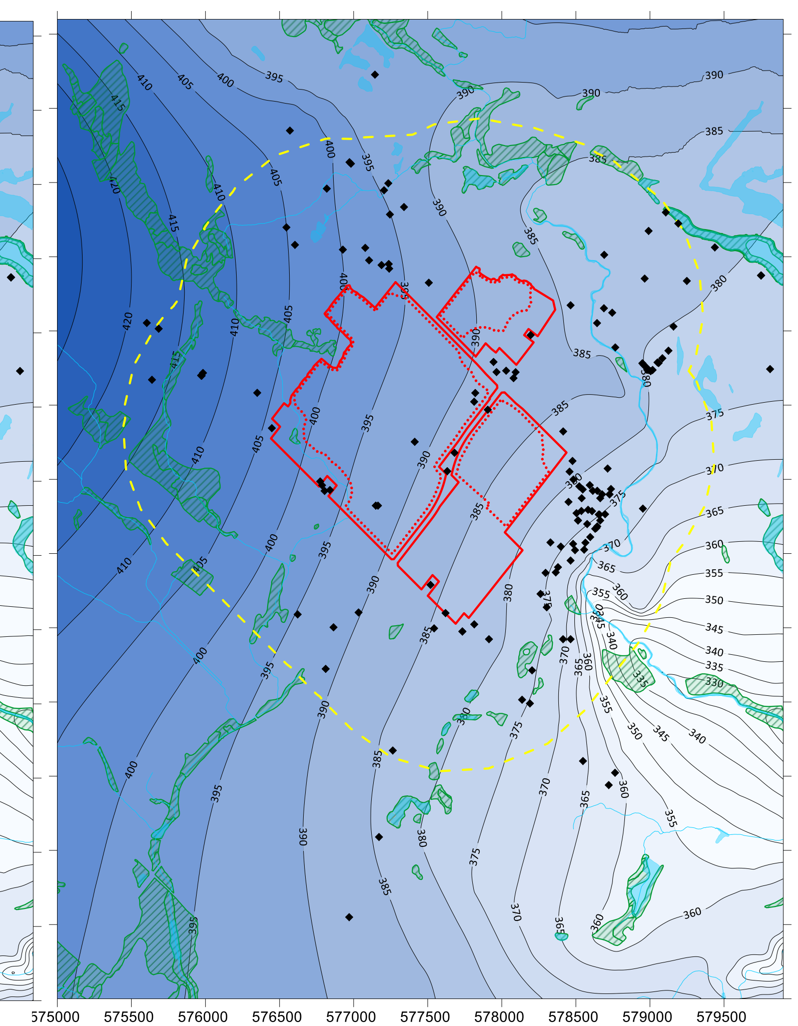
2. DEEP OVERBURDEN



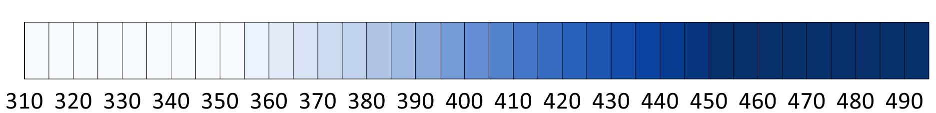
3. GASPORT FORMATION



4. MANITOULIN/ WHIRLPOOL FORMATION



HEAD (masl)



LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
3	14 to 18
4	18 to 23
5	23 to 29
6	27 to 33
7	33 to 37

NOTES

1. Simulated hydraulic head is shown at a contour interval of 5m
2. Gasport formation head extracted from model slice 22 (base of Gasport)
3. Manitoulin/ Whirlpool formation head extracted from model slice 25
4. Shallow overburden head extracted from model slice 2 (top of overburden sequence in model)
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7. Private wells shown are from the Ministry of Environment Conservation and Parks (MECP) Water Well Information System Database (MECP, 2021).

CLIENT
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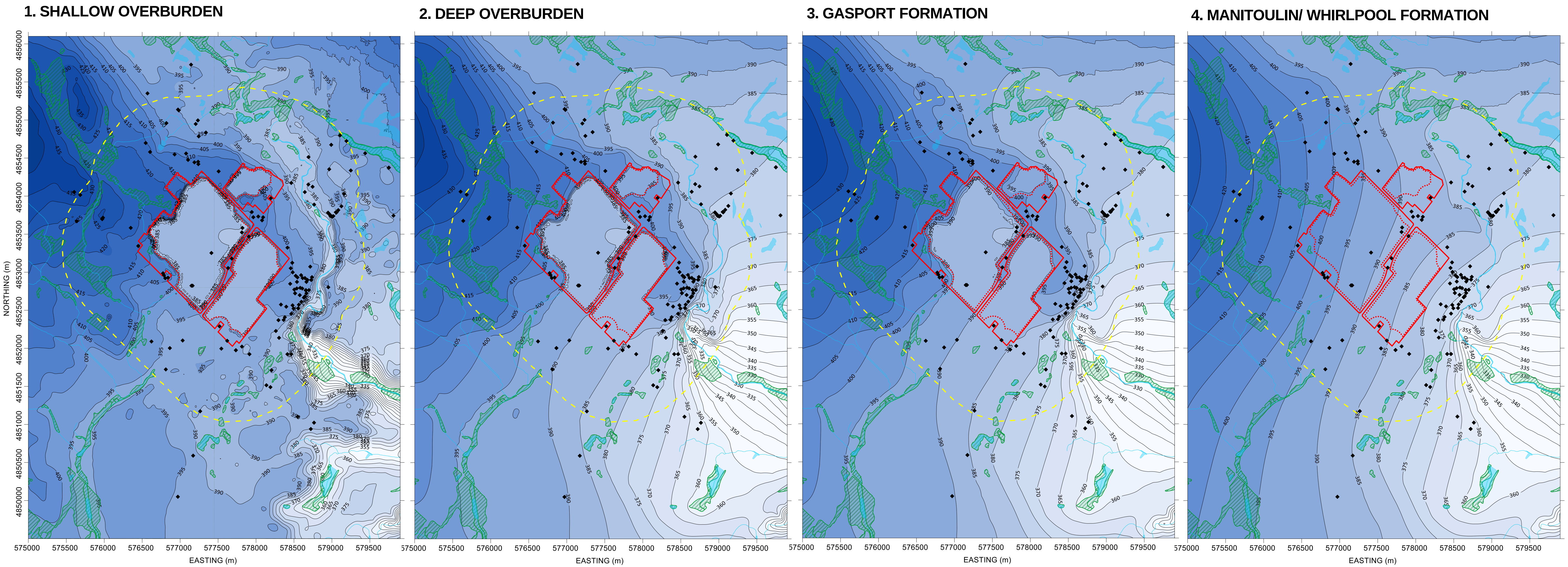
PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

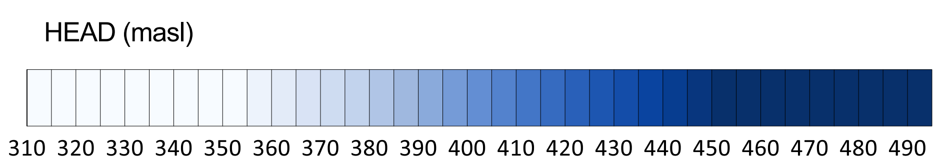
CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

TITLE
PHASE 6 SIMULATED HEAD

PROJECT No. 19129150
Rev. 0
FIGURE 8-2F





LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
3	14 to 18
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5	23 to 29
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NOTES

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PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

TITLE
PHASE 7 SIMULATED HEAD

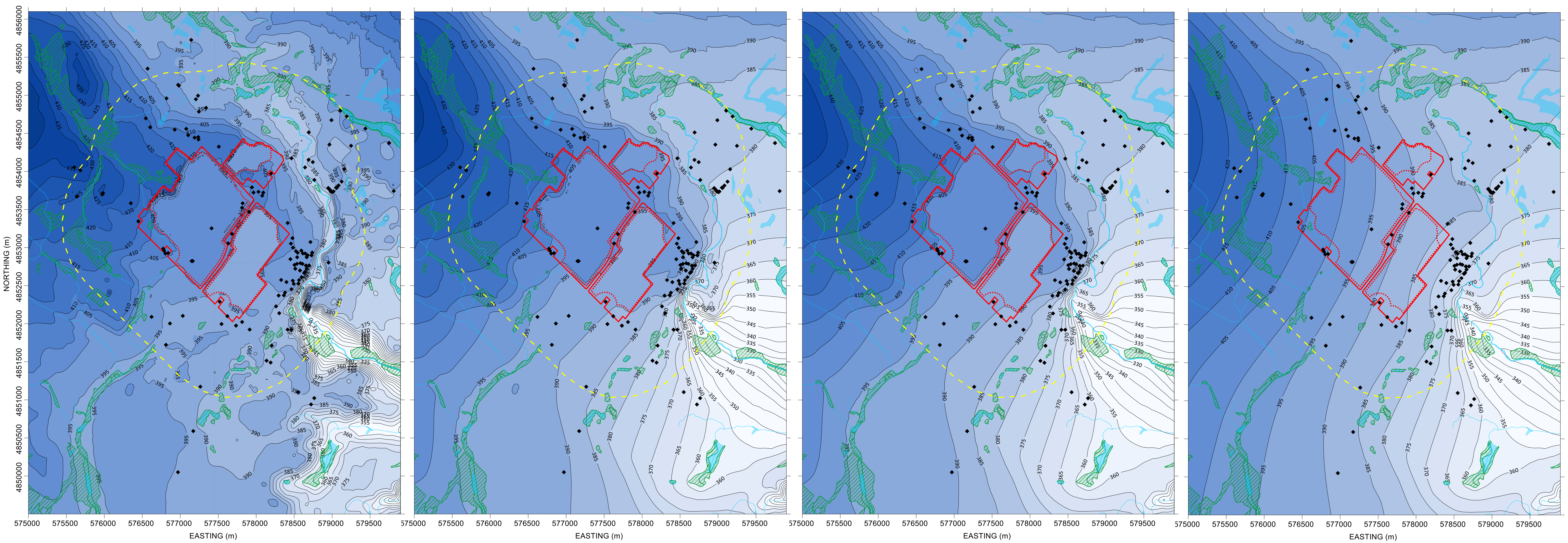
PROJECT No. 19129150
Rev. 0
FIGURE 8-2G

1. SHALLOW OVERBURDEN

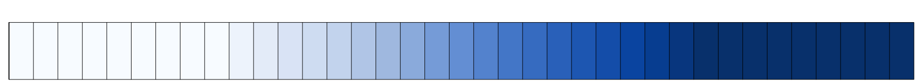
2. DEEP OVERBURDEN

3. GASPORT FORMATION

4. MANITOULIN/ WHIRLPOOL FORMATION



HEAD (masl)



LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
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NOTES

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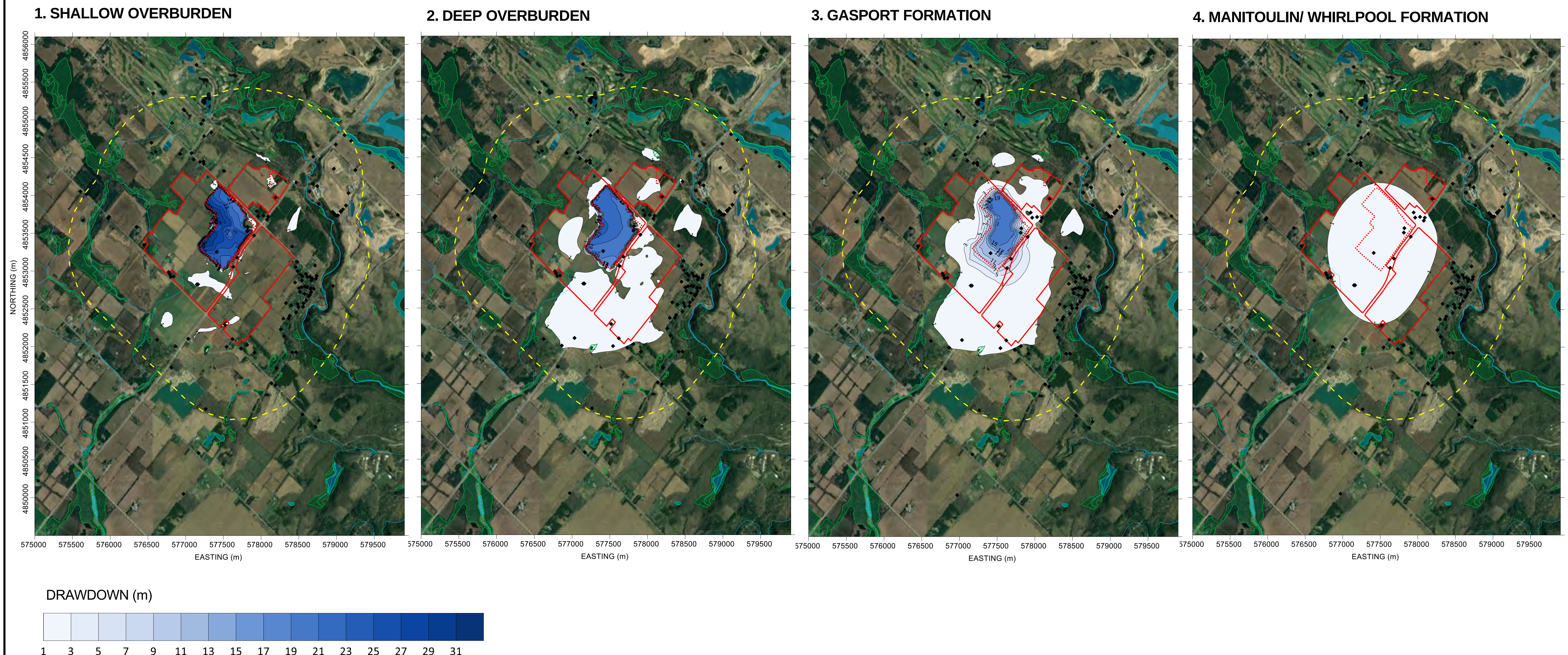
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

TITLE
REHABILITATION SIMULATED HEAD

PROJECT No. 19129150 Rev. 0 FIGURE 8-2H



LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
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YYYY-MM-DD	2022-12-15
PREPARED	HW
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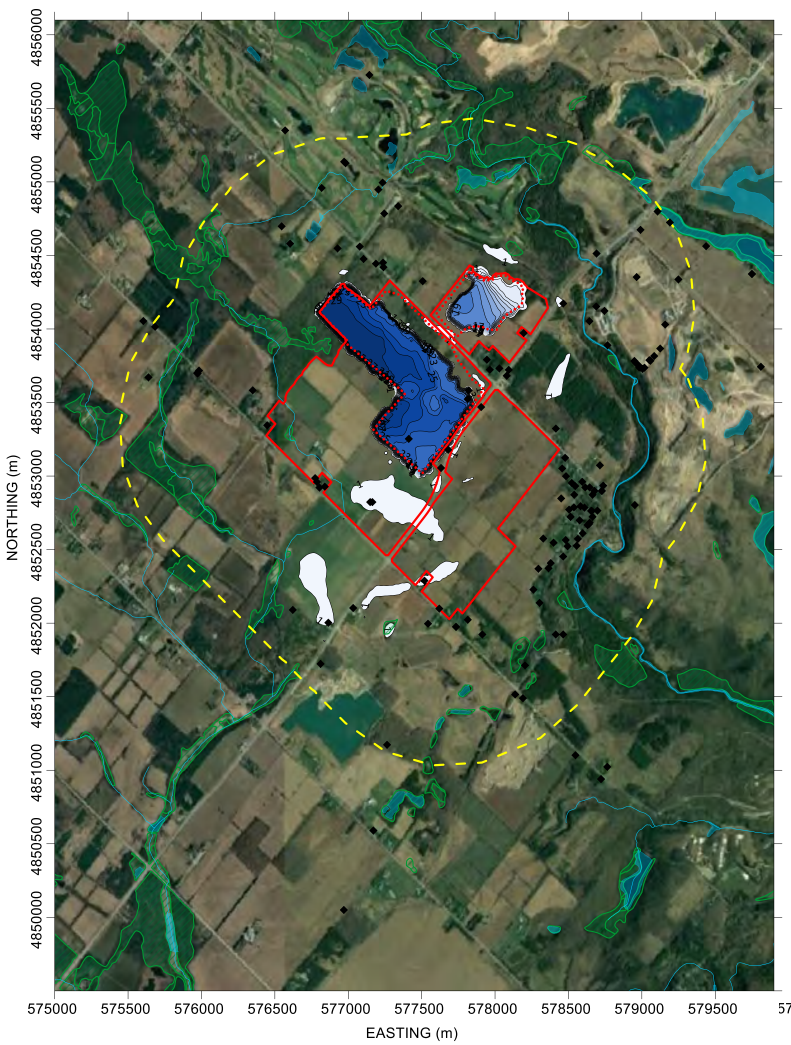
REVIEW	SD
APPROVED	GS

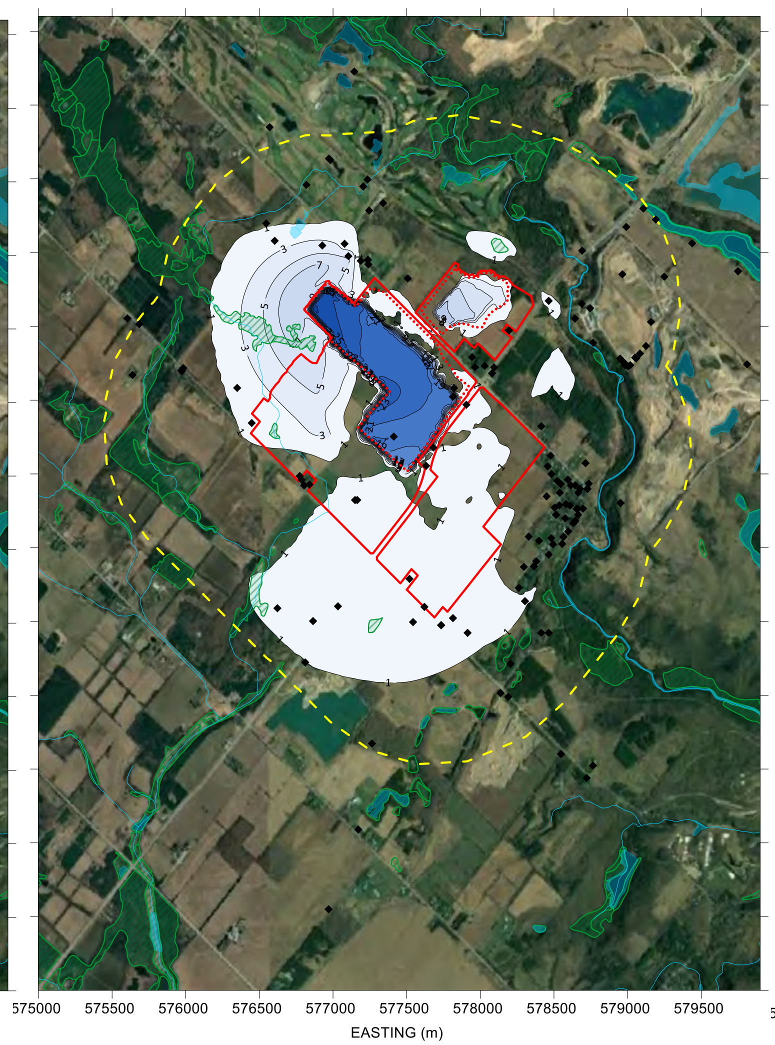
TITLE
PHASE 1 SIMULATED DRAWDOWN

PROJECT No.	Rev.	FIGURE
19129150	0	8-3A

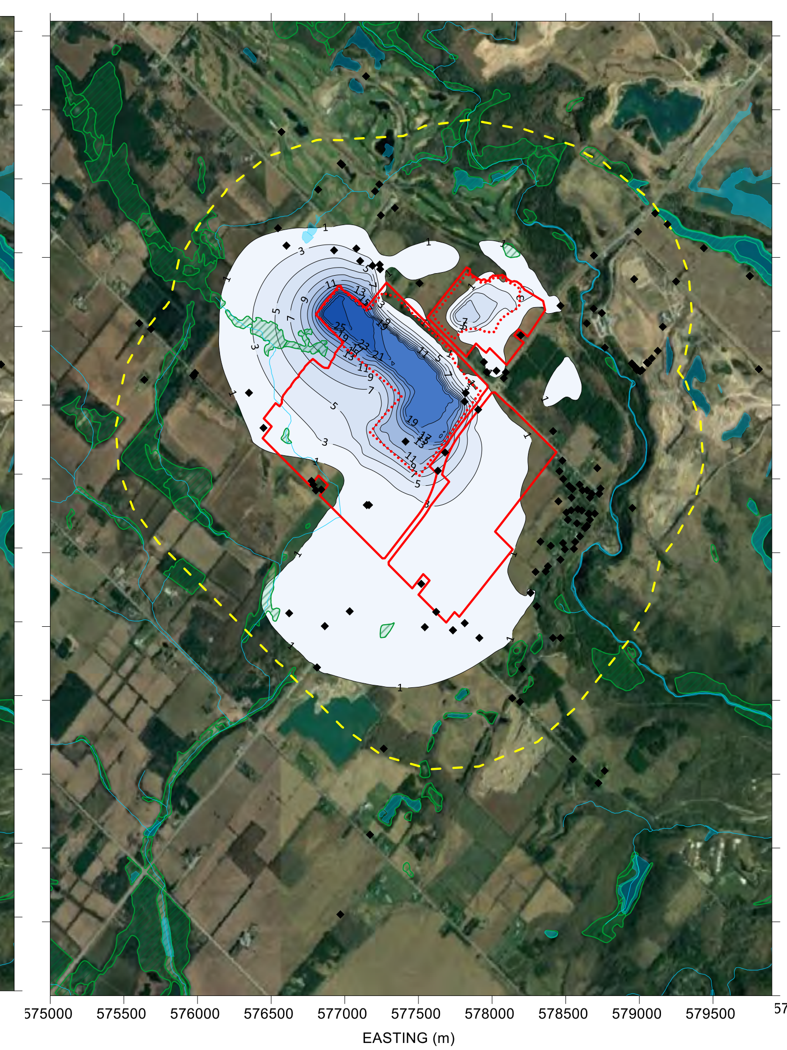
1. SHALLOW OVERBURDEN



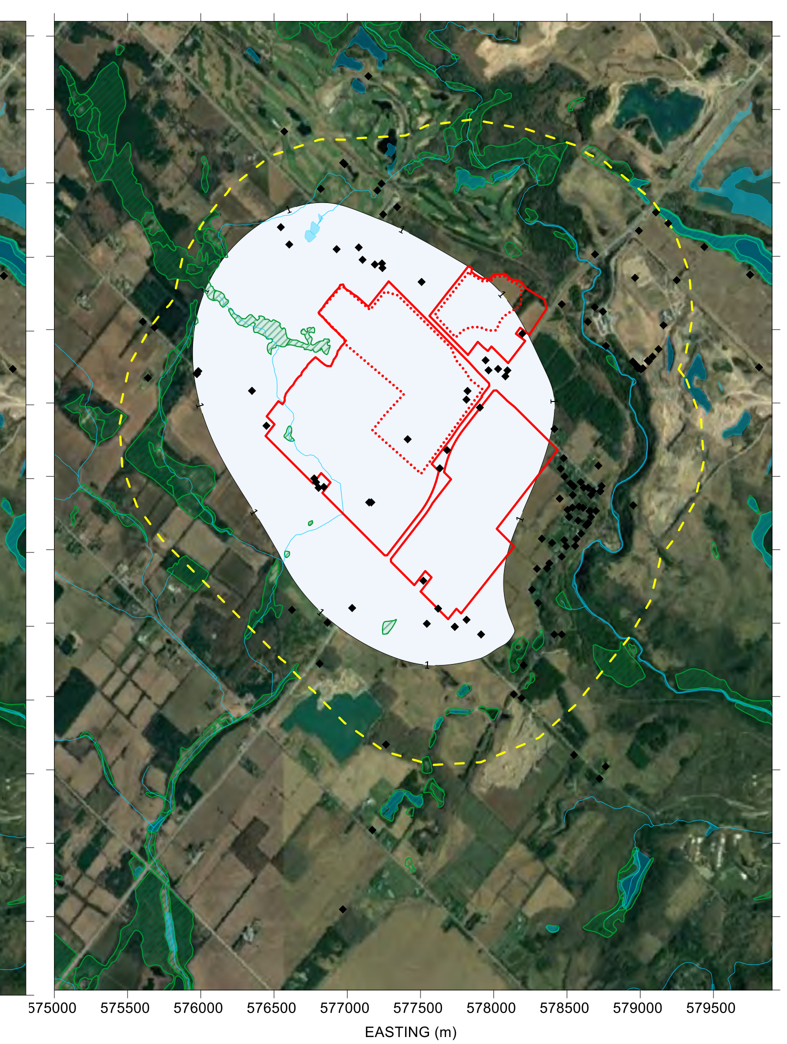
2. DEEP OVERBURDEN



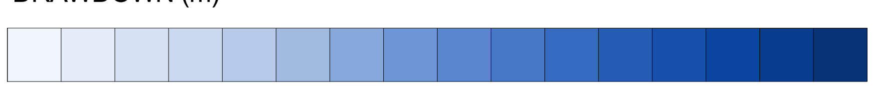
3. GASPORT FORMATION



4. MANITOULIN/ WHIRLPOOL FORMATION



DRAWDOWN (m)



LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
3	14 to 18
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NOTES

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PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

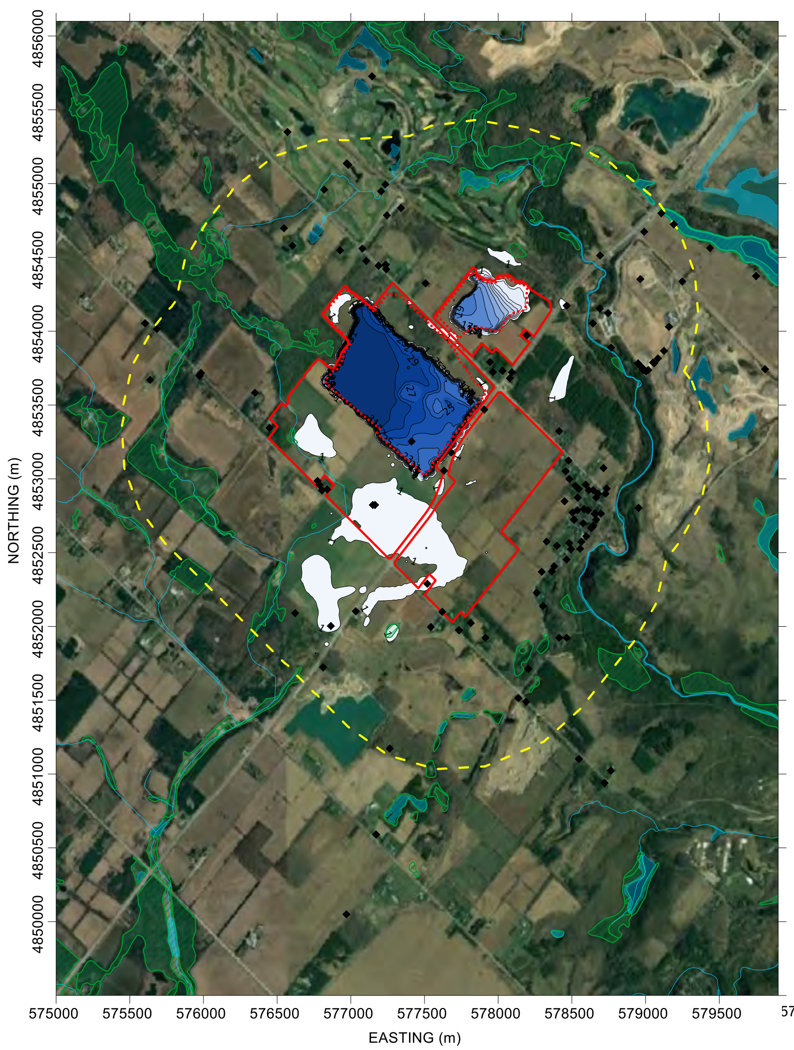
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

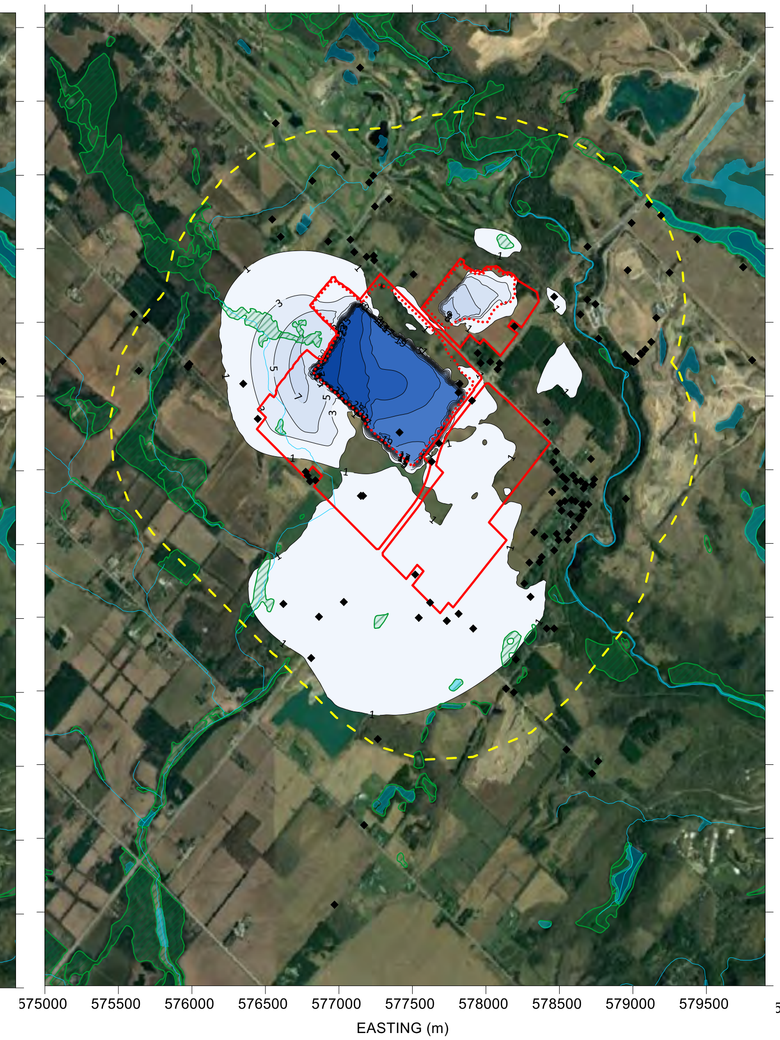
TITLE
PHASE 2 SIMULATED DRAWDOWN

PROJECT No. 19129150 | Rev. 0 | FIGURE 8-3B

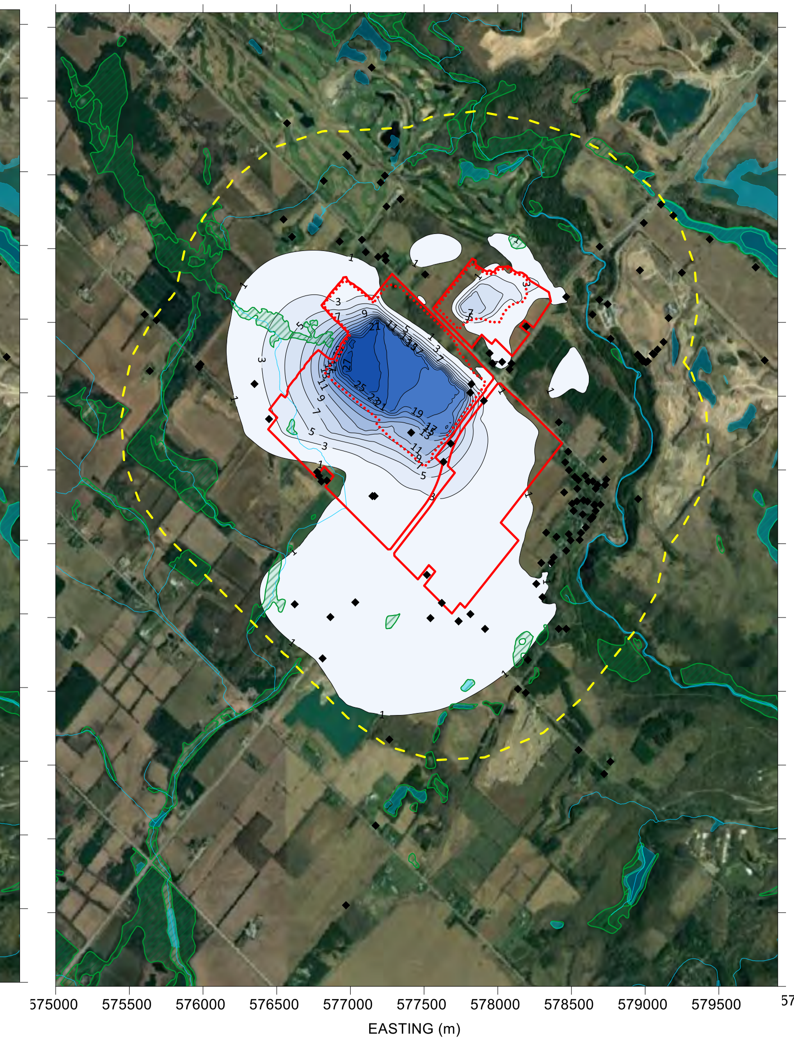
1. SHALLOW OVERBURDEN



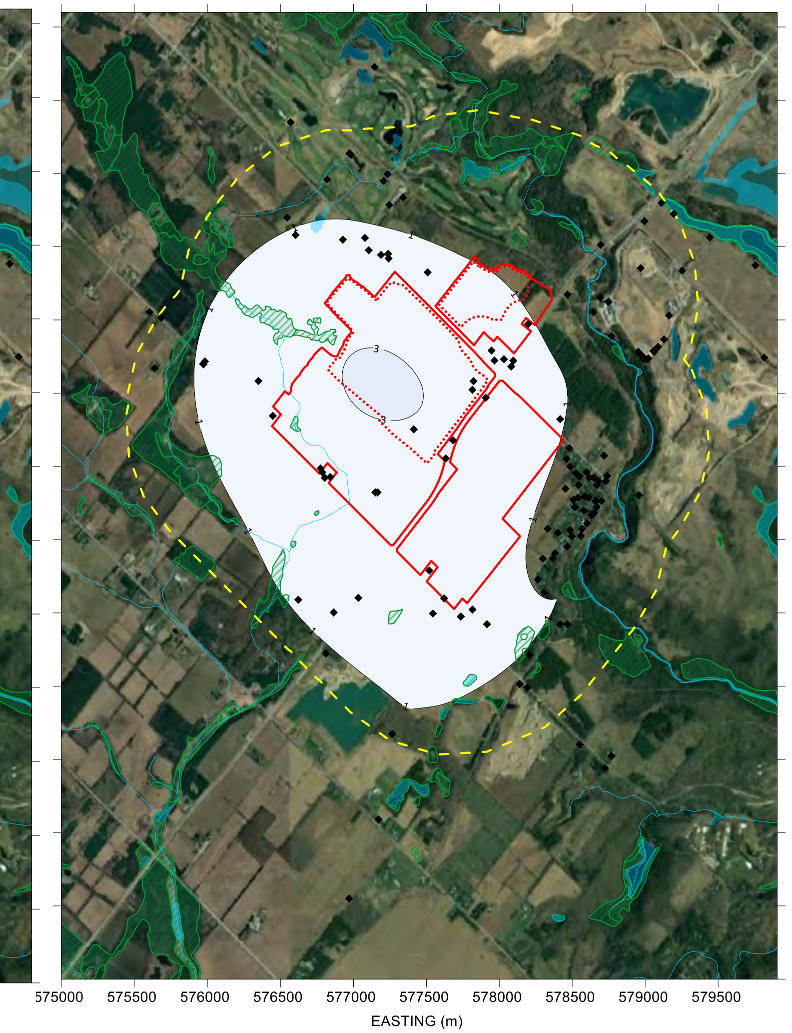
2. DEEP OVERBURDEN



3. GASPORT FORMATION



4. MANITOULIN/ WHIRLPOOL FORMATION



DRAWDOWN (m)

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31

LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
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NOTES

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CALEDON PIT AND QUARRY NUMERICAL MODELLING

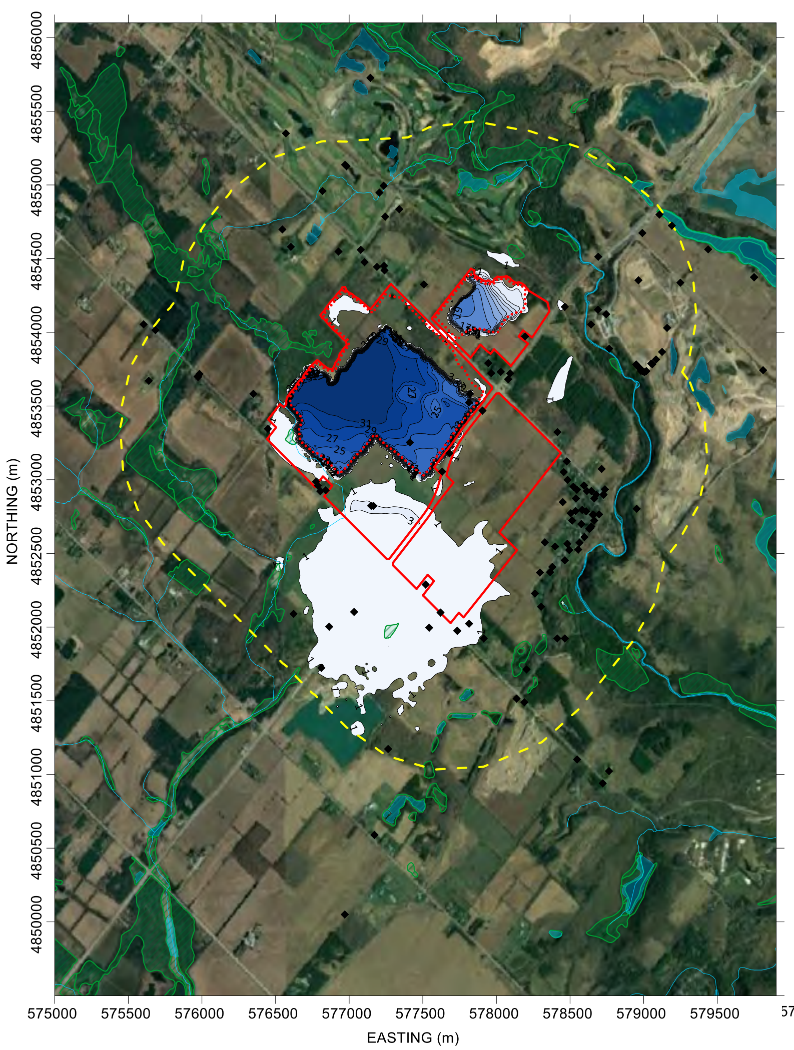
CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

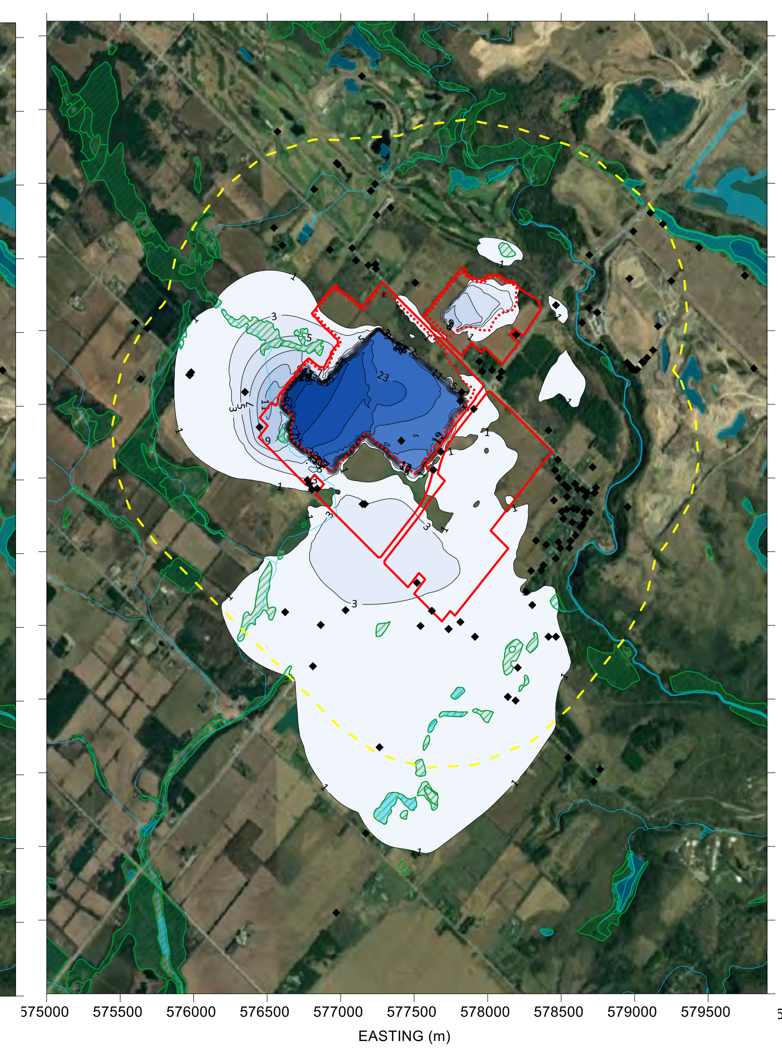
TITLE
PHASE 3 SIMULATED DRAWDOWN

PROJECT No.	Rev.	FIGURE
19129150	0	8-3C

1. SHALLOW OVERBURDEN

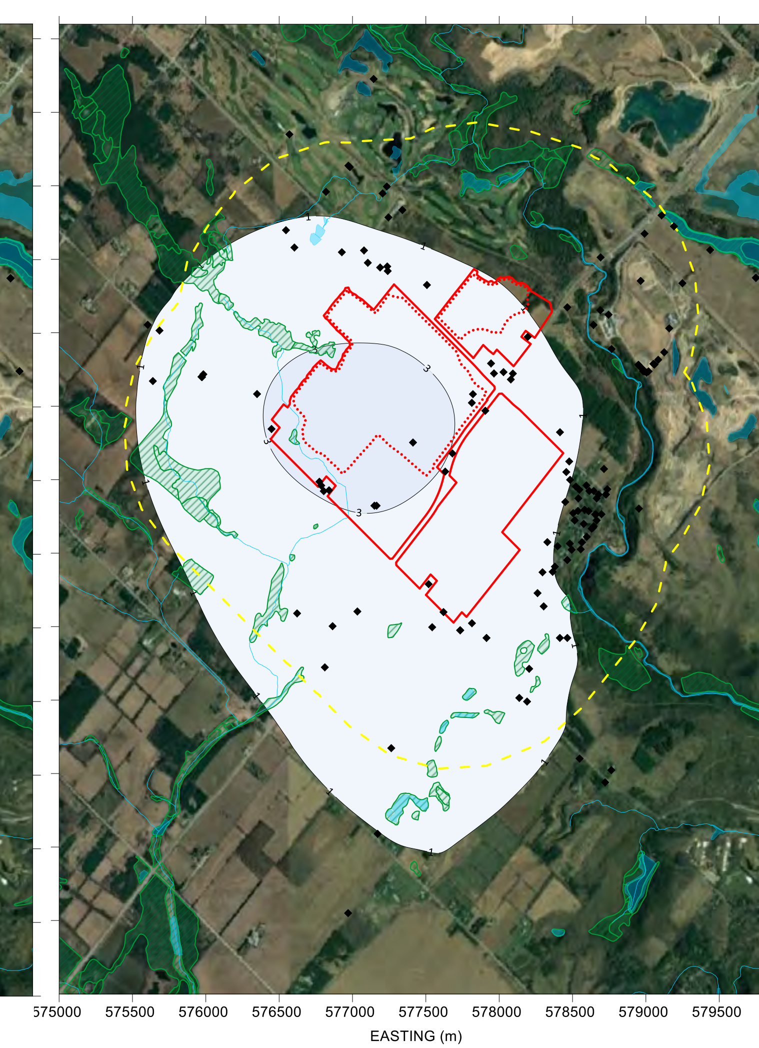


2. DEEP OVERBURDEN

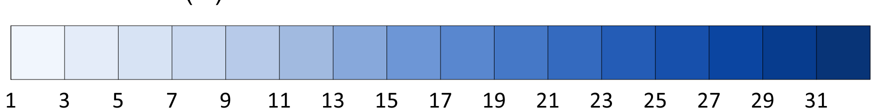


3. GASPORT FORMATION

4. MANITOULIN/ WHIRLPOOL FORMATION



DRAWDOWN (m)



LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
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CALEDON PIT AND QUARRY NUMERICAL MODELLING

CONSULTANT
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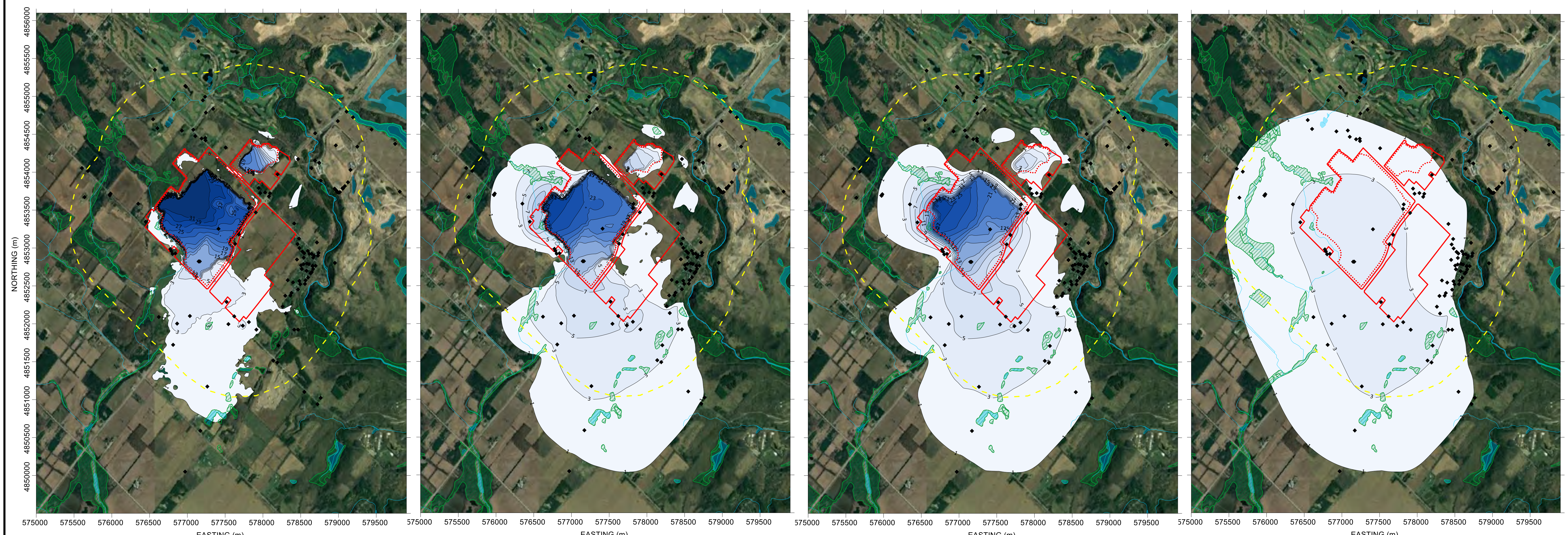
MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

TITLE
PHASE 4 SIMULATED DRAWDOWN

PROJECT No.	Rev.	FIGURE
19129150	0	8-3D

1. SHALLOW OVERBURDEN | 2. DEEP OVERBURDEN | 3. GASPORT FORMATION | 4. MANITOULIN/ WHIRLPOOL FORMATION



DRAWDOWN (m)

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31

LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
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PROJECT
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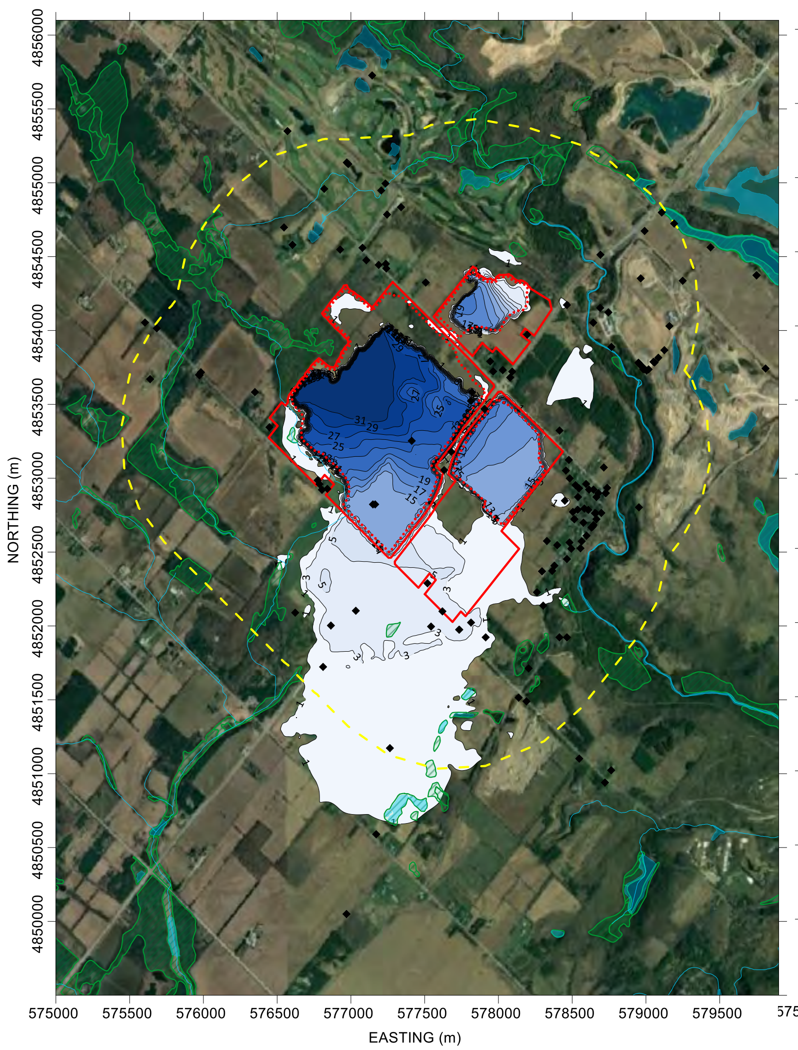
YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

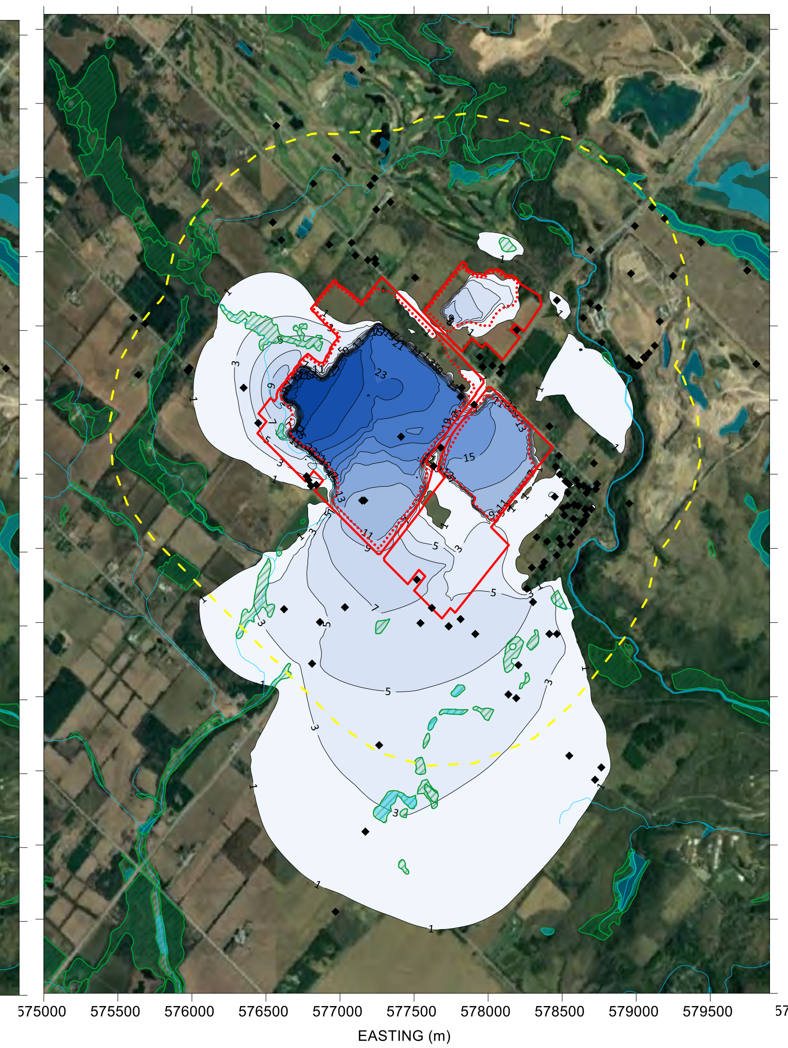
TITLE
PHASE 5 SIMULATED DRAWDOWN

PROJECT No. 19129150 | Rev. 0 | FIGURE 8-3E

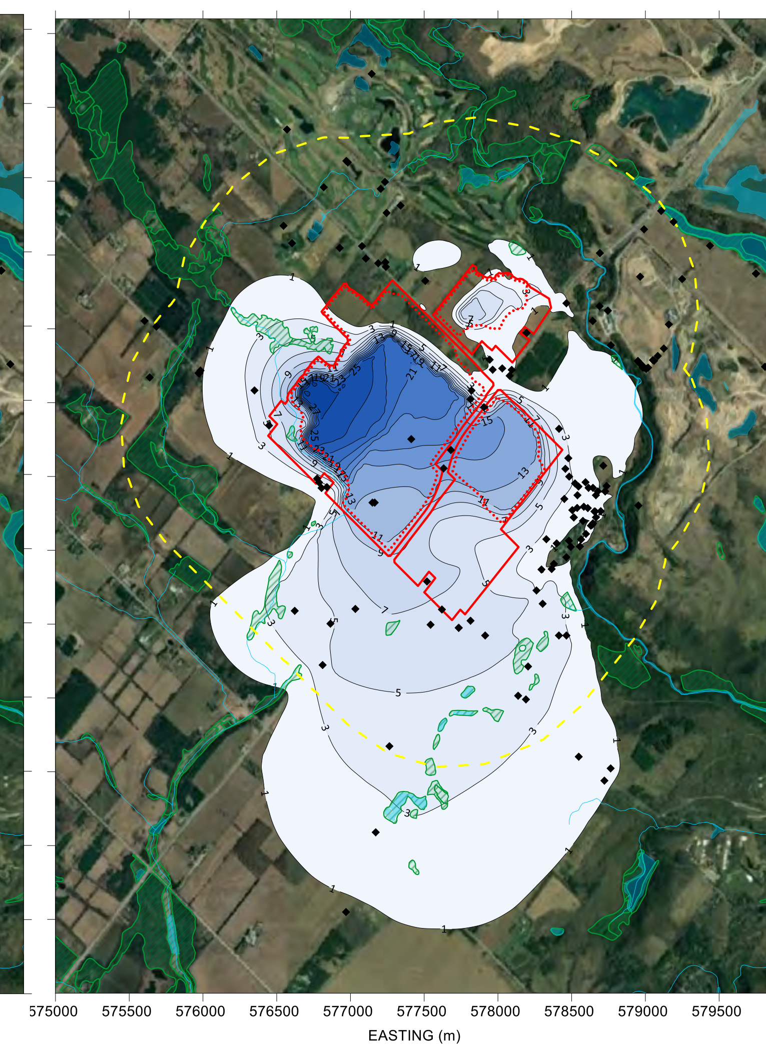
1. SHALLOW OVERBURDEN



2. DEEP OVERBURDEN



3. GASPORT FORMATION



4. MANITOULIN/ WHIRLPOOL FORMATION

DRAWDOWN (m)

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31

LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
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PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

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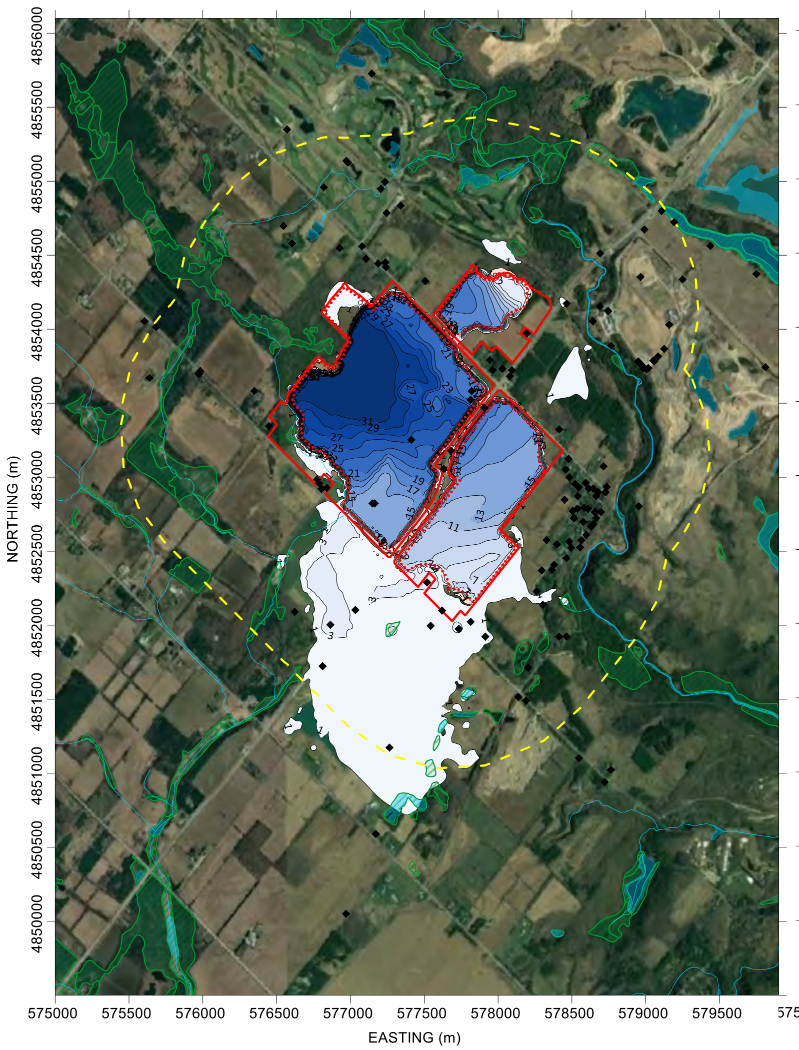
MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

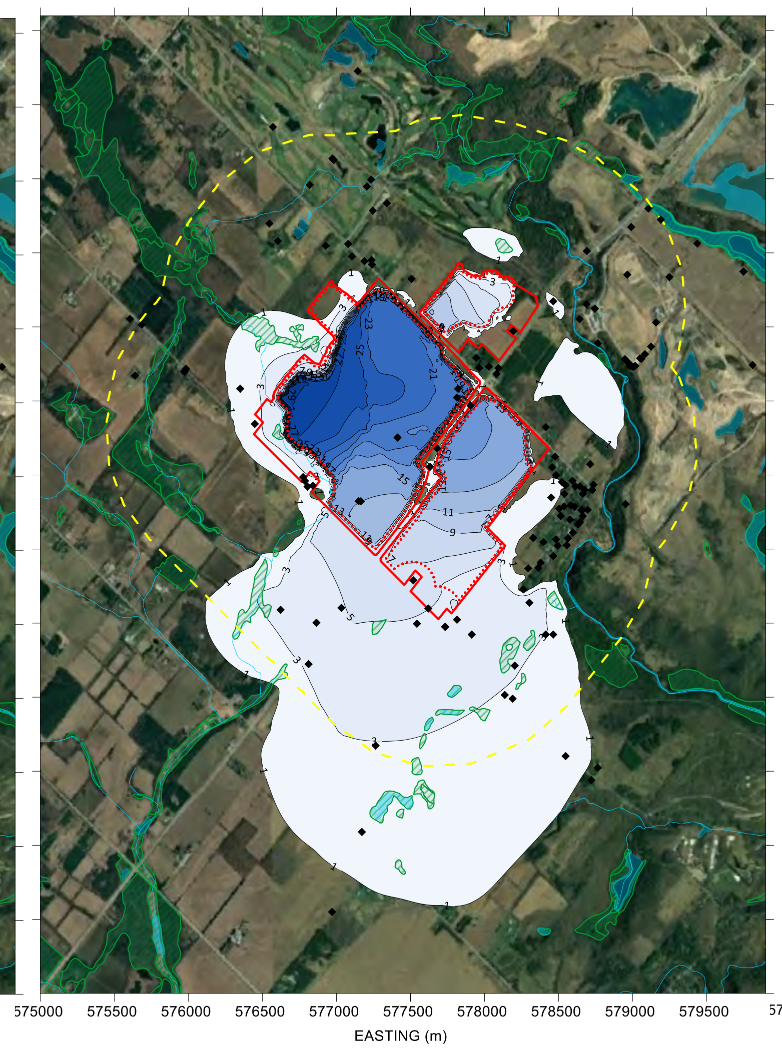
TITLE
PHASE 6 SIMULATED DRAWDOWN

PROJECT No. 19129150 | Rev. 0 | FIGURE 8-3F

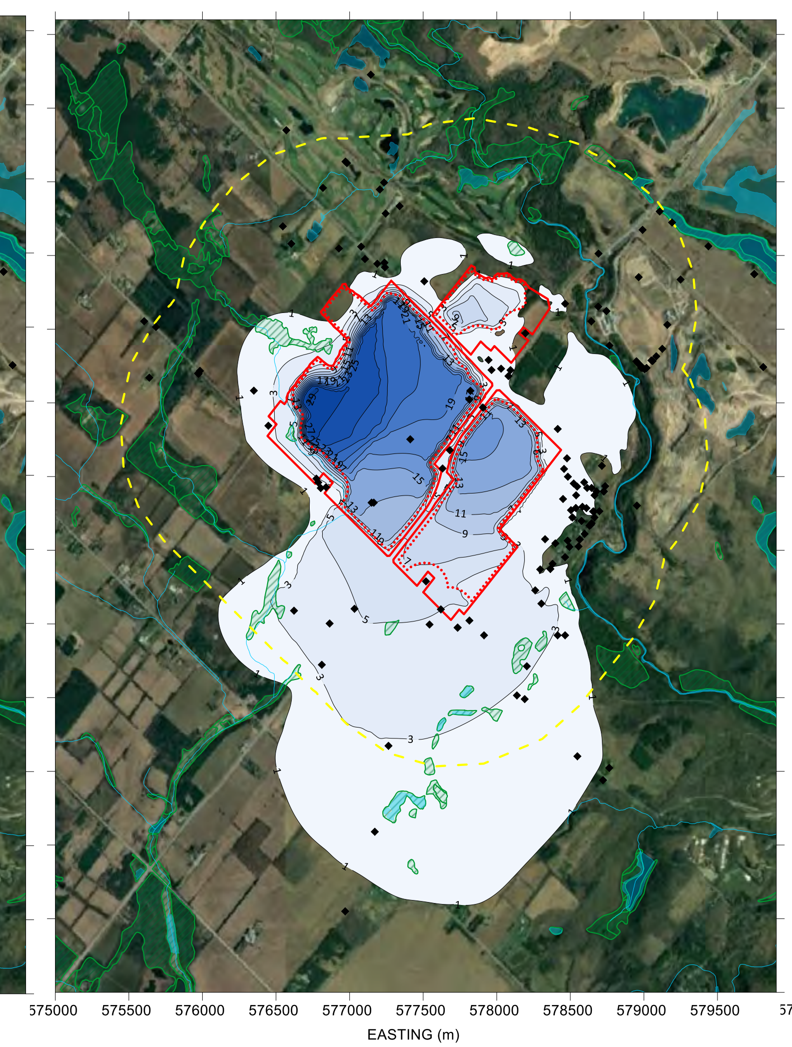
1. SHALLOW OVERBURDEN



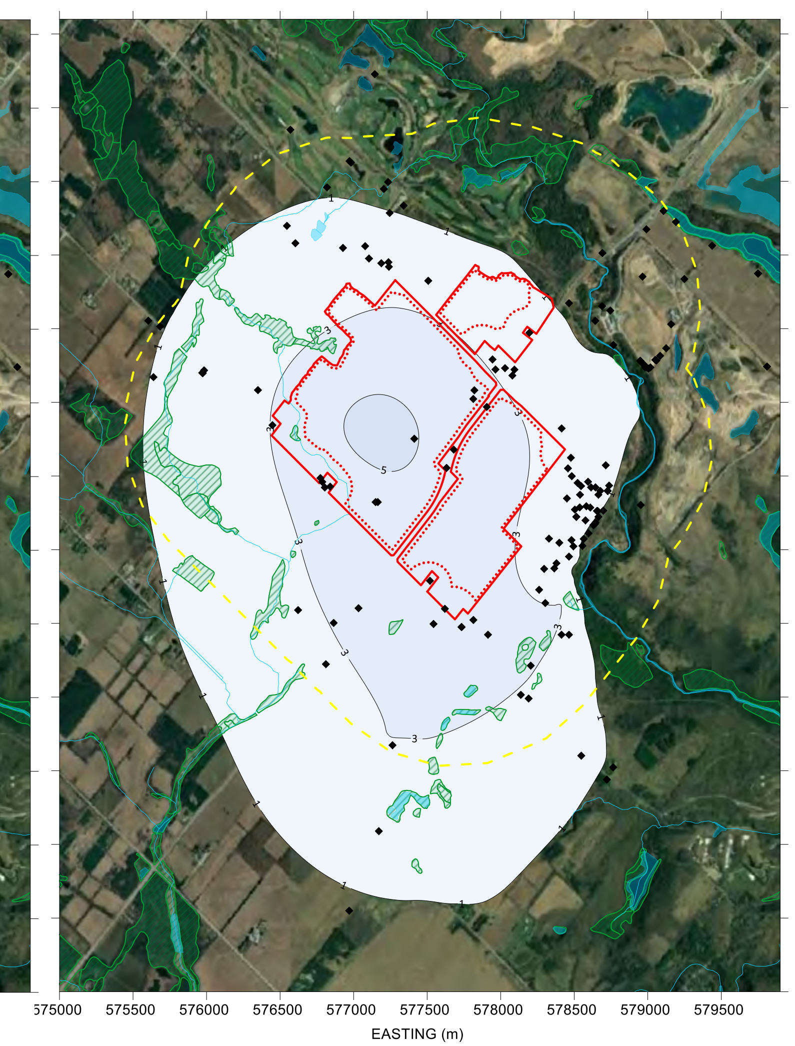
2. DEEP OVERBURDEN



3. GASPORT FORMATION



4. MANITOULIN/ WHIRLPOOL FORMATION



DRAWDOWN (m)

1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31

LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
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1. Drawdown values shown are relative to the existing conditions head in each unit.
2. Simulated drawdown is shown at a contour interval of 2m, where the shaded area represents a drawdown of 1m or more.
3. Gasport formation drawdown extracted from model slice 22 (base of Gasport)
4. Manitoulin/ Whirlpool formation drawdown extracted from model slice 25
5. Shallow overburden drawdown extracted from model slice 2 (top of overburden sequence in model)
6. Deep overburden drawdown extracted from model slice 12 (base of overburden sequence in model)
7. Source of spatial mapping of watercourses, waterbodies, and wetlands: Land Information Ontario (MNRF, 2018)
8. Private wells shown are from the Ministry of Environment Conservation and Parks (MECP) Water Well Information System Database (MECP, 2021).

CLIENT
CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

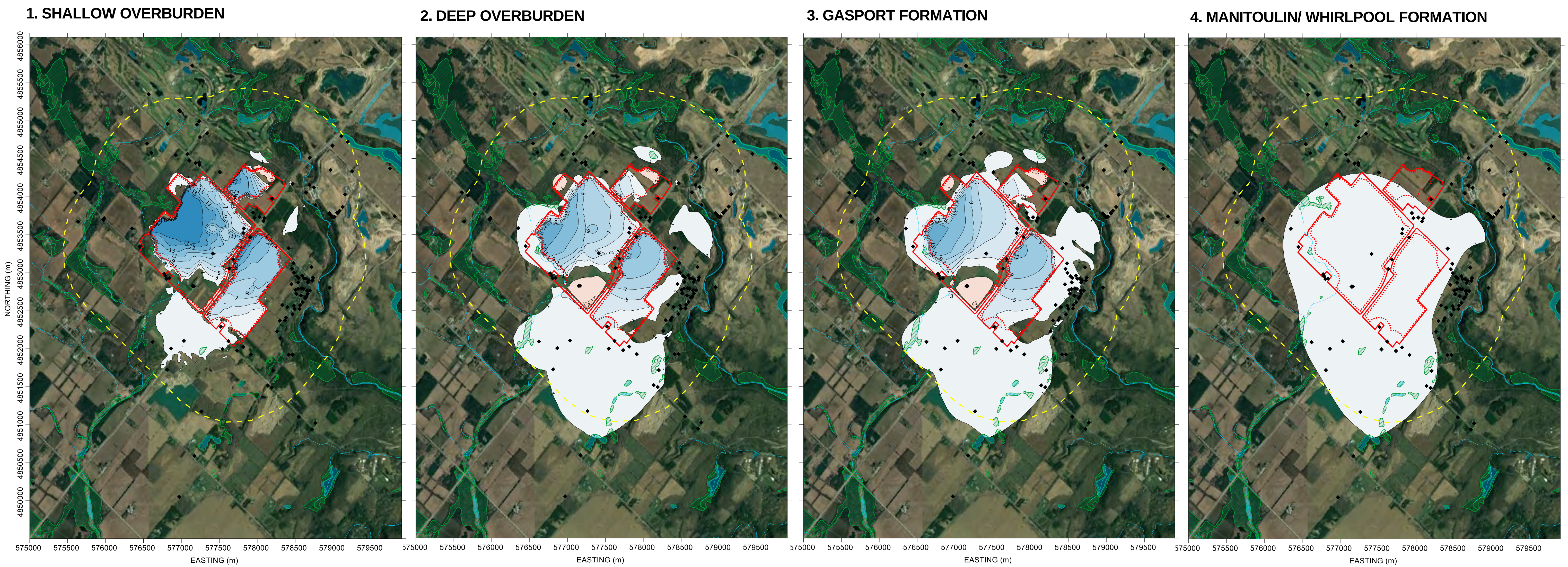
PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

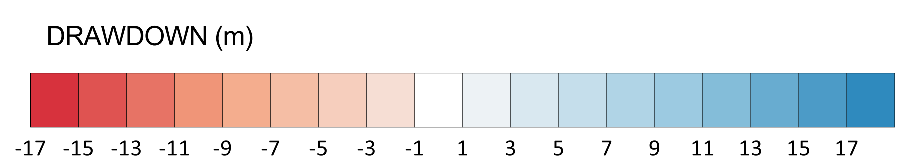
CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

TITLE
PHASE 7 SIMULATED DRAWDOWN

PROJECT No. 19129150 | Rev. 0 | FIGURE 8-3G





LEGEND

- LAKES
- RIVERS/ STREAMS
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- WETLAND
- 1KM BUFFER AROUND PROPERTY
- MECP PRIVATE WELL LOCATION

Phase of Operation	Years
1	1 to 10
2	9 to 14
3	14 to 18
4	18 to 23
5	23 to 29
6	27 to 33
7	33 to 37

NOTES

1. Drawdown values shown are relative to the existing conditions head in each unit.
2. Simulated drawdown is shown at a contour interval of 2m, where the shaded area represents a drawdown of 1m or more.
3. Gasport formation drawdown extracted from model slice 22 (base of Gasport)
4. Manitoulin/ Whirlpool formation drawdown extracted from model slice 25
5. Shallow overburden drawdown extracted from model slice 2 (top of overburden sequence in model)
6. Deep overburden drawdown extracted from model slice 12 (base of overburden sequence in model)
7. Source of spatial mapping of watercourses, waterbodies, and wetlands: Land Information Ontario (MNRF, 2018)
8. Private wells shown are from the Ministry of Environment Conservation and Parks (MECP) Water Well Information System Database (MECP, 2021).

CLIENT
CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

CONSULTANT
GOLDER MEMBER OF WSP

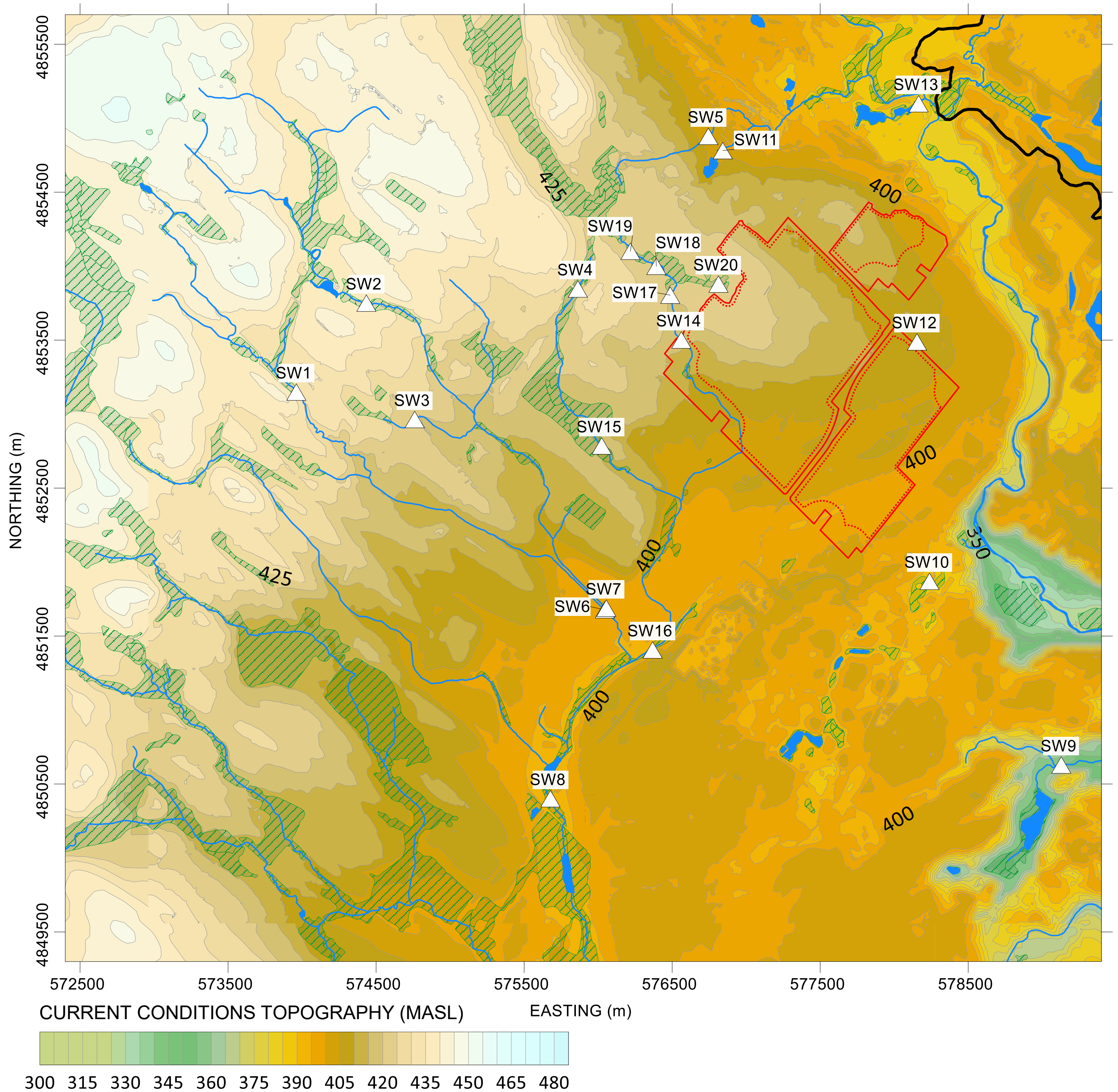
YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

PROJECT
CALEDON PIT AND QUARRY NUMERICAL MODELLING

TITLE
REHABILITATION SIMULATED DRAWDOWN

PROJECT No.	Rev.	FIGURE
19129150	0	8-3H

SURFACE WATER MONITORING STATIONS



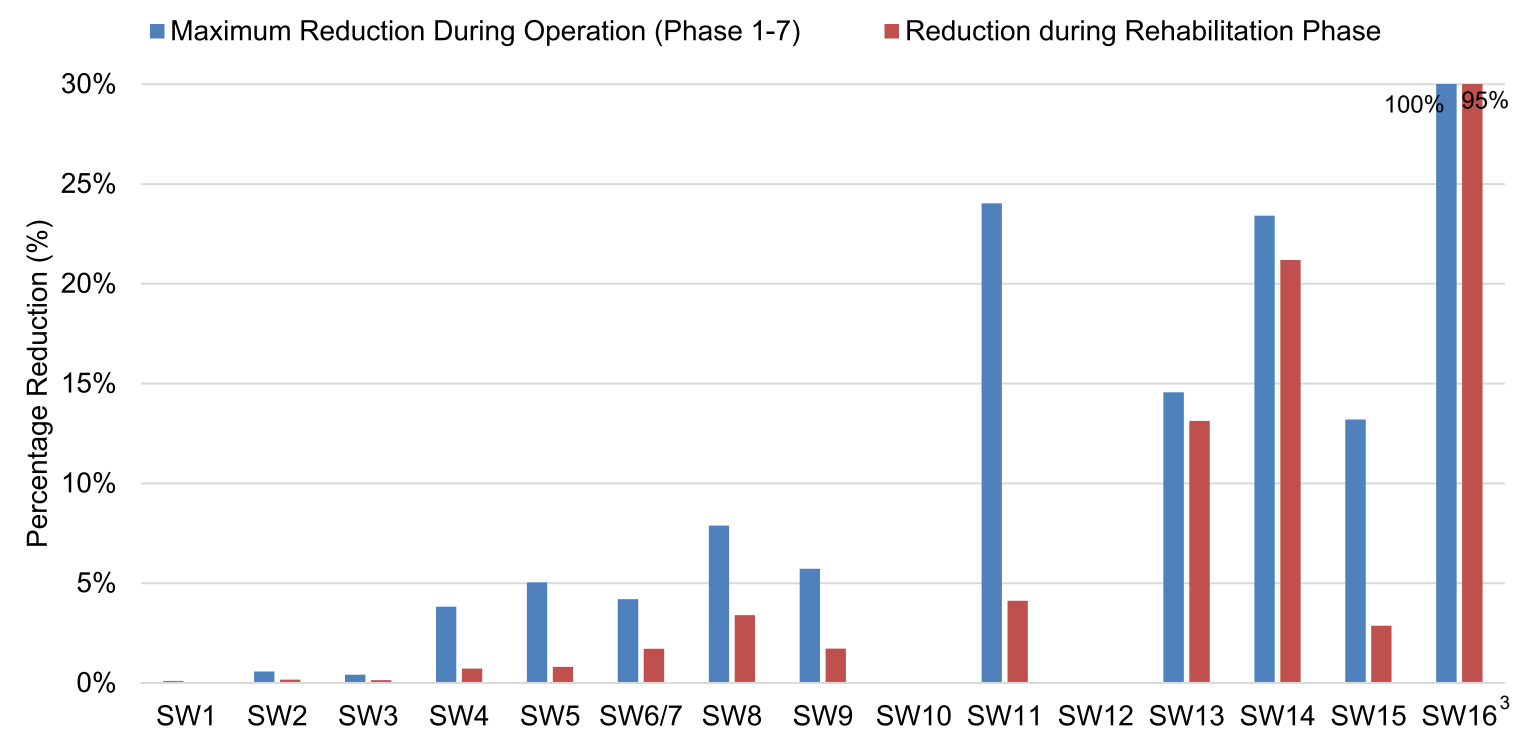
NOTES:

1. Simulated surface water flows for phases 1-7 and rehabilitation represent long term average (steady state) values
2. Several surface water stations have a current conditions simulated flow of 0.00 L/s (SW10 and SW12), and continue to have a simulated flow of 0.00 L/s throughout quarry operation and rehabilitation
3. While SW16 reports a simulated reduction in flow during operations, it is noted that there is presently no surface flow measured at this location (average measured flow is 0.00 L/s)

SIMULATED REDUCTION IN SURFACE WATER FLOW THROUGH VARIOUS QUARRY PHASES AND AT REHABILITATION

Station	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6	Phase 7	Rehab
SW1	0%	0%	0%	0%	0%	0%	0%	0%
SW2	0%	0%	0%	-1%	-1%	-1%	0%	0%
SW3	0%	0%	0%	0%	0%	0%	0%	0%
SW4	0%	-2%	-2%	-4%	-3%	-3%	-1%	-1%
SW5	0%	-5%	-3%	-4%	-4%	-3%	-2%	-1%
SW6/7	-1%	-2%	-2%	-3%	-4%	-4%	-3%	-2%
SW8	-2%	-2%	-3%	-5%	-7%	-8%	-6%	-3%
SW9	-1%	-1%	-1%	-2%	-5%	-6%	-4%	-2%
SW10	0%	0%	0%	0%	0%	0%	0%	0%
SW11	-1%	-24%	-9%	-6%	-6%	-6%	-6%	-4%
SW12	0%	0%	0%	0%	0%	0%	0%	0%
SW13	-9%	-13%	-11%	-10%	-10%	-11%	-15%	-13%
SW14	-1%	-11%	-20%	-20%	-18%	-18%	-23%	-21%
SW15	-1%	-5%	-5%	-13%	-12%	-9%	-5%	-3%
SW16[3]	-87%	-89%	-91%	-100%	-100%	-100%	-100%	-95%

SIMULATED PERCENT REDUCTION IN SURFACE WATER FLOW: MAXIMUM DURING OPERATION, AND REHABILITION PHASES



LEGEND

- LAKES
- RIVERS/ STREAMS
- WETLAND
- SITE PROPERTY BOUNDARY
- EXTRACTION EXTENTS
- SURFACE WATER MONITORING STATION

ADDITIONAL MAP NOTES

4. Source of spatial mapping of watercourses, waterbodies, and wetlands: Land Information Ontario (MNRF, 2018)
5. Source of Regional Topography dataset Ontario Ministry of Natural Resources and Forestry (MNRF) Southwestern Ontario Orthophotography (SWOOP) 2019
6. Source of Site Topography dataset provided by Firstbase Solutions (Spring 2021)
7. Quarry license and limit of extraction provided by MHBC (2022)

CLIENT
CBM AGGREGATES (CBM), A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

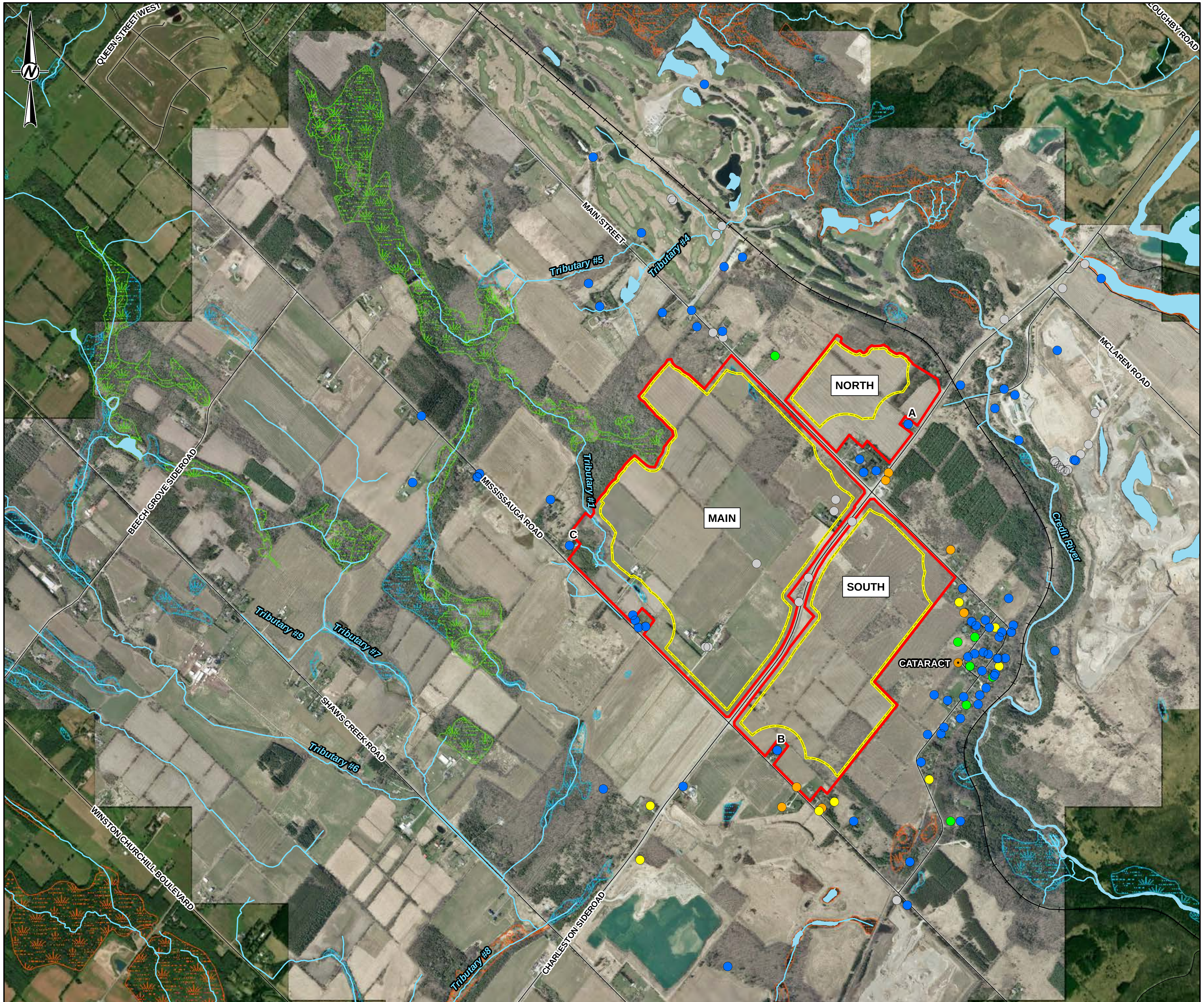
PROJECT
CALEDON PIT AND QUARRY

CONSULTANT
GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-15
PREPARED	HW
DESIGN	HW
REVIEW	SD
APPROVED	GS

TITLE
SIMULATED CHANGE IN SURFACE WATER FLOW AT MONITORING STATIONS

PROJECT No. 19129150
Rev. 0
FIGURE 8-4



LEGEND

TOWN/VILLAGE

POTENTIAL FOR IMPACT TO WATER USER

- NEGLIGIBLE POTENTIAL
- LOW POTENTIAL
- MODERATE POTENTIAL
- SIGNIFICANT POTENTIAL
- NON-WATER SUPPLY WELL
- ROAD
- RAILWAY
- WATERCOURSE
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASEDATA MNRF LIO OBTAINED APRIL 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA)

PROJECT
CALEDON PIT / QUARRY

TITLE
WATER SUPPLY WELL IMPACT ASSESSMENT

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	SO
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

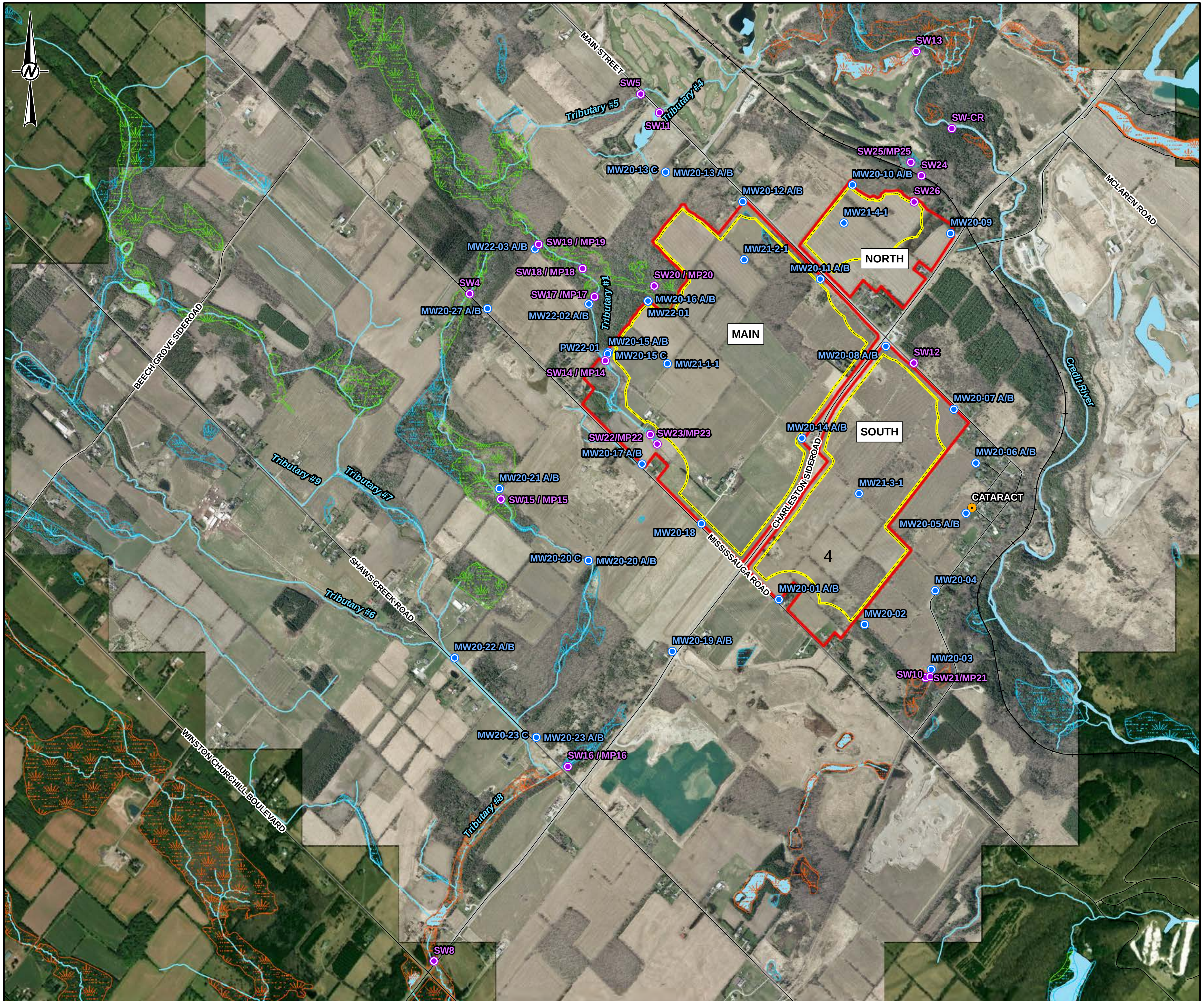
PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	9-1

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

25mm

0

PATH: S:\Clients\Votorantim_Cimentos\Long_Par_5_Caledon\99_PROJ\19129150\40_PROD\0036_Water_Resources\19129150-0036-CH-0009_1.mxd PRINTED ON: 2022-12-13 AT: 12:33:18 PM



LEGEND

- TOWN
- MONITORING WELL
- SURFACE WATER STATION
- ROAD
- RAILWAY
- WATERBODY
- UNEVALUATED WETLAND
- OTHER EVALUATED WETLAND
- PROVINCIALLY SIGNIFICANT WETLAND
- LICENCE BOUNDARY
- LIMIT OF EXTRACTION

0 500 1,000

1:20,000 METRES

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. WATERCOURSES OBTAINED FROM CREDIT VALLEY CONSERVATION AUTHORITY OPEN DATA PORTAL, NOVEMBER 2022 IN COMBINATION WITH SITE WATERCOURSE SURVEY PROVIDED BY FIRST BASE SOLUTIONS NOVEMBER 2021.
3. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
4. LICENCE AND LIMIT OF EXTRACTION PROVIDED BY MHBC NOVEMBER 2022.
5. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT

CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT

CALEDON PIT / QUARRY

TITLE

PROPOSED MONITORING PROGRAM

CONSULTANT

GOLDER MEMBER OF WSP

YYYY-MM-DD	2022-12-13
DESIGNED	CGE
PREPARED	SO
REVIEWED	GWS
APPROVED	HM

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0036	0.0	9-2

25mm

APPENDIX A

Terms of Reference

GOLDER
MEMBER OF WSP

TECHNICAL MEMORANDUM

DATE August 24, 2022 **Project No.** 19129150

TO David Hanratty, PGeo
CBM Aggregates

CC Jennifer Deleemans, Mike Lebreton

FROM Heather Melcher **EMAIL heather_melcher@golder.com**

PROPOSED CBM CALEDON QUARRY TERMS OF REFERENCE – WATER RESOURCES AND NATURAL ENVIRONMENT

Golder Associates Ltd. (Golder) has been retained by CBM Aggregates (CBM), a division of St. Marys Cement Inc. (Canada) to complete technical studies to accompany an application to the Ministry of Natural Resources and Forestry (MNRF) for a new Class A Quarry Below Water licence under the *Aggregate Resources Act* (ARA) (project). The assessment will also be used for a Planning Act approval and application for Town of Caledon Official Plan and Zoning By-law amendment. Furthermore, these studies will provide an assessment of the application taking into consideration the applicable in-effect policies contained in the relevant Provincial Plans, Region of Peel Official Plan and Town of Caledon Official Plan.

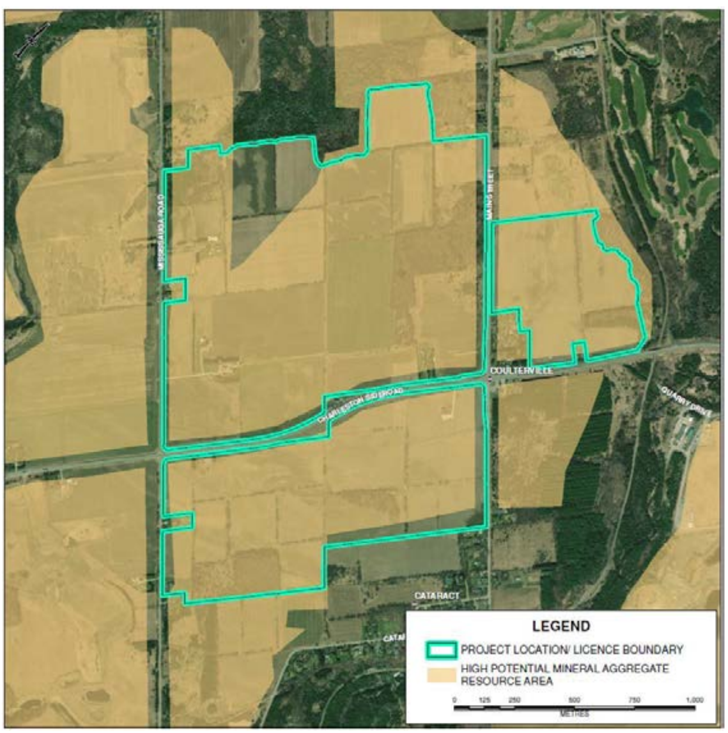


Figure 1: Proposed CBM Caledon Quarry Location

The properties to be licensed are located on Charleston Sideroad and Mississauga Road, Town of Caledon, Region of Peel, Ontario (site). The site is approximately 262.4 hectares (ha) in size (Figure 1).

This Terms of Reference (TOR) includes a summary of the assessment and deliverables associated with the water resources and natural environment components.

On June 2, 2021, CBM submitted to Credit Valley Conservation (CVC), the Town of Caledon, and the Region of Peel an earlier version of this TOR document, as requested during a meeting held on April 22, 2021. Comments were received from CVC on the TOR on July 9, 2021. Comments were also recently received from the Region of Peel on July 11, 2022. Golder has incorporated these comments into this TOR document, where applicable.

1.0 WATER RESOURCES

Groundwater and surface water resource investigations will be undertaken in accordance with the Technical Reports and Information Standards published by the MNRF in August 2020, with the following technical reports being prepared by qualified persons upon completion of the investigations.

Maximum Predicted Water Table Report

This report will detail how the maximum predicted water table is identified in metres above sea level, relative to the proposed depth of excavation at the site, and will be determined by monitoring the groundwater table for a minimum of one (1) year to account for seasonal variations and influences due to precipitation.

Water Report Level 1 and 2 (combined)

Level 1 – This assessment will determine the potential for impacts to groundwater and surface water resources and their uses (including water wells, groundwater aquifers, surface water courses and bodies, springs, discharge areas) and will identify if the site is in a Wellhead Protection Area for Quantity (WHPA-Q) under the Clean Water Act. If so, the report will identify applicable source water protection policies and mitigation measures that will be implemented.

Level 2 – Where the Level 1 assessment has identified a potential for impacts from the site on groundwater and/or surface water resources and their uses, an impact assessment will be carried out to determine the significance of the effect and the potential for mitigation. The assessment will address the potential effects of the operation on groundwater and surface water features located within the zone of influence, including but not limited to:

- Water wells (includes all types e.g., municipal, private, industrial, commercial, geothermal and agricultural);
- Springs (e.g., place where ground water flows out of the ground);
- Aquifers;
- Surface water courses and bodies (e.g., lakes, rivers, brooks); and
- Wetlands.

The assessment will include (but not be limited to) the following:

- A description of the physical setting including local geology, hydrogeology, and surface water systems;
- Any proposed water diversion, discharge, storage and drainage facilities;
- A water budget (e.g., how water is managed on-site);
- The possible positive or negative impacts that the proposed site may have on the water regime;
- Monitoring and mitigation plan(s); and
- Technical supporting data in the form of tables, graphs and figures.

Greenbelt Plan Considerations

The scope of the planned groundwater and surface water investigations will also address key hydrologic areas and features, as described in the Greenbelt Plan (2017). Key hydrogeologic areas are areas which contribute to the hydrologic functions of the Water Resource System. These areas maintain ground and surface water quality and quantity by collecting, storing and filtering rainwater and overland flow, recharge aquifers and feed downstream tributaries, lakes, wetlands and discharge areas. These areas are also sensitive to contamination and feed key hydrologic features and drinking water sources.

Key hydrologic areas include:

- Significant groundwater recharge areas;
- Highly vulnerable aquifers; and
- Significant surface water contribution areas.

Key hydrologic features within these areas include:

- Permanent and intermittent streams;
- Lakes (and their littoral zones);
- Seepage areas and springs; and
- Wetlands.

For lands within a key hydrologic feature in the Protected Countryside, it is noted that development or site alteration is permitted for aggregate extraction, subject to the non-renewable resource policies set out in Section 4.3.2 of the Greenbelt Plan.

Caledon Official Plan Considerations

The scope of the planned groundwater and surface water investigations will also address the requirements for development within valley and stream corridors as set out in Section 3.2.5 of the Town of Caledon Official Plan (2018). This includes the following considerations:

- The quality and quantity of surface water entering valley and stream corridors are to be maintained, and, where appropriate, enhanced and restored.

- Restoration and enhancement of valley and stream corridors is encouraged. Where appropriate, a riparian habitat zone will be maintained or established on lands abutting watercourses and waterbodies.
- Management and restoration of valley and stream corridors will adhere to the Town's ecosystem principle, goals, objectives, policies and performance measures.

Other Considerations

The groundwater and surface water investigations will be undertaken at the scales necessary to characterize groundwater and surface water conditions potentially impacted by the proposed quarry, including the immediate site, zone of influence and surrounding subwatershed scales, where information is available and relevant to the assessment of impacts.

The predicted zone of influence of the quarry will ultimately be determined through the hydrogeologic and surface water assessments, and as such, a pre-defined maximum zone of influence is not assumed. Justification of the proposed extent and scale of the investigation and analysis undertaken will be provided in the Water Report.

The impact assessment will evaluate the potential for cumulative impacts of the proposed quarry where information for the assessment of cumulative impacts is available and relevant to the impact assessment, including groundwater quantity, groundwater users and total groundwater use in the broader subwatershed).

The study will also assess the potential impact of the quarry in relation to future climate change, including a drought scenario, if considered applicable.

1.1 Hydrogeologic Investigation

The hydrogeologic investigation is a key component of the overall program to support the licence application. The hydrogeologic investigation program integrates with the surface water and natural environment studies. The key components of the hydrogeologic investigation are summarized below.

A karst assessment will also be completed as part of the hydrogeologic investigation which will include: an investigation of closed depressions and surface water flows, tracer tests and conductivity profiling in wells during the planned pumping tests, an evaluation of the proportions of surface water and groundwater flows in the study area, and an assessment of evidence potentially indicative of preferential flow in the bedrock aquifer.

1.1.1 Initial Activities

A detailed background review of hydrogeological information will be carried out initially, including the following:

- LIO SWOOP Topographic Data;
- OGS Surficial geology;
- OGS Bedrock geology;
- OGS Drift thickness;
- MECP Water Well Records;
- MECP PTTWs;
- AquaResource Integrated Water Budget Report - Tier 2, Credit Valley Source Protection Area;

- Information from previous site investigations Credit Valley Conservation (CVC) Subwatershed Study Reports;
- CVC Source Protection Area and CTC Source Protection Region Assessment Reports; and
- Other websites with information on water taking activities and natural features in the study area.

Published geological data for the area provides an initial understanding of the distribution of overburden on the site, the depth to bedrock, the thickness of the Gasport (formerly Amabel) Formation and approximate elevation of the base of the Gasport (formerly Amabel) Formation, and an initial understanding of groundwater elevations across the area.

The hydrogeological information compiled during the background review will be presented as a series of maps and will establish a framework for the refinement and finalization of the field investigations.

Initial activities will also include site reconnaissance of the area to help verify information obtained during the background review and support finalization of the field investigations.

A survey of private wells within 1 km of the site will also be undertaken.

1.1.2 Monitoring Well Installation and Testing

Twenty-eight monitoring well locations will be drilled, to an approximate depth of 30 m (assumed 5 m of overburden, on average, and 25 m of rock). All locations in the monitoring network will be surveyed for location and elevation. Further details of the proposed monitoring well network are provided in Attachment A.

Drilling, Core Logging and Photography

The drilling will be carried out under Golder supervision using Choice Sonic Drilling Ltd. (CSD), obtaining 100 mm continuous core through the overburden and HQ-sized (63.5 mm) continuous core in the bedrock. All cores will be logged and photographed. Overburden core will be bagged, and rock core will be boxed (1.5 m boxes holding a total of 3 m of core per box).

Following coring, the rock boreholes will be reamed to 120 mm to facilitate monitoring well installation. A surface casing will be installed into the top of rock to provide access for geophysical logging and hydraulic (packer) testing, and for monitoring well installation.

Geophysical Logging

Geophysical logging will be carried out immediately following the coring of the drillholes, and will consist of collecting natural gamma, conductivity, heat pulse flowmeter (static and low pumping conditions), and optical televiewer (OTV) logs. The field work and analysis will be carried out in house by Golder staff using in house equipment. Results will be compiled and processed relatively quickly and used to help plan the hydraulic (packer) testing program. All data will be processed and presented using WellCAD.

Hydraulic (Packer) Testing

Upon completion of geophysical logging, the boreholes will be packer tested. We will complete up to three interval tests per borehole using straddle packers (nominally spaced at 5 m), testing from the bottom of the hole up to the highest level possible within the water column. Using the geological and hydrogeological information obtained from coring and geophysics, the tests will be conducted within appropriate geologic intervals (i.e., within the Gasport (formerly Amabel) or within the underlying strata).

Monitoring Well Installation and Instrumentation

Each of the 28 boreholes will be completed with two piezometers. The piezometers will typically have 1.5 m well screens and be 32 mm in diameter. The wells will be constructed by a licensed well driller using filter sand, bentonite pellets and grout, and completed at surface with a lockable protective casing and registered in the MECP system with a well tag.

We understand that it is important to obtain hydraulic information in the Gasport (formerly Amabel), and underlying Clinton and Cataract Groups, and propose that each piezometer nest target two of the three zones, to provide overall coverage of hydraulic heads in all three zones (i.e., 56 piezometers will provide the ability to have about 18 monitors in each of these three zones).

Single-well Hydraulic Testing

All piezometers will be developed, and single well response tests completed in the piezometer. This will be carried out by using dedicated water level loggers, which will be left in place for the groundwater monitoring program. Hydraulic conductivity will be estimated from the tests, and used as input to the hydrogeological assessment, and groundwater-surface water modelling.

Water Quality Sampling

All wells will be completed with dedicated water sampling equipment (tubing and Waterra foot-valves) for groundwater sampling. The wells will be purged and then sampled following standard collection and sample handling protocols. All 56 piezometers will be sampled for general chemistry, nutrients, inorganics and metals (RCAP suite), and 28 of the wells will also be sampled for BTEX and PHC F1-F4. The analytical work will be carried out by BV Labs (formerly Maxxam Analytics) in Mississauga.

Analysis and Reporting

The data collected during the drilling and testing, and water sampling will be compiled and used to inform other investigations and be incorporated into the combined Water Report Level 1/2 and a Maximum Predicted Water Table Report.

1.1.3 Groundwater Monitoring Program

The groundwater monitoring program will take place from the point of drilling the wells until submission of the licence application package to the MNRF and include monitoring of the 56 piezometers at the 28 proposed monitoring well locations, in addition to monitoring springs and seeps located in areas along the Credit River, the Niagara Escarpment and the Alton Forest complex.

All wells and piezometers will be equipped with water level loggers, programmed to record at 15 minute intervals. Loggers will be downloaded quarterly, and manual water level measurements made to correlate to the logger data. A barologger station will be set up at the site to provide barometric corrections to the logger data. Hydrographs will be compiled on a quarterly basis.

Analysis and Reporting

The data collected during the groundwater monitoring program will be compiled and used to inform other investigations, provide important hydrogeological inputs to groundwater-surface water modelling and support the hydrogeological impact assessment. The overall results will be incorporated into the Level 1 and 2 Water Report and . Maximum Predicted Water Table Report.

1.1.4 Pumping and Tracer Tests

Based on the data obtained during the monitoring well and resource investigations described above, locations to conduct pumping / tracer tests will be selected on the property. Up to four tests, if required, will be completed depending on the nature of hydrogeologic conditions on the site.

Combined pumping and tracer tests will help establish the transmissivity of the rock, as well as assess the potential connectivity of fractures in the rock mass to various natural environment features in the area. Four pumping / tracer tests will be performed, each of 96 hours in duration, as described below.

Install Pumping Wells and Offset Monitoring Wells

Once the number and location of the test areas have been determined, a 150 mm diameter pumping well will be installed at each test location (cased through the overburden and open in the bedrock), to an assumed depth of 30 m (assumed 5 m through overburden and 25 m in the rock). Up to four offset wells nests will also be installed at each location to the same assumed maximum depth, completing the open holes with two-level 32 mm diameter piezometers, in a manner similar to the other monitoring wells. Pumping and offset observation wells will be MECP registered and tagged.

Obtain Category 2 PTTW

Golder will prepare and submit EASR applications on behalf of VCNA for permits to take water (PTTW) for each of the four planned 96 hour tests.

Conduct Four (96 hour) Pumping and Tracer Tests

Once the pumping and offset observation wells have been installed and permits obtained, pumping and tracer tests will be carried out. An ecologically friendly tracer such as fluorescein would be introduced in one or more observation wells prior to the start of pumping, and the pumping well water monitored using a fluorometer or other appropriate device to detect the potential presence of traced water at the pumping well. Pumped water will be managed to ensure that it is not recirculated into the groundwater system during the test.

Groundwater levels at the pumping well, offset wells, and other monitoring wells will be monitored using data loggers and/or manual measurements during the test. Levels would also be monitored prior to the test for a minimum of 48 hours and immediately following the test for a period of 7 days, to monitor the recovery data.

It is proposed that the four tests will be completed a minimum of 3 weeks apart, which should allow time for water levels to recover to ambient between successive tests.

Analysis and Reporting

The data collected during the pumping / tracer tests will be compiled and used to inform other investigations, provide important hydrogeological inputs to groundwater-surface water modelling and support the hydrogeological impact assessment. The overall results will be incorporated into the Level 1/2 Hydrogeological Study Report.

1.1.5 Integrated Groundwater / Surface Water Modelling

An integrated, fully-coupled groundwater / surface water model will be developed to simulate current conditions and estimate future water quantity impacts as a result of quarrying. The modelling will be undertaken using the computer program HydroGeoSphere (HGS).

HGS has been successfully applied in water resource and mining applications at the watershed and subwatershed scale in Ontario and worldwide. Of particular note, HGS was given a comparatively favourable review in the MNRF-sponsored document *Integrated Surface and Groundwater Model Review and Technical Guide* (AquaResource, 2011).

HGS is a three-dimensional numerical code that can dynamically consider all major components of the hydrologic cycle, including: precipitation, evapotranspiration, snowmelt, overland flow, infiltration, unsaturated zone flow, and saturated groundwater flow. HGS may model flow within bedrock using an equivalent porous media (EPM) approach or a discrete fracture network; however, at the scale of this analysis we assume that an EPM approach is sufficient. HGS' fully inclusive treatment of the hydrologic system allows for a seamless and robust simulation of flow and water level behaviour within the watershed, including at quarries, streams, wetlands and within the subsurface.

The model will be constructed on the basis of both publicly available data and the results of the site-specific geology and water resources field assessments, including: Digital Elevation Model (DEM) topography, government mapping and databases (e.g., Ministry of Environment, Conservation and Parks [MECP], Water Well Information System [WWIS] and Permit To Take Water [PTTW] databases), background data/reporting including CVC source water protection modelling, climate data, subcatchment delineations and water budgets, drilling data including geologic picks and hydrostratigraphic unit characterization, geophysical testing, packer testing, pumping tests, spring reconnaissance and measured groundwater levels and surface water levels / flows. The model will be calibrated to field observations in both steady-state (long-term average) and transient settings at appropriate time scale(s).

The modelling assessment will consider the following base simulations:

1) Existing Conditions (calibrated model)

2) Full Build-Out Operations (maximum extraction and dewatered state)

3) Full Rehabilitation (all rehabilitative measures, including backfilling and flooding, in-place)

The modelling will examine potential impacts under both average annual steady-state and transient (likely monthly) conditions for each scenario. Modelled effects will include drawdown and flow changes at key receptors including PTTW permit holders, private water wells, wetlands, streams and the Credit River as well as any interaction with pre-existing source protection plans and policies. The modelling may also include, at a relatively coarse scale, other major water users within the zone of influence and will thus be able to address cumulative impacts.

After the base scenarios have been finalized, a sensitivity analysis will be performed to better understand potential upper and lower bounds to potential impacts.

1.1.6 Impact Assessment and Hydrogeological Reporting

The results of the various geological and hydrogeological field investigations, monitoring, pumping and tracer testing, and integrated groundwater-surface modelling will be brought together to complete a hydrogeologic impact assessment. The hydrogeologic impact assessment and its supporting studies will inform the natural environment studies and provide the basis for preparing the combined Level 1 and 2 Water Report and a Maximum Predicted Water Table for a Class A, Quarry Below Water licence application under the Aggregate Resources Act.

If the assessment identifies a potential for impacts, mitigation measures and/or an adaptive management plan, if required, will be identified in the report.

1.2 Surface Water Resources Assessment

A surface water monitoring program and impact assessment will be completed for the site and surrounding catchment areas. The impact assessment and reporting for these tasks will be combined with the results of the hydrogeological assessment in the combined Water Report Level 2 and a Maximum Predicted Water Table Report.

1.2.1 Background Review

Golder will complete a background review of the available information pertaining to the site and surround area that may be within the zone of influence of the proposed quarry. The information reviewed will consist of:

- Aerial photographs and topographic, physiographic and geologic mapping;
- Water Survey or Canada and Credit Valley Conservation stream gauging data;
- Meteorological data from local CVC gauges (i.e., 1795 Quarry Drive, Town of Caledon, etc.);
- Ontario source water protection mapping;
- Published water resources reports; and
- Any existing permits or monitoring reports from the site.

Any additional work to fill data gaps identified as part of the background review will be included in a separate scope and budget.

1.2.2 Field Monitoring

A stream monitoring network will be established on the watercourses that drain the site and the areas of the proposed numerical model extents. We have assumed this will include 14 - 16 monitoring stations on tributaries to the Credit River. The exact number of stations and locations will be determined through the initial field reconnaissance that will be completed with the hydrogeology and natural environment component leads.

Manual water level (staff gauges) and flow measurements will be conducted at each station quarterly for a period of two years. Pressure transducers will be deployed at each station to develop a water level record for each station at 15-minute intervals. A barologger will also be installed at the site to provide atmospheric pressure compensation for the water level transducer data. Two on-site stations will be paired with mini-piezometers to better understand surface groundwater interactions in the area. Field monitoring will be continued following the development of the impact assessment to continue the understanding and characterisation of the watercourses.

No stream flow monitoring stations are proposed on the main channel of the Credit River at this time. Publicly available government stream gauge data will be relied upon to provide water level and flow data from the Credit River. Available baseflow data will be supplemented by completing low flow monitoring in the Credit River at three locations, to evaluate the baseflow contributions in the project study area. Two low flow monitoring events are currently proposed.

The surface water monitoring will also include a one-year of quarterly water quality monitoring program. This program will include the analysis of metals, nutrients and general chemistry at five watercourse stations surrounding the Site. The five sampling locations will be selected from a subset of the stream flow monitoring stations in an attempt to maximise the value of each monitoring station by selected stations that more likely maintain water and flow year-round (avoiding stations that have dry conditions most of the year). The five stations will be remain consistent throughout the sampling year. Turbidity and total suspended solids (TSS) will also be collected at these five stations to develop a turbidity / TSS relationship that can be used to estimate TSS from real-time measurements.

1.2.3 Cross Sectional Surveys

To develop a reliable stage-discharge rating curves (rating curves) at the surface water stations, cross sectional surveys will be collected and used to develop small local hydraulic models, which will in turn be used to interpolate and extrapolate the rating curves somewhat beyond the range of measured flows. It is recommended that approximately four detailed cross sectional surveys be completed at each surface water station to capture key hydraulic controls. Surveys are to be completed at upstream and downstream locations for each of the water level logger installations. The cross sectional surveys are typically distributed along the stream profile to capture the station equipment and key hydraulic characteristics (i.e., pools, riffles and control features), with the feature controlling the downstream water levels being most important to capture. The cross sectional surveys are expected to extend over the stream banks and on to the floodplain, to capture the total flow cross section under a flood event.

All survey data will be tied into a local benchmark which is permanently secured above the anticipated high water level. The water level logger installation will be surveyed to the benchmark upon installation and once each year to identify any settling, heave or other movement of the logger stations.

1.2.4 Rating Curve Development

The cross-sectional survey data will be collected and incorporated into a hydraulic model to develop theoretical rating curves which will be calibrated to measured flows.

Rating curves will be developed for each water level monitoring station in a hydraulic modelling package (i.e., HEC-RAS or equivalent) using the manual flow and water level measurements and cross sectional survey data collected during the monitoring program. The hydraulic model will utilize the cross sectional surveys at each station to generate a theoretical rating curve that will be calibrated using the measured flows and water levels collected over the monitoring period. Typically, the HEC-RAS modelled results are utilized to extrapolate the upper end of the rating curve, while field measured points better served to populate the lower and mid sections of the curve.

The Water Survey of Canada operates flow stations and already provides continuous flow data for the Credit River (downstream of Charleston Sideroad, and others further up and downstream), meaning that Golder will not need to develop rating curves and flow hydrographs for the stations on the Credit River.

1.2.5 Water Balance

An annual water balance will be developed for the drainage areas contributing to the quarry and monitoring station catchments using Thornthwaite water budgets available from Meteorological Services of Canada under the existing, operational and rehabilitated conditions. The results of the water balances will be used to help assess the potential impacts that the proposed extraction and rehabilitation activities may have on the existing local hydrologic cycle. Meteorological Services of Canada data will be compared to local CVC station data.

Results of the Thornthwaite water balance will also be used to verify the recharge distributions developed using the integrated numerical model.

1.2.6 Water Level Hydrographs

Continuous water level and flow data will be processed on a monthly basis to confirm data quality and equipment accuracy. This will allow Golder to identify, and correct, any variations or potential issues with the monitoring stations, or equipment, early to reduce the risk of lost data.

The continuous water level record will be used with the rating curves to develop a continuous flow record which will be presented in flow hydrographs. Flow hydrographs will be created for the continuous water level stations. The flow hydrograph records will be further analysed to provide an estimate of baseflow, flow duration statistics, peak flows and totals of monthly and annual discharge at each location. This information will be used to calibrate and verify the HGS existing conditions model.

1.2.7 Stream Temperature Monitoring

Through their review of an earlier version of this TOR document, CVC requested continuous temperature monitoring be completed at the 14 – 16 surface water stations located on tributaries to the Credit River. Dedicated water temperature loggers will be installed to collect continuous daily temperature measurements. Monitoring of these loggers will be completed as part of the quarterly surface water monitoring program outlined in Section 1.2.2.

1.2.8 Impact Assessment and Reporting

The data collected will be analysed in conjunction with the background information and integrated with the hydrogeological and natural science studies. The impact assessment will consider potential effects of the proposed extraction on the surface water features on the site, and up to the distance of the expected groundwater drawdown zone (nine stream flow monitoring stations have been assumed within this drawdown). Potential effects will be estimated for two future scenarios including full development of the proposed quarry (i.e., the last day of extraction) and rehabilitated conditions (i.e., the residual effects of the development following completion of rehabilitation to a flooded quarry lake or partially backfilled and flooded excavation).

Reporting will be completed in conjunction with the hydrogeology discipline and will include the following:

- Documented field data
- Present rating curves and water level / flow hydrographs as well as monthly and annual total volumes
- Present WSC gauge flows on the Credit River as well as monthly and annual total volumes

- Quantify expected project effects on surface water resources by comparing projected post-development to pre-development flow rates. This information will be provided to the Natural Environment discipline for assessment of the significance of changes to the natural environment

2.0 NATURAL ENVIRONMENT ASSESSMENT

Golder will undertake a work program for a Natural Environment Report (NER) in order to evaluate the natural features in the vicinity of the site. Golder will assess the potential impacts of the proposed below water extraction on those features and their ecological functions and, if necessary, recommend measures to prevent or mitigate negative impacts on any significant features.

This study will provide an assessment of the application taking into consideration the applicable in-effect policies contained in the relevant Provincial Plans, Region of Peel Official Plan and Town of Caledon Official Plan.

2.1 Background Review

A background information search and literature review will be completed to gather data about the local area and identify significant natural features, as defined under the Provincial Policy Statement, Greenbelt Plan, Region of Peel (Core Areas, Natural Features and Corridors and Potential Natural Features and Corridors), and Town of Caledon (Environmental Policy Areas), and species at risk (SAR) that have been reported as occurring, or potentially occurring in the local landscape, including the following resources:

- Natural Heritage Information Centre (NHIC) database maintained by the Ontario Ministry of Natural Resources and Forestry (MNRF)
- Species at Risk Public Registry
- Species at Risk in Ontario (SARO) List
- Atlas of Breeding Birds of Ontario (OBBA)
- Bat Conservation International (BCI) range maps
- Ontario Butterfly Atlas
- Atlas of the Mammals of Ontario
- Ontario's Reptile and Amphibian Atlas
- Land Information Ontario (LIO)
- MNRF LIO Aquatic Resources Area Layer
- MNRF Fish On-Line
- DFO Aquatic Species at Risk Maps
- eBird species range maps
- Town of Caledon Official Plan

- Region of Peel Official Plan
- Information available from CVC (e.g., fish collection records, wetland mapping)
- Credit River Watershed Natural Heritage System Final Summary Report
- Existing aerial photography.

To develop an understanding of the ecological communities, wildlife habitat and potential natural heritage features in the study area, MNRF LIO data were used to create base layer mapping for the study area. A geographic query of the NHIC database was conducted to identify element occurrences of any natural heritage features, including wetlands, Areas of Natural and Scientific Interest (ANSIs), life science sites, rare vegetation communities, provincially rare species (ranked S1-S3 by the NHIC) and other natural heritage features within 1 km of the site.

2.1.1 SAR Screening

A SAR screening will be completed conducted for species listed under the *Endangered Species Act* (ESA) (Ontario 2007) per the Species at Risk in Ontario (SARO) List (O. Reg. 230/08), as well as those listed under the *Species at Risk Act* (SARA).

An assessment will be conducted to determine which SAR had potential habitat in the study area**.** Species with ranges overlapping the study area, or recent occurrence records in the vicinity, will be screened by comparing their habitat requirements to habitat conditions in the study area, as interpreted from aerial imagery.

The potential for the species to occur will be determined through a probability of occurrence. A ranking of low indicates no suitable habitat availability for that species in the study area and no specimens identified. Moderate probability indicates more potential for the species to occur, as suitable habitat appeared to be present in the study area, but no occurrence of the species has been recorded. Alternatively, a moderate probability could indicate an observation of a species, but there is no suitable habitat in the study area. High potential indicates a known species record in the study area (based on the background data review) and good quality habitat is present.

The desktop SAR screening will be confirmed and updated through the field surveys, described below.

2.2 Field Surveys

Based on preliminary desktop review, there are limited surface water features on the site. Golder is planning limited surveys in the designated and/or mapped significant woodlands as it is anticipated, based on review of land use policies and regulations, that extraction will not be permitted within the woodlands, and a setback may be required.

The following field surveys will be completed on the site (assuming no land access in the study area will be permitted). In the case that Golder is not scoping to complete the survey in the mapped/designated significant woodlands, it has been identified below. If a feature was to be excluded from the licence or extraction boundary, field surveys were sufficient to determine potential impacts of the project, but not as detailed as if the feature was going to be removed. The field surveys have been determined based on the known habitats on the site, as determined through the desktop assessment. Species-specific surveys will target SAR identified as having a moderate or high potential to occur in the vicinity of the site, to confirm use of habitats. Observations of wildlife and vegetation during all surveys will be documented and a running list maintained for inclusion in the NER.

Species-specific surveys will also provide data for evaluation of significant wildlife habitat (SWH). All surveys will be completed using provincially-approved methods and guidelines.

- Three-season plant community assessment (using Ecological Land Classification [ELC]) and botanical inventory (spring, summer and late summer). Due to the large size of the site, the botanical inventory will be limited to dominant species in each ELC community. Based on preliminary knowledge of the site, the potential for SAR plants is anticipated to be minimal and specific surveys for rare plants will not be required. However, all rare plants observed in the field will be recorded.
- Verification of any on-site wetlands and evaluation using the Ontario Wetland Evaluation System [OWES] where necessary).
- Woodland dripline delineation. Woodlands will be assessed for significance based on the applicable in-effect policies contained in the relevant Provincial Plans, Region of Peel Official Plan and Town of Caledon Official Plan. The boundary of significant woodlands will be delineated using a handheld GPS and verified with the Town of Caledon, the Region of Peel and CVC.
- Two rounds of breeding bird surveys.
- Three rounds of nighttime anuran (frog and toad) call count surveys.
- Turtle habitat assessment.
- Qualitative aquatic/fish habitat assessment of the on-site watercourses. “Windshield” survey of the watercourses that will be monitored as part of surface water assessment. Only the portion of the watercourses that intersect a public road or access will be assessed. The Credit River will not be assessed. It is assumed that there is sufficient background fish community data available for all watercourses and a fish inventory is not required.
- Bat habitat assessment. Golder will complete an assessment for habitat suitability for maternity roosting and for hibernacula.
- Bat acoustic assessment. Golder will deploy up to seven acoustic detectors to be located throughout the site in areas identified as suitable maternity roost habitat, during the bat habitat assessment. Acoustic monitoring will not be completed in the mapped/designated significant woodlands.
- Wildlife habitat assessment, including SWH. VES will be completed using MNRF-approved protocols to search for wildlife, including mammals, amphibians, reptiles, etc. Focus will be given to habitat edges and all signs of wildlife (e.g., scat, fur, browse, etc.) will be documented.

2.3 Impact Assessment and Reporting

The data collected will be analysed in conjunction with the background data and integration with other disciplines, including hydrogeological and surface water studies. The impact assessment will consider all potential impacts of the proposed extraction on the natural environment on the site, and up to the distance of the expected groundwater drawdown zone. Where relevant, the impact assessment will evaluate wetland water balance based on guidance from Toronto and Region Conservation Authority (TRCA) documents: Wetland Water Balance Risk Evaluation (2017), Water Balance Guidelines for the Protection of Natural Features (2012), and Wetland Water Balance Monitoring Protocol (2016). The results of the desktop review, SAR screening, any consultation with agencies, field surveys, and the impact assessment will be incorporated into a report that satisfies the requirements of both the NER, including relevant figures, under the ARA and an Environmental Impact Study (EIS) for the Town of Caledon and the Region of Peel. Mitigation measures and recommendations on suitable setbacks from natural features with appropriate rationale will also be included.

Where relevant, this study shall be shared with other technical experts completing studies for the application to avoid internal inconsistencies.

In addition, Golder will provide proactive input to the development of the site plans, including the progressive and final rehabilitation plans for the site, in consultation with the planner. It is anticipated that the analysis will also facilitate discussions of potential regional enhancement opportunities.

3.0 CLOSURE

We trust that this technical memorandum meets your current needs. Please contact the undersigned with any questions or comments.

Golder Associates Ltd.

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Director, Ecology

Craig De Vito, PEng
Surface Water Engineer

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Senior Geoscientist

HM/CDV/GS/mp

Attachments: Attachment A – Groundwater Monitoring Well Network Details

ATTACHMENT A

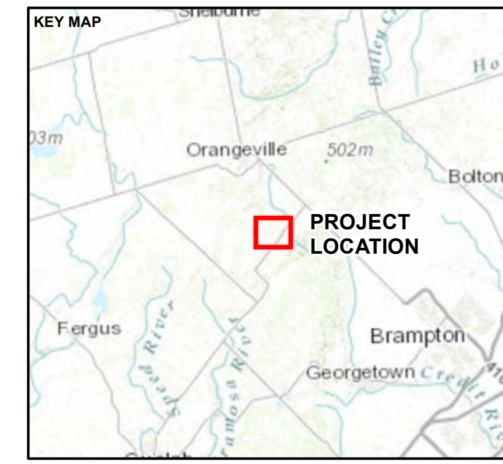
Groundwater Monitoring Well Network Details

TABLE 1 - SUMMARY OF MONITORING WELLS INSTALLED
PROPOSED CBM CALEDON QUARRY

Drilled Name:	Date Drilled:	Easting (m) UTM 17T	Northing (m) UTM 17T	Elevation (masl)	Total Hole Depth (mbgs):	Depth of casing (mbgs):	Depth to Bedrock (mbgs):	Depth to bottom of Gasport (mbgs)	Depth to top of Cabot Head (mbgs):	Downhole Geophysics Completion	Packer Testing Completion	Mon Well Completion	Deep (A) Well Stickup (m)	Deep (A) Well Formation	Screen from (m)	Screen to (m)	Shallow (B) Well Stickup (m)	Shallow (B) Well Formation	Screen from (m)	Screen to (m)
MW20-01(CAL) A/B	27-Feb-20	577458.50	4852268.28	395.10	19.41	9.06	8.53	14.86	17.32	13-Mar-20	19-Mar-20	20-Mar-20	0.99	Shaley Dolostone or Cabot Head Fm	15.40	17.10	0.99	Gasport Fm	11.10	12.62
MW20-02(CAL)	02-Mar-20	577900.04	4852138.37	399.63	19.57	15.94	15.24	18.05	19.57	11-Mar-20	N/A	23-Mar-20	1.05	Shaley Dolostone or Cabot Head Fm	16.96	18.48				
MW20-03(CAL)	04-Mar-20	578243.54	4851907.30	390.67	35.97	N/A	34.44	Not present	35.66	N/A	N/A	05-Mar-20	1.00	Overburden	15.58	18.63				
MW20-04(CAL)	06-Mar-20	578264.75	4852313.19	399.46	18.50	15.08	14.33	Not present	16.54	13-Mar-20	N/A	24-Mar-20	1.04	Shaley Dolostone or Cabot Head Fm	16.11	17.63				
MW20-05(CAL) A/B	09-Mar-20	578423.10	4852712.60	399.63	14.84	2.06	1.52	10.60	13.91	20-Mar-20	25-Mar-20	25-Mar-20	1.00	Shaley Dolostone or Cabot Head Fm	12.25	13.77	1.00	Gasport Fm	4.25	5.77
MW20-06(CAL) A/B	10-Mar-20	578474.24	4852972.59	400.15	16.03	2.32	2.14	10.96	14.25	23-Mar-20	26-Mar-20	26-Mar-20	0.99	Gasport Fm	10.12	11.64	0.99	Gasport Fm	4.20	5.72
MW20-07(CAL) A/B	11-Mar-20	578359.89	4853250.44	404.07	19.45	2.74	2.13	13.20	16.40	18-Mar-20	01-Apr-20	01-Apr-20	0.77	Shaley Dolostone or Cabot Head Fm	15.11	16.63	0.77	Gasport Fm	9.74	11.26
MW20-08(CAL) A/B	13-Mar-20	578009.81	4853574.83	406.93	18.59	2.74	1.98	15.10	17.32	19-Mar-20	30-Mar-20	31-Mar-20	0.92	Gasport Fm	13.30	14.82	0.92	Gasport Fm	5.38	6.90
MW20-09(CAL)	17-Mar-20	578343.84	4854157.49	399.95	9.01	5.79	5.33	Not Present	7.48	26-Mar-20	N/A	07-Apr-20	1.01	Shaley Dolostone or Cabot Head Fm	6.85	8.37				
MW20-10(CAL) A/B	19-Mar-20	577837.95	4854407.28	411.32	21.19	12.04	10.97	16.76	19.55	24-Mar-20	08-Apr-20	08-Apr-20	0.92	Shaley Dolostone or Cabot Head Fm	18.62	20.14	0.89	Gasport Fm	14.49	16.01
MW20-11(CAL) A/B	24-Mar-20	577671.98	4853921.39	409.72	19.39	3.07	2.13	16.46	18.16	07-Apr-20	14-Apr-20	15-Apr-20	1.03	Gasport Fm	13.81	15.33	1.01	Gasport Fm	3.96	5.48
MW20-12(CAL) A/B	26-Mar-20	577271.90	4854321.42	412.43	22.65	5.94	3.66	19.80	21.66	08-Apr-20	17-Apr-20	17-Apr-20	1.02	Gasport Fm	17.09	18.62	1.01	Gasport Fm	4.42	5.94
MW20-13(CAL) A/B	08-Apr-20	576873.11	4854473.14	415.53	28.23	15.08	13.10	23.92	25.68	15-Apr-20	23-Apr-20	24-Apr-20	0.93	Shaley Dolostone or Cabot Head Fm	24.05	25.57	0.93	Gasport Fm	18.14	19.66
MW20-13 (CAL) C	08-Apr-20	576873.11	4854473.14	415.53	5.10	N/A	N/A	N/A	N/A	N/A	N/A	08-Apr-20	0.93	Overburden	3.08	4.60				
MW20-14(CAL) A/B	28-Apr-20	577575.99	4853100.42	406.71	26.35	2.74	2.29	22.40	24.50	14-May-20	26-May-20	26-May-20	0.96	Shaley Dolostone or Cabot Head Fm	22.60	24.12	1.05	Gasport Fm	14.98	16.50
MW20-15(CAL) A/B	20-May-20	576576.79	4853544.15	417.06	37.17	12.30	11.60	33.84	35.62	27-May-20	08-Jun-20	09-Jun-20	0.70	Shaley Dolostone or Cabot Head Fm	33.77	35.29	0.71	Gasport Fm	28.81	30.33
MW20-15 (CAL) C	20-May-20	576576.79	4853544.15	417.06	5.00	N/A	N/A	N/A	N/A	N/A	N/A	20-May-20	0.70	Overburden	2.74	4.27				
MW20-16(CAL) A/B	22-May-20	576784.58	4853806.76	421.40	39.77	14.90	11.90	35.52	37.28	26-May-20	10-Jun-20	10-Jun-20	1.05	Gasport Fm	34.84	36.36	1.05	Gasport Fm	16.80	18.33
MW20-17(CAL) A/B	26-May-20	576752.28	4852966.36	406.64	28.82	3.15	3.05	24.84	27.49	01-Jun-20	02-Jun-20	02-Jun-20	1.05	Shaley Dolostone or Cabot Head Fm	25.64	27.16	0.99	Gasport Fm	12.75	14.27
MW20-18(CAL)	09-Jun-20	577058.36	4852658.80	404.29	28.15	12.19	11.88	23.80	26.06	12-Jun-20	15-Jun-20	15-Jun-20	1.03	Gasport Fm	12.42	13.94				
MW20-19(CAL) A/B	27-Oct-20	576906.96	4851999.96	396.98	27.39	6.20	2.14	22.05	24.48	29-Oct-20	30-Oct-20	31-Oct-20	1.07	Gasport Fm	15.95	17.47	1.07	Gasport Fm	8.00	9.52
MW20-20(CAL) A/B	29-Oct-20	576476.35	4852467.69	403.00	27.99	5.98	2.14	25.15	27.18	30-Oct-20	03-Nov-20	03-Nov-20	0.82	Shaley Dolostone or Cabot Head Fm	25.33	26.85	0.82	Gasport Fm	12.97	14.49
MW20-20(CAL) C	03-Nov-20	576476.26	4852468.33	403.00	5.00	N/A	2.14	N/A	N/A	N/A	N/A	03-Nov-20	0.96	Gasport Fm	2.42	3.95				
MW20-21(CAL) A/B	04-Nov-20	576014.37	4852839.77	415.23	39.70	15.10	12.51	36.73	38.38	05-Nov-20	06-Nov-20	07-Nov-20	1.07	Gasport Fm	33.27	34.79	1.07	Gasport Fm	15.77	17.29
MW20-22(CAL) A/B	18-Nov-20	575785.36	4851966.28	399.27	30.75	5.94	4.57	28.16	29.81	18-Nov-20	N/A	19-Nov-20	0.97	Goat Island Fm	23.47	25.00	0.97	Goat Island Fm	6.89	8.41
MW20-23(CAL) A/B	23-Nov-20	576205.53	4851555.91	395.05	26.76	12.19	11.28	23.54	25.30	24-Nov-20	N/A	24-Nov-20	0.87	Shaley Dolostone or Cabot Head Fm	22.59	24.11	0.87	Goat Island Fm	14.68	16.20
MW20-23 (CAL) C	23-Nov-20	576205.91	4851556.34	395.00	7.00	N/A	N/A	N/A	N/A	N/A	N/A	23-Nov-20	0.88	Overburden	4.57	6.09				
MW20-24(CAL) A/B	03-Dec-20	575337.66	4854341.85	437.75	37.49	20.88	20.11	37.49	N/A	04-Dec-20	N/A	04-Dec-20	0.87	Gasport Fm	33.81	35.33	0.87	Goat Island Fm	21.49	23.02
MW20-25(CAL) A/B	10-Dec-20	574853.76	4852900.48	419.02	51.82	13.39	10.52	48.93	50.67	10-Dec-20	N/A	11-Dec-20	1.56	Gasport Fm	44.03	45.55	1.55	Goat Island Fm	16.84	18.36
MW20-26(CAL) A/B	17-Dec-20	574373.86	4853638.42	438.89	66.11	15.55	12.19	64.55	66.11	18-Dec-20	N/A	21-Dec-20	1.16	Gasport Fm	55.16	56.68	1.16	Goat Island Fm	31.12	32.64
MW20-26 (CAL) C	17-Dec-20	574375.17	4853637.62	438.88	10.00	N/A	N/A	N/A	N/A	N/A	N/A	17-Dec-20	1.07	Overburden	7.26	8.78				
MW20-27(CAL) A/B	12-Feb-21	575953.96	4853770.16	431.15	52.43	31.24	28.96	50.32	51.93	17-Feb-21	N/A	18-Feb-21	0.97	Goat Island Fm	41.99	43.51	0.98	Goat Island Fm	33.85	35.37
MW20-28(CAL) A/B	22-Feb-21	576139.79	4854987.82	419.31	30.82	12.80	12.19	28.45	30.20	23-Feb-21	N/A	23-Feb-21	0.96	Gasport Fm	24.07	25.59	0.93	Gasport Fm	16.51	18.03

LEGEND

- MONITORING WELL
- MONITORING WELL (PUMPING TEST)
- TEST WELL
- HISTORICAL MONITORING WELL
- TOWN/VILLAGE
- WATERCOURSE
- ROAD
- WATERBODY
- WETLAND
- PRELIMINARY PROJECT LOCATION



0 500 1,000

1:15,000 METRES

NOTE(S)

REFERENCE(S)

1. BASE DATA MNRF LIO OBTAINED 2020
2. IMAGERY FIRSTBASE SOLUTIONS SPRING 2019 (15CM RESOLUTION) AND SOURCES: ESRI, HERE, GARMIN, INTERMAP, INCREMENT P CORP., GEBCO, USGS, FAO, NPS, NRCAN, GEOBASE, IGN, KADASTER NL, ORDNANCE SURVEY, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY
SOURCE: ESRI, MAXAR, EARTHSTAR GEOGRAPHICS, AND THE GIS USER COMMUNITY
3. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83 COORDINATE SYSTEM: UTM ZONE 17N

CLIENT
CBM AGGREGATES, A DIVISION OF ST. MARYS CEMENT INC. (CANADA).

PROJECT
CALEDON QUARRY

TITLE
2020-2021 MONITORING AND PUMPING WELL LOCATIONS

CONSULTANT

GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-08-26
DESIGNED	CGE
PREPARED	CGE
REVIEWED	GP
APPROVED	-

PROJECT NO.	CONTROL	REV.	FIGURE
19129150	0006	0.0	1

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

25mm

APPENDIX B

MECP Water Well Record Summary

Table B-1 - Water Well Records (<1 km from Study Site)
Caledon Pit / Quarry

Well ID	Easting	Northing	Elevation (masl)	Distance from Pit / Quarry (m)	Well Depth (m)	Screen Top (m)	Screen Bottom (m)	Reported Static WL (m)	Aquifer Type	Aquifer Description	Well Purpose	Well Use	Driller ID	Date Drilled	Borehole ID	Tag Number	County	Con.	Lot
4900845	579191	4854724	395.27	991.65	11.00	10.20	11.00	6.70	1	Overburden	Water Supply	Domestic	1307	10/31/1958	10315693		PEEL	02	015
4900876	578952	4852803	402.29	638.87	13.10	11.89	13.11	7.00	1	Overburden	Water Supply	Domestic	2613	12/9/1965	10315724		PEEL	03	013
4900878	578079	4853682	410.00	91.75	15.20	6.70	15.20	7.60	2	Bedrock (Gasport)	Water Supply	Domestic	4703	6/20/1955	10315726		PEEL	03	015
4900879	578093	4853722	409.71	50.04	13.70	5.80	13.70	6.10	2	Bedrock (Gasport)	Water Supply	Domestic	3513	8/22/1956	10315727		PEEL	03	015
4900880	578643	4854053	383.99	296.56	50.90	45.70	50.90	6.10	1	Overburden	Water Supply	Domestic	4728	10/26/1956	10315728		PEEL	03	015
4900882	576819	4854959	400.46	667.84	17.70	16.46	17.68	7.30	1	Overburden	Water Supply	Domestic	4813	6/12/1965	10315730		PEEL	03	018
4900941	578697	4852765	399.57	460.16	36.60	18.30	36.60	19.80	3	Bedrock (Below Gasport)	Water Supply	Domestic	4703	7/5/1948	10315788		PEEL	04	014
4900942	578261	4852228	396.31	278.28	38.70	11.30	38.70	2.40	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4501	12/10/1951	10315789		PEEL	04	014
4900943	578639	4852673	400.45	470.68	34.10	9.80	34.10	23.80	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4703	9/17/1958	10315790		PEEL	04	014
4900944	578328	4852575	400.04	195.48	36.60	5.20	36.60	23.80	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4703	9/20/1958	10315791		PEEL	04	014
4900945	578477	4853124	402.48	66.52	18.30	6.70	18.30	4.60	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4703	9/25/1961	10315792		PEEL	04	014
4900946	578303	4852138	395.31	367.26	15.80	14.63	15.85	5.50	1	Overburden	Water Supply	Domestic	3512	5/11/1964	10315793		PEEL	04	014
4900947	578483	4852999	401.04	147.67	12.80	4.60	12.80	5.50	2	Bedrock (Gasport)	Water Supply	Domestic	3513	6/16/1966	10315794		PEEL	04	014
4900948	578450	4852848	399.92	214.09	13.70	8.20	13.70	8.50	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3406	8/26/1967	10315795		PEEL	04	014
4900949	577905	4853469	408.85	3.09	18.90	6.10	18.90	4.90	2	Bedrock (Gasport)	Water Supply	Domestic	4728	8/22/1956	10315796		PEEL	04	015
4900950	576546	4854698	416.68	564.96	5.30	4.80	5.30	1.50	1	Overburden	Water Supply	Domestic	5001	10/2/1962	10315797		PEEL	04	018
4901026	577033	4852103	398.00	410.38	19.80	8.50	19.80	6.40	2	Bedrock (Gasport)	Water Supply	Domestic / Livestock	3316	3/16/1964	10315873		PEEL	05	015
4901027	576811	4851723	397.74	835.94	12.20	10.40	12.20	3.70	2	Bedrock (Gasport)	Water Supply	Domestic	4728	9/8/1956	10315874		PEEL	05	015
4902982	578204	4851713	393.20	554.38	39.30	36.90	38.10	12.20	1	Overburden	Water Supply	Domestic	3316	12/17/1968	10317823		PEEL	04	014
4903132	578644	4852923	399.80	321.53	10.10	6.10	10.10	6.40	2	Bedrock (Gasport)	Water Supply	Domestic	3406	3/1/1968	10317972		PEEL	04	014
4903169	578964	4854353	397.65	635.37	30.80	21.30	30.80	1.80	4	Bedrock (Gasport and Lower)	Water Supply	Commerical	1315	9/20/1968	10318009		PEEL	03	015
4903186	578664	4852873	398.51	367.91	41.50	36.90	41.50	9.80	3	Bedrock (Below Gasport)	Water Supply	Domestic	1315	3/1/1969	10318026		PEEL	03	014
4903189	578664	4852723	399.93	459.81	15.20	9.80	15.20	10.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4813	4/8/1969	10318029		PEEL	04	014
4903324	578689	4854153	387.20	329.23	69.80	42.40	69.80	9.80	3	Bedrock (Below Gasport)	Water Supply	Commerical	1315	3/8/1969	10318162		PEEL	03	015
4903338	576864	4852003	397.17	600.78	16.20	13.40	16.20	4.60	2	Bedrock (Gasport)	Water Supply	Domestic	3317	7/19/1969	10318175		PEEL	05	016
4903531	577164	4852823	404.18	191.11	52.10	7.30	52.10	8.50	4	Bedrock (Gasport and Lower)	Water Supply	Domestic / Livestock	3316	12/1/1970	10318365		PEEL	04	016
4903532	578654	4852763	399.05	427.40	32.90	10.70	32.90	9.80	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3316	9/16/1970	10318366		PEEL	04	014
4903625	577149	4852823	403.95	180.45	25.00	8.20	25.00	7.60	4	Bedrock (Gasport and Lower)	Water Supply	Domestic / Livestock	3316	4/28/1971	10318459		PEEL	04	016
4903630	578379	4852408	399.01	265.05	24.40	10.40	24.40	9.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3316	4/23/1971	10318464		PEEL	04	014
4903765	576349	4853583	421.50	186.08	42.70	21.00	42.70		4	Bedrock (Gasport and Lower)	Water Supply	Domestic / Livestock	3316	11/20/1971	10318598		PEEL	04	018
4903810	578539	4852873	399.90	269.12	13.10	3.70	13.10	5.50	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3406	1/19/1972	10318641		PEEL	04	014
4903844	578714	4853073	400.10	297.45	27.40	5.50	27.40	4.90	4	Bedrock (Gasport and Lower)	Water Supply	Industrial	4320	6/12/1972	10318673		PEEL	03	014
4903950	578464	4851923	389.99	627.01	14.30	10.67	11.58	5.20	1	Overburden	Water Supply	Commerical	3316	9/7/1972	10318739		PEEL	04	013
4904052	578644	4852683	400.47	468.50	29.90	7.30	29.90	7.90	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4320	4/6/1973	10318841		PEEL	04	014
4904054	578494	4852523	400.33	354.20	16.80	7.30	16.80	7.60	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4320	4/3/1973	10318843		PEEL	04	014
4904102	576927	4854548	414.92	244.47	23.20	14.90	23.20	10.70	2	Bedrock (Gasport)	Water Supply	Domestic	3406	6/18/1973	10318890		PEEL	04	018
4904175	578564	4852573	399.87	427.23	27.70	10.70	27.70	10.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4320	8/5/1973	10318963		PEEL	04	014
4904178	578464	4852453	398.55	331.49	29.90	8.80	29.90	11.90	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4320	7/25/1973	10318966		PEEL	04	014
4904252	578537	4852787	400.22	320.22	43.30	6.10	43.30	22.90	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3316	12/11/1973	10319040		PEEL	04	014
4904297	578630	4852667	400.40	467.24	32.00	25.90	32.00	13.70	3	Bedrock (Below Gasport)	Water Supply	Domestic	4320	9/23/1973	10319085		PEEL	04	014
4905093	578364	4852373	397.48	269.29	24.70	10.70	24.70	6.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	3/31/1976	10319852		PEEL	04	014
4905163	577264	4851173	396.57	953.77	31.40	30.80	31.40	12.20	1	Overburden	Water Supply	Domestic	2336	6/30/1977	10319918		PEEL	05	014
4905228	578414	4853323	404.47	84.98	8.50	4.90	8.50	3.70	2	Bedrock (Gasport)	Water Supply	Domestic	3349	8/22/1976	10319983		PEEL	03	015
4905272	578514	4852723	400.08	341.25	13.70	4.90	13.70	5.20	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	2918	11/15/1977	10320027		PEEL	04	014
4905365	578514	4852723	400.08	341.25	29.90	13.70	29.90	5.20	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	2918	6/17/1978	10320112		PEEL	04	014
4905439	578414	4851923	391.72	587.13	12.80	8.53	12.50	3.70	1	Overburden	Water Supply	Commerical	3317	11/14/1977	10320172		PEEL	04	013
4905497	577914	4851923	398.04	197.82	82.60	39.60	82.60	22.30	3	Bedrock (Below Gasport)	Water Supply	Domestic	4320	5/30/1978	10320227		PEEL	04	014
4905577	578614	4852923	399.49	297.78	43.00	7.00	43.00	14.30	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	11/22/1979	10320304		PEEL	04	014
4905677	577814	4853523	410.02	72.50	32.00	12.50	32.00	4.90	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4320	5/19/1976	10320381		PEEL	04	016
4905870	578464	4854173	387.90	108.16	36.60	12.50	36.60	6.10	3	Bedrock (Below Gasport)	Water Supply	Domestic	3317	7/31/1981	10320544		PEEL	03	015
4906023	577964	4853723	408.53	60.07	19.50	9.80	19.50	3.70	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	6/18/1982	10320662		PEEL	03	016
4906026	577814	4852023	398.72	56.99	23.50	17.40	23.50	10.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	11/8/1982	10320665		PEEL	04	014
4906521	576787	4852960	406.29	10.61	22.90	11.00	22.90	4.90	2	Bedrock (Gasport)	Water Supply	Domestic	4778	8/2/1986	10321086		PEEL	04	019
4906547	577543	4851996	400.04	124.94	22.60	17.80	22.60	9.10	2	Bedrock (Gasport)	Water Supply	Domestic	3317	7/14/1986	10321112		PEEL	05	015
4906635	577507	4854325	415.01	156.07	21.60	8.70	21.60	7.60	2	Bedrock (Gasport)	Water Supply	Domestic	3317	3/25/1987	10321199		PEEL	03	017
4906636	575684	4854015	436.19	976.43	50.30	27.60	50.30	7.30	2	Bedrock (Gasport)	Water Supply	Domestic	3317	6/12/1987	10321200		PEEL	05	019

GOLDER

Table B-1 - Water Well Records (<1 km from Study Site)
Caledon Pit / Quarry

Well ID	Easting	Northing	Elevation (masl)	Distance from Pit / Quarry (m)	Well Depth (m)	Screen Top (m)	Screen Bottom (m)	Reported Static WL (m)	Aquifer Type	Aquifer Description	Well Purpose	Well Use	Driller ID	Date Drilled	Borehole ID	Tag Number	County	Con.	Lot
4906637	576804	4852922	405.95	41.93	22.90	6.70	22.90	5.50	2	Bedrock (Gasport)	Water Supply	Domestic	4778	11/12/1986	10321201		PEEL	05	016
4906774	578691	4854513	383.73	462.53	57.90	18.90	21.64	11.30	1	Overburden	Observation Wells	Public	1663	11/18/1987	10321335		PEEL	03	016
4906777	576622	4852090	398.39	710.48	25.30	9.10	25.30	3.70	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	9/4/1987	10321338		PEEL	05	016
4906974	578659	4852763	398.98	431.35	34.70	8.50	34.70	13.70	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4778	9/18/1988	10321535		PEEL	03	018
4907018	578029	4853732	409.42	76.70	30.20	6.01	30.20	6.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	11/23/1988	10321579		PEEL	03	016
4907069	575970	4853700	430.25	561.02	25.90	22.60	25.90	6.70	1	Overburden	Water Supply	Domestic	3132	3/2/1989	10321630		PEEL	05	018
4907145	577944	4853791	408.86	65.28	50.30	6.90	50.30	17.40	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	6/1/1989	10321706		PEEL	03	016
4907147	576840	4852928	405.77	16.86	55.20	4.30	55.20	3.70	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	6/21/1989	10321708		PEEL	04	017
4907199	575974	4853698	430.08	556.56	25.90	24.10	25.90	7.30	1	Overburden	Water Supply	Domestic	3132	9/24/1989	10321759		PEEL	05	018
4907201	575983	4853717	430.11	559.14	21.30	19.20	20.42	6.70	1	Overburden	Water Supply	Domestic	3132	9/19/1989	10321761		PEEL	05	018
4907244	577734	4851975	402.01	68.99	20.10	13.40	20.10	7.00	2	Bedrock (Gasport)	Water Supply	Domestic	4778	8/12/1989	10321804		PEEL	04	014
4907246	577734	4851975	402.01	69.18	24.70	14.00	24.70	7.00	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	4778	8/20/1989	10321806		PEEL	04	014
4907314	578727	4852899	399.99	401.90	29.00	7.60	29.00	8.80	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	3/29/1990	10321873		PEEL	04	021
4907315	578504	4852772	400.15	303.33	30.50	12.20	30.50	4.90	3	Bedrock (Below Gasport)	Water Supply	Domestic	2576	5/31/1990	10321874		PEEL	04	014
4907362	578398	4852547	400.21	259.39	38.40	6.10	38.40	16.80	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	2663	8/30/1990	10321921		PEEL	04	014
4907363	576774	4852986	406.75	15.35	61.00	6.10	61.00	21.30	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	2663	8/27/1990	10321922		PEEL	04	017
4907364	578609	4852786	399.89	377.74	31.10	6.70	31.10	11.60	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	2918	6/27/1990	10321923		PEEL	04	014
4907456	578727	4852899	399.99	401.90	48.80	6.70	48.80	14.90	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	6/18/1990	10322015		PEEL	04	014
4907589	578457	4853052	401.91	94.67	15.20	6.10	15.20	3.40	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	5/10/1991	10322148		PEEL	04	015
4907628	576570	4855350	401.43	1113.03	24.40	7.30	24.40	2.10	4	Bedrock (Gasport and Lower)	Water Supply	Public	3406	6/28/1991	10322187		PEEL	03	018
4907629	577340	4854835	399.80	509.63	67.10	26.20	67.10	18.30	3	Bedrock (Below Gasport)	Water Supply	Commerical	3406	7/4/1991	10322188		PEEL	03	017
4907630	577245	4854785	400.03	458.00	42.70	24.70	42.70	11.60	3	Bedrock (Below Gasport)	Water Supply	Commerical	3406	7/4/1991	10322189		PEEL	03	017
4907700	577240	4854420	414.17	101.01	13.70	10.67	13.72		2	Bedrock (Gasport)	Observation Wells	Testing	1839	11/9/1992	10322259		PEEL	03	017
4907701	577188	4854444	414.43	149.20	13.70	10.67	13.72		2	Bedrock (Gasport)	Observation Wells	Testing	1839	11/9/1992	10322260		PEEL	03	017
4907712	578481	4852565	401.11	343.88	44.20	8.00	44.20	19.80	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	3/31/1992	10322271		PEEL	04	014
4907787	578576	4852699	400.02	404.95	36.60	6.70	36.60		4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3602	10/27/1993	10322346		PEEL	04	014
4907794	577104	4854476	411.45	214.27	33.50	10.80	33.50	7.00	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	10/27/1993	10322353		PEEL	04	017
4907804	577205	4854948	393.54	624.26	18.90	18.30	18.90	7.90	3	Bedrock (Below Gasport)	Observation Wells	Monitoring	3406	2/16/1993	10322363		PEEL	03	019
4907806	577234	4854995	393.29	668.22	19.80	17.37	18.90	8.80	3	Bedrock (Below Gasport)	Observation Wells	Not Used	3406	2/17/1993	10322365		PEEL	03	019
4907808	576982	4855127	396.15	819.60	55.50	22.30	55.50	3.00	3	Bedrock (Below Gasport)	Observation Wells	Monitoring	3406	2/22/1993	10322367		PEEL	03	020
4907809	576972	4855137	397.36	829.54	37.20	21.20	37.20		3	Bedrock (Below Gasport)	Observation Wells	Monitoring	3406	3/2/1993	10322368		PEEL	03	020
4907938	578582	4852795	400.11	350.89	43.60	6.10	43.60	21.30	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	11/4/1994	10322497		PEEL	04	014
4908005	578546	4852932	399.99	238.50	21.00	6.40	21.00	6.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	6/2/1995	10322564		PEEL	04	014
4908100	577078	4854560	412.89	274.01	27.40	8.20	27.40	5.50	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3108	1/24/1996	10322659		PEEL	04	018
4908162	577620	4852099	399.99	2.33	15.20	13.41	14.33	9.40	2	Bedrock (Gasport)	Water Supply	Domestic	1350	12/2/1996	10322721		PEEL	04	015
4908197	578677	4852899	399.94	362.32	47.20	5.50	47.20	18.90	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3317	11/4/1996	10322756		PEEL	04	014
4908541	578745	4854123	389.83	385.57	15.50	11.58	12.50	9.10	1	Overburden	Water Supply	Other	1737	9/23/1999	10323076		PEEL		
4908895	578556	4852526	397.51	415.82	42.10	10.70	42.10	10.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	2576	1/7/2002	10526828		PEEL	04	014
4908901	579018	4853737	394.15	772.74	12.50	7.32	11.89	10.10	1	Overburden	Recharge Well	Industrial	1737	2/27/2001	10526834		PEEL		
4908902	579005	4853729	396.09	765.99	16.80	8.23	10.67	9.80	1	Overburden	Recharge Well	Industrial	1737	2/27/2001	10526835		PEEL		
4908903	579084	4853816	392.94	794.00	15.50	12.19	13.11	8.80	1	Overburden	Dewatering	Not Used	1737	2/26/2001	10526836		PEEL		
4908904	579125	4853867	392.90	812.85	12.50	9.14	10.06	9.40	1	Overburden	Dewatering	Not Used	1737	2/23/2001	10526837		PEEL		
4908905	579059	4853784	393.40	785.37	13.70	9.14	10.06	10.10	1	Overburden	Water Supply	Industrial	1737	2/21/2001	10526838		PEEL		
4908906	578972	4853758	393.47	722.59	15.20	9.40	14.00	8.80	1	Overburden	Recharge Well	Not Used	1737	3/6/2001	10526839		PEEL		
4908907	578950	4853781	392.28	691.76	14.60	8.80	13.72	7.60	1	Overburden	Recharge Well	Not Used	1737	3/2/2001	10526840		PEEL		
4908908	578958	4853771	392.59	703.82	15.20	8.70	10.20	7.90	1	Overburden	Recharge Well	Not Used	1737	3/1/2001	10526841		PEEL		
4908909	578982	4853746	394.99	737.46	16.50	10.36	11.28	8.80	1	Overburden	Recharge Well	Not Used	1737	3/1/2001	10526842		PEEL		
4908910	578992	4853737	395.77	750.73	16.50	10.06	14.63	9.10	1	Overburden	Recharge Well	Not Used	1737	2/28/2001	10526843		PEEL		
4908976	578295	4852370	398.40	216.23	54.30	6.10	54.30	24.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	2576	4/2/2002	10526909		PEEL	04	014
4909013	577412	4853253	410.83	232.17	8.20	7.90	8.20	4.00	2	Bedrock (Gasport)	Water Supply	Domestic	7143	7/24/2002	10534190		PEEL	04	016
4909045	577821	4853582	409.25	102.85	23.80	6.10	23.80	6.70	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	2576	8/21/2002	10534222		PEEL	03	016
4909122	578766	4853889	381.15	478.47	29.00	27.13	28.35	9.40	3	Bedrock (Below Gasport)	Water Supply	Municipal	7143	3/19/2003	10540557		PEEL	03	015
4909177	577144	4855727	396.20	1405.31	53.34	24.38	53.34	11.28	4	Bedrock (Gasport and Lower)	Water Supply	Commercial	2644	7/7/2003			PEEL	03	020
4909251	578594	4852961	400.00	258.41	44.80	6.10	44.80	16.80	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	7154	8/23/2003	10546522		PEEL	05	014
4909536	578523	4852953	400.08	207.15	45.70	19.00	45.70		3	Bedrock (Below Gasport)	Recharge Well	Cooling / AC	7143	9/22/2004	11177164	A004248	PEEL	04	014
4909671	578737	4852935	400.04	387.50	41.80	7.60	41.80	19.50	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	7154	3/11/2005	11323404	A020435	PEEL	03	014

Table B-1 - Water Well Records (<1 km from Study Site)
Caledon Pit / Quarry

Well ID	Easting	Northing	Elevation (masl)	Distance from Pit / Quarry (m)	Well Depth (m)	Screen Top (m)	Screen Bottom (m)	Reported Static WL (m)	Aquifer Type	Aquifer Description	Well Purpose	Well Use	Driller ID	Date Drilled	Borehole ID	Tag Number	County	Con.	Lot
4909830	579159	4854030	391.39	806.58	5.30	3.66	5.33		1	Overburden	Observation Wells	Not Used	6032	4/4/2005	11323563	A005050	PEEL		
4909948	575639	4853671	427.47	852.11	50.90	24.40	50.90	7.00	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	7154	10/21/2005	11323681	A032493	PEEL	05	019
7108579	579107	4854799	393.66	965.09	7.60	1.50	7.60		1	Overburden	Observation Wells	Monitoring	7238	6/17/2008	1002676179	A070012	PEEL	02	014
7108579	578991	4854674	399.59	797.18	12.20	6.10	12.20		1	Overburden	Observation Wells	Monitoring	7238	6/16/2008	1002676170	A070012	PEEL	02	014
7108579	579249	4854337	401.52	909.66	16.70	10.60	16.70		1	Overburden	Observation Wells	Monitoring	7238	6/20/2008	1002676233	A070012	PEEL	02	014
7139063	577237	4854451	415.24	130.76	29.60	7.60	29.60	8.50	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	2576	6/29/2009	1002932231	A079686	PEEL	03	019
7145140	578190	4851490	391.09	708.83	39.30	37.49	39.32		1	Overburden	Water Supply	Domestic	7143	5/6/2010	1002984167	A091638	PEEL	05	013
7161619	578982	4853738	395.74	741.79	17.06	10.21	15.24		1	Overburden	Recharge Well	Industrial	3406	3/17/2010	1003494944	A071538	PEEL	03	015
7193044	576604	4854580	417.19	443.69	60.40	11.30	60.40	8.70	4	Bedrock (Gasport and Lower)	Water Supply	Domestic / Livestock	1663	10/17/2012	1004216798	A116219	PEEL	04	017
7199658	578949	4853782	392.25	690.39	13.72	10.21	13.72		1	Overburden	Other Status	Injection	3406	5/29/2012	1004270103	A112253	PEEL	03	015
7218147	578597	4852611	400.00	465.36	60.40	6.10	60.35	12.10	4	Bedrock (Gasport and Lower)	Water Supply	Domestic	3406	2/7/2013	1004724172	A133928	PEEL		
7241044	579051	4853788	393.64	776.42	16.80	11.40	15.20	9.50	1	Overburden	Other Status	Purge well	7221	4/22/2015	1005342382	A173444	PEEL	03	015
7298702	578137	4851515	392.69	658.25	6.90	3.81	6.86		1	Overburden	Observation Wells	Monitoring	7282	7/19/2017	1006791550	A219078	PEEL	05	
7363752	577681	4853179	408.59	25.38	8.50	5.49	8.53		2	Bedrock (Gasport)	Observation Wells	Monitoring	7675	8/7/2020	1008374815	A294093	PEEL	04	015
7363754	577632	4853055	406.02	18.31	8.20	5.18	8.23		2	Bedrock (Gasport)	Observation Wells	Monitoring	7675	8/7/2020	1008374821	A289819	PEEL	04	015

APPENDIX C

Records of Borehole and Monitoring Well Drilling and Installation

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-01 (CAL)

SHEET 1 OF 1

LOCATION: N 4853292.8 ;E 578000.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 6, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate
BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular
PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. (m)	DEPTH (m)
GROUND SURFACE	406.80	0.00
(GP/SP) gravelly SAND, some silt; brown/tan, no odor, no staining, non-cohesive, moist	405.00	1.80
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	389.70	17.10
SHALEY DOLOSTONE, bedded shaley dolostone, cream to grey	387.86	18.94
SHALE, bedded, shale, blue green (CABOT HEAD FORMATION)	384.73	22.07
BOTTOM OF HOLE		

RUN No.: 1, 2, 3, 4, 5, 6, 7

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

TYPE AND SURFACE DESCRIPTION:
BD,IR,VR
BD,IR,VR
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,UN,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,SM
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,CU,SM
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,SM
BD,CU,SM
BD,IR,SM
BD,IR,SM
BD,CU,SM
BD,IR,SM
BD,IR,SM
BD,IR,SM
BD,IR,SM
BD,IR,RO
BD,IR,VR
BD,CU,RO
BD,IR,SM
BD,R,SM

NOTES: ∇ Febuary 12, 2020

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL/KS

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-02 (CAL)

SHEET 1 OF 1

LOCATION: N 4853078.9 ;E 577839.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 10, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	405.52
(SP) SAND, some silt; brown, no odor, no staining, non-cohesive, moist (TOPSOIL)	0.00
(SP) SAND, some silt; brown, no odor, no staining, non-cohesive, moist	0.30
(SG) SAND and GRAVEL, some cobbles; brown, no odor, no staining, non-cohesive, moist	0.80
(CL) CLAYEY SILT TILL, some sand, some cobbles; brown, no odor, no staining, non-cohesive, moist	403.08 / 2.44
(SG) SAND and GRAVEL; brown, no odor, no staining, non-cohesive, moist	402.17 / 3.35
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light to medium grey (GASPORT FORMATION)	3.84
SHALEY DOLOSTONE, bedded shaley dolostone, brown to grey	385.33 / 20.19
BOTTOM OF HOLE	383.50 / 22.02

Run No.: 1, 2, 3, 4, 5, 6

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Water level: Febuary 11, 2020

Discontinuity type and surface description:
BD,IR,VR
F,IR,RO
BD,IR,RO
F,UN,RO
BD,UN,RO
BD,IR,VR
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,VR
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,PL,RO
BD,UN,VR
BD,UN,RO
BD,IR,RO
F,IR,RO
BD,IR,VR
F,IR,RO
BD,IR,VR
BD,UN,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: KS

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-03 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4852796.3 ;E 577655.1

DRILLING DATE: Febuary 25-26, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint; FLT - Fault; SHR - Shear; VN - Vein; CJ - Conjugate; BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage; PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular; PO - Polished; K - Slickensided; SM - Smooth; Ro - Rough; MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE %, SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	402.91
(SM) SILTY SAND TILL; brown, no odor, no staining, non-cohesive, moist (TOPSOIL)	0.00
(GP/SP) SAND and GRAVEL; light brown, no odor, no staining, non-cohesive, moist	402.30 0.61
DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	400.17 2.74
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey with blue banding	385.03 17.88
BOTTOM OF HOLE	383.58 19.33

Depth scale (metres): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

RUN No.: 1, 2, 3, 4, 5, 6

Discontinuity type and surface description:

BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR

NOTES / WATER LEVELS: ∇ Febuary 27, 2020

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-04 (CAL)

SHEET 1 OF 1

LOCATION: N 4852528.1 ;E 577511.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 13, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate
BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular
PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE % (80 60 40 20) / SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA: B Angle (0 90 180 270) / DIP w.r.t. CORE AXIS (0 30 60 90) / TYPE AND SURFACE DESCRIPTION / Jr Ja Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		400.81											
0		(ML) SANDY SILT TILL; brown, no odor, no staining, non-cohesive, moist		0.00											
2		(SP/GP) SAND and GRAVEL, some cobbles; brown, no odor, no staining, non-cohesive, moist		398.37 / 2.44											
4															
6		(GP) GRAVEL; grey, no odor, no staining, non-cohesive, moist		394.71 / 6.10											
		DOLOSTONE, fresh to highly weathered, bedded dolostone, light grey (GASPORT FORMATION)		6.52											
8															Febuary 19, 2020
10					1						BD,IR,VR BD,IR,RO BD,IR,VR BD,CU,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR				
12					2						BD,IR,RO BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,VR BD,IR,VR BD,IR,RO BD,IR,RO				
14					3						BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,VR BD,IR,VR				
16											BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,VR BD,IR,RO				
		SHALEY DOLOSTONE, bedded shaley dolostone, light and dark grey banding		383.41 / 17.40											
18					4						BD,IR,VR BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,VR BD,IR,VR BD,IR,RO BD,IR,VR BD,IR,VR BD,UN,RO BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,RO				
		BOTTOM OF HOLE		381.24 / 19.57											
20															
22															
24															
26															
28															
30															

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-05 (CAL)

SHEET 1 OF 1

LOCATION: N 4852520.2 ;E 577786.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 18-19, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | FLUSH COLOUR % RETURN | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. / Depth (m)
GROUND SURFACE	398.83
(SM) SILTY SAND TILL; brown, no odor, no staining, non-cohesive, moist (TOPSOIL)	0.00
(SP) SAND, trace gravel; brown, no odor, no staining, non-cohesive, moist	0.50
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	393.96 / 4.87
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	385.78 / 13.05
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	383.03 / 15.80
BOTTOM OF HOLE	382.48 / 16.35

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Run No.: 1, 2, 3, 4

Type and surface description:

BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,UN,VR
BD,UN,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,UN,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,S
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,CU,RO
BD,IR,SM
BD,IR,SM
BD,IR,SM
BD,IR,SM

Notes: Febuary 20, 2020

RECORD OF DRILLHOLE: BH20-06 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4852520.2 ;E 578056.5

DRILLING DATE: Febuary 19, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate

BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage

PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular

PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		397.70		
0		(SP) SAND, some gravel; brown, no odor, no staining, non-cohesive, moist		0.00		
2		(SP/GP) SAND and GRAVEL, some cobbles; brown, no odor, no staining, non-cohesive, moist		394.66 3.04		
4		(GP) GRAVEL, some cobbles, some sand; brown, no odor, no staining, non-cohesive, moist		393.13 4.57		
6		(MH) CLAYEY SILT, some gravel; reddish brown, no odor, no staining, non-cohesive, moist		391.70 6.00		Febuary 21, 2020
8–12		DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)		390.38 7.32	1, 2	
14–16		SHALEY DOLOSTONE, bedded shaley dolostone, light and dark grey banding		384.20 13.50	3	
		BOTTOM OF HOLE		381.10 16.60		

Column headings: PENETRATION RATE min/(m); FLUSH; COLOUR % RETURN; RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.25 m 5 10 15 20; DISCONTINUITY DATA: B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn; HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; Diametral Point Load Index (MPa) 2 4 6; RMC -Q' AVG.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

TYPE AND SURFACE DESCRIPTION:
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,UN,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,IR,VR
BD,IR,S
BD,IR,S
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

RECORD OF DRILLHOLE: BH20-07 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4853102.3 ;E 578129.1

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 20, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate
BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular
PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN	FLUSH	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA: B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		404.73																		
0		(SP) SAND, some gravel; brown, no odor, no staining, non-cohesive, moist		0.00																		Febuary 24, 2020
2		DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)		402.44 / 2.29	1, 2, 3, 4, 5																	
17.32		SHALEY DOLOSTONE, bedded shaley dolostone, light and dark grey banding		387.41 / 17.32	6																	
		BOTTOM OF HOLE		386.06 / 18.67																		

TYPE AND SURFACE DESCRIPTION (in order of depth):

BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,VR
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-08 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4852832.0 ;E 577962.0

DRILLING DATE: Febuary 20-21, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint; FLT - Fault; SHR - Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage
PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular
PO - Polished; K - Slickensided; SM - Smooth; Ro - Rough; MB - Mechanical Break
BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		404.50																	
0		(SM) SILTY SAND, some gravel; dark brown, no odor, no staining, non-cohesive, moist		0.00																	
2		(SP) SAND, some silt, some bolders; dark brown, no odors, no staining, non-cohesive moist, boulder at 3.96m		402.06 2.44																	
4		(SP) SAND, some cobbles and boulders; brown, no odors, no staining, non-cohesive, moist		400.53 3.97																	
6		DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)		399.17 5.33																	Febuary 25, 2020
8–16					1 2 3									BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,RO BD,IR,VR BD,IR,VR BD,IR,VR BD,UN,RO BD,IR,VR BD,IR,RO BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,UN,VR BD,IR,VR BD,IR,RO BD,IR,VR BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,RO BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,CU,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,CU,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO							
		SHALEY DOLOSTONE, bedded shaley dolostone, slate grey and light grey banding		387.23 17.27	4																
18		BOTTOM OF HOLE		386.60 17.90																	
20																					
22																					
24																					
26																					
28																					
30																					

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DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-09 (CAL)

LOCATION: N 4852803.0 ;E 578186.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 24-25, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.
	GROUND SURFACE	402.26	
0	(SM) SILTY SAND TILL; brown, no odor, no staining, non-cohesive, moist	0.00	
	(SP/GP) SAND and GRAVEL, some cobbles; brown, no odor, no staining, non-cohesive, moist	401.04 / 1.22	
2	DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	399.52 / 2.74	
4			1
6			2
8–10			3
12			4
14			5
16	SHALEY DOLOSTONE, bedded shaley dolostone, dark grey	386.63 / 15.63	
		385.49	6
	BOTTOM OF HOLE	16.77	

Column headings: DRILLING RECORD; SYMBOLIC LOG; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.25 m 5 10 15 20; DISCONTINUITY DATA: B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn; HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; Diametral Point Load Index (MPa) 2 4 6; RMC -Q' AVG.; NOTES WATER LEVELS INSTRUMENTATION

TYPE AND SURFACE DESCRIPTION:

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,CU,RO
BD,CU,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO

NOTES: Febuary 25, 2020 (water level)

Depth scale: 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

DEPTH SCALE
1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-10 (CAL)

SHEET 1 OF 1

LOCATION: N 4853952.3 ;E 577940.1

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 16-17, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate; BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage; PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular; PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr Ja Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	411.07 / 0.00
(SM) SILTY SAND TILL, some clay; brown/black, no odors, no staining, non-cohesive, moist (TOPSOIL)	410.46 / 0.61
(SM) CLAYEY SILTY SAND, some cobbles; brown, no odors, no staining, non-cohesive, moist then wet at 1.52m	405.59 / 5.49
(SM) BOULDERS and SILTY SAND; brown, no odors, no staining, non-cohesive, wet	404.97 / 6.10
(SM) CLAYEY SILTY SAND TILL and COBBLES; light brown, no odors, no staining, non-cohesive, dry	403.45 / 7.62
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	394.32 / 16.75
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey with dark grey banding	392.50 / 18.57
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	391.52 / 19.55
BOTTOM OF HOLE	

RUN No.: 1, 2, 3, 4

Water level: March 18, 2020

TYPE AND SURFACE DESCRIPTION:

BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-11 (CAL)

SHEET 1 OF 1

LOCATION: N 4854240.5 ;E 578065.1

DRILLING DATE: March 17-18, 2020

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.
		GROUND SURFACE		402.10	
0		(SM) CLAYEY SILTY SAND TILL; black/brown, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.00	
		(SP) SAND; brown, no odors, no staining, non-cohesive, moist		401.49 / 0.61	
2		DOLOSTONE, fresh to slightly weathered, bedded dolostone, light grey (GASPORT FORMATION)		400.27 / 1.83	
4					1
6					2
8					3
		SHALEY DOLOSTONE, bedded shaley dolostone, slate grey		393.46 / 8.64	
10		BOTTOM OF HOLE		391.90 / 10.20	

Column headings: PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.25 m 5 10 15 20; DISCONTINUITY DATA: B Angle 0 90 180 270, DIP w.r.t. CORE AXIS 0 30 60 90, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn; HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; Diametral Point Load Index (MPa) 2 4 6; RMC -Q' AVG.

TYPE AND SURFACE DESCRIPTION:
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO

NOTES WATER LEVELS INSTRUMENTATION

∇ March 19, 2020

Depth scale: 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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DEPTH SCALE
1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-12 (CAL)

SHEET 1 OF 1

LOCATION: N 4854244.9 ;E 577780.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 20-23, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	415.22
(SM) CLAYEY SILTY SAND; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00
(CL) SILTY CLAY; brown, no odors, no staining, cohesive, W ~ PL	0.30
(CH) SANDY CLAY TILL, some gravel; brown, no odors, no staining, cohesive	414.00 / 1.22
(CL) SANDY SILTY CLAY TILL, some gravel; reddish brown, no odors, no staining, cohesive, W < PL	408.21 / 7.01
DOLOSTONE, fresh to lightly weathered, bedded dolostone, light grey to light beige (GASPORT FORMATION)	404.82 / 10.40
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey to brown	395.88 / 19.34
BOTTOM OF HOLE	393.46 / 21.76

Depth scale (m): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

RUN No.: 1, 2, 3, 4

Discontinuity type and surface description:
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO

Water level: March 25, 2020 (approx. 8.5 m)

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: CS

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-13 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4854103.2 ;E 577209.7

DRILLING DATE: March 27, 2020

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

Abbreviations: JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

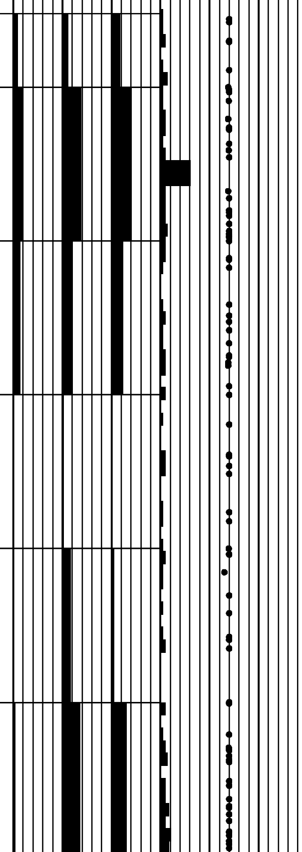
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle; DIP w.r.t. CORE AXIS; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	412.94
(SC) SILTY CLAYEY SAND TILL; black, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00
(SP/GP) Sand and GRAVEL, some clay; light brown, no odors, no staining, non-cohesive, moist	412.03 / 0.91
(SC) CLAYEY SAND TILL, some cobbles some gravel; light brown, no odors, no staining, non-cohesive, moist	410.50 / 2.44
(SP/GP) SANDY GRAVEL and COBBLES; grey, no odors, no staining, non-cohesive, moist	409.89 / 3.05
DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	407.76 / 5.18
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	392.16 / 20.78
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	390.30 / 22.80
BOTTOM OF HOLE	

Run No.: 1, 2, 3, 4, 5, 6

Depth scale (m): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30



Type and surface description:
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,CU,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR

Water level: April 2, 2020

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-14 (CAL)

LOCATION: N 4853881.7 ;E 577288.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 30, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20 | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr Ja Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	417.27
(ML) SANDY SILT; dark brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00
(CL) SILTY CLAY TILL, some sand, some gravel, some cobbles; light brown, no odors, no staining, cohesive, W ~ PL	0.40
(CL) SANDY SILTY CLAY TILL, some gravel, some cobbles; brown, no odors, no staining, cohesive, W < PL	412.70 / 4.57
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to light beige (GASPORT FORMATION)	409.19 / 8.08
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey to brown	389.79 / 27.48
	387.85 / 29.42

Run No.: 1, 2, 3, 4, 5, 6, 7, 8

Type and surface description: BD,IR,RO; BD,IR,RO; BD,IR,SM; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,UN,RO; BD,UN,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO

Water level: April 7, 2020

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: CS

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-14 (CAL)

PROJECT: 19129150

LOCATION: N 4853881.7 ;E 577288.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 30, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30		SHALE, bedded shale, blue green (CABOT HEAD FORMATION)		385.81	8									BD,IR,RO BD,IR,RO BD,IR,S BD,IR,RO BD,IR,RO BD,IR,VR BD,IR,RO BD,UN,RO BD,IR,RO BD,IR,RO							
		BOTTOM OF HOLE		31.46																	

Depth scale: 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: CS

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-15 (CAL)

PROJECT: 19129150

SHEET 1 OF 2

LOCATION: N 4854113.1 ;E 576925.2

DRILLING DATE: April 2, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. / Depth (m)
GROUND SURFACE	421.52
SANDY SILT; dark brown, no odors, no straining, non-cohesive, moist (TOPSOIL)	0.08
(CL) SILTY CLAY TILL, some sand, some gravel; red brown, no odors, no staining, cohesive, W < PL	
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to light beige (GASPORT FORMATION)	408.11 / 13.41

Run No.: 1, 2, 3, 4, 5, 6

Discontinuity type and surface description:
BD,IR,RO
BD,IR,K
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,SM
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,SM
BD,IR,RO
BD,IR,SM
BD,UN,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,VR
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,SM
BD,IR,RO
BD,IR,RO

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

CONTINUED NEXT PAGE

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-15 (CAL)

SHEET 2 OF 2

LOCATION: N 4854113.1 ;E 576925.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 2, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint	BD - Bedding	PL - Planar	PO - Polished	BR - Broken Rock
FLT - Fault	FO - Foliation	CU - Curved	K - Slickensided	**NOTE:** For additional abbreviations refer to list of abbreviations & symbols.
SHR - Shear	CO - Contact	UN - Undulating	SM - Smooth	
VN - Vein	OR - Orthogonal	ST - Stepped	Ro - Rough	
CJ - Conjugate	CL - Cleavage	IR - Irregular	MB - Mechanical Break	

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH	COLOUR / % RETURN	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA: B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																				
30		DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to light beige (GASPORT FORMATION)			6										BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,UN,RO BD,PO,RO BD,PO,VR BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,UN,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,K BD,PO,RO BD,IR,RO BD,IR,K BD,IR,K BD,IR,RO BD,IR,K BD,IR,K BD,IR,RO BD,IR,RO BD,IR,RO							
32					7																	
34		SHALEY DOLOSTONE, bedded shaley dolostone, brown		387.66 33.86																		
		BOTTOM OF HOLE		386.76 34.76																		

36 38 40 42 44 46 48 50 52 54 56 58 60

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: CS

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-16 (CAL)

PROJECT: 19129150

LOCATION: N 4853859.5 ;E 576991.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 9, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. (m)	Depth (m)
GROUND SURFACE	420.74	0.00
(SC) CLAYEY SAND TILL and GRAVEL; brown/black, no odor, no staining, non-cohesive, wet (TOPSOIL)		0.00
(SP/GP) SAND and GRAVEL; brown, no odors, no staining, non-cohesive, wet		0.50
(CL) SANDY CLAY TILL, some gravel, some cobbles; reddish brown, no odors, no staining, cohesive, W < PL		0.75
(SC) CLAYEY SAND and GRAVEL; brown, no odors, no staining, non-cohesive, moist then wet at 10.05m	412.21	8.53
DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	408.85	11.89

Water level (notes column, approx. 3.4 m): April 16, 2020

Run No.: 1, 2, 3, 4, 5, 6

Type and surface description (discontinuities, approx. 15 m to 30 m):

BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR

BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,PO,SM
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

CONTINUED NEXT PAGE

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-16 (CAL)

LOCATION: N 4853859.5 ;E 576991.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 9, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	NOTES WATER LEVELS INSTRUMENTATION
	--- CONTINUED FROM PREVIOUS PAGE ---			
30	DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)		6	
32	SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	388.30 / 32.44	7	
34	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	386.58 / 34.18		
	BOTTOM OF HOLE			

Column headings: DRILLING RECORD; SYMBOLIC LOG; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.25 m 5 10 15 20; DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn); HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; Diametral Point Load Index (MPa) 2 4 6; RMC -Q' AVG.

Type and surface description (discontinuities, in depth order):
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
N,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,VR
BD,IR,RO

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-17 (CAL)

LOCATION: N 4853391.6 ;E 577474.7

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 16, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20 | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	413.06 / 0.00
(SC) CLAYEY SAND; black, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.50
(SC) CLAYEY SAND TILL, some gravel, some cobbles; brown, no odors, no staining, non-cohesive, moist	411.84 / 1.22
(SC/GP) CLAYEY SAND and GRAVEL, some cobbles; brown, no odors, no staining, non-cohesive, moist	409.71 / 3.35
DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	386.29 / 26.77
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	384.23 / 28.83
BOTTOM OF HOLE	

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Run No.: 1, 2, 3, 4, 5, 6, 7, 8

Discontinuity data (type and surface description), from top:

BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,PL,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO

NOTES / WATER LEVELS: ∇ April 24, 2020

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GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-17 (CAL)

LOCATION: N 4853391.6 ;E 577474.7

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 16, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- *CONTINUED FROM PREVIOUS PAGE* ---																			
30														BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,VR BD,IR,RO BD,IR,SM BD,IR,RO BD,IR,RO							
32																					
34																					
36																					
38																					
40																					
42																					
44																					
46																					
48																					
50																					
52																					
54																					
56																					
58																					
60																					

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-18 (CAL)

LOCATION: N 4853571.8 ;E 577313.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 20, 2020
DRILL RIG: Sonic
DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		417.53																	
0		(SM) CLAYEY SILTY SAND TILL; brown/black, no odors, no staining, non-cohesive, wet		0.00																	
2		BOULDERS and COBBLES; grey, no odors, no staining, non-cohesive, moist		415.70 1.83																	
4		DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)		413.57 3.96																	
6–30					1, 2, 3, 4, 5, 6, 7, 8, 9																April 24, 2020 (water level, approx. 11 m)

Discontinuity type and surface description (6 m to 30 m, top to bottom):

BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,CU,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,CU,VR

BD,IR,RO
BD,IR,VR
BD,IR,RO

BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

RECORD OF DRILLHOLE: BH20-18 (CAL)

PROJECT: 19129150

LOCATION: N 4853571.8 ;E 577313.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 20, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate; BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage; PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular; PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	DISCONTINUITY DATA – TYPE AND SURFACE DESCRIPTION	NOTES WATER LEVELS INSTRUMENTATION
	--- CONTINUED FROM PREVIOUS PAGE ---				
30	DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	386.53 / 31.00	9	BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO RB,IR,RO	
	SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	385.69 / 31.84		BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,SM BD,IR,RO BD,IR,RO BD,IR,RO	
32	BOTTOM OF HOLE				

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

Column headings: DRILLING RECORD; SYMBOLIC LOG; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; B Angle; DIP w.r.t. CORE AXIS; Jr; Ja; Jn; HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-19 (CAL)

PROJECT: 19129150

LOCATION: N 4853580.0 ;E 577733.1

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 23-24, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.
		GROUND SURFACE		411.42	
0		(SC) SILTY CLAYEY SAND; brown/black, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.00	
		(SC) SILTY CLAYEY SAND; brown/black, no odors, no staining, non-cohesive, moist		0.50	
		(SM/GP) SILTY SAND and GRAVEL, some cobbles; golden brown, no odors, no staining, non-cohesive, moist		0.91	
		DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)		408.68 / 2.74	1–6
		SHALEY DOLOSTONE, bedded shaley dolostone, slate grey		388.94 / 22.48	7
		SHALE, bedded shale, blue green (CABOT HEAD FORMATION)		387.02 / 24.40	
		BOTTOM OF HOLE		24.64	

Column headings: PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.25 m 5 10 15 20; DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn); HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; Diametral Point Load Index (MPa) 2 4 6; RMC -Q' AVG.; NOTES WATER LEVELS INSTRUMENTATION

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Discontinuity data (type and surface description):

BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,SM
BD,IR,SM

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-20 (CAL)

SHEET 1 OF 2

LOCATION: N 4853551.6 ;E 577031.1

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 28-30, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	423.60			
0	(SC) SILTY CLAYEY SAND; brown/black, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00			
	(SC/GP) CLAYEY SAND TILL and GRAVEL, some cobbles; red, no odors, no staining, cohesive, W ~ PL	0.31			
6	(CH) SANDY CLAY TILL, some gravel; brown, no odors, no staining, cohesive, W < PL	418.11 5.49			
12					May 6, 2020
14	DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	409.27 14.33			
16–17			1	BD,IR,RO BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO	
18–20			2	BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO	
20–23			3	BD,IR,RO (×12)	
23–26			4	BD,IR,RO (×12)	
26–29			5	BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,UN,RO	
29–30			6	BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO	
30					

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-20 (CAL)

LOCATION: N 4853551.6 ;E 577031.1

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 28-30, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

--- *CONTINUED FROM PREVIOUS PAGE* ---

Depth (m)	Description	Elev. / Depth (m)	Run No.	Discontinuity data (type and surface description)
30	DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)		6	BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,VR; BD,IR,VR; BD,IR,VR; BD,IR,RO
32			7	BD,IR,VR; BD,IR,VR; BD,IR,VR; BD,IR,VR
34			8	BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO
36			9	BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO
38	SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	384.95 / 38.65	10	BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO
40	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	383.02 / 40.58		BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,K; BD,IR,K; BD,IR,K
	BOTTOM OF HOLE	40.98		

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-21 (CAL)

LOCATION: N 4853276.6 ;E 576935.7

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 4-5, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

ELEV. / DEPTH (m)	DESCRIPTION
413.53	GROUND SURFACE
0.00	(ML) SANDY SILT; dark brown, no odors, no staining, non-cohesive, moist (TOPSOIL)
0.30	(CL) SILTY CLAY TILL, some sand some gravel;brown, no odors, no staining, cohesive, W < PL
408.04 / 5.49	DOLOSTONE, fresh with some weathering, bedded dolostone, light grey to light beige (GASPORT FORMATION)

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

RUN No.: 1, 2, 3, 4, 5, 6, 7, 8, 9

DISCONTINUITY DATA – TYPE AND SURFACE DESCRIPTION (in order of depth):

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,PL,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,CU,RO
BD,PL,RO
BD,IR,K
BD,IR,RO
BD,PL,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,PL,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,CU,K
BD,PL,RO
BD,IR,RO
BD,IR,VR
BD,PL,VR
BD,CU,RO
BD,IR,K
BD,PL,SM
JN,IR,RO
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,PL,RO
BD,PL,RO
BD,IR,RO
BD,PL,RO
BD,PL,RO
BD,IR,VR
BD,IR,RO
BD,PL,RO
BD,UN,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,PL,VR
BD,PL,K
BD,IR,K
BD,CU,RO
BD,PL,RO
BD,IR,VR
BD,PL,RO
BD,IR,VR
BD,IR,PO
BD,PL,RO
BD,IR,RO
BD,IR,RO
BD,PL,RO

NOTES / WATER LEVELS: May 6, 2020

CONTINUED NEXT PAGE

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-21 (CAL)

LOCATION: N 4853276.6 ;E 576935.7

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 4-5, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	NOTES WATER LEVELS INSTRUMENTATION
	--- *CONTINUED FROM PREVIOUS PAGE* ---				
30	DOLOSTONE, fresh with some weathering, bedded dolostone, light grey to light beige (GASPORT FORMATION)	381.99 / 31.54	9	BD,IR,RO; BD,IR,RO	
32	SHALEY DOLOSTONE, bedded shaley dolostone, brown grey	380.05 / 33.48	10	BD,IR,K; BD,PL,K; BD,PL,RO; BD,UN,RO; BD,IR,K; BD,PL,RO; BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,IR,RO; BD,PL,RO; BD,PL,RO; BD,IR,RO; BD,IR,K; BD,IR,K; BD,IR,K; BD,PL,RO; BD,IR,RO	
34	BOTTOM OF HOLE				

Column headers: DEPTH SCALE METRES; DRILLING RECORD; DESCRIPTION; SYMBOLIC LOG; ELEV. DEPTH (m); RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.; NOTES WATER LEVELS INSTRUMENTATION

Depth scale: 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: CS

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-22 (CAL)

PROJECT: 19129150

LOCATION: N 4853294.0 ;E 576701.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 6-7, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE %, SOLID CORE % | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA: B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Depth (m)	Description	Elev. / Depth (m)
	GROUND SURFACE	410.98
0	(MH) SANDY CLAYEY SILT; dark brown, no odors, no staining, cohesive W < PL (TOPSOIL)	0.00
	(CL) SILTY CLAY TILL, some gravel, trace cobbles; brown, no odors, no staining, cohesive, W < PL	0.36
2	(MH) CLAYEY SILT TILL, some sand, some gravel; brown, no odors, no staining, cohesive, W > PL	408.54 / 2.44
4	DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to light beige (GASPORT FORMATION)	407.02 / 3.96
28	SHALEY DOLOSTONE, bedded shaley dolostone, grey to dark grey	383.46 / 27.52
	BOTTOM OF HOLE	382.37 / 28.61

Run No.	Discontinuity type and surface description
1	BD,PL,RO; BD,IR,VR; BD,PL,RO
2	BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,PL,SM; BD,CU,RO; BD,CU,PO; BD,CU,RO; BD,PL,VR
3	BD,PL,RO; BD,IR,RO; BD,CU,K; BD,UN,RO; BD,PL,PO; BD,UN,RO; BD,UN,RO
4	BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,PL,RO; BD,IR,RO; BD,UN,RO; BD,UN,RO; BD,PL,RO; BD,IR,RO; BD,IR,RO
5	BD,PL,RO; BD,PL,RO; BD,IR,VR; BD,IR,RO; BD,CU,RO; BD,PL,RO
6	BD,PL,RO; BD,IR,RO; BD,PL,RO; BD,UN,RO; BD,PL,RO; BD,UN,RO; BD,IR,RO; BD,IR,K; BD,PL,RO
7	BD,IR,RO; BD,IR,SM; BD,IR,RO; BD,PL,RO; BD,PL,RO; BD,PL,RO
8	BD,CU,RO; BD,PL,RO; BD,PL,RO; BD,PL,SM; BD,PL,RO; BD,PL,VR; BD,PL,RO; BD,PL,VR; BD,PL,RO; BD,PL,RO; BD,PL,RO; BD,CU,RO; BD,PL,RO; BD,PL,RO; BD,UN,RO; BD,PL,RO

Notes / water levels: ∇ May 8, 2020 (approx. 3.0 m depth)

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: CS

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-23 (CAL)

LOCATION: N 4853559.8 ;E 576779.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 8-11, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	420.27
(SM) SILTY SAND; brown, no odor, no staining, non-cohesive, moist (TOPSOIL)	0.00
(MH) SANDY SILT TILL, some gravel; medium brown, no odors, no staining, non-cohesive, moist	0.25
(CH) SANDY CLAY TILL, trace gravel; brown, no odors, no staining, cohesive, W ~ PL	411.77 / 8.50
(SM) SANDY SILT TILL, some gravel; brown, no odors, no staining, cohesive W ~ PL	409.60 / 10.67
(CL) SILTY CLAY TILL, some gravel; brown, no odors, no staining, cohesive, W ~ PL	408.69 / 11.58
DOLOSTONE, fresh, bedded dolostone, light grey to light beige (GASPORT FORMATION)	407.47 / 12.80

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

RUN No.: 1, 2, 3, 4, 5, 6

TYPE AND SURFACE DESCRIPTION:
BD,PL,RO
BD,PL,RO
BD,PL,RO
BD,PL,RO
BD,PL,RO
BD,PL,VR
BD,PL,VR
BD,UN,RO
BD,UN,RO
BD,CU,RO
BD,UN,RO
BD,PL,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,PL,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,PL,VR
BD,UN,RO
BD,UN,RO
BD,PL,RO
BD,PL,RO
BD,PL,RO
BD,IR,RO
BD,PL,RO
BD,IR,RO
BD,CU,RO
BD,PL,RO
BD,PL,RO
BD,PL,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,PL,RO
BD,PL,RO
BD,IR,VR
BD,PL,VR
BD,PL,RO
BD,PL,RO
BD,PL,RO
BD,PL,RO
BD,UN,RO

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: PM

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-23 (CAL)

LOCATION: N 4853559.8 ;E 576779.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 8-11, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr Ja Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

--- CONTINUED FROM PREVIOUS PAGE ---

Depth (m)	Description	Elev. / Depth (m)	Run No.
30	DOLOSTONE, fresh, bedded dolostone, light grey to light beige (GASPORT FORMATION)		6
32			7
34		384.45 / 35.82	
36	SHALEY DOLOSTONE, bedded shaley dolostone, grey to brown	382.65 / 37.62	8
38	BOTTOM OF HOLE		

Depth scale markings: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

Discontinuity type and surface descriptions:

BD,PL,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,PL,RO
BD,PL,RO
BD,CU,RO
BD,PL,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,PL,RO
BD,IR,RO
BD,PL,RO
BD,PL,RO
BD,IR,RO
BD,PL,RO
BD,PL,RO
BD,IR,RO
BD,UN,RO
BD,PL,RO
BD,PL,RO
BD,PL,RO
BD,PL,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,PL,RO
BD,PL,RO
BD,UN,RO
BD,PL,RO
BD,PL,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,IR,RO

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: PM

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: BH20-24 (CAL)

SHEET 1 OF 1

LOCATION: N 4852710.3 ;E 577296.0

DRILLING DATE: May 27, 2020

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		403.60																	
0		(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.00																	
		(SP) SAND, trace gravel; brown, no odor, no staining, non-cohesive, moist		402.99 / 0.61																	
2		(SM/GP) SILTY SAND and GRAVEL, some cobbles; greyish brown, no odors, no staining, non-cohesive, moist		402.07 / 1.52																	
6		(SP/GP) SAND and GRAVEL, some cobbles, some silt; brown, no odors, no staining, moist		398.13 / 5.47																	
8		(ML/GP) SANDY SILT and GRAVEL, some cobbles; brown, no odors, no staining, moist		395.06 / 8.53																	
10		DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)		8.80																	
12–14					1									BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,VR							
14–16					2									BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO							
17–20					3									BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO							
20–22					4									BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,PL,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO							
22		SHALEY DOLOSTONE, bedded shaley dolostone, slate grey		381.85 / 21.75																	
		SHALE, bedded shale, blue green (CABOT HEAD FORMATION)		381.15 / 22.45																	
		BOTTOM OF HOLE		22.76																	

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-25 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4852975.0 ;E 577402.1

DRILLING DATE: June 10, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle; DIP w.r.t. CORE AXIS; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. (m)	DEPTH (m)
GROUND SURFACE	405.48	0.00
(SP) SAND, some clay, some silt; brown/black, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.50
(SP) SAND, some clay, some silt; brown/black, no odors, no staining, non-cohesive, moist	403.65	1.83
(SC/GP) CLAYEY SAND TILL and GRAVEL, some cobbles; brown, no odors, no staining, cohesive, W ~ PL	400.60	4.88
DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	384.44	21.04
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	383.45	22.03
BOTTOM OF HOLE		

Depth scale (m): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

RUN No.: 1, 2, 3, 4, 5, 6

TYPE AND SURFACE DESCRIPTION:

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
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BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,RO
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BD,IR,RO

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-26 (CAL)

PROJECT: 19129150

LOCATION: N 4852942.8 ;E 577037.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: June 11, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN / FLUSH	RECOVERY (TOTAL CORE % / SOLID CORE %)	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA (B Angle / DIP w.r.t. CORE AXIS / TYPE AND SURFACE DESCRIPTION / Jr / Ja / Jn)	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		404.82											
0		(SC) CLAYEY SAND TILL; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.00											
		(SM/GP) SILTY SAND and GRAVEL; grey, no odors, no staining, non-cohesive, moist		403.82 / 1.22											
2		(SP/GP) SAND and GRAVEL, some cobbles; brown, no odors, no staining, non-cohesive,		402.38 / 2.44											
4		(SM/GP) SILTY SAND and GRAVEL, some cobbles; brown, no odors, no staining, non-cohesive, moist		400.85 / 3.96											
		DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)													
6–8					1										
8–10					2										
10–14					3										
14–16					4										
16–20					5										
20–22					6										
		SHALEY DOLOSTONE, bedded shaley dolostone, grey		383.78 / 21.04											
22		BOTTOM OF HOLE		382.09 / 22.73											

Depth scale ticks: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

TYPE AND SURFACE DESCRIPTION (in order with depth):

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-27 (CAL)

PROJECT: 19129150

LOCATION: N 4853168.7 ;E 577212.3

DRILLING DATE: October 21-22, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate; BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage; PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular; PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20 | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA: B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr Ja Jn | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. / Depth (m)
GROUND SURFACE	408.64
(SP) GRAVELLY SAND; brown to red, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00
(SP) GRAVELLY SAND; brown to red, no odors, no staining, non-cohesive, moist	0.30
DOLOSTONE, fresh to weathered, bedded dolostone, light to medium grey (GASPORT FORMATION)	407.04 / 1.60
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey to medium grey	383.56 / 25.08
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	381.77 / 26.87
BOTTOM OF HOLE	380.99 / 27.65

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Run No.: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Discontinuity type and surface description:

BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; FR,CU,RO; FR,CU,RO; BD,IR,RO; BD,PL,RO; BD,PL,RO

BD,IR,RO; FR,PL,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO

BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; FR,UN,RO; BD,UN,RO; BD,IR,RO; FR,PL,RO; BD,IR,RO; FR,CU,RO; BD,IR,RO

BD,R,RO; BD,IR,RO; FR,IR,RO; BD,IR,RO; BD,IR,RO; FR,IR,RO; FR,PL,RO; BD,PL,RO; BD,PL,RO; BD,IR,RO; FR,UN,RO; BD,IR,RO; BD,IR,RO; FR,PO,RO; BD,PO,RO; BD,IR,RO; FR,PO,RO; BD,PO,RO

BD,IR,RO; FR,IR,RO; FR,IR,RO; FR,IR,RO; BD,PL,RO; BD,UN,RO; BD,PO,RO

BD,UN,RO; BD,UN,RO; FR,PO,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; FR,UN,RO; BD,PO,RO; BD,UN,RO

BD,UN,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; BD,UN,RO; BD,IR,RO; BD,IR,RO; FR,PO,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,UN,RO

Notes / water levels: ∇ October 26, 2020

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: PM

CHECKED: GRP

RECORD OF DRILLHOLE: BH20-27 (CAL)

PROJECT: 19129150

LOCATION: N 4853168.7 ;E 577212.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: October 21-22, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint; FLT - Fault; SHR - Shear; VN - Vein; CJ - Conjugate; BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage; PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular; PO - Polished; K - Slickensided; SM - Smooth; Ro - Rough; MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30														BD,PO,RO BD,PO,RO BD,PO,RO BD,PO,RO							
32																					
34																					
36																					
38																					
40																					
42																					
44																					
46																					
48																					
50																					
52																					
54																					
56																					
58																					
60																					

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: PM

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-01 (CAL)

LOCATION: N 4852268.3 ;E 577458.5

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 26-27, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	395.10
(SM) SILTY SAND TILL; brown, no odor, no staining, non-cohesive, moist (TOPSOIL)	0.16
(GP/SP) SAND and GRAVEL, some cobbles; brown, no odor, no staining, non-cohesive, moist	392.66 / 2.44
(SP) SAND, some gravel; brown, no odor, no staining, non-cohesive, wet	391.14 / 3.96
(SM) SILTY SAND; brown, no odor, no staining, non-cohesive, wet	389.61 / 5.49
(GP)GRAVEL some sand some silt; brown, no odor, no staining, wet	386.57 / 8.53
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	380.24 / 14.86
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey with blue banding	377.78 / 17.32
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	375.69 / 19.41
BOTTOM OF HOLE	

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

RUN No.: 1, 2, 3, 4

TYPE AND SURFACE DESCRIPTION:
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,CU,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,UN,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO

NOTES / WATER LEVELS / INSTRUMENTATION:
April 19, 2021 (A)
April 19, 2021 (B)
Bentonite
Sand
Screen
Sand
Bentonite
Sand
Screen
Sand
Bentonite

CONTINUED NEXT PAGE

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-01 (CAL)

SHEET 2 OF 2

LOCATION: N 4852268.3 ;E 577458.5

DRILLING DATE: Febuary 26-27, 2020

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30														BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO							
32																					
34																					
36																					
38																					
40																					
42																					
44																					
46																					
48																					
50																					
52																					
54																					
56																					
58																					
60																					

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-02 (CAL)

SHEET 1 OF 1

LOCATION: N 4852138.4 ;E 577900.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 28- March 2, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Description	Elev. (m)	Depth (m)	Run No.	Discontinuity type and surface description	Notes / Water levels / Instrumentation
GROUND SURFACE	399.63				
(SM) SILTY SAND TILL; brown, no odor, no staining, non-cohesive, moist		0.00			
(SP/GP) SAND and GRAVEL, some cobbles; brown, no odor, no staining, non-cohesive, moist	398.11	1.52			
(SP) GRAVELLY SAND; brown, no odor, no staining, non-cohesive, moist	395.06	4.57			
(GM) SILTY GRAVEL, some sand; brown/grey, no odor, no staining, non-cohesive, wet	394.14	5.49			Bentonite
(SP) SAND, some silt; brown, no odor, no staining, non-cohesive, wet	391.10	8.53			April 19, 2021 (water level)
(GP) GRAVEL and COBBLES; red, no odor, no staining, non-cohesive, wet	388.63	11.00			
(SP/GP) SAND and GRAVEL, some cobbles; brown, no odor, no staining, non-cohesive, wet	388.05	11.58			
(SM/GP) SILTY SAND and GRAVEL, some clay; reddish brown, no odor, no staining, non-cohesive, wet	386.53	13.10			
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	384.39	15.24	1	BD,IR,RO; BD,IR,RO; BD,IR,VR; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,SM; BD,IR,SM; BD,IR,SM; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,VR; BD,IR,RO; BD,IR,VR; BD,IR,RO; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,IR,K; BD,UN,VR	Sand; Screen; Sand; Bentonite
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	381.58	18.05			
BOTTOM OF HOLE	380.06	19.57			

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW20-03 (CAL)

PROJECT: 19129150
SHEET 1 OF 2

LOCATION: N 4851907.3 ;E 578243.5
DRILLING DATE: March 3-4, 2020
DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---
DRILL RIG: Sonic
DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	390.67	
0	(SM) SILTY SAND TILL; brown, no odor, no staining, non-cohesive, moist (TOPSOIL)	0.00	
	(SP/GP) SAND and GRAVEL, some cobbles; reddish brown, no odor, no staining, non-cohesive, moist	389.67 / 1.00	
	(SP) GRAVELLY SAND; brown, no odor, no staining, non-cohesive, wet	386.10 / 4.57	
	(SP) SAND, some silt; reddish brown, no odor, no staining, non-cohesive, wet	384.57 / 6.10	April 19, 2021 (water level); Bentonite
			Sand
	(CH) CLAYEY SILT; golden brown, no odor, no staining, cohesive W ~ PL	373.67 / 17.00	Screen
	(CH) CLAY, some silt; brown/grey, no odors, no staining, cohesive, W ~ PL	372.99 / 17.68	Sand
	(CH) CLAY TILL, some silt; brown/grey, no odors, no staining, cohesive, W ~ PL	369.24 / 21.43	Natural Backfil
30			

Other column headings (no data recorded): DRILLING RECORD; SYMBOLIC LOG; RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-03 (CAL)

LOCATION: N 4851907.3 ;E 578243.5

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 3-4, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH / COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30		(CH) CLAY TILL, some silt; brown/grey, no odors, no staining, cohesive, W ~ PL																			Natural Backfil
34				356.23 / 34.44																	
		SHALEY DOLOSTONE, bedded shaley dolostone, slate grey		355.01 / 35.66																	
36		SHALE, bedded shale, blue green (CABOT HEAD FORMATION)		35.97																	
		BOTTOM OF HOLE																			

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW20-04 (CAL)

PROJECT: 19129150
SHEET 1 OF 1

LOCATION: N 4852313.2 ;E 578264.7
DRILLING DATE: March 5-6, 2020
DATUM: Geodetic

INCLINATION: -90°   AZIMUTH: ---
DRILL RIG: Sonic
DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)	RUN No.
GROUND SURFACE	399.46	
(SC) CLAYEY SAND TILL, some silt; dark brown, no odors, no staining, cohesive,W ~ PL	0.00	
(SP/GP) SAND and GRAVEL, some cobbles; dark brown, no odors, no staining, non-cohesive, moist	397.94 / 1.52	
(SM/GP) SILTY SAND and GRAVEL; dark brown, no odors, no staining, non-cohesive, moist	395.50 / 3.96	
(SP) SAND; brown, no odors, no staining, non-cohesive, moist	392.45 / 7.01	
(SM/GP) SILTY SAND and GRAVEL; brown, no odors, no staining, non-cohesive, moist	391.46 / 8.00	
(SP) GRAVELLY SAND; brown, no odors, no staining, non-cohesive, wet	390.93 / 8.53	
(SM) SILTY SAND, some clay, some cobbles; golden brown, no odors, no staining, non-cohesive, wet	389.40 / 10.06	
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey with dark grey banding	385.13 / 14.33	1
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	382.92 / 16.54	2
BOTTOM OF HOLE	380.96 / 18.50	

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Discontinuity data – type and surface description:
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO

Notes / Water levels / Instrumentation:
Bentonite
April 19, 2021
Sand
Screen
Sand
Bentonite

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-05 (CAL)

SHEET 1 OF 1

LOCATION: N 4852712.6 ;E 578423.1

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 9, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	399.63
(SC) CLAYEY SAND, some silt; brown/black, no odor, no staining, non-cohesive, wet (TOPSOIL)	0.00
(SM) SILTY SAND, some clay; light brown, no odors, no staining, non-cohesive, wet	399.02 / 0.61
DOLOSTONE, fresh to slightly weathered, bedded dolostone, light grey (GASPORT FORMATION)	398.11 / 1.52
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey with dark grey banding	389.03 / 10.60
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	385.72 / 13.91
BOTTOM OF HOLE	384.79 / 14.84

Run No.: 1, 2, 3, 4, 5

Depth scale (m): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Discontinuity type and surface description (top to bottom):
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,CU,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,K
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K

Notes / Water levels / Instrumentation (top to bottom): Bentonite; Sand; Screen; Sand; April 19, 2021 (A); Bentonite; Sand; Screen; Sand; Bentonite

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-06 (CAL)

SHEET 1 OF 1

LOCATION: N 4852972.6 ;E 578474.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 10, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint
FLT - Fault
SHR- Shear
VN - Vein
CJ - Conjugate
BD- Bedding
FO- Foliation
CO- Contact
OR- Orthogonal
CL - Cleavage
PL - Planar
CU- Curved
UN- Undulating
ST - Stepped
IR - Irregular
PO- Polished
K - Slickensided
SM- Smooth
Ro - Rough
MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. / Depth (m)
GROUND SURFACE	400.15 / 0.00
(SC/GP) CLAYEY SAND and GRAVEL, some cobbles; brown, no odors, no staining, non-cohesive, wet	398.63 / 1.52
(SM/GP) SILTY SAND and GRAVEL; golden brown, no odors, no staining, non-cohesive, wet	398.01 / 2.14
DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	389.19 / 10.96
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey with dark grey banding	385.90 / 14.25
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	384.12 / 16.03
BOTTOM OF HOLE	

Run No.: 1, 2, 3, 4, 5

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Type and surface description:
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,VR
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,SM
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,UN,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K

Notes / Water levels / Instrumentation:
Bentonite
April 19, 2021 (B)
April 19, 2021 (A)
Sand
Screen
Sand
Bentonite
Sand
Screen
Sand
Bentonite

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW20-07 (CAL)

PROJECT: 19129150

LOCATION: N 4853250.4 ;E 578359.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 11, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | FLUSH | COLOUR % RETURN | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	404.07
(SC) CLAYEY SAND, some silt some cobbles; brown, no odirs, no staining, non-cohesive, moist (TOPSOIL)	0.00
(SM/GP) SILTY SAND and GRAVEL, some cobbles; golden brown, no odors, no staining, non-cohesive, moist	0.50
DOLOSTONE, fresh to moderately weathered, bedded, dolostone, light grey to blue-grey (GASPORT FORMATION)	401.94 / 2.13
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	390.87 / 13.20
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	387.67 / 16.40
BOTTOM OF HOLE	384.62 / 19.45

Depth scale (metres): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

RUN No.: 1, 2, 3, 4, 5, 6

TYPE AND SURFACE DESCRIPTION:

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,UN,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,K

NOTES / WATER LEVELS / INSTRUMENTATION:

April 19, 2021 (B)
April 19, 2021 (A)

Bentonite

Sand

Screen

Sand

Bentonite

Sand

Screen

Sand

Bentonite

CONTINUED NEXT PAGE

RECORD OF DRILLHOLE: MW20-07 (CAL)

PROJECT: 19129150

LOCATION: N 4853250.4 ;E 578359.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 11, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH	COLOUR % RETURN	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																				
30															BD,IR,K BD,IR,K							
32																						
34																						
36																						
38																						
40																						
42																						
44																						
46																						
48																						
50																						
52																						
54																						
56																						
58																						
60																						

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

RECORD OF DRILLHOLE: MW20-08 (CAL)

PROJECT: 19129150

LOCATION: N 4853574.8 ;E 578009.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 12, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate

BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage

PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular

PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break

BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | FLUSH: COLOUR, % RETURN | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	406.93
(SM) CLAYEY SILTY SAND TILL, some cobbles; brown, no odors, no staining, non-cohesive, wet (TOPSOIL)	0.00
(SM) CLAYEY SILTY SAND, some cobbles; brown, no odors, no staining, non-cohesive, wet	406.32 / 0.61
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	404.95 / 1.98
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	391.83 / 15.10
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	389.61 / 17.32
BOTTOM OF HOLE	388.34 / 18.59

Depth scale (m): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Run No.: 1, 2, 3, 4, 5, 6

Type and surface description:
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,SM
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K

Notes / Water levels / Instrumentation:
Bentonite
April 19, 2021 (B)
April 19, 2021 (A)
Sand
Screen
Sand
Bentonite
Sand
Screen
Sand
Bentonite

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-09 (CAL)

LOCATION: N 4854157.5 ;E 578343.8

DRILLING DATE: March 17, 2020

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE % / SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle / DIP w.r.t. CORE AXIS / TYPE AND SURFACE DESCRIPTION / Jr / Ja / Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		399.95												
0		(SC) SILTY CLAYEY SAND TILL; black/brown, no odors, no staining, non-cohesive, wet (TOPSOIL)		0.00												
		(SP) SAND; brown, no odors, no staining, non-cohesive, moist		399.04 0.91												
2		(CH) SANDY CLAY TILL and COBBLES, some gravel; grey/light brown, no odors, no staining, non-cohesive, moist		397.36 2.59												Bentonite April 19, 2021
4																
		SHALEY DOLOSTONE, bedded shaley dolostone, slate grey		394.62 5.33												
6					1							BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,VR BD,IR,RO BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,K BD,IR,K BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,VR BD,CU,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,K BD,IR,SM BD,IR,K				Sand Screen
8		SHALE, bedded shale, blue green (CABOT HEAD FORMATION)		392.47 7.48	2											Sand Bentonite
		BOTTOM OF HOLE		390.94 9.01												

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-10 (CAL)

SHEET 1 OF 1

LOCATION: N 4854407.3 ;E 577838.0

DRILLING DATE: March 18-19, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | FLUSH COLOUR % RETURN | RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20 | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr Ja Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	411.32
(SC) SILTY CLAYEY SAND, some cobbles; brown/black, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00
(CH) SANDY CLAY; red, no odors, no staining, cohesive, W ~ PL	410.71 / 0.61
(SP) GRAVELLY SAND, some cobbles; golden brown, no odors, no staining, non-cohesive, moist	409.49 / 1.83
(SM/GP) SILTY SAND and GRAVEL, some cobbles; whitish brown, no odors, no staining, non-cohesive, moist	408.88 / 2.44
(SC/GP) CLAYEY SAND and GRAVEL, some cobbles; reddish brown, no odors, no staining, non-cohesive, moist	404.31 / 7.01
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to beige grey (GASPORT FORMATION)	400.35 / 10.97
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	394.56 / 16.76
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	391.77 / 19.55
BOTTOM OF HOLE	390.13 / 21.19

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Run No.: 1, 2, 3, 4

Discontinuity type and surface description:

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,K
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,IR,K
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
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BD,IR,K
BD,IR,K
BD,IR,K

Notes / Water levels / Instrumentation:

Bentonite

April 19, 2021 (A)

April 19, 2021 (B)

Sand

Screen

Sand

Bentonite

Sand

Screen

Sand

Bentonite

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL/CS

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-11 (CAL)

SHEET 1 OF 1

LOCATION: N 4853921.4 ;E 577672.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 23-24

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.
	GROUND SURFACE	409.72	
0	(SP) GRAVELLY SAND, some cobbles; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.40	
	(SP) GRAVELLY SAND, some cobbles; brown, no odors, no staining, non-cohesive, moist	407.59 / 2.13	
2	(SM) SILTY SAND, some clay, some gravel; brown, no odors, no staining, cohesive, W ~ PL		
4	DOLOSTONE, fresh to slightly weathered, bedded dolostone, light grey to blue grey (GASPORT FORMATION)		1, 2, 3, 4, 5
16	SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	393.26 / 16.46	6
18	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	391.56 / 18.16	
	BOTTOM OF HOLE	390.33 / 19.39	

Column headings: DEPTH SCALE METRES; DRILLING RECORD; DESCRIPTION; SYMBOLIC LOG; ELEV. DEPTH (m); RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.25 m 5 10 15 20; DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn); HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; Diametral Point Load Index (MPa) 2 4 6; RMC -Q' AVG.; NOTES WATER LEVELS INSTRUMENTATION

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

TYPE AND SURFACE DESCRIPTION:
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K

NOTES / WATER LEVELS / INSTRUMENTATION:
Bentonite
April 19, 2021 (B)
Sand
April 19, 2021 (A)
Screen
Sand
Bentonite
Sand
Screen
Sand
Bentonite

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: KS
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-12 (CAL)

SHEET 1 OF 1

LOCATION: N 4854321.4 ;E 577271.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 25-26, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	412.43 / 0.00
(ML) SANDY SILT TILL; brown, no odor, no staining, cohesive, W < PL (TOPSOIL)	0.30
(ML) SANDY SILT TILL; brown, no odor, no staining, cohesive, W < PL	411.12 / 1.31
(SP) SAND, some gravel; brown, no odors, no staining, non-cohesive, moist	1.61
(ML) SANDY SILT TILL, some gravel; brown, cohesive, W < PL	
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to beige (GASPORT FORMATION)	408.77 / 3.66
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	392.63 / 19.80
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	390.77 / 21.66
BOTTOM OF HOLE	389.78 / 22.65

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

RUN No.: 1, 2, 3, 4, 5, 6

TYPE AND SURFACE DESCRIPTION:

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
FR,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,UN,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,VR
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BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,CU,VR
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,CU,K
BD,IR,K
BD,IR,K
BD,IR,K
BD,IR,K

NOTES / WATER LEVELS / INSTRUMENTATION:

Bentonite

April 19, 2021 (B)

Sand

Screen

Sand

Bentonite

Sand

Screen

Sand

Bentonite

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: KS/AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-13 (CAL)

LOCATION: N 4854473.1 ;E 576873.1

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 7-8, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)
	GROUND SURFACE	415.53
0	(ML) SANDY SILT; dark brown, no odors, no straining, non-cohesive, moist (TOPSOIL)	0.00
	(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, moist	0.46
	(SP) SILTY GRAVELLY SAND; red/brown, no odors, no staining, non-cohesive, moist	414.31 / 1.22
2	(SP) SAND, some silt; reddish brown, no odor, no staining, non-cohesive, moist	413.55 / 1.98
4	(CL) SILTY CLAY TILL, some gravel; grey/brown, no odors, no staining, cohesive, W < PL	410.96 / 4.57
12	DOLOSTONE, fresh, bedded dolostone, light grey to blue grey (GASPORT FORMATION)	402.43 / 13.10
24	SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	391.61 / 23.92
26	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	389.85 / 25.68
28	BOTTOM OF HOLE	387.30 / 28.23

RUN No.: 1, 2, 3, 4, 5

DISCONTINUITY DATA – TYPE AND SURFACE DESCRIPTION:

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,K
BD,IR,VR
BD,IR,RO
BD,IR,RO

NOTES / WATER LEVELS / INSTRUMENTATION:

April 19, 2021 (B)
April 19, 2021 (A)

Bentonite
Sand
Screen
Sand
Bentonite
Sand
Screen
Sand
Bentonite

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: CS/AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-13 (CAL)

LOCATION: N 4854473.1 ;E 576873.1

DRILLING DATE: April 7-8, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate
BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage
PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular
PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN / FLUSH	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30														BD,IR,RO BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,iR,K BD,iR,K BD,iR,K BD,IR,K BD,IR,K BD,iR,K BD,IR,K							
32																					
34																					
36																					
38																					
40																					
42																					
44																					
46																					
48																					
50																					
52																					
54																					
56																					
58																					
60																					

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: CS/AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-13 (CAL) - OFFSET

SHEET 1 OF 1

LOCATION: N 4854473.1 ;E 576873.1

DRILLING DATE: April 7-8, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	415.53	
0	(ML) SANDY SILT; dark brown, no odors, no straining, non-cohesive, moist (TOPSOIL)	0.00	
		0.46 / 414.31	Bentonite
	(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, moist	1.22 / 413.55	
2	(SP) SILTY GRAVELLY SAND; red/brown, no odors, no staining, non-cohesive, moist	1.98	April 19, 2021 (C)
	(SP) SAND, some silt; reddish brown, no odor, no staining, non-cohesive, moist		Sand
4		410.96	Screen
	(CL) SILTY CLAY TILL, some gravel; grey/brown, no odors, no staining, cohesive, W < PL	4.57 / 410.43	Sand
		5.10	Bentonite
6	BOTTOM OF HOLE		

Column headings: DEPTH SCALE METRES; DRILLING RECORD; DESCRIPTION; SYMBOLIC LOG; ELEV. DEPTH (m); RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.25 m 5 10 15 20; DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn); HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; Diametral Point Load Index (MPa) 2 4 6; RMC -Q' AVG.; NOTES WATER LEVELS INSTRUMENTATION

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: CS/AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-14 (CAL)

LOCATION: N 4853100.4 ;E 577576.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 27-28, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint	BD- Bedding	PL - Planar	PO- Polished	BR - Broken Rock
FLT - Fault	FO- Foliation	CU- Curved	K - Slickensided	NOTE: For additional abbreviations refer to list of abbreviations & symbols.
SHR- Shear	CO- Contact	UN- Undulating	SM- Smooth	
VN - Vein	OR- Orthogonal	ST - Stepped	Ro - Rough	
CJ - Conjugate	CL - Cleavage	IR - Irregular	MB- Mechanical Break	

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Depth scale (metres): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	406.71
(SC) SILTY CLAYEY SAND TILL; black/brown, no odors, no staining, non-cohesive, wet (TOPSOIL)	0.00
(SC) SILTY CLAYEY SAND TILL; black/brown, no odors, no staining, non-cohesive, wet	0.50
DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	404.42 2.29
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	384.31 22.40
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	382.21 24.50
BOTTOM OF HOLE	380.36 26.35

RUN No.: 1, 2, 3, 4, 5, 6, 7, 8, 9

TYPE AND SURFACE DESCRIPTION:

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
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BD,IR,RO
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BD,IR,RO
BD,IR,RO
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BD,IR,SM
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
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BD,IR,RO
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BD,IR,VR
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BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,UN,RO
BD,iR,RO
BD,iR,RO
BD,iR,RO
BD,IR,RO
BD,IR,RO
BD,iR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,VR
BD,IR,RO
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BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,UN,RO
BD,IR,RO
BD,IR,RO

NOTES WATER LEVELS INSTRUMENTATION:

April 19, 2021 (B)
April 19, 2021 (A)

Bentonite
Sand
Screen
Sand
Bentonite
Sand
Screen
Sand
Bentonite

CONTINUED NEXT PAGE

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-14 (CAL)

LOCATION: N 4853100.4 ;E 577576.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: April 27-28, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30														BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,K BD,IR,RO BD,IR,RO BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,k BD,IR,k BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K							
32																					
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42																					
44																					
46																					
48																					
50																					
52																					
54																					
56																					
58																					
60																					

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-15 (CAL)

LOCATION: N 4853544.2 ;E 576576.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 12, 19-20, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. / Depth (m)
GROUND SURFACE	417.06
(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.20
(CH) SANDY CLAY TILL; brown, no odors, no staining, cohesive, W ~ PL	414.66
(SC) CLAYEY SAND, some cobbles, some gravel; brown, no odors, no staining	2.40 / 413.06
(SP) SAND, some gravel, some clay; brown, no odors, no staining, non-cohesive, moist	4.00 / 412.46
(CL) SILTY CLAY TILL, some sand, some gravel; brown, no odors, no staining, cohesive, W < PL	4.60 / 405.46
DOLOSTONE, fresh to moderately weathered, bedded dolostone, grey to beige to blue grey (GASPORT FORMATION)	11.60

Run Nos.: 1, 2, 3, 4, 5, 6, 7

Discontinuity data (type and surface description):

BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,PO,SM
BD,PO,SM
BD,IR,RO
BD,PO,RO
BD,PO,RO
BD,IR,VR
BD,UN,VR
BD,IR,VR
BD,UN,RO
BD,CU,RO
BD,IR,VR
BD,IR,SM
BD,PO,RO
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,PO,VR
BD,PO,RO
BD,IR,VR
BD,PO,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,PO,RO
BD,UN,RO
BD,UN,RO
BD,CU,RO
BD,UN,RO
BD,IR,SM
BD,UN,RO
BD,PO,RO
BD,UN,RO
BD,UN,SM
BD,UN,RO
BD,IR,SM
BD,PO,RO
BD,iR,VR
BD,PO,RO
BD,UN,RO
BD,IR,SM
BD,PO,RO
BD,PO,SM
BD,PO,RO
BD,IR,VR
BD,PO,SM
BD,PO,SM
BD,UN,SM

Notes / Water levels / Instrumentation: April 19, 2021 (A); April 19, 2021 (B); Bentonite; Sand; Screen

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

CONTINUED NEXT PAGE

RECORD OF DRILLHOLE: MW20-15 (CAL)

PROJECT: 19129150

LOCATION: N 4853544.2 ;E 576576.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 12, 19-20, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

--- *CONTINUED FROM PREVIOUS PAGE* ---

Depth (m)	Description	Elev. / Depth (m)	Run No.
30	DOLOSTONE, fresh to moderately weathered, bedded dolostone, grey to beige to blue grey (GASPORT FORMATION)		7, 8
34	SHALEY DOLOSTONE, bedded shaley dolostone, grey to brown	383.22 / 33.84	
36	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	381.44 / 35.62	9
	BOTTOM OF HOLE	379.89 / 37.17	

Type and surface description:

BD,PO,SM
BD,PO,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,UN,VR
BD,IR,VR
BD,PO,VR
BD,IR,VR
BD,PO,VR
BD,IR,RO
BD,UN,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,IR,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,PO,RO
BD,PO,RO
BD,IR,RO
BD,PO,RO
BD,IR,VR
BD,PO,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,PO,RO
BD,PO,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,PO,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,RO
BD,IR,RO
BD,PO,K
BD,PO,K
BD,IR,RO
BD,PO,RO
BD,PO,SM
BD,PO,SM
BD,PO,SM
BD,PO,SM
BD,PO,SM
BD,PO,SM
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,PO,SM
BD,PO,SM
BD,PO,SM
BD,PO,SM
BD,PO,SM

Notes / Instrumentation: Screen, Sand, Bentonite, Sand, Screen, Sand, Bentonite

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: PM/CS

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-15 (CAL) - OFFSET

SHEET 1 OF 1

LOCATION: N 4853544.2 ;E 576576.8

DRILLING DATE: May 12, 19-20, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN / FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		417.06																	
0		(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.20																	April 19, 2021 (C); Bentonite
		(CH) SANDY CLAY TILL; brown, no odors, no staining, cohesive, W ~ PL		414.66																	
2		(SC) CLAYEY SAND, some cobbles, some gravel; brown, no odors, no staining		2.40 / 413.06																	Sand; Screen
4		(SP) SAND, some gravel, some clay; brown, no odors, no staining, non-cohesive, moist		4.00 / 412.46 / 4.60																	Sand; Bentonite
		(CL) SILTY CLAY TILL, some sand, some gravel; brown, no odors, no staining, cohesive, W < PL		5.00																	
		BOTTOM OF HOLE																			

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: PM/CS

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-16 (CAL)

LOCATION: N 4853806.8 ;E 576784.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 21, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. (m)	Depth (m)
GROUND SURFACE	421.40	
(SM) SANDY SILT, some clay; dark brown, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.10
(CL) SILTY CLAY TILL, some sand, some gravel; brown, no odors, no staining, cohesive, W < PL	415.90	5.70
SAND, some silt; brown/red, no odors, no staining, non-cohesive, moist		
(CL) SILTY CLAY TILL, some gravel, trace sand; grey, no odors, no staining, cohesive, W < PL	409.50	11.90
DOLOSTONE, fresh, bedded dolostone, light grey to beige grey (GASPORT FORMATION)		

Run No.	Type and surface description
1	BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,SM; BD,PO,SM; BD,IR,RO; BD,PO,SM
2	BD,PO,RO; BD,CU,RO; BD,PO,RO; BD,IR,VR; BD,PO,RO; BD,iR,VR; BD,PO,RO
3	BD,iR,VR; BD,iR,VR; BD,PO,VR; BD,iR,RO; BD,PO,VR; BD,PO,RO; BD,iR,RO; BD,IR,SM; BD,iR,RO; BD,iR,RO
4	BD,PO,RO; BD,iR,VR; BD,PO,RO; BD,IR,RO
5	BD,UN,RO; BD,PO,RO; BD,PO,VR; BD,UN,RO; BD,UN,RO; BD,IR,RO; BD,UN,RO; BD,UN,RO; BD,IR,RO
6	BD,PO,SM; BD,PO,RO; BD,PO,RO; BD,PO,SM; BD,PO,SM

Notes / water levels / instrumentation: April 19, 2021 (B); April 19, 2021 (A); Bentonite; Sand; Screen; Sand; Bentonite

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: CS

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-16 (CAL)

LOCATION: N 4853806.8 ;E 576784.6

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 21, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	NOTES WATER LEVELS INSTRUMENTATION
	--- CONTINUED FROM PREVIOUS PAGE ---			
30	DOLOSTONE, fresh, bedded dolostone, light grey to beige grey (GASPORT FORMATION)		6	
32			7	Bentonite
34		385.88 35.52	8	Sand
36	SHALEY DOLOSTONE, bedded shaley dolostone, grey to brown	384.12 37.28		Screen; Sand
38	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	381.63 39.77		Bentonite
40	BOTTOM OF HOLE			
42				
44				
46				
48				
50				
52				
54				
56				
58				
60				

Column headings: DRILLING RECORD; SYMBOLIC LOG; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20; R.Q.D. % 80 60 40 20; FRACT. INDEX PER 0.25 m 5 10 15 20; DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn); HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}; Diametral Point Load Index (MPa) 2 4 6; RMC -Q' AVG.

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: CS

CHECKED: GRP

RECORD OF DRILLHOLE: MW20-17 (CAL)

PROJECT: 19129150

LOCATION: N 4852966.4 ;E 576752.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: May 25-26, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. (m)	Depth (m)
GROUND SURFACE	406.64	0.00
(CH) SANDY CLAY; red, no odors, no staining, non-cohesive, moist (TOPSOIL)	405.12	1.52
(CH) SANDY CLAY TILL, some gravel, some silt; redish brown, no odors, no staining, cos, W ~ PL	404.21	2.44
(SP/GP) CLAYEY SAND and GRAVEL, some cobbles; grey, no odors, no staining, non-cohesive, moist	403.60	3.05
DOLOSTONE, fresh to highly weathered, bedded dolostone, light grey (GASPORT FORMATION)	381.80	24.84
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	379.15	27.49
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	377.82	28.82
BOTTOM OF HOLE		

Run No.: 1, 2, 3, 4, 5, 6, 7, 8, 9

Discontinuity data (type and surface description), top to bottom:

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
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BD,PO,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,iR,VR
BD,iR,RO
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BD,iR,RO
BD,iR,RO
BD,iR,RO
FR,iR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO

Notes / Water levels / Instrumentation:

April 19, 2021 (A)
April 19, 2021 (B)
Bentonite
Sand
Screen
Sand
Bentonite
Sand
Screen
Sand
Bentonite

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

CONTINUED NEXT PAGE

RECORD OF DRILLHOLE: MW20-17 (CAL)

PROJECT: 19129150
SHEET 2 OF 2

LOCATION: N 4852966.4 ;E 576752.3
DRILLING DATE: May 25-26, 2020
DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---
DRILL RIG: Sonic
DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30														BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO							
32																					
34																					
36																					
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48																					
50																					
52																					
54																					
56																					
58																					
60																					

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-18 (CAL)

LOCATION: N 4852658.8 ;E 577058.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: June 8-9, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	404.29		
0	(SP) CLAYEY SAND; black, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00		
	(SP/GP) SAND and GRAVEL, some cobbles; brown, no odors, no staining, non-cohesive,	403.68 0.61		
	(SP) SAND; brown, no odors, no staining, non-cohesive, moist	398.80 5.49		Bentonite
	(SP/GP) CLAYEY SAND and GRAVEL, some cobbles, some bolders; grey, no odors, no staining, non-cohesive, moist	395.76 8.53		
	DOLOSTONE, fresh, bedded dolostone, light grey (GASPORT FORMATION)	392.41 11.88	1, 2, 3, 4	April 19, 2021; Sand; Screen; Sand; Bentonite
	SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	380.49 23.80	5	
	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	378.23 26.06	6	
28	BOTTOM OF HOLE	376.14 28.15		

Column headings: DRILLING RECORD; SYMBOLIC LOG; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle; DIP w.r.t. CORE AXIS; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

Discontinuity type and surface description (in order of depth):
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
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BD,IR,RO

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW20-18 (CAL)

PROJECT: 19129150

LOCATION: N 4852658.8 ;E 577058.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: June 8-9, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30														BD,iR,RO BD,iR,VR BD,iR,RO BD,iR,RO BD,iR,RO BD,iR,RO BD,iR,RO BD,iR,RO BD,iR,RO							
32																					
34																					
36																					
38																					
40																					
42																					
44																					
46																					
48																					
50																					
52																					
54																					
56																					
58																					
60																					

DEPTH SCALE

1 : 150

GOLDER

MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-19 (CAL)

LOCATION: N 4852000.0 ;E 576907.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: October 27, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

Legend: JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) 80 60 40 20 | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr Ja Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. (m)	Depth (m)
GROUND SURFACE	396.98	0.00
(SP) SAND, some silt, some gravel; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.30
(SP) SAND, some silt, some gravel; brown, no odors, no staining, non-cohesive, moist	394.84	2.14
DOLOSTONE, fresh to highly weathered, bedded dolostone, light grey to blue grey (GASPORT FORMATION)	374.93	22.05
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	372.50	24.48
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	369.59	27.39
BOTTOM OF HOLE		

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Run No.: 1, 2, 3, 4, 5, 6, 7, 8, 9

Discontinuity data (type and surface description):
BD,PO,RO
BD,IR,SM
BD,CU,RO
BD,PO,RO
BD,UN,RO
BD,UN,RO
FR,IR,RO
BD,CU,RO
BD,IR,RO
BD,IR,VR
BD,UN,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
FR,PO,RO
BD,PO,RO
BD,PO,RO
FR,PO,RO
FR,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
FR,IR,RO
BD,PO,RO
FR,UN,RO
BD,PO,RO
BD,PO,RO
BD,UN,RO
BD,PO,RO
BD,PO,RO
FR,CU,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,UN,RO
FR,PO,RO
FR,PO,RO
FR,PO,RO
BD,PO,RO
FR,PO,RO
FR,IR,RO
FR,CU,RO
BD,PO,RO
BD,PO,RO
BD,UN,RO
BD,PO,RO
FR,IR,RO
FR,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,pO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,IR,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
FR,PO,RO
BD,PO,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO

Notes / Instrumentation:
Bentonite
Sept 17, 2021 (B)
Sand
Screen
Sand
Bentonite
Sand
Screen
Sand
Bentonite

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: PM

CHECKED: GRP

LOCATION: N 4852000.0 ;E 576907.0

DRILLING DATE: October 27, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
32														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
34														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
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36														BD,PO,RO							
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38														BD,PO,RO							
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														BD,PO,RO							
														BD,PO,RO							
40														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
														BD,PO,RO							
42																					
44																					
46																					
48																					
50																					
52																					
54																					
56																					
58																					
60																					

RECORD OF DRILLHOLE: MW20-20 (CAL)

PROJECT: 19129150

LOCATION: N 4852467.7 ;E 576476.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: October 28-29, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate; BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage; PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular; PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr Ja Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	403.00
(SM) SILTY SAND; dark brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00 – 0.30
(SP) SAND, some silt, some gravel; brown, no odors, no staining, non-cohesive, moist	400.86 / 2.14
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to blue grey (GASPORT FORMATION)	377.85 / 25.15
SHALEY DOLOSTONE, bedded shaley dolostone, medium grey	375.82 / 27.18
SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	375.01 / 27.99
BOTTOM OF HOLE	27.99

Run No.: 1, 2, 3, 4, 5, 6, 7, 8, 9

Discontinuity type and surface description:

BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,UN,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,UN,RO
FR,PO,RO
BD,UN,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
FR,PO,RO
FR,IR,RO
BD,PO,RO
BD,PO,RO
FR,IR,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
FR,PO,RO
BD,PO,RO
BD,PO,RO
FR,PO,RO
BD,PO,RO
FR,CU,RO
FR,PO,RO
BD,PO,RO
BD,IR,RO
BD,PO,VR
BD,UN,RO
BD,UN,RO
BD,PO,RO
BD,PO,RO
BD,IR,RO
BD,UN,RO
BD,UN,RO
BD,PO,RO
BD,PO,RO
BD,UN,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,IR,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,UN,RO
BD,PO,RO
BD,PO,RO
BD,IR,RO
BD,PO,RO
BD,CU,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
FR,IR,RO
BD,PO,RO

NOTES / WATER LEVELS / INSTRUMENTATION:

WL above ground April 19, 2021 (A and B)

Bentonite

Sand

Screen

Sand

Bentonite

Sand

Screen

Sand

Bentonite

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

CONTINUED NEXT PAGE

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-20 (CAL)

LOCATION: N 4852467.7 ;E 576476.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: October 28-29, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30														FR,CR,RO BD,UN,RO BD,PO,RO BD,PO,RO BD,PO,RO BD,PO,RO BD,PO,RO BD,PO,RO BD,PO,RO BD,PO,RO BD,PO,RO BD,PO,RO BD,PO,RO							
32																					
34																					
36																					
38																					
40																					
42																					
44																					
46																					
48																					
50																					
52																					
54																					
56																					
58																					
60																					

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: PM

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-20 (CAL) - OFFSET

LOCATION: N 4852468.3 ;E 576476.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 3, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	403.00	
0	(SM) SILTY SAND; dark brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00	Bentonite
	(SP) SAND, some silt, some gravel; brown, no odors, no staining, non-cohesive, moist	0.30	April 19, 2021 (C)
2	DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to blue grey (GASPORT FORMATION)	400.86 2.14	Sand Screen
4			Sand Bentonite
	BOTTOM OF HOLE	398.00 5.00	

Column headings: DRILLING RECORD; SYMBOLIC LOG; RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: PM

CHECKED: GRP

RECORD OF DRILLHOLE: MW20-21 (CAL)

PROJECT: 19129150

LOCATION: N 4852839.8 ;E 576014.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 3-4, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr Ja Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. (m)	Depth (m)
GROUND SURFACE	415.23	0.00
(SP) SAND, some silt; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.30
(SP) SAND TILL, some gravel, some silt; brown, no odors, no staining, non-cohesive, moist	409.74	5.49
(ML) SILT TILL, some sand, some gravel; brown, no odors, no staining, non-cohesive, moist	408.22	7.01
(SP) SAND TILL, some gravel, some silt; brown, no odors, no staining, non-cohesive, moist	403.65	11.58
(SP/GP) SAND and GRAVEL TILL; grey, no odors, no staining, non-cohesive, moist	402.72	12.51
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to blue grey (GASPORT FORMATION)		

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Run No.: 1, 2, 3, 4, 5, 6

Discontinuity type and surface description:

Run	Type and surface description
1	BD,PO,RO
2	BD,PO,RO; BD,UN,RO; BD,PO,RO; BD,CU,RO; BD,PO,RO
3	BD,PO,RO; BD,PO,RO; BD,UN,RO; BD,UN,RO
4	BD,PO,RO; BD,IR,RO; BD,CU,RO
5–6	FR,CU,RO; BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,UN,RO; BD,PO,RO; BD,PO,RO; BD,PO,RO; BD,IR,RO; BD,CU,RO; BD,UN,RO; BD,UN,RO; BD,UN,RO; BD,UN,RO; BD,PO,RO; BD,PO,RO; BD,UN,RO; BD,CU,RO; BD,PO,RO; BD,CU,RO

Notes / water levels / instrumentation: April 19, 2021 (B); April 19, 2021 (A); Bentonite; Sand; Screen; Sand; Bentonite

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: PM

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-21 (CAL)

LOCATION: N 4852839.8 ;E 576014.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 3-4, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate; BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage; PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular; PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

--- CONTINUED FROM PREVIOUS PAGE ---

Depth (m)	Description	Elev. / Depth (m)	Run No.
30	DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to blue grey (GASPORT FORMATION)		6, 7, 8
36.73	SHALEY DOLOSTONE, bedded shaley dolostone, dark grey	378.50 / 36.73	9
38.38	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	376.85 / 38.38	9
39.70	BOTTOM OF HOLE	375.53 / 39.70	

Discontinuity type and surface description (top to bottom):
BD,PO,RO
FR,IR,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
FR,IR,RO
RD,PO,RO
FR,PO,RO
BD,PO,RO
BD,PL,RO
BD,PO,RO
BD,PO,RO
FR,PO,RO
FR,PO,RO
BD,PO,RO
BD,PO,RO
FR,PO,RO
BD,UN,RO
BD,UN,RO
BD,CU,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,UN,RO
BD,CU,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO
BD,PO,RO

Notes / Instrumentation: Bentonite; Sand; Screen; Sand; Bentonite

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: PM

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-22 (CAL)

SHEET 1 OF 2

LOCATION: N 4851966.3 ;E 575785.4

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 17-18, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate; BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage; PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular; PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	399.27 / 0.00
(SP) CLAYEY SAND; black, no odors, no staining, non-cohesive, moist (TOPSOIL)	398.36 / 0.91
(SM) SILTY SAND, some gravel; light brown, no odors, no staining, non-cohesive, moist	397.75 / 1.52
(SP) CLAYEY SAND TILL, some gravel; brown, no odors, no staining, non-cohesive, moist	395.01 / 4.27
(CH) SILTY SANDY CLAY TILL; light brown, no odors, no staining, cohesive, wet	4.57
DOLOSTONE, fresh to moderately weathered, bedded dolostone, grey (GOAT ISLAND FORMATION)	374.27 / 25.00
DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	371.11 / 28.16
SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	369.46

Runs: 1, 2, 3, 4, 5, 6, 7, 8

Discontinuity type and surface description:
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,K
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,UN,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO

Notes / Water levels / Instrumentation: April 19, 2021 (A); April 19, 2021 (B); Bentonite; Sand; Screen; Sand; Bentonite; Sand; Screen; Sand; Bentonite

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GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-22 (CAL)

SHEET 2 OF 2

LOCATION: N 4851966.3 ;E 575785.4

DRILLING DATE: November 17-18, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN / FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30		SHALE, bedded shale, blue green (CABOT HEAD FORMATION)		29.81 / 368.52	8									BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,VR BD,IR,SM BD,IR,RO BD,IR,RO BD,UN,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,K							Bentonite
		BOTTOM OF HOLE		30.75																	

Depth scale marks: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-23 (CAL)

LOCATION: N 4851555.9 ;E 576205.5

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 19-23, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate; BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage; PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular; PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	RUN No.	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	395.05		
0	(SM) SILTY SAND, some gravel, some cobbles; light brown, no odors, no staining, non-cohesive, moist	0.00		April 19, 2021 (A); April 19, 2021 (B)
2	(SM/GP) SILTY SAND TILL and GRAVEL, some cobbles; brown, no odors, no staining, moist	392.61 / 2.44		
7	(CH) CLAY TILL with cobbles; red, no odors, no staining, W > PL	388.04 / 7.01		Bentonite
11	DOLOSTONE, fresh to moderately weathered, bedded dolostone, grey (GOAT ISLAND FORMATION)	383.77 / 11.28	1, 2	Sand; Screen; Sand
18	DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	376.95 / 18.10	3, 4	Bentonite; Sand; Screen; Sand
23.5	SHALEY DOLOSTONE, bedded shaley dolostone, grey/brown	371.51 / 23.54		
25	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	369.75 / 25.30	5	Bentonite
26.8	BOTTOM OF HOLE	368.29 / 26.76		

Discontinuity data (type and surface description, from ~14 m): BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,UN,RO; BD,IR,VR; BD,IR,VR; BD,IR,VR; BD,IR,VR; BD,IR,VR; BD,IR,RO (×23); BD,IR,RO; ... BD,UN,RO; BD,UN,RO; BD,IR,VR; BD,IR,RO (remaining entries to 30 m)

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-23 (CAL)

LOCATION: N 4851555.9 ;E 576205.5

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 19-23, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																				
30															BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,Vr BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,SM BD,IR,VR BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,UN,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,UN,RO BD,UN,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO							
32																						
34																						
36																						
38																						
40																						
42																						
44																						
46																						
48																						
50																						
52																						
54																						
56																						
58																						
60																						

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-23 (CAL) - OFFSET

LOCATION: N 4851556.3 ;E 576205.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 19-23, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		395.00																	
0		(SM) SILTY SAND, some gravel, some cobbles; light brown, no odors, no staining, non-cohesive, moist		0.00																	Bentonite
2				392.56																	April 19, 2021 (C)
		(SM/GP) SILTY SAND TILL and GRAVEL, some cobbles; brown, no odors, no staining, moist		2.44																	Sand
4																					Screen
6																					Sand
				388.00																	Bentonite
		BOTTOM OF HOLE		7.00																	

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-24 (CAL)

LOCATION: N 4854341.9 ;E 575337.7

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: November 25- December 3, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	DISCONTINUITY DATA – TYPE AND SURFACE DESCRIPTION	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	437.75			
0	(CH) SANDY CLAY TILL, some gravel; brown/black, no odors, no staining, cohesive, W < PL	0.00			
2	(SP/GP) SAND and GRAVEL TILL; grey, no odors, no staining, non-cohesive, moist	435.92 / 1.83			
4	(SP) SAND, some silt, trace gravel at 7.01m to 8.53m; brown, no odors, no staining, non-cohesive, moist	433.79 / 3.96			Sept 17, 2021 (B); Sept 17, 2021 (A)
8	(SM) SILTY SAND TILL; brown, no odor, no staining, non-cohesive, moist	429.22 / 8.53			Bentonite
11	(SP/GP) SAND and GRAVEL TILL; grey, no odors, no staining, non-cohesive, moist	426.78 / 10.97			
12	(CL) SILTY CLAY TILL; grey, no odors, no staining, cohesive, W < PL	426.17 / 11.58			
16	(GM) SILTY GRAVEL TILL; grey, no odors, no staining, non-cohesive, wet	421.25 / 16.50			
20	DOLOSTONE, fresh to slightly weathered, bedded dolostone, light grey/brown (GOAT ISLAND FORMATION)	417.64 / 20.11			Sand
22			1	BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,IR,RO	Screen; Sand
24			2	BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO	Bentonite
28			3	BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO	
30					

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW20-24 (CAL)

PROJECT: 19129150

LOCATION: N 4854341.9 ;E 575337.7
DRILLING DATE: November 25- December 3, 2020
DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---
DRILL RIG: Sonic
DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	NOTES WATER LEVELS INSTRUMENTATION
	--- CONTINUED FROM PREVIOUS PAGE ---			
30	DOLOSTONE, fresh to slightly weathered, bedded dolostone, light grey/brown (GOAT ISLAND FORMATION)			
32			4	Bentonite
	DOLOSTONE, fresh to slightly weathered, bedded dolostone, light grey (GASPORT FORMATION)	404.75 / 33.00	5	Sand
34				Screen
			6	
36				Sand
				Bentonite
	BOTTOM OF HOLE	400.26 / 37.49		
38				
40				
42				
44				
46				
48				
50				
52				
54				
56				
58				
60				

Discontinuity data — Type and surface description:
BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,Vr; BD,UN,RO; BD,IR,RO; BD,IR,VR; BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO

DEPTH SCALE
1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

RECORD OF DRILLHOLE: MW20-25 (CAL)

PROJECT: 19129150

LOCATION: N 4852900.5 ;E 574853.8

DRILLING DATE: December 7-10, 2020

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.	NOTES / WATER LEVELS / INSTRUMENTATION
	GROUND SURFACE	419.02		
0	(SC) CLAYEY SAND TILL; brown, no odors, no staining, non-cohesive, moist	0.00		Sept 17, 2021 (A); Sept 17, 2021 (B)
2.74	(CH) SANDY CLAY TILL; brown/grey, no odors, no staining, cohesive, W > PL	416.28 / 2.74		Bentonite
10.52	DOLOSTONE, fresh to moderately weathered, bedded, dolostone, grey (GOAT ISLAND FORMATION)	408.50 / 10.52	1, 2, 3, 4	Sand; Screen; Sand; Bentonite
25.00	DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	394.02 / 25.00	5, 6	

Discontinuity type and surface description (approx. 13 m to 30 m): BD,IR,RO; BD,IR,Vr; BD,IR,RO (repeated); BD,IR,VR; BD,IR,RO (repeated); BD,IR,Vr; BD,IR,RO (repeated); BD,IR,VR; BD,IR,RO (repeated)

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-25 (CAL)

LOCATION: N 4852900.5 ;E 574853.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: December 7-10, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

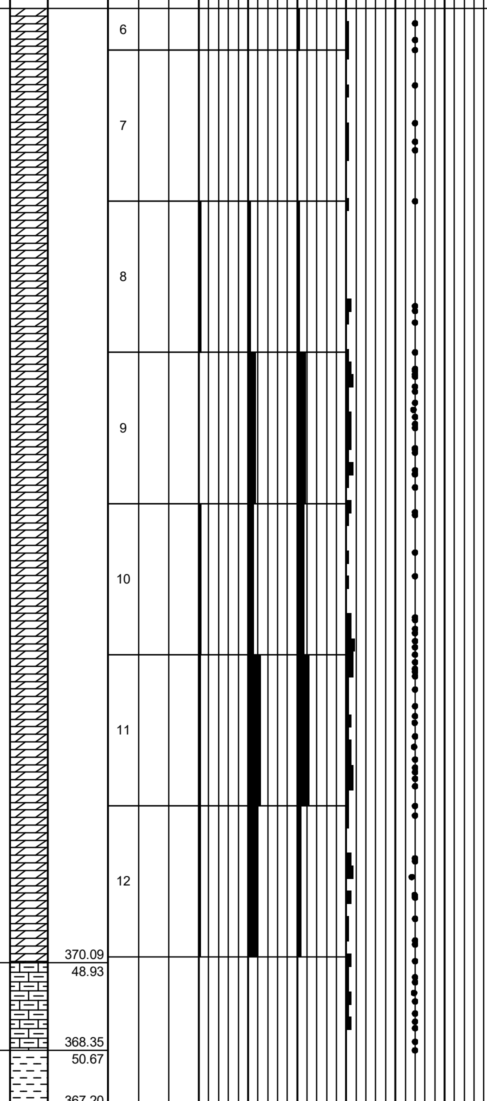
Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

--- CONTINUED FROM PREVIOUS PAGE ---

Depth (m)	Description	Elev. / Depth (m)
30	DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey (GASPORT FORMATION)	
48.93	SHALEY DOLOSTONE, bedded shaley dolostone, grey/brown	370.09 / 48.93
50.67	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	368.35 / 50.67
51.82	BOTTOM OF HOLE	367.20 / 51.82

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

RUN No.: 6, 7, 8, 9, 10, 11, 12



TYPE AND SURFACE DESCRIPTION:
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,UN,RO
BD,IR,RO

NOTES / WATER LEVELS / INSTRUMENTATION:
Bentonite
Sand
Screen
Sand
Bentonite

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-26 (CAL)

LOCATION: N 4853638.4 ;E 574373.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: December 14-17, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate; BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage; PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular; PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Depth (m)	Description	Elev. / Depth (m)	Run No.	Notes / Water Levels / Instrumentation
	GROUND SURFACE	438.89		
0	(CH) SANDY CLAY; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00		
	(SM) SILTY SAND; golden brown, no odors, no staining, non-cohesive, moist	438.28 / 0.61		
	(SM) SILTY SAND TILL, some cobbles; golden brown, no odors, no staining, non-cohesive, moist	437.37 / 1.52		April 19, 2021 (B); April 19, 2021 (A)
	(ML) SANDY SILT TILL; brown, no odors, no staining, non-cohesive, moist	430.05 / 8.84		
	DOLOSTONE, fresh to moderately weathered, bedded dolostone, grey (ERAMOSA FORMATION)	426.70 / 12.19	1, 2, 3, 4	Bentonite
	DOLOSTONE, fresh to moderately weathered, bedded dolostone, black grey (ERAMOSA FORMATION)	413.99 / 24.90	5	
	DOLOSTONE, fresh to moderately weathered, bedded dolostone, grey (GOAT ISLAND FORMATION)	410.62 / 28.27	6	

Discontinuity data (type and surface description), approx. 15.7 m to 30 m: BD,IR,RO (repeated for each recorded discontinuity)

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-26 (CAL)

LOCATION: N 4853638.4 ;E 574373.9

DRILLING DATE: December 14-17, 2020

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate
BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage
PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular
PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY: TOTAL CORE % (80 60 40 20), SOLID CORE % (80 60 40 20) | R.Q.D. % (80 60 40 20) | FRACT. INDEX PER 0.25 m (5 10 15 20) | DISCONTINUITY DATA: B Angle (0 90 180 270), DIP w.r.t. CORE AXIS (0 30 60 90), TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}) | Diametral Point Load Index (MPa) (2 4 6) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

--- CONTINUED FROM PREVIOUS PAGE ---

Depth (m)	Description	Elev. / Depth (m)
30	DOLOSTONE, fresh to moderately weathered, bedded dolostone, grey (GOAT ISLAND FORMATION)	
37.70	DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to grey brown (GASPORT FORMATION)	401.19 / 37.70

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

Run No.: 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

Type and surface description (in order, 30 m to 60 m):
BD,IR,RO (48 entries)
BD,UN,RO
BD,UN,RO
BD,IR,RO (27 entries)
BD,UN,RO
BD,IR,VR
BD,IR,RO
BD,IR,VR
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,VR
BD,IR,RO (9 entries)
BD,UN,RO
BD,IR,RO (5 entries)

Notes / Water levels / Instrumentation (top to bottom): Bentonite, Sand, Screen, Sand, Bentonite, Sand, Screen, Sand, Bentonite

CONTINUED NEXT PAGE

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-26 (CAL)

LOCATION: N 4853638.4 ;E 574373.9

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: December 14-17, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH (m)	DESCRIPTION	ELEV. / DEPTH (m)	RUN No.
60	DOLOSTONE, fresh to moderately weathered, bedded dolostone, light grey to grey brown (GASPORT FORMATION)		16, 17
64.55	SHALEY DOLOSTONE, bedded shaley dolostone, slate grey	374.34 / 64.55	18
66.11	BOTTOM OF HOLE	372.78 / 66.11	

Discontinuity data – TYPE AND SURFACE DESCRIPTION: BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,UN,RO; BD,IR,RO (repeated, 51 entries total in the printed column: BD,IR,RO except one BD,UN,RO)

NOTES / WATER LEVELS / INSTRUMENTATION: Bentonite

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-26 (CAL) - OFFSET

LOCATION: N 4853637.6 ;E 574375.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: December 14-17, 2020

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		438.88																	
0		(CH) SANDY CLAY; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.00																	
		(SM) SILTY SAND; golden brown, no odors, no staining, non-cohesive, moist		438.27 0.61																	
2		(SM) SILTY SAND TILL, some cobbles; golden brown, no odors, no staining, non-cohesive, moist		437.35 1.52																	April 19, 2021 (C) Bentonite Sand Screen Sand
		(ML) SANDY SILT TILL; brown, no odors, no staining, non-cohesive, moist		430.04 8.84																	Bentonite
10		BOTTOM OF HOLE		428.88 10.00																	

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW20-27 (CAL)

PROJECT: 19129150

LOCATION: N 4853770.2 ;E 575954.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 9-12, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	431.15	
0	(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00	
	(SM) SILTY SAND TILL; brown, no odors, no staining, non-cohesive, moist	430.54 / 0.61	
4	(CH) SANDY CLAY TILL; brown, no odors, no staining, cohesive, W > PL	427.19 / 3.96	
7	(SC) CLAYEY SAND TILL, some gravel, some silt; brown, no odors, no staining, cohesive	424.14 / 7.01	April 19, 2021 (A) April 19, 2021 (B)
10	(SM) SILTY CLAY TILL, some sand, some gravel; red, no odor, no straining, cohesive, W > PL	421.09 / 10.06	
12	(SC) CLAYEY SAND TILL, some cobbles; brown, no odors, no staining, cohesive	419.57 / 11.58	
14	(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, wet	416.52 / 14.63	Bentonite
16	(ML) SILT, some sand; brown, no odors, no staining, wet	415.00 / 16.15	
18	(SM) SILTY SAND and GRAVEL; brown, no odors, no staining, non-cohesive, wet	413.47 / 17.68	
19	(GP) COBBLES and BOLDERS; grey, no odors, no staining, non-cohesive, wet	411.95 / 19.20	
21	(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, wet	409.81 / 21.34	
27	(SM) SILTY SAND and GRAVEL TILL, some clay, some bolders; brown, no odors, no staining, non-cohesive, wet	404.33 / 26.82	
29	DOLOSTONE, fresh, bedded dolostone, grey to grey blue (GOAT ISLAND FORMATION)	402.19 / 28.96	
30			

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-27 (CAL)

LOCATION: N 4853770.2 ;E 575954.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 9-12, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH (m)	DESCRIPTION	ELEV. / DEPTH (m)
30	DOLOSTONE, fresh, bedded dolostone, grey to grey blue (GOAT ISLAND FORMATION)	
43.75	DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)	387.40 / 43.75
50.32	SHALEY DOLOSTONE,bedded, shaley dolostone, grey/brown	380.83 / 50.32
51.93	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	379.22 / 51.93
52.43	BOTTOM OF HOLE	52.43

Run No.: 1, 2, 3, 4, 5, 6, 7, 8

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

Type and surface description:

BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,UN,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
BD,IR,RO
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BD,IR,VR
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Notes / Instrumentation:

Bentonite
Sand
Screen
Sand
Bentonite
Sand
Screen
Sand
Bentonite

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

LOCATION: N 4853770.2 ;E 575954.0

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 9-12, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
60														BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K BD,IR,K							
62																					
64																					
66																					
68																					
70																					
72																					
74																					
76																					
78																					
80																					
82																					
84																					
86																					
88																					
90																					

RECORD OF DRILLHOLE: MW20-28 (CAL)

PROJECT: 19129150

LOCATION: N 4854987.8 ;E 576139.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 18-22, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate
BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage
PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular
PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break
BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		419.31																		
0		(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)		0.00																		April 19, 2021 (B) April 19, 2021 (A)
		(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, moist then wet at 1.5m		418.70 0.61																		
2		(SP/GP) SAND and GRAVEL, some cobbles; brown, no odors, no staining, non-cohesive, wet		416.87 2.44																		
4		(SM) SILTY SAND some gravel; light brown, no odors, no staining, non-cohesive, moist		415.04 4.27																		
6		(SM) SILTY SAND TILL; grey, no odors, no staining, cohesive		413.83 5.48																		Bentonite
8		(CH) CLAY TILL; grey, no odors, no staining, cohesive, W > PL		410.78 8.53																		
12		DOLOSTONE, fresh to moderately weathered, bedded dolostone, grey (GASPORT FORMATION)		407.12 12.19	1, 2, 3, 4, 5										BD,IR,RO; BD,IR,RO; BD,IR,VR; BD,UN,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,RO; BD,IR,VR; BD,IR,RO; BD,IR,RO; BD,IR,VR; BD,IR,VR; BD,IR,VR; BD,IR,RO (×20); BD,IR,VR; BD,IR,RO (×16)							Sand, Screen, Sand, Bentonite, Sand, Screen, Sand, Bentonite
28		SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey to brown		390.86 28.45	6																	
30																						

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW20-28 (CAL)

LOCATION: N 4854987.8 ;E 576139.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: Febuary 18-22, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint; FLT - Fault; SHR- Shear; VN - Vein; CJ - Conjugate; BD- Bedding; FO- Foliation; CO- Contact; OR- Orthogonal; CL - Cleavage; PL - Planar; CU- Curved; UN- Undulating; ST - Stepped; IR - Irregular; PO- Polished; K - Slickensided; SM- Smooth; Ro - Rough; MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN / FLUSH	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30		SHALE, bedded shale, blue green (CABOT HEAD FORMATION)		389.11 / 30.20	6									BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,UN,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO BD,IR,RO							Bentonite
		BOTTOM OF HOLE		388.49 / 30.82																	
32																					
34																					
36																					
38																					
40																					
42																					
44																					
46																					
48																					
50																					
52																					
54																					
56																					
58																					
60																					

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW21-1-1 (CAL)

PROJECT: 19129150

LOCATION: N 4853485.0 ;E 576882.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 2-3, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.25 m (5 10 15 20)	DISCONTINUITY DATA B Angle (0 90 180 270)	DIP w.r.t. CORE AXIS (0 30 60 90)	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	Diametral Point Load Index (MPa) (2 4 6)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		418.94																		
0		(SM) SILTY SAND, some clay; brown/black, no odors, no staining, non-cohesive, wet		0.00																		
		(CH) SILTY SANDY CLAY TILL; brown/grey, no odors, no staining, cohesive, W > PL		417.42 1.52																		March 12, 2021
																						Bentonite
10		DOLOSTONE, fresh, bedded, dolostone, grey (GASPORT FORMATION)		408.88 10.06																		Sand
																						Screen
30																						

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DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-1-1 (CAL)

LOCATION: N 4853485.0 ;E 576882.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 2-3, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																				
30		DOLOSTONE, fresh, bedded, dolostone, grey (GASPORT FORMATION)																				
32																						Screen
34				384.64																		
		SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown		34.30																		Sand
																						Bentonite
36				382.67																		
		BOTTOM OF HOLE		36.27																		
38																						
40																						
42																						
44																						
46																						
48																						
50																						
52																						
54																						
56																						
58																						
60																						

DEPTH SCALE

1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW21-1-2 (CAL)

PROJECT: 19129150

SHEET 1 OF 2

LOCATION: N 4853505.1 ;E 576909.6

DRILLING DATE: Febuary 24, 2021

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	420.58	
0	(CH) SANDY CLAY TILL; brown, no odors, no staining, cohesive (TOPSOIL)	0.00	
	(CH) SANDY CLAY TILL; brown, no odors, no staining, cohesive, W > PL	419.06 1.52	
6			March 12, 2021 Bentonite
	(CH) SILTY CLAY TILL some sand; brown, no odors, no staining, cohesive, W > PL	413.26 7.32	
12	DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)	408.39 12.19	Sand
22			Screen
30	CONTINUED NEXT PAGE		

Other column headings: DRILLING RECORD; SYMBOLIC LOG; RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle; DIP w.r.t. CORE AXIS; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

Depth scale ticks: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

LOCATION: N 4853505.1 ;E 576909.6

DRILLING DATE: Febuary 24, 2021

DATUM: Geodetic

DRILL RIG: Sonic

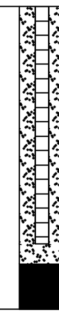
INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	--- CONTINUED FROM PREVIOUS PAGE ---		
30	DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)		
32			Screen
34			Sand
	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	385.22 35.36	Bentonite
36	BOTTOM OF HOLE	384.58 36.00	
38			
40			
42			
44			
46			
48			
50			
52			
54			
56			
58			
60			



PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-1-3 (CAL)

SHEET 1 OF 2

LOCATION: N 4853420.3 ;E 576965.5

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 1-2, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	417.51	
0	(CH) SILTY SANDY CLAY TILL; brown, no odors, no staining , W > PL	0.00	Bentonite
4	(CH) SILTY CLAY TILL some sand; brown, no odors, no staining, cohesive, W > PL	413.24 4.27	March 12, 2021
7.32	DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)	410.19 7.32	Sand Screen

Other column headings: DRILLING RECORD; SYMBOLIC LOG; RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

CONTINUED NEXT PAGE

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-1-3 (CAL)

LOCATION: N 4853420.3 ;E 576965.5

DRILLING DATE: March 1-2, 2021

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH	COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																				
30		DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)		382.61 34.90																		Screen
36		SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown		380.93 36.58																		Sand
		SHALE, bedded shale, blue green (CABOT HEAD FORMATION)		380.02 37.49																		Bentonite
38		BOTTOM OF HOLE																				

Depth scale marks: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW21-1-4 (CAL)

PROJECT: 19129150

LOCATION: N 4853450.6 ;E 576866.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 3-4, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Column headings: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | FLUSH | COLOUR % RETURN | RECOVERY (TOTAL CORE % 80 60 40 20; SOLID CORE % 80 60 40 20) | R.Q.D. % 80 60 40 20 | FRACT. INDEX PER 0.25 m 5 10 15 20 | DISCONTINUITY DATA (B Angle 0 90 180 270; DIP w.r.t. CORE AXIS 0 30 60 90; TYPE AND SURFACE DESCRIPTION; Jr Ja Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3} | Diametral Point Load Index (MPa) 2 4 6 | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. / Depth (m)
GROUND SURFACE	417.83
SILTY CLAYEY SAND TILL; brown, no odors, no staining, non-cohesive wet	0.00
(CH) SANDY CLAY TILL some gravel; brown/black, no odors, no staining, cohesive, W > PL	409.91 / 7.92
DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)	406.86 / 10.97

Depth scale (m): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Notes / Instrumentation: Bentonite; water level March 12, 2021; Sand; Screen

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PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-1-4 (CAL)

LOCATION: N 4853450.6 ;E 576866.2

DRILLING DATE: March 3-4, 2021

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	--- *CONTINUED FROM PREVIOUS PAGE* ---		
30	DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)		Screen
32			Sand
	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	384.30 / 33.53	
34			Bentonite
	SHALE, bedded shale, blue green (CABOT HEAD FORMATION)	382.17 / 35.66	
36	BOTTOM OF HOLE	35.96	

Column headings (no data recorded): DRILLING RECORD; SYMBOLIC LOG; RUN No.; PENETRATION RATE min/(m); FLUSH COLOUR % RETURN; RECOVERY TOTAL CORE % / SOLID CORE %; R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA: B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn; HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-2-1 (CAL)

SHEET 1 OF 1

LOCATION: N 4854021.1 ;E 577279.1

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 15-16, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DESCRIPTION	ELEV. / DEPTH (m)	NOTES / WATER LEVELS / INSTRUMENTATION
GROUND SURFACE	413.40	
(SM) SILTY SAND LOAM; brown/black, no odors, no staining, non-cohesive, wet (TOPSOIL)	0.00	Bentonite
(SM) SILTY SAND LOAM; brown/black, no odors, no staining, non-cohesive, wet	412.18 / 1.22	
(SM) SILTY SAND TILL, some gravel; brown, no odors, no staining, non-cohesive, moist to wet	1.52	March 20, 2021 (water level)
DOLOSTONE, highly weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	407.61 / 5.79	Sand; Screen; Sand
SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	390.69 / 22.71	Bentonite
SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	390.08 / 23.47	
BOTTOM OF HOLE		

Column headings: DEPTH SCALE METRES; DRILLING RECORD; DESCRIPTION; SYMBOLIC LOG; ELEV. DEPTH (m); RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle; DIP w.r.t. CORE AXIS; TYPE AND SURFACE DESCRIPTION; Jr; Ja; Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.; NOTES WATER LEVELS INSTRUMENTATION

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-2-2 (CAL)

SHEET 1 OF 1

LOCATION: N 4854050.9 ;E 577260.0

DRILLING DATE: March 11-15, 2021

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	412.64	
0	(SM) SILTY SANDY LOAM; brown/black, no odors, no staining, non-cohesive, wet (TOPSOIL)	0.00	
	(SM) SILTY SANDY LOAM; brown/black, no odors, no staining, non-cohesive, wet	0.30	
2	(SM) SILTY SAND TILL, some gravel; brown, no odors, no staining, non-cohesive, wet	411.12 / 1.52	Bentonite
4			∇ March 20, 2021
6	DOLOSTONE, highly weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	406.54 / 6.10	Sand
12–14			Screen
20			Sand
21	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	391.68 / 20.96	Bentonite
23	SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	389.76 / 22.88	
24	BOTTOM OF HOLE	389.17 / 23.47	

Other columns (no data): DRILLING RECORD, SYMBOLIC LOG, RUN No., PENETRATION RATE min/(m), COLOUR % RETURN, FLUSH, RECOVERY (TOTAL CORE %, SOLID CORE %), R.Q.D. %, FRACT. INDEX PER 0.25 m, DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn), HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}), Diametral Point Load Index (MPa), RMC -Q' AVG.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW21-2-3 (CAL)

PROJECT: 19129150

LOCATION: N 4854098.5 ;E 577349.7

DRILLING DATE: March 10-11, 2021

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	NOTES / WATER LEVELS / INSTRUMENTATION
	GROUND SURFACE	410.76	
0	(SM) SILTY SAND, some gravel; brown/black, no odors, no staining, non-cohesive, wet (TOPSOIL)	0.00 / 0.30	
	(SM) SILTY SAND, some gravel; brown/black, no odors, no staining, non-cohesive, wet	409.24 / 1.52	
	(SM) SILTY SAND and GRAVEL, some gravel; golden brown, no odors, no staining, non-cohesive, moist	408.02 / 2.74	Bentonite
	DOLOSTONE,highly weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)		March 20, 2021; Sand; Screen; Sand
	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	391.78 / 18.98	
	SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	390.14 / 20.62	Bentonite
24	BOTTOM OF HOLE	386.99 / 23.77	

Column headings: DEPTH SCALE METRES; DRILLING RECORD; DESCRIPTION; SYMBOLIC LOG; ELEV. DEPTH (m); RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.; NOTES WATER LEVELS INSTRUMENTATION

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-2-4 (CAL)

SHEET 1 OF 1

LOCATION: N 4854001.7 ;E 577297.5

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 16, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	413.86	
0	(SM) SILTY SANDY LOAM; brown/black, no odors, no staining, non-cohesive, wet (TOPSOIL)	0.00	
	(SM) SILTY SANDY LOAM; brown/black, no odors, no staining, non-cohesive, wet	0.30	
	(SM) SILTY SAND TILL; brown, no odors, no staining, non-cohesive, wet to moist	412.34 1.52	Bentonite
4	DOLOSTONE, highly weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	409.59 4.27	March 20, 2021 (water level) Sand Screen
24	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	390.22 23.64	Sand Bentonite
26	SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	388.26 25.60	
	BOTTOM OF HOLE	387.34 26.52	

Column headings also shown (no data recorded): DRILLING RECORD; SYMBOLIC LOG; RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-3-1 (CAL)

SHEET 1 OF 1

LOCATION: N 4852814.1 ;E 577871.8

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 29-30, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. / DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Description	Elev. (m)	Depth (m)
GROUND SURFACE	403.69	
(SP) SAND some silt; brown, no odors, no staining, non-cohesive, moist	403.69	0.00
(SP/GP) SAND and GRAVEL, some silt; brown, no odors, no staining, non-cohesive, moist	402.17	1.52
DOLOSTONE, moderately weathered, bedded dolostone, grey (GASPORT FORMATION)	399.12	4.57
SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	386.62	17.07
SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	384.19	19.50
BOTTOM OF HOLE	382.66	21.03

Instrumentation (notes): Bentonite; Sand; Water level April 3, 2021; Screen; Sand; Bentonite

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

GTA-RCK 004 S:\CLIENTS\VOTORANTIM_CIMENTOS\LONG_PAR_5_CALEDON\02_DATA\GINT\LONG_PAR_5_CALEDON.GPJ GAL-MISS.GDT 1/13/22

DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-3-2 (CAL)

SHEET 1 OF 1

LOCATION: N 4852838.4 ;E 577920.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 30, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	404.87 / 0.00
(SM) SILTY SAND LOAM; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.30
(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, wet	403.35 / 1.52
(SM/GP) SILTY SAND and GRAVEL, some cobbles; brown, no odors, no staining, non-cohesive, moist	401.21 / 3.66
DOLOSTONE, highly weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	386.91 / 17.96
SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	384.67 / 20.20
SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	383.84 / 21.03
BOTTOM OF HOLE	

NOTES / WATER LEVELS / INSTRUMENTATION:

- Bentonite
- Sand
- April 3, 2021 (water level)
- Screen
- Sand
- Bentonite

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW21-3-3 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4852730.9 ;E 577935.5

DRILLING DATE: March 30, 2021

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | COLOUR % RETURN | FLUSH | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}) | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

Depth Scale (m)	Description	Elev. / Depth (m)	Notes / Instrumentation
	GROUND SURFACE	405.12	
0	(SM) SILTY SAND LOAM; brown, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00	
	(SM) SILTY SAND; brown, no odors, no staining, non-cohesive, moist	0.30	
2	(SM/GP) SILTY SAND and GRAVEL, some cobbles; brown, no odors, no staining, non-cohesive, moist	403.60 / 1.52	
4			Bentonite
8	DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)	396.89 / 8.23	Sand
12			April 3, 2021 (water level)
14			Screen
18			Sand
	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	386.22 / 18.90	Bentonite
	BOTTOM OF HOLE	19.20	

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

RECORD OF DRILLHOLE: MW21-3-4 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4852827.3 ;E 577837.9

DRILLING DATE: March 29, 2021

DATUM: Geodetic

INCLINATION: -90°   AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	NOTES / WATER LEVELS / INSTRUMENTATION
	GROUND SURFACE	403.16	
0	(SP) SAND and GRAVEL, some silt, some cobbles; brown/black, no odors, no staining, non-cohesive, moist (TOPSOIL)	0.00 / 401.64	
2	(SP) SAND and GRAVEL, some silt, some cobbles; brown/black, no odors, no staining, non-cohesive, moist	1.52 / 399.81	Bentonite
4	DOLOSTONE, moderately weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	3.35 / 387.00	Sand; water level April 3, 2021; Screen (~10); Sand (~16)
16	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	16.16 / 384.71	Bentonite
	SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	18.45 / 383.96	
	BOTTOM OF HOLE	19.20	

Other columns (Drilling Record, Symbolic Log, Run No., Penetration Rate min/(m), Colour % Return, Flush, Recovery – Total Core % / Solid Core %, R.Q.D. %, Fract. Index per 0.25 m, Discontinuity Data – B Angle / Dip w.r.t. Core Axis / Type and Surface Description / Jr Ja Jn, Hydraulic Conductivity K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}), Diametral Point Load Index (MPa), RMC -Q' AVG.) contain no entries.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

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DEPTH SCALE

1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: MW21-4-1 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4854211.5 ;E 577793.1

DRILLING DATE: March 22, 2021

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate; BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage; PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular; PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	415.22	
0	(SP) CLAYEY SAND LOAM; brown/black, no odors, no staining, cohesive (TOPSOIL)	0.00	
	(SP) CLAYEY SAND TILL, some gravel; brown, no odors, no staining, cohesive, W > PL	413.70 / 1.52	Bentonite
	DOLOSTONE, highly weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	406.38 / 8.84	Sand; Water level March 26, 2021; Screen; Sand
	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	395.36 / 19.86	Bentonite
	SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	392.62 / 22.60	
	BOTTOM OF HOLE	391.45 / 23.77	

Other column headings (no entries): DRILLING RECORD; SYMBOLIC LOG; RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

Depth scale marks: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-4-2 (CAL)

SHEET 1 OF 1

LOCATION: N 4854247.2 ;E 577790.3

DRILLING DATE: March 22, 2021

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	415.07	
0	(SP) CLAYEY SAND TILL, some gravel; brown, no odors, no staining, cohesive, W > PL	0.00	Bentonite
9.14	DOLOSTONE, moderately weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	405.93 9.14	Sand; water level March 26, 2021; Screen
19.52	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	395.55 19.52	Sand; Bentonite
22.40	SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	392.67 22.40	Bentonite
23.77	BOTTOM OF HOLE	391.30 23.77	

Other log columns (DRILLING RECORD, SYMBOLIC LOG, RUN No., PENETRATION RATE min/(m), COLOUR % RETURN, FLUSH, RECOVERY TOTAL CORE % / SOLID CORE %, R.Q.D. %, FRACT. INDEX PER 0.25 m, DISCONTINUITY DATA B Angle / DIP w.r.t. CORE AXIS / TYPE AND SURFACE DESCRIPTION / Jr Ja Jn, HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}, Diametral Point Load Index (MPa), RMC -Q' AVG.) contain no data.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: MW21-4-3 (CAL)

SHEET 1 OF 1

LOCATION: N 4854182.8 ;E 577813.9

DRILLING DATE: March 23, 2021

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

Columns: DEPTH SCALE METRES | DRILLING RECORD | DESCRIPTION | SYMBOLIC LOG | ELEV. DEPTH (m) | RUN No. | PENETRATION RATE min/(m) | FLUSH | COLOUR % RETURN | RECOVERY (TOTAL CORE %, SOLID CORE %) | R.Q.D. % | FRACT. INDEX PER 0.25 m | DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn) | HYDRAULIC CONDUCTIVITY K, cm/sec | Diametral Point Load Index (MPa) | RMC -Q' AVG. | NOTES WATER LEVELS INSTRUMENTATION

DESCRIPTION	ELEV. / DEPTH (m)	NOTES / INSTRUMENTATION
GROUND SURFACE	414.78	
(SP) CLAYEY SAND LOAM; brown/black, no odors, no staining, cohesive (TOPSOIL)	0.00	
(SP) CLAYEY SAND TILL, some gravel; brown, no odors, no staining, cohesive, W > PL	0.30	Bentonite
DOLOSTONE, moderately weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	405.64 / 9.14	Sand; water level March 26, 2021; Screen
SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	395.20 / 19.58	Sand; Bentonite
BOTTOM OF HOLE	393.14 / 21.64	

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DEPTH SCALE

1 : 150

GOLDER

MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: PW21-1 (CAL)

LOCATION: N 4853478.7 ;E 576890.2

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 4-8, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. / DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	418.76	
0	(CH) SILTY SANDY CLAY TILL; light brown, no odors, no staining, cohesive, W > PL	0.00	
	(SM) CLAYEY SILTY SAND TILL; brown/black, no odors, no staining, cohesive, W > PL	417.24 / 1.52	April 19, 2021
	(CH) SILTY SANDY CLAY TILL; brown/grey, no odors, no staining, cohesive, W > PL	415.72 / 3.04	
	(CH) GRAVELLY SILTY CLAY TILL; brown/grey, no odors, no staining, cohesive, W > PL	409.92 / 8.84	
	DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)	407.79 / 10.97	

Other column headings: DRILLING RECORD; SYMBOLIC LOG; RUN No.; PENETRATION RATE min/(m); FLUSH COLOUR % RETURN; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

CONTINUED NEXT PAGE

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: PW21-1 (CAL)

PROJECT: 19129150

SHEET 2 OF 2

LOCATION: N 4853478.7 ;E 576890.2

DRILLING DATE: March 4-8, 2021

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE min/(m)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---																			
30		DOLOSTONE, fresh, bedded dolostone, grey (GASPORT FORMATION)		384.34 / 34.42																	
34		SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown		382.18 / 36.58																	
36		SHALE, bedded shale, blue green (CABOT HEAD FORMATION)		380.35 / 38.41																	
38		BOTTOM OF HOLE																			

Depth scale: 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60

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DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

RECORD OF DRILLHOLE: PW21-2 (CAL)

PROJECT: 19129150

LOCATION: N 4854027.5 ;E 577286.3

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 17, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR - Shear, VN - Vein, CJ - Conjugate, BD - Bedding, FO - Foliation, CO - Contact, OR - Orthogonal, CL - Cleavage, PL - Planar, CU - Curved, UN - Undulating, ST - Stepped, IR - Irregular, PO - Polished, K - Slickensided, SM - Smooth, Ro - Rough, MB - Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DESCRIPTION	ELEV. / DEPTH (m)	NOTES / WATER LEVELS / INSTRUMENTATION
GROUND SURFACE	413.07	
(SM) SILTY SAND LOAM; brown/black, no odors, no staining, non-cohesive, wet (TOPSOIL)	0.00	
(SM) SILTY SAND TILL; golden brown, no odors, no staining, non-cohesive, wet	411.55 / 1.52	
DOLOSTONE, highly weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	408.80 / 4.27	April 19, 2021
SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	390.51 / 22.56	
SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	388.69 / 24.38	
BOTTOM OF HOLE	387.92 / 25.15	

Column headings: DEPTH SCALE METRES; DRILLING RECORD; DESCRIPTION; SYMBOLIC LOG; ELEV. DEPTH (m); RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.; NOTES WATER LEVELS INSTRUMENTATION

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DEPTH SCALE
1 : 150

GOLDER
MEMBER OF WSP

LOGGED: AL
CHECKED: GRP

RECORD OF DRILLHOLE: PW21-3 (CAL)

PROJECT: 19129150

SHEET 1 OF 1

LOCATION: N 4852797.5 ;E 577875.5

DRILLING DATE: March 31, 2021

DATUM: Geodetic

DRILL RIG: Sonic

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Choice Sonic Drilling

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate; BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage; PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular; PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break; BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	405.45
(SM) SILTY SAND; brown/black, no odors, no staining, non-cohesive, wet (TOPSOIL)	0.00
(SP) SAND; brown, no odor, no staining, non-cohesive, moist	404.84 / 0.61
(SM) SILTY SAND and GRAVEL; brown, no odors, no staining, non-cohesive, moist	401.79 / 3.66
DOLOSTONE, highly weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	399.35 / 6.10
SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	386.77 / 18.68
SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	384.45 / 21.00
BOTTOM OF HOLE	21.34

Column headings: DEPTH SCALE METRES; DRILLING RECORD; DESCRIPTION; SYMBOLIC LOG; ELEV. DEPTH (m); RUN No.; PENETRATION RATE min/(m); FLUSH; COLOUR % RETURN; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.; NOTES WATER LEVELS INSTRUMENTATION

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

Water level: April 19, 2021

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

PROJECT: 19129150

RECORD OF DRILLHOLE: PW21-4 (CAL)

LOCATION: N 4854214.4 ;E 577802.1

INCLINATION: -90° AZIMUTH: ---

DRILLING DATE: March 23, 2021

DRILL RIG: Sonic

DRILLING CONTRACTOR: Choice Sonic Drilling

DATUM: Geodetic

JN - Joint, FLT - Fault, SHR- Shear, VN - Vein, CJ - Conjugate, BD- Bedding, FO- Foliation, CO- Contact, OR- Orthogonal, CL - Cleavage, PL - Planar, CU- Curved, UN- Undulating, ST - Stepped, IR - Irregular, PO- Polished, K - Slickensided, SM- Smooth, Ro - Rough, MB- Mechanical Break, BR - Broken Rock

NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NOTES WATER LEVELS INSTRUMENTATION
	GROUND SURFACE	415.08	
0	(SP) CLAYEY SAND LOAM; brown/black, no odors, no staining, cohesive (TOPSOIL)	0.00	
	(SP) CLAYEY SAND TILL, some gravel; brown, no odors, no staining, cohesive, W > PL	0.30	
8	DOLOSTONE, highly weathered to fresh, bedded dolostone, grey (GASPORT FORMATION)	406.24 8.84	
10			April 19, 2021
20	SHALEY DOLOSTONE, bedded, shaley dolostone, slate grey/brown	395.48 19.60	
22	SHALE; bedded shale, blue green (CABOT HEAD FORMATION)	393.59 21.64	
	BOTTOM OF HOLE		

Column headings: DRILLING RECORD; SYMBOLIC LOG; RUN No.; PENETRATION RATE min/(m); COLOUR % RETURN; FLUSH; RECOVERY (TOTAL CORE %, SOLID CORE %); R.Q.D. %; FRACT. INDEX PER 0.25 m; DISCONTINUITY DATA (B Angle, DIP w.r.t. CORE AXIS, TYPE AND SURFACE DESCRIPTION, Jr, Ja, Jn); HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6}, 10^{-5}, 10^{-4}, 10^{-3}); Diametral Point Load Index (MPa); RMC -Q' AVG.

Depth scale: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30

DEPTH SCALE 1 : 150

GOLDER MEMBER OF WSP

LOGGED: AL

CHECKED: GRP

APPENDIX D

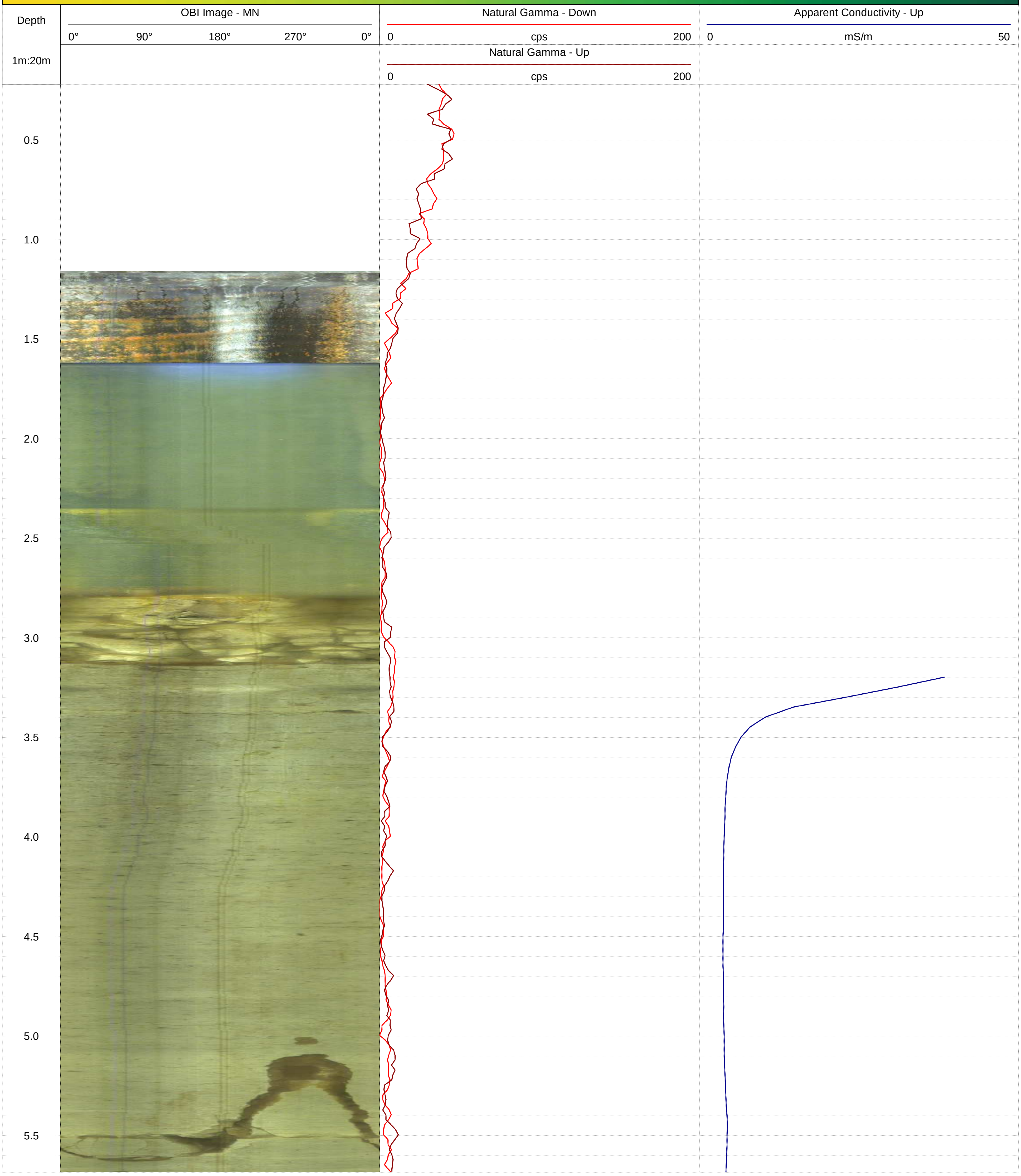
Geophysical Logs

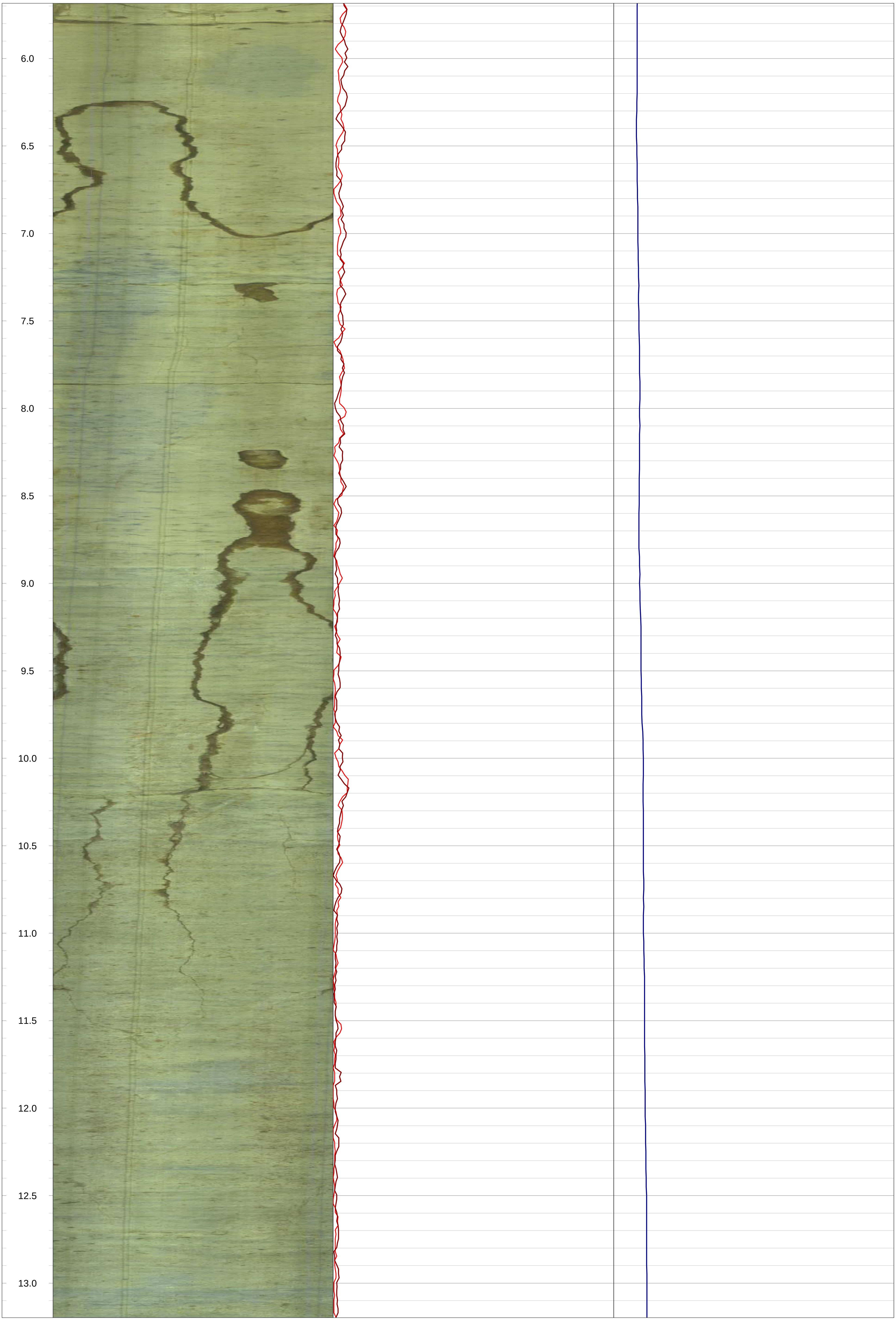
Geophysical Record of Borehole: BH20-01 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	2.75 m bgs	**Location:**	Caledon, Ontario
Easting:	578000.61 m	**Drilled Depth:**	22.07 m bgs	**Water Level:**	1.6 m bgs	**Log Date:**	Feb-18-2020
Northing:	4853292.80 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	406.80 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.46 m ags	**Logged By:**	CM

Notes: OBI image is opaque > 21.60m

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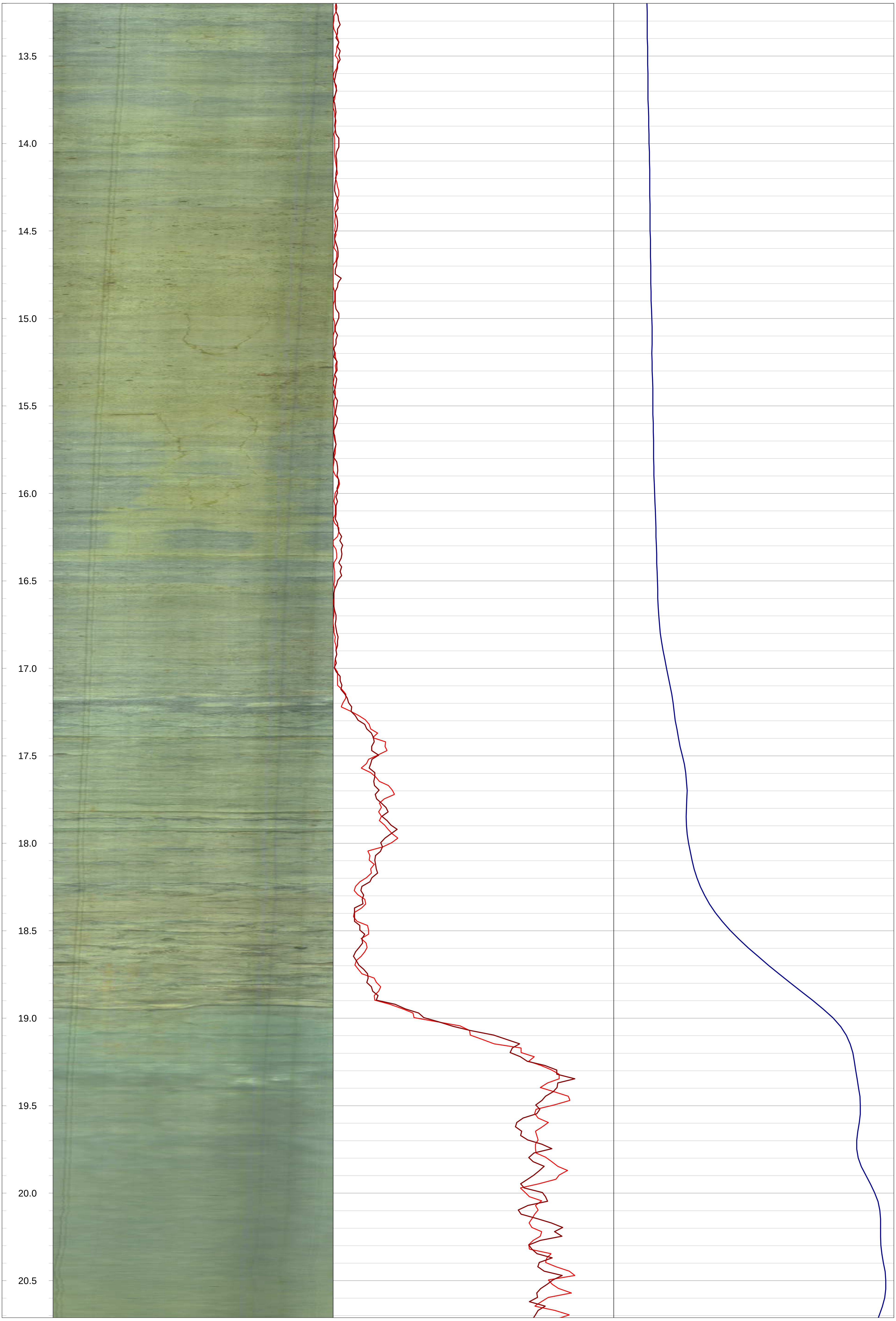
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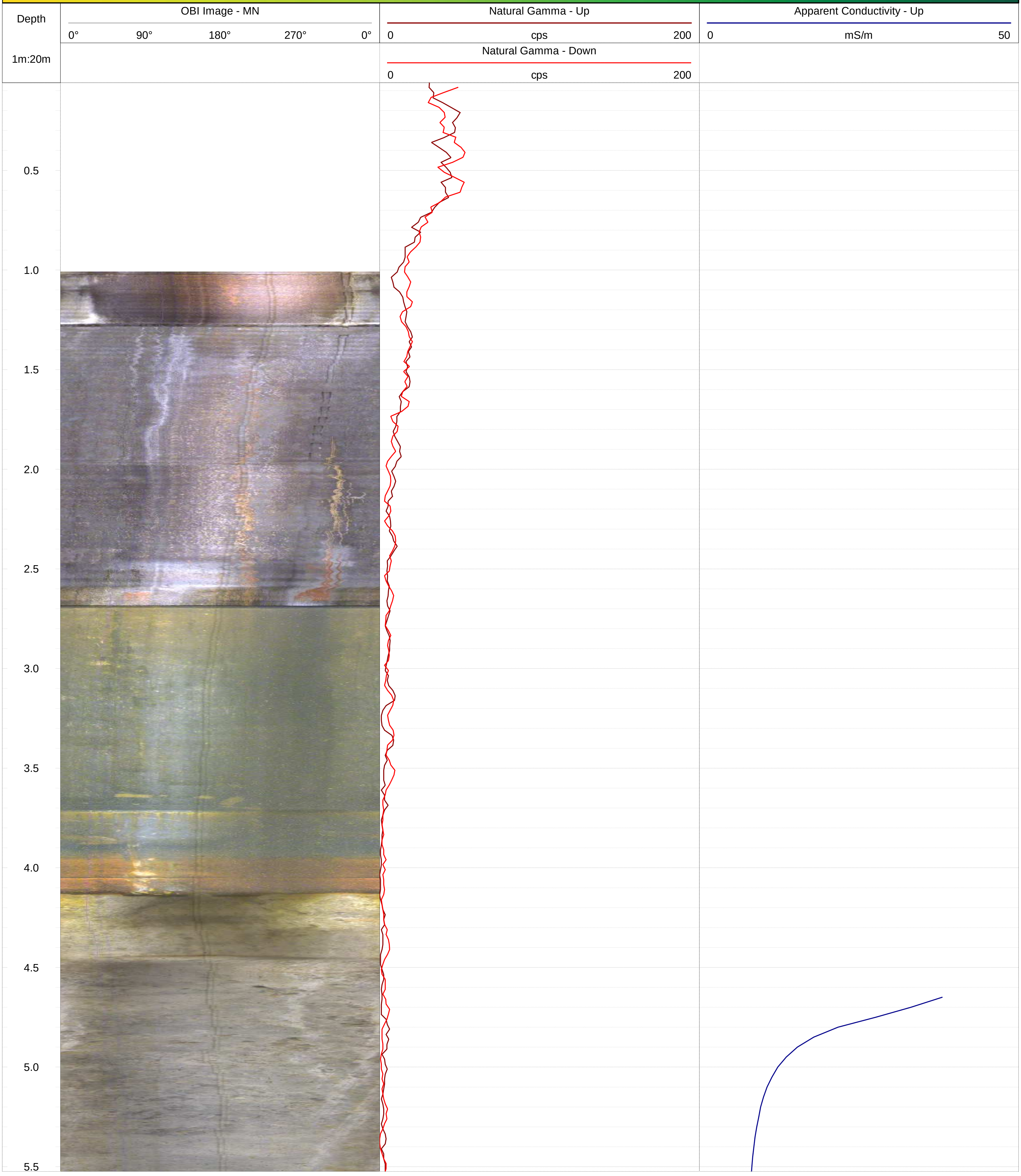
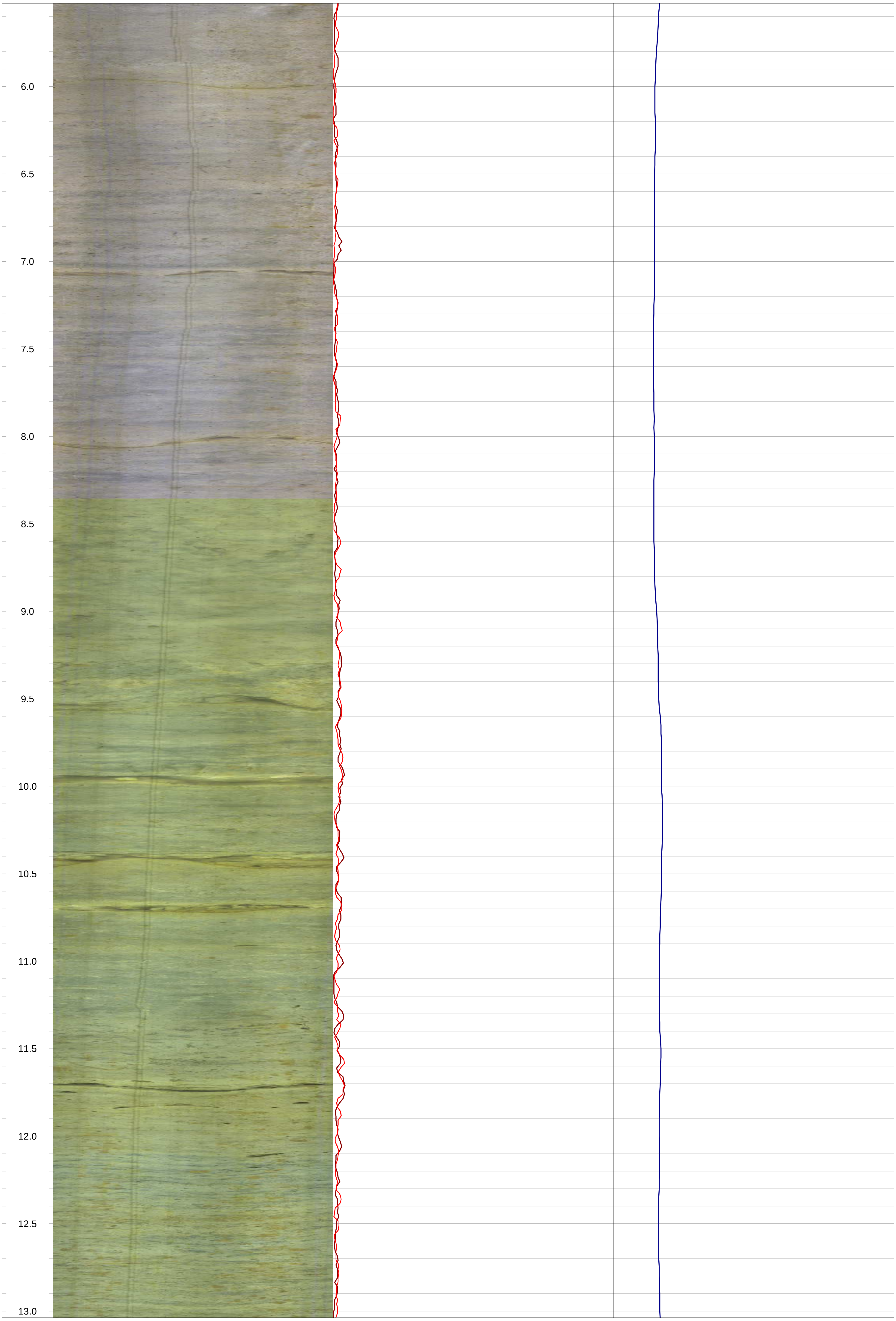
Geophysical Record of Borehole: BH20-02 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	4.11 m bgs	**Location:**	Caledon, Ontario
Easting:	577839.36 m	**Drilled Depth:**	22.02 m bgs	**Water Level:**	2.70 m bgs	**Log Date:**	Feb-18-2020
Northing:	4853078.92 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	405.52 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.61 m ags	**Logged By:**	CM

Notes:

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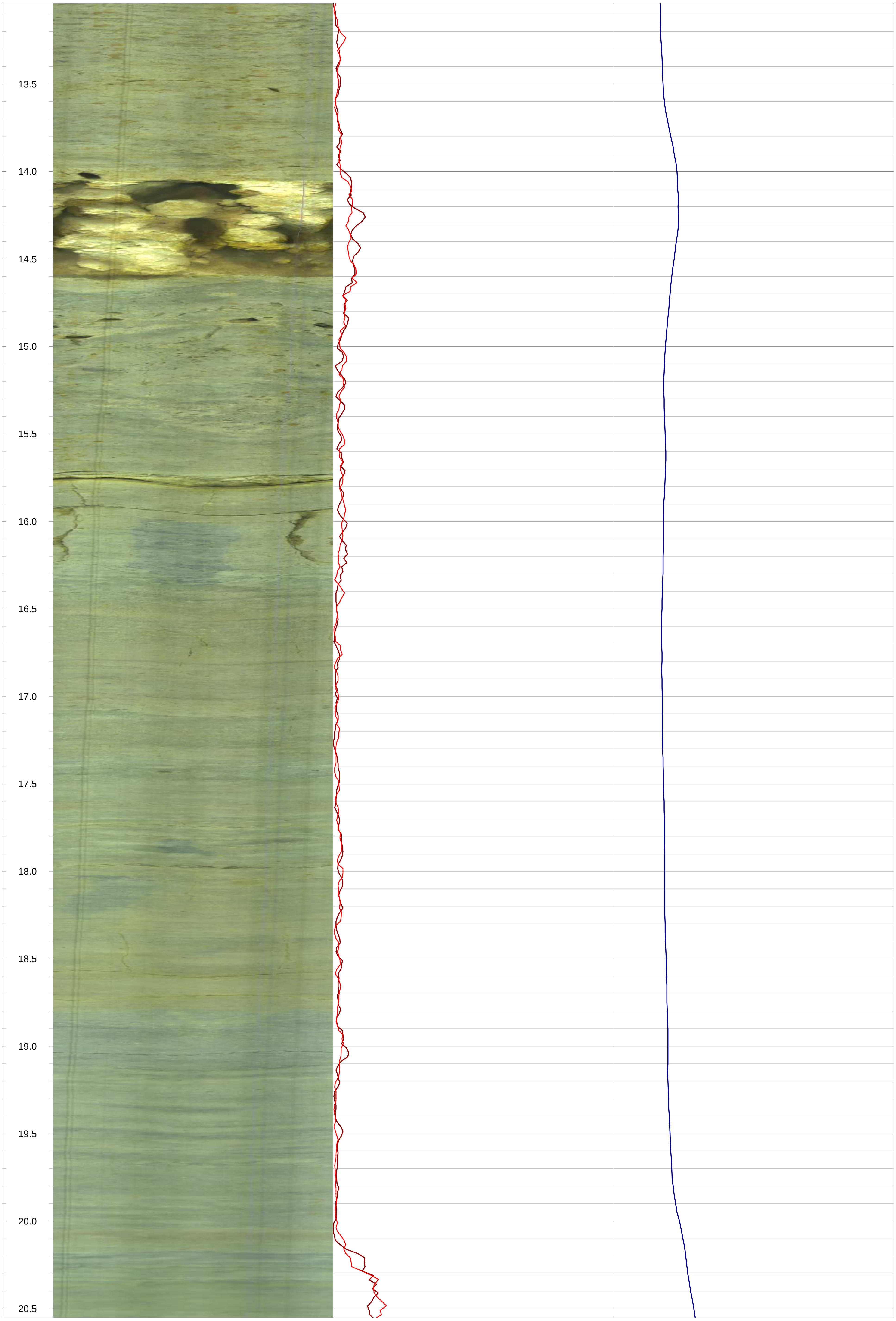
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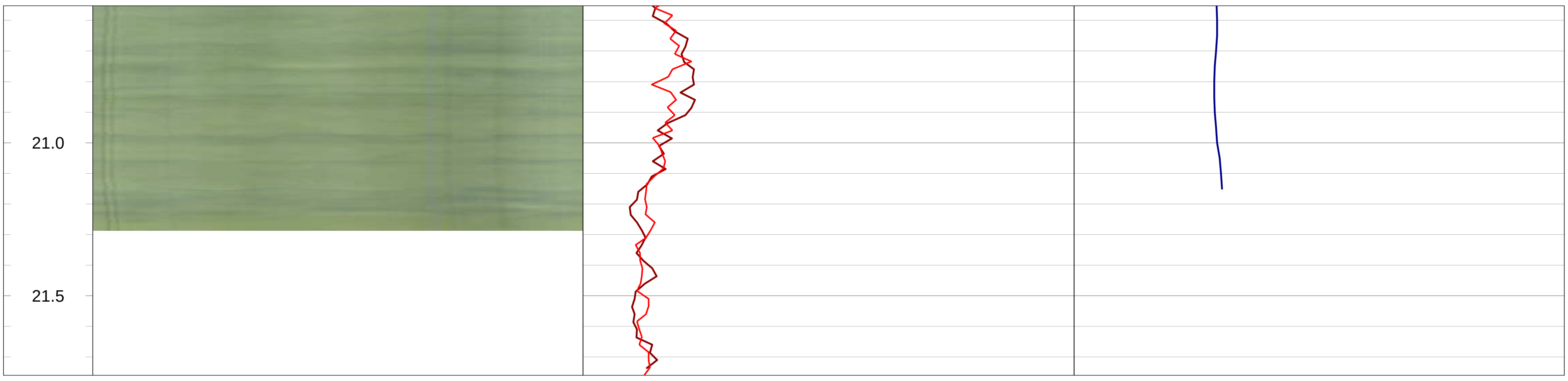
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Geophysical Record of Borehole: BH20-03 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	3.03 m bgs	**Location:**	Caledon, Ontario
Easting:	577655.12 m	**Drilled Depth:**	19.33 m bgs	**Water Level:**	7.14 m bgs	**Log Date:**	Mar-10-2020
Northing:	4852796.26 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	402.91 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.23 m ags	**Logged By:**	CM

Notes:

Depth	OBI Image - MN	Natural Gamma - Down	Apparent Conductivity - Up
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1m:20m		Natural Gamma - Up 0 cps 200	

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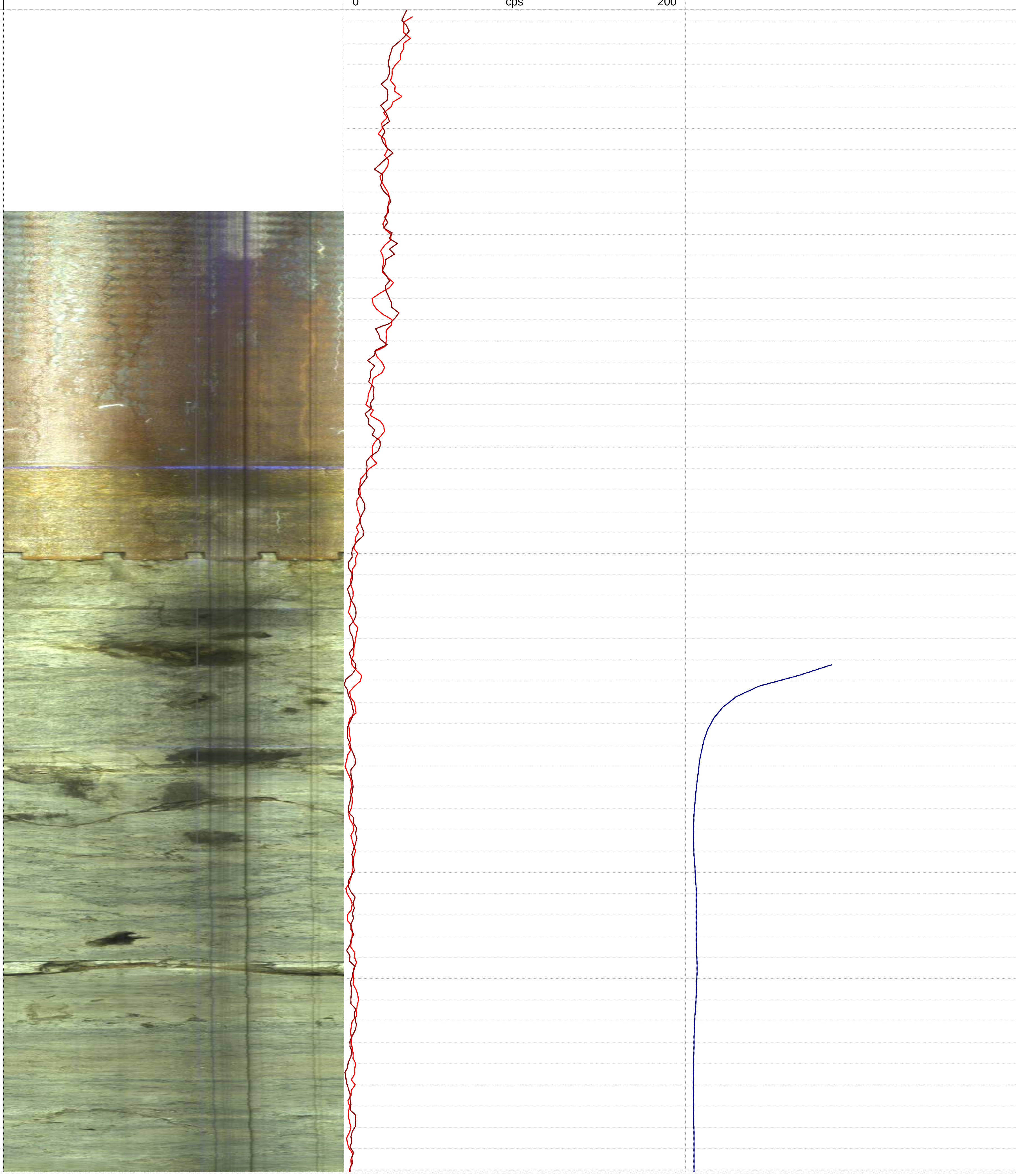

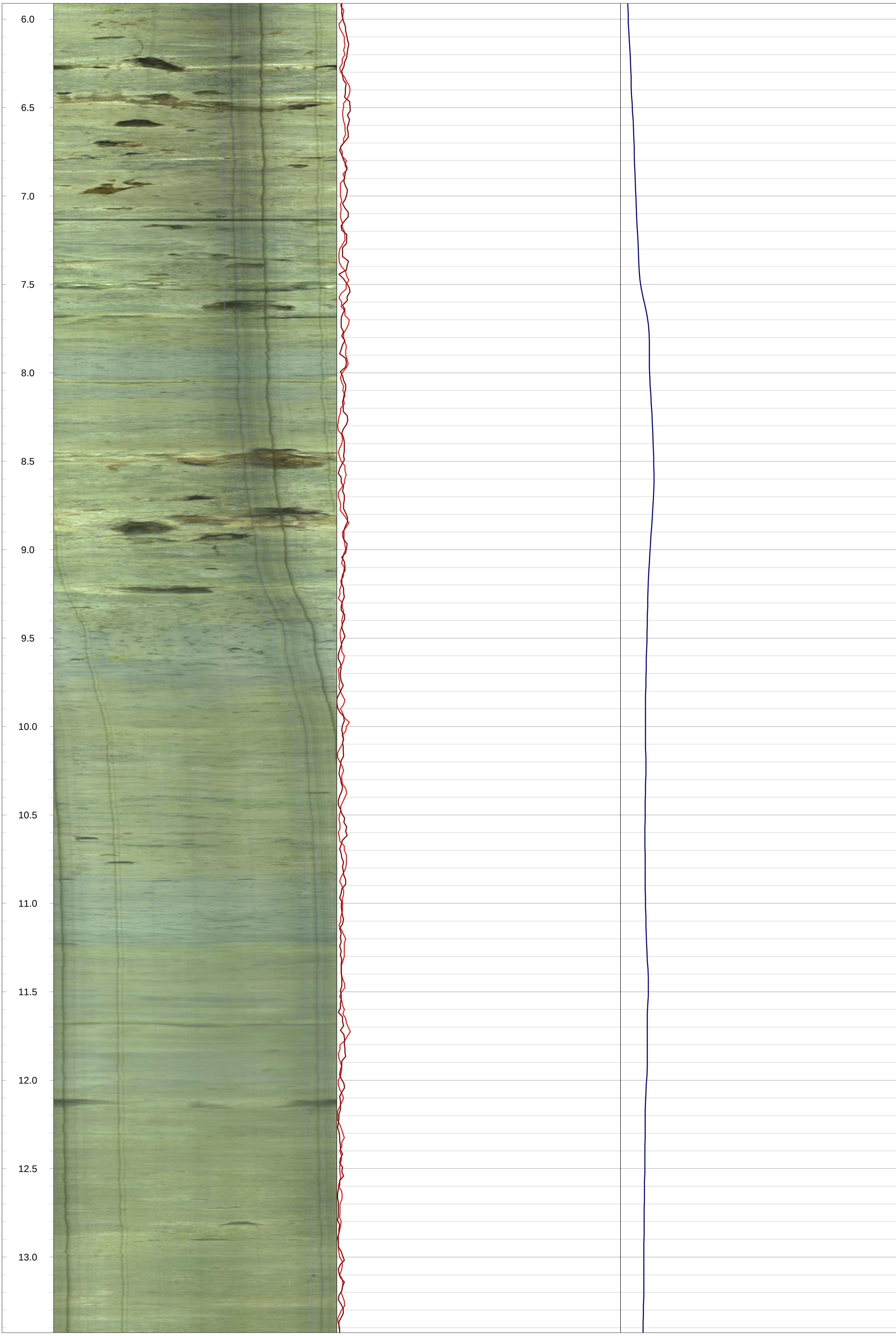
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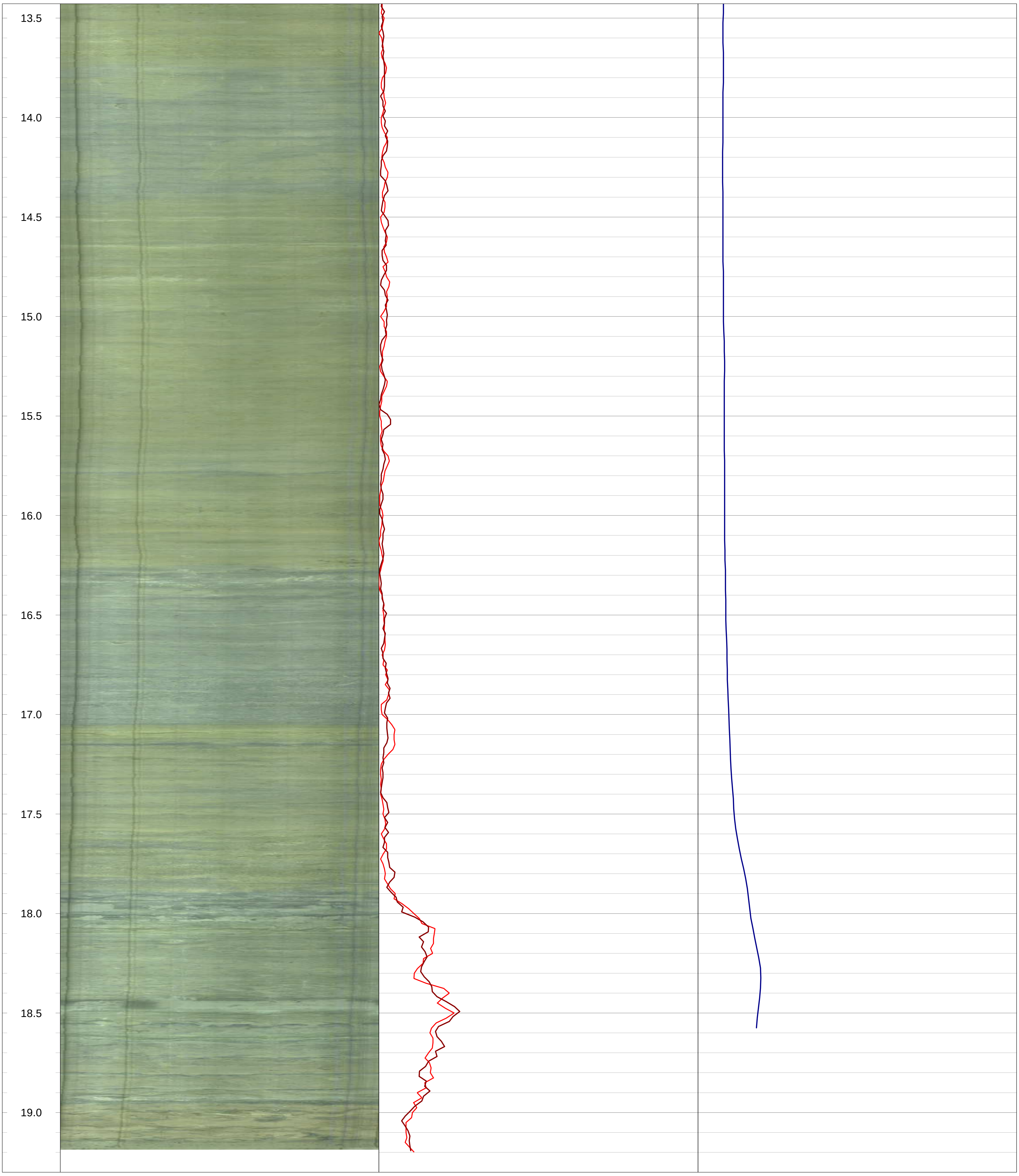
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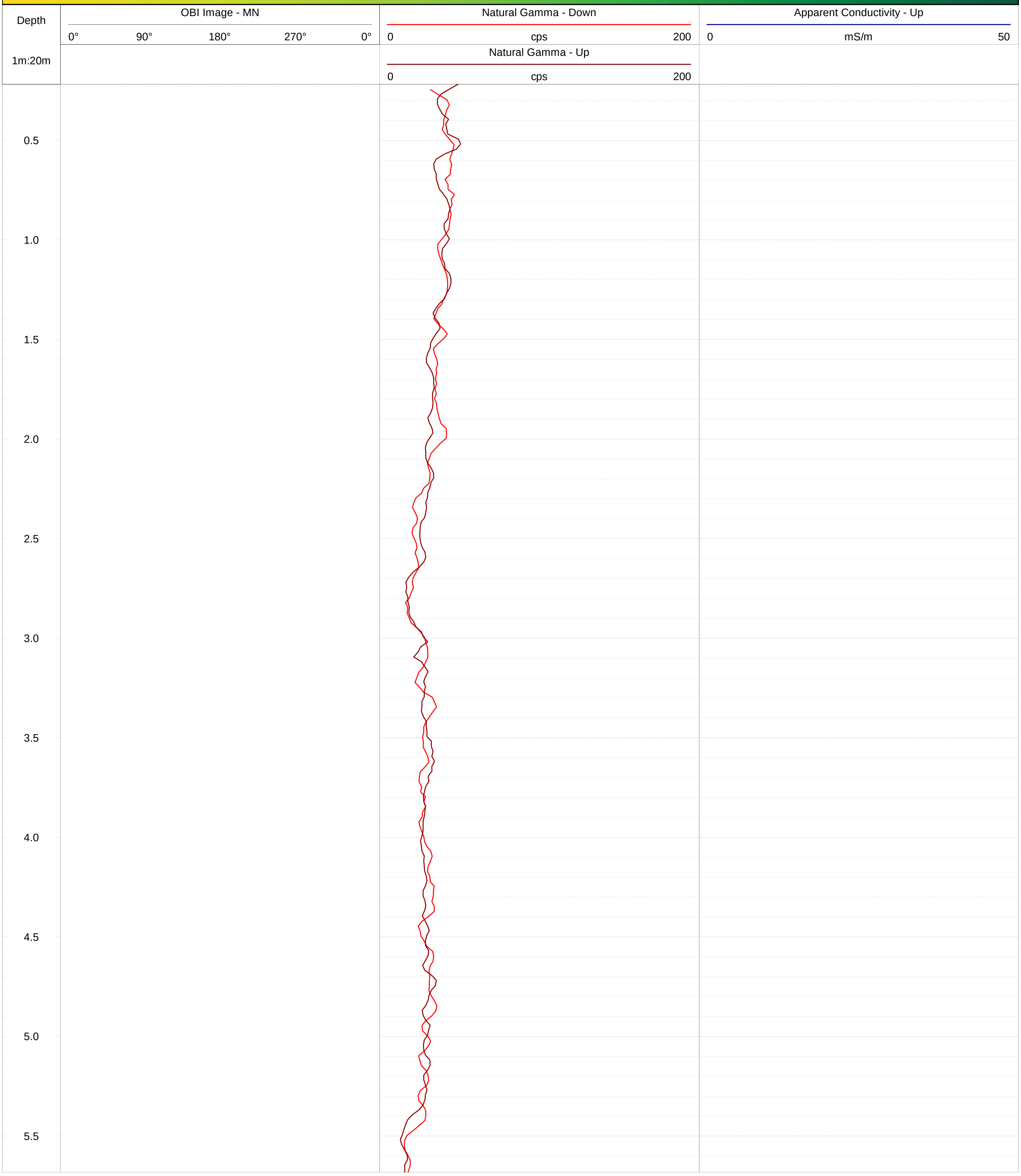
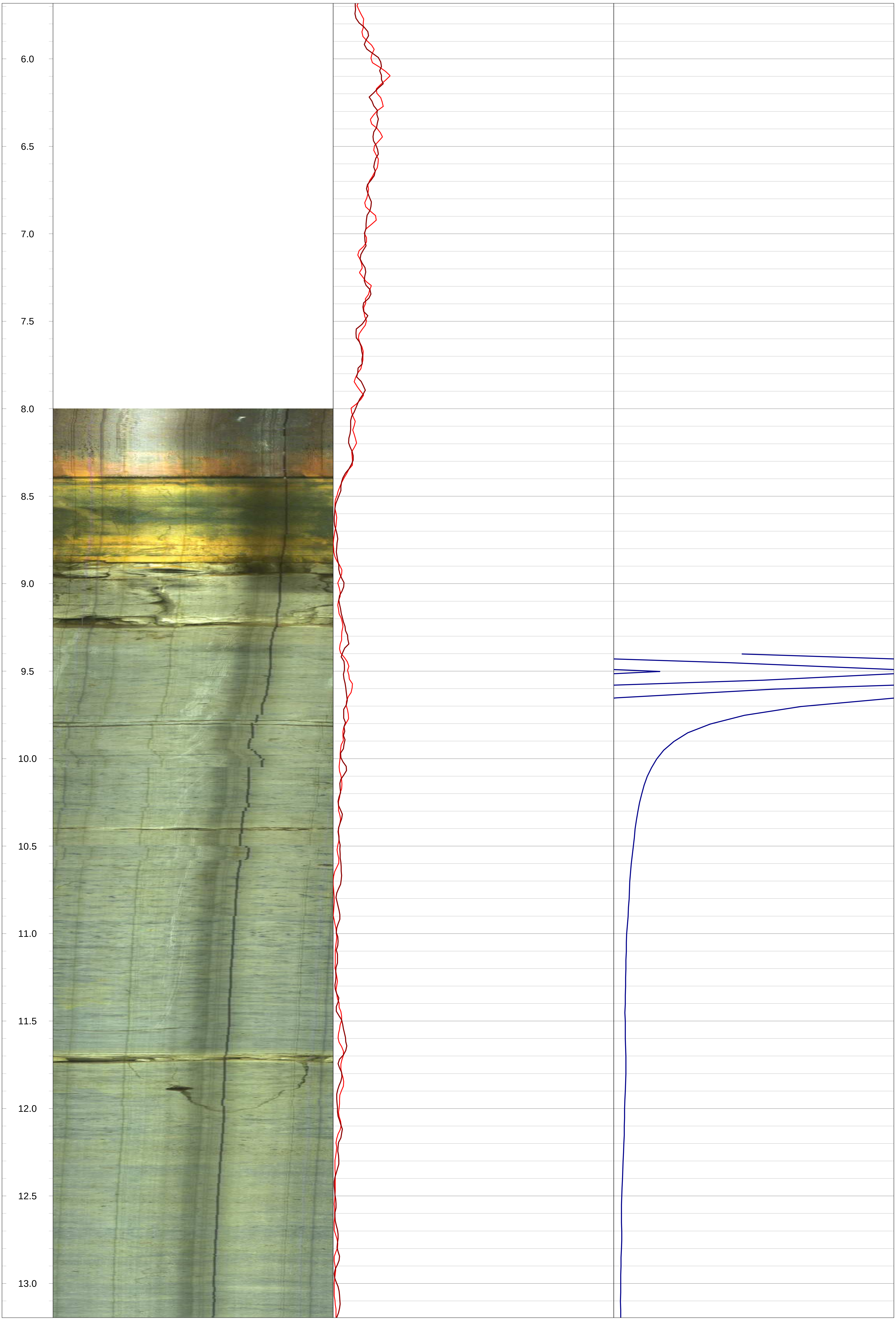
Geophysical Record of Borehole: BH20-04 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	8.89 m bgs	**Location:**	Caledon, Ontario
Easting:	577511.78 m	**Drilled Depth:**	19.57 m bgs	**Water Level:**	8.31 m bgs	**Log Date:**	Feb-24-2020
Northing:	4852528.07 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	400.81 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.46 m ags	**Logged By:**	CM

Notes:

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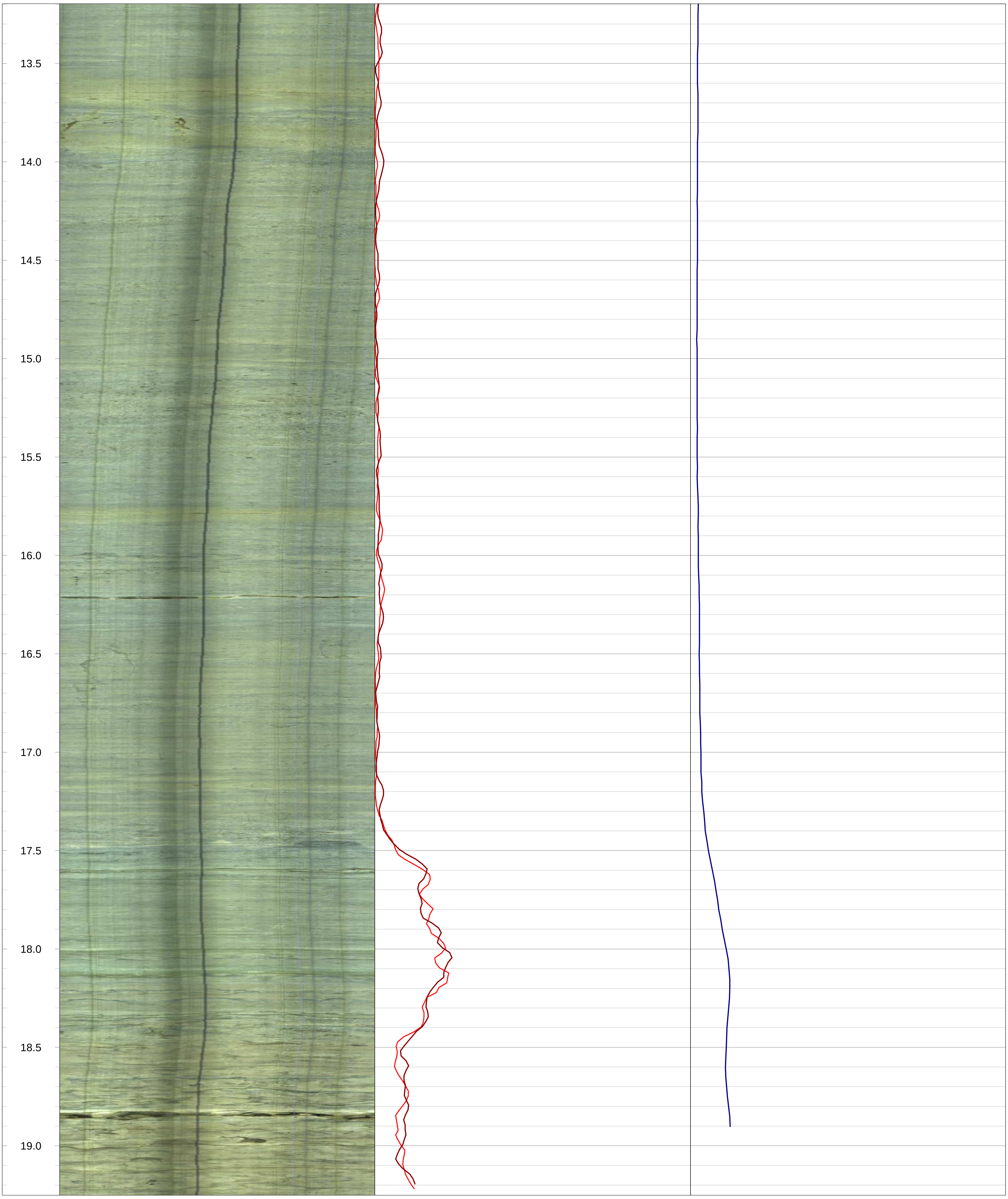
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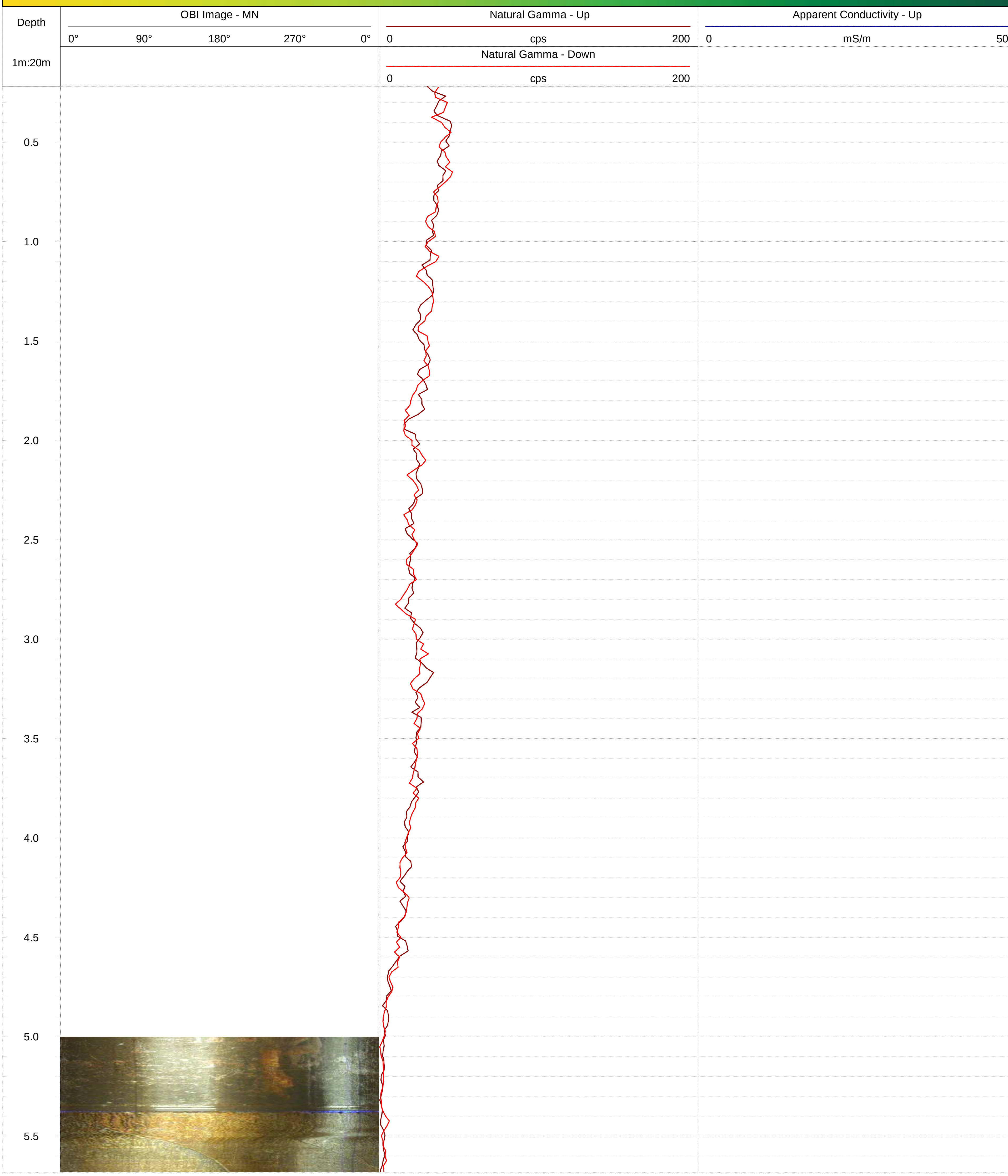
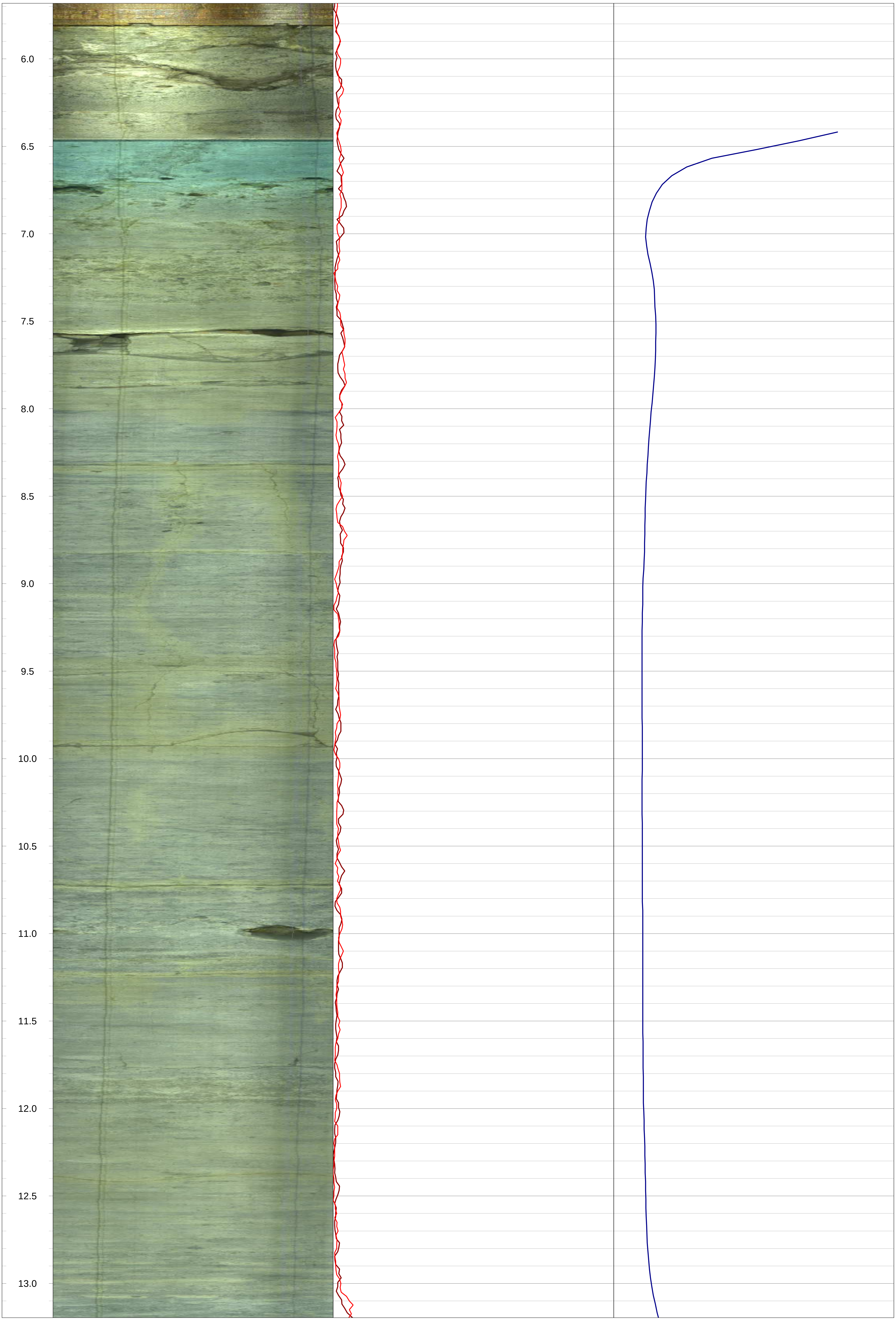
Geophysical Record of Borehole: BH20-05 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	5.81 m bgs	**Location:**	Caledon, Ontario
Easting:	577786.25 m	**Drilled Depth:**	16.35 m bgs	**Water Level:**	6.51 m bgs	**Log Date:**	Feb-24-2020
Northing:	4852520.23 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	398.83 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.48 m ags	**Logged By:**	CM

Notes: OBI image dark > 15.5 m bgs

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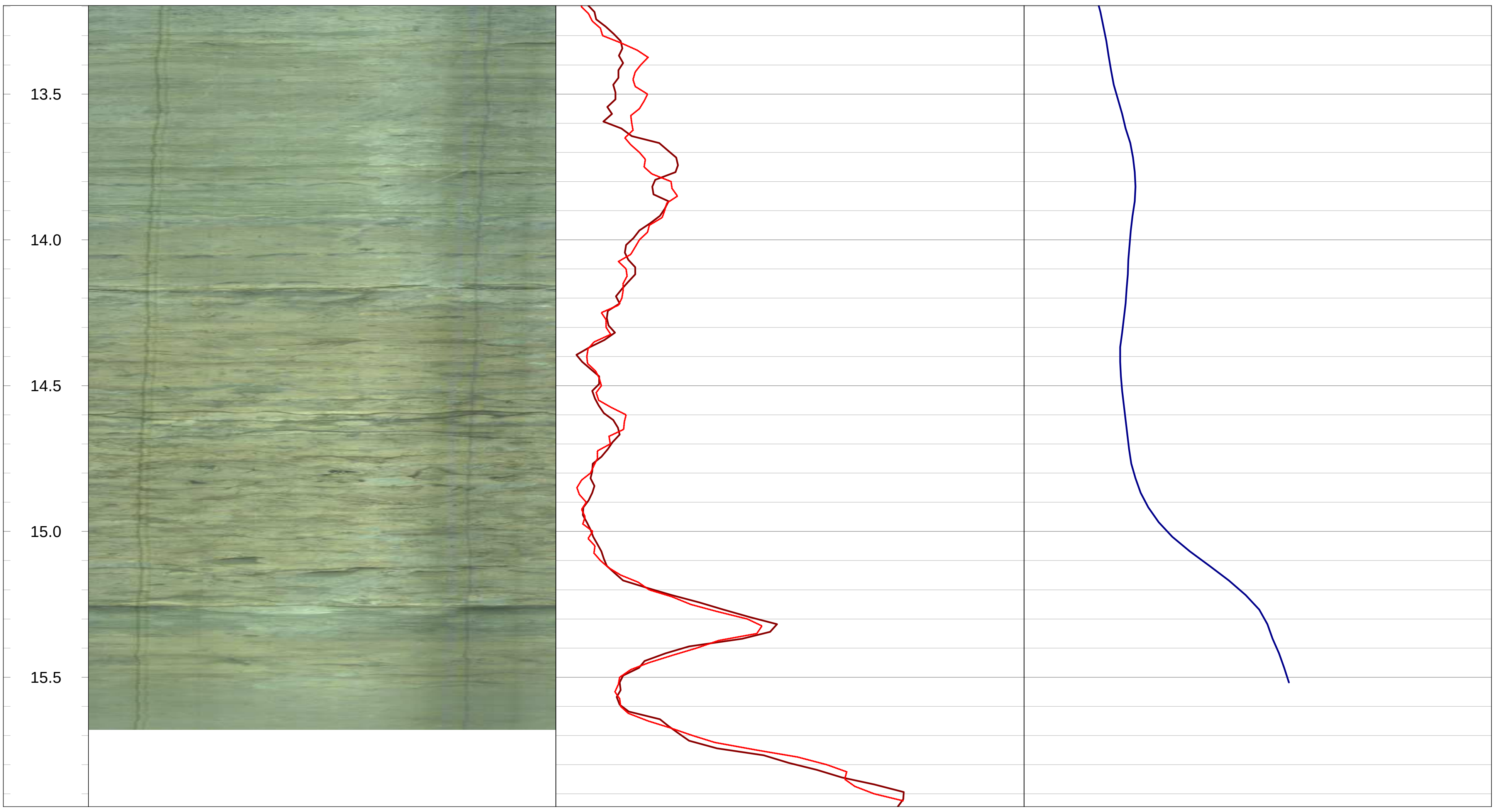
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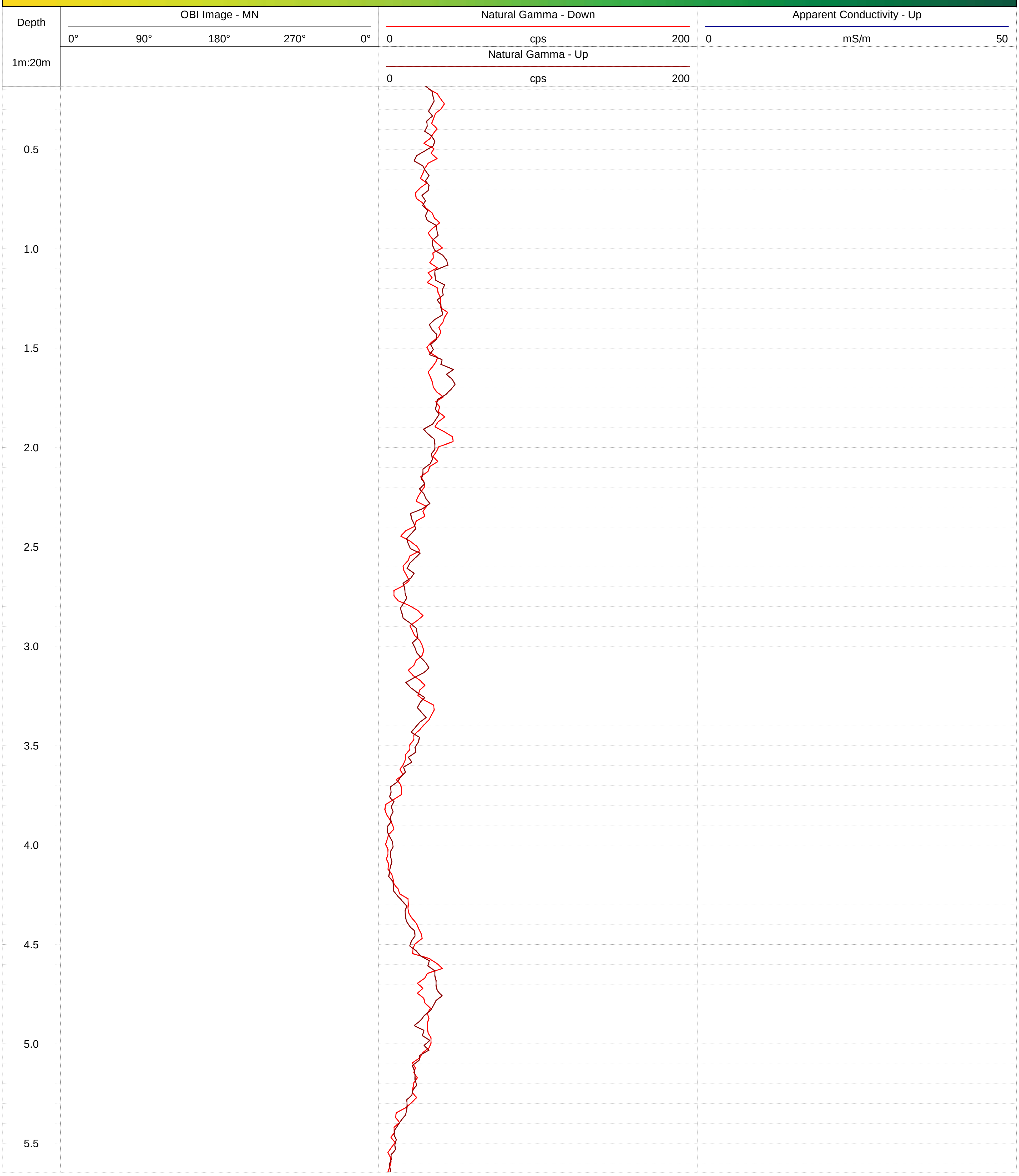
GOLDER
MEMBER OF WSP

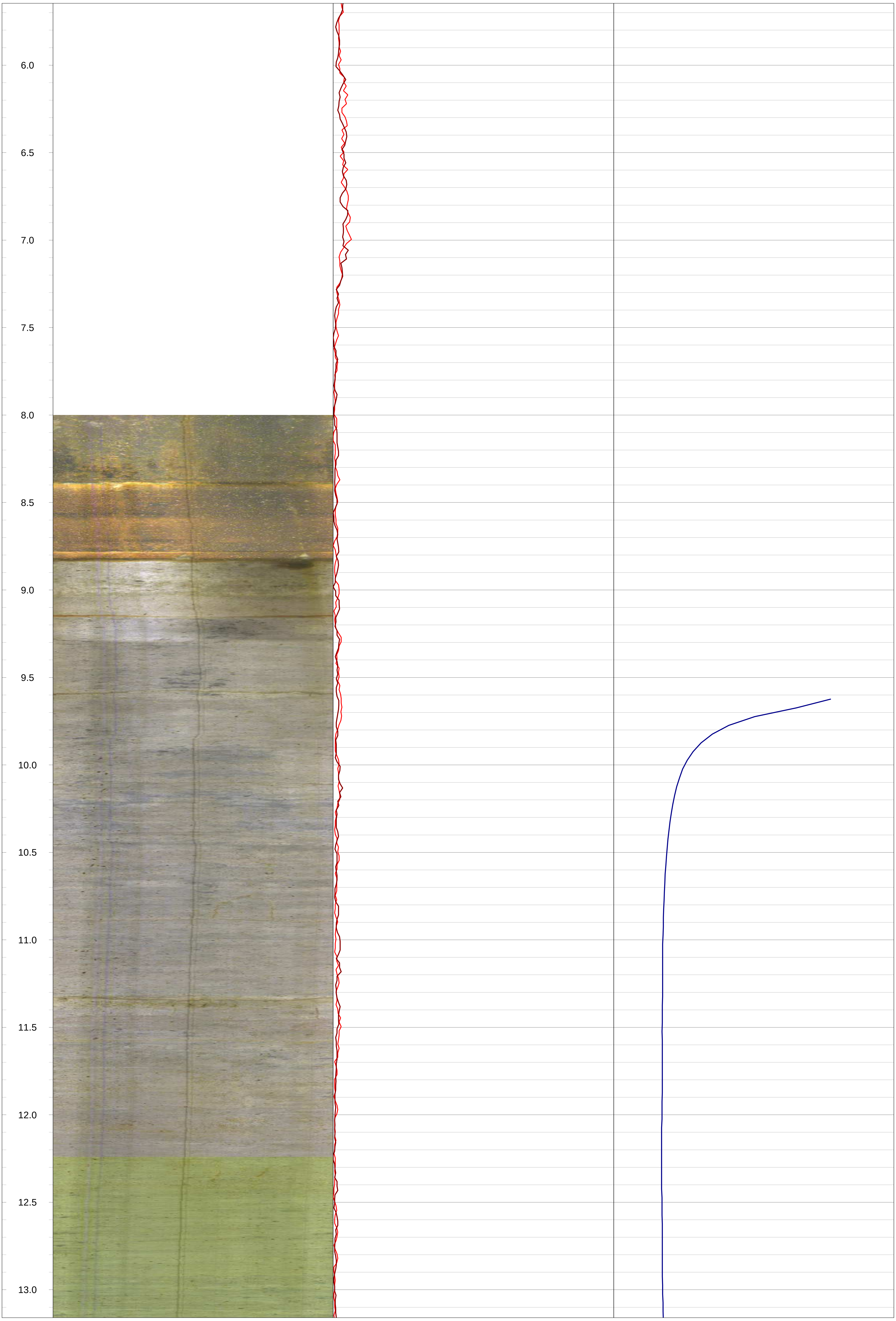
Geophysical Record of Borehole: BH20-06 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	8.83 m bgs	**Location:**	Caledon, Ontario
Easting:	578056.45 m	**Drilled Depth:**	16.60 m bgs	**Water Level:**	5.49 m bgs	**Log Date:**	Feb-25-2020
Northing:	4852520.24 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	397.70 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.51 m ags	**Logged By:**	CM

Notes:

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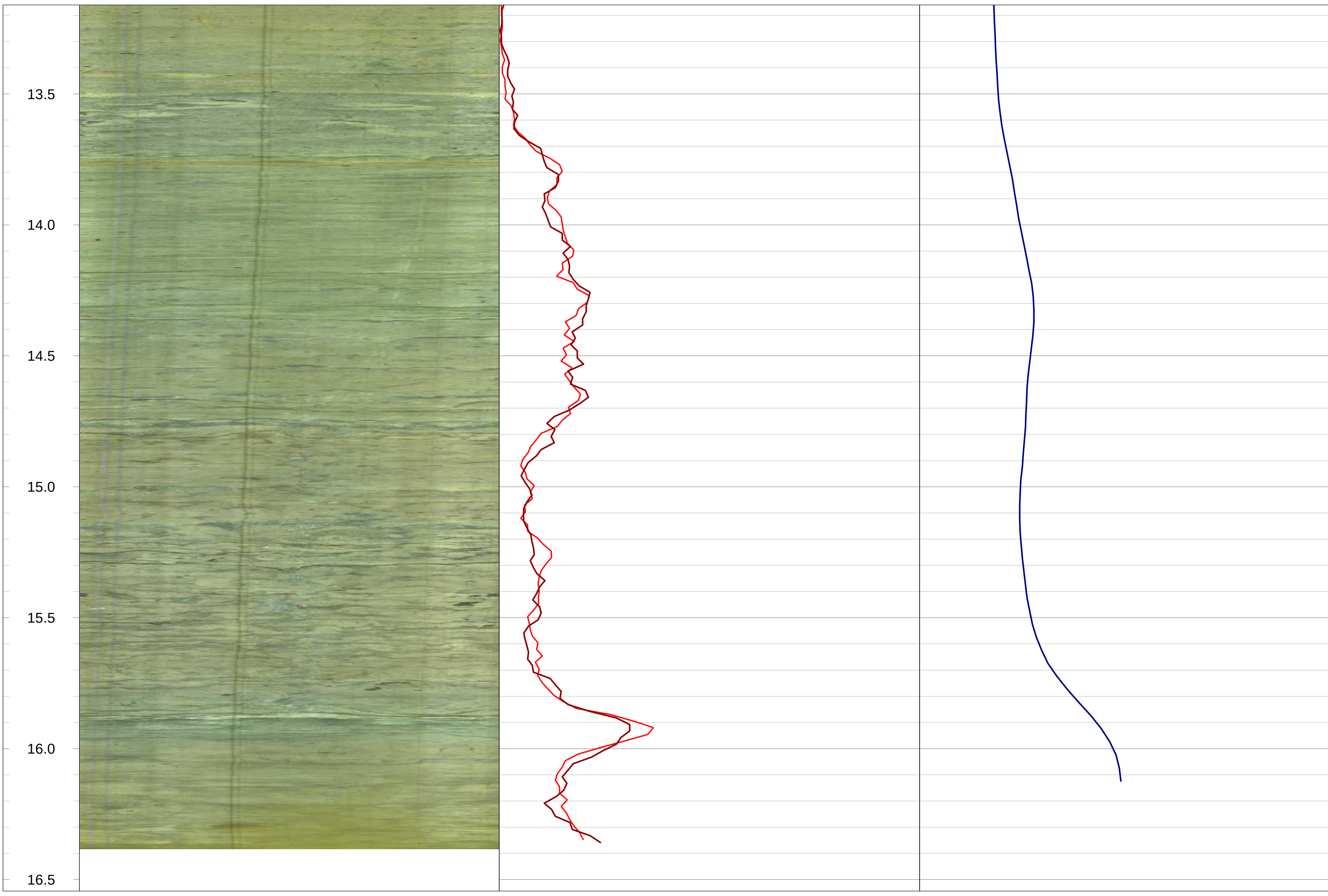
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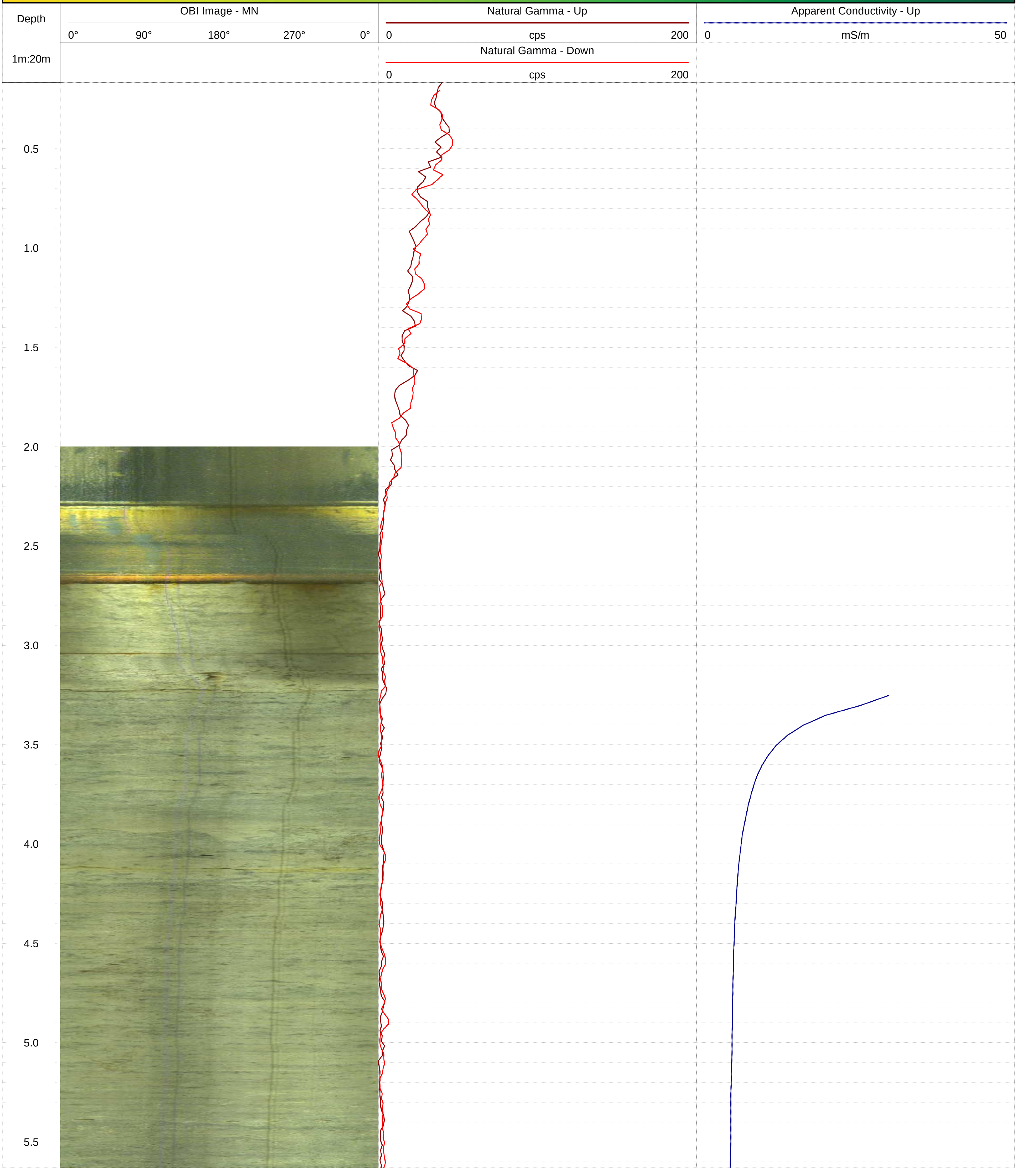
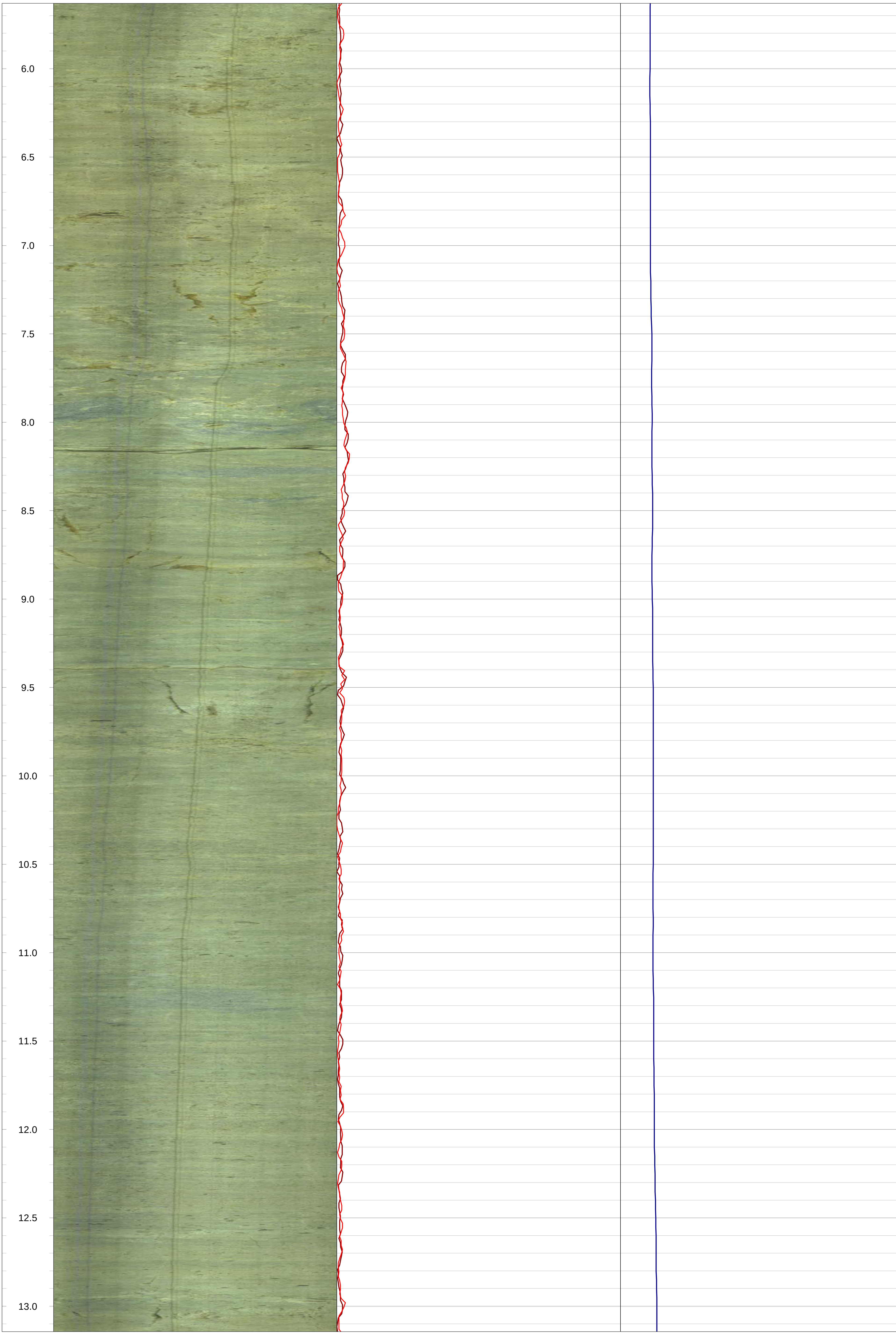
Geophysical Record of Borehole: BH20-07 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	2.69 m bgs	**Location:**	Caledon, Ontario
Easting:	578129.13 m	**Drilled Depth:**	18.67 m bgs	**Water Level:**	1.40 m bgs	**Log Date:**	Feb-25-2020
Northing:	4853102.34 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	404.73 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.50 m ags	**Logged By:**	CM

Notes: OBI image is dark >16.40 m bgs

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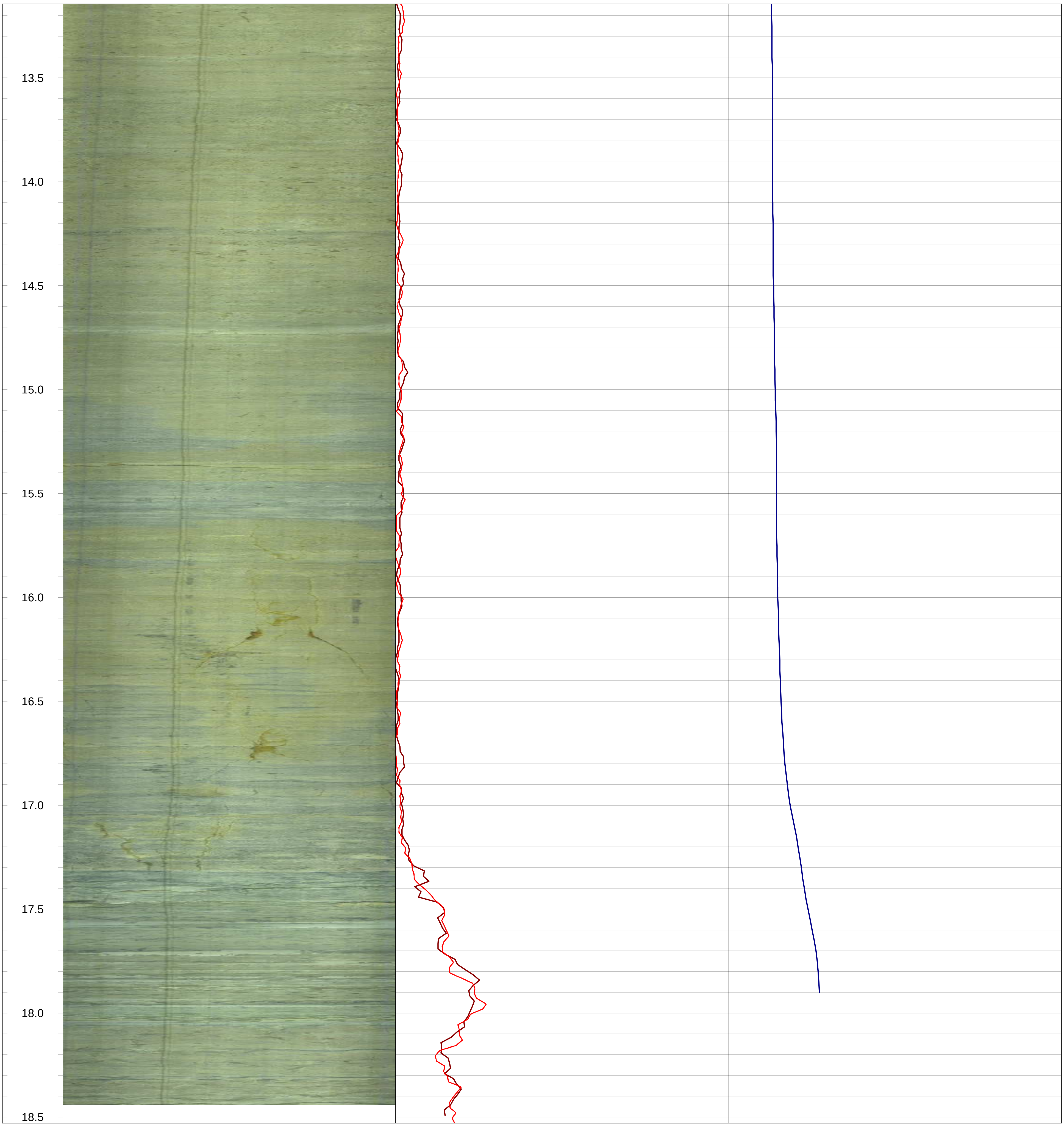
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Geophysical Record of Borehole: BH20-08 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	5.85 m bgs	**Location:**	Caledon, Ontario
Easting:	577961.99 m	**Drilled Depth:**	17.90 m bgs	**Water Level:**	6.64 m bgs	**Log Date:**	Mar-11-2020
Northing:	4852832.00 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	404.50 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.44 m ags	**Logged By:**	CM

Notes:

Depth	OBI Image - MN	Natural Gamma - Down	Apparent Conductivity - Up
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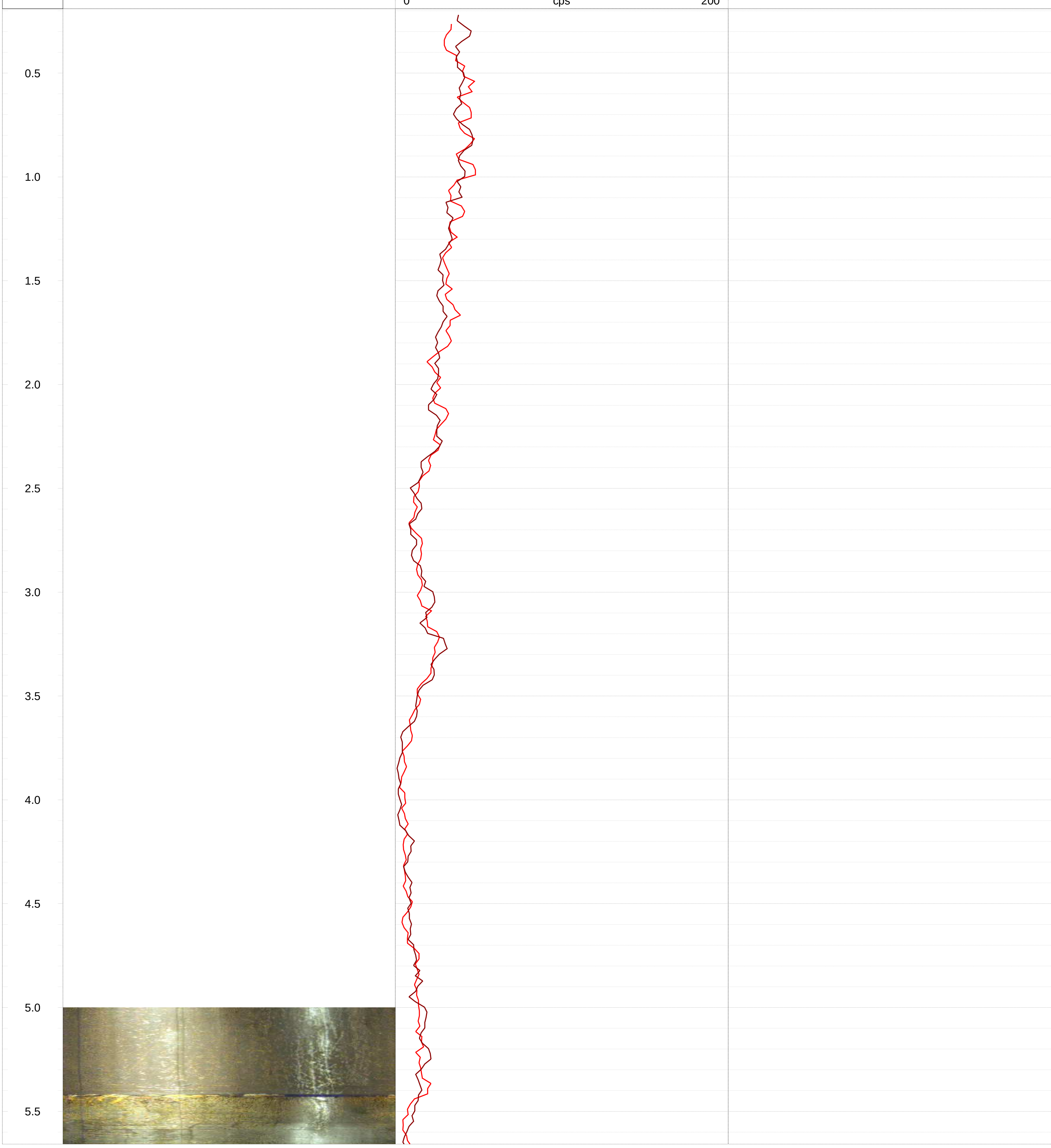
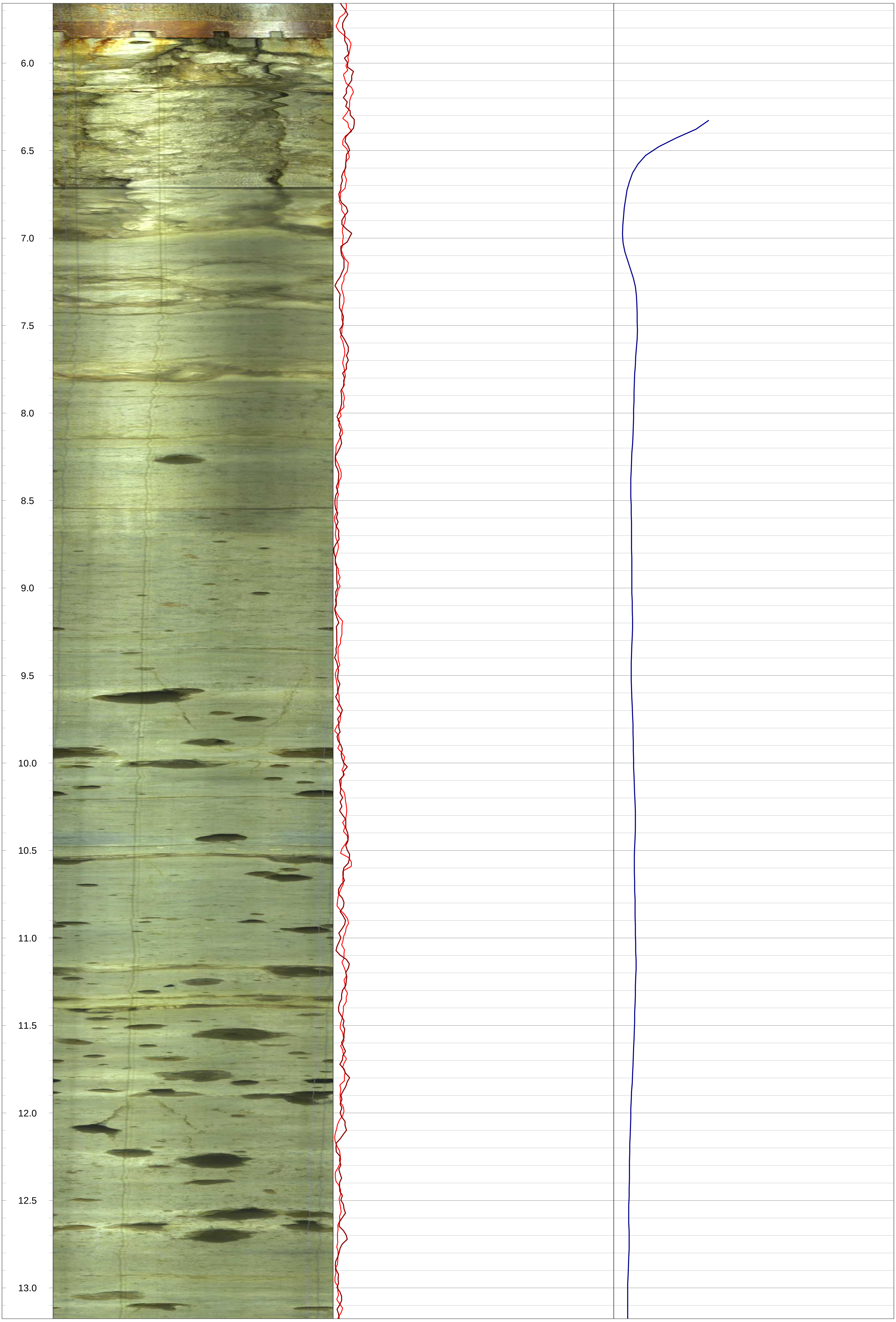
1m:20m		Natural Gamma - Up	
		0 cps 200	

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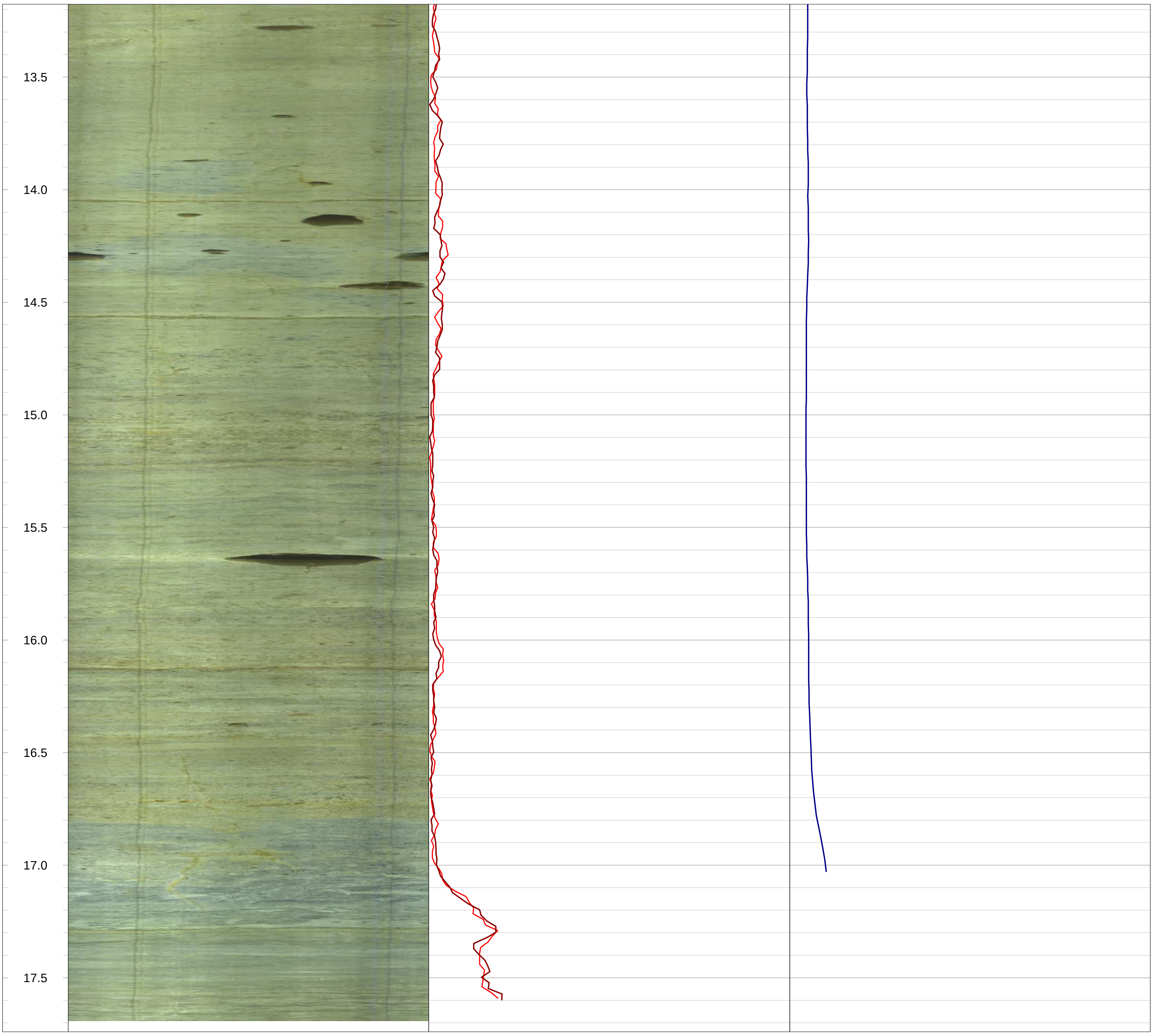
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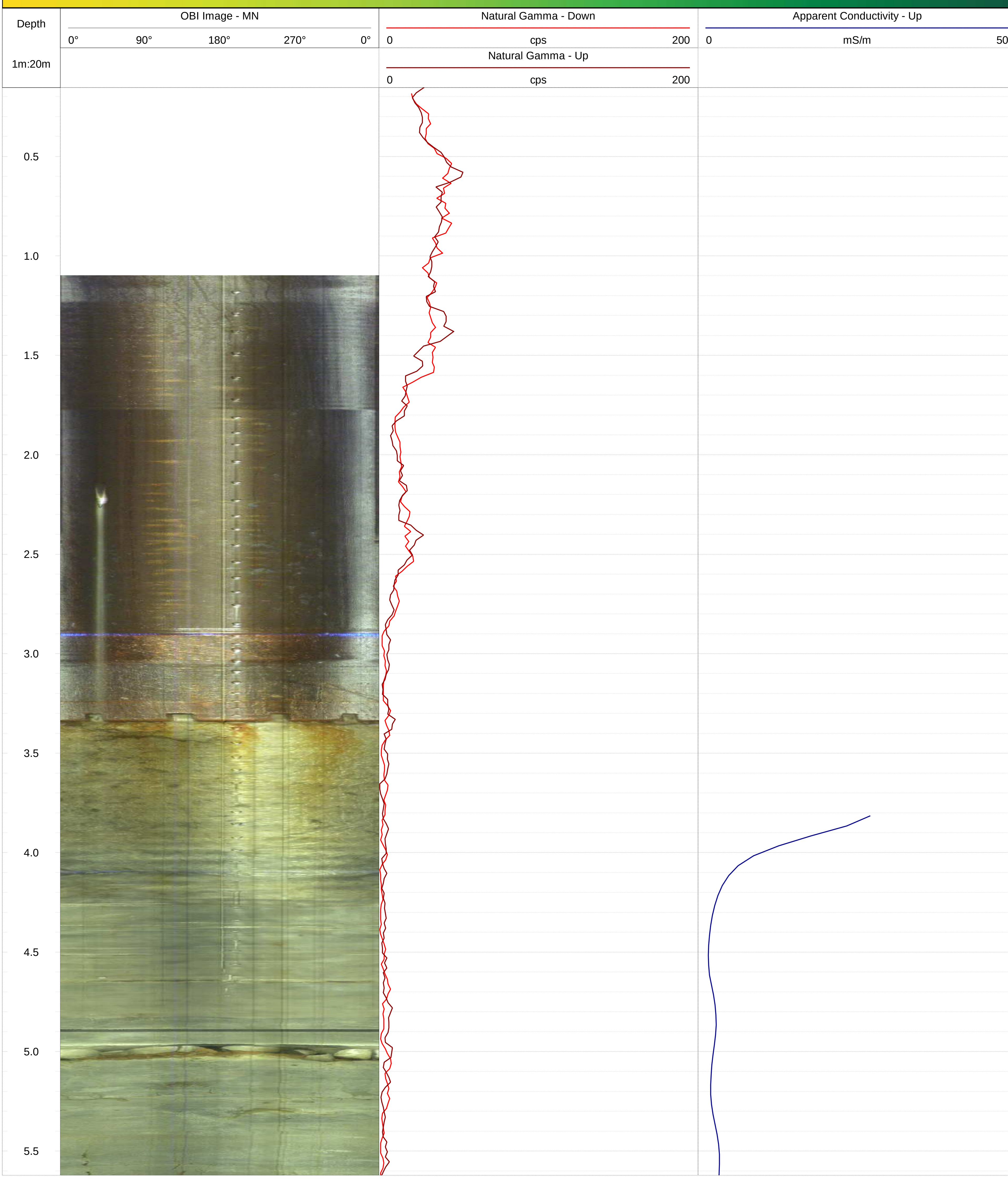
GOLDER
MEMBER OF WSP

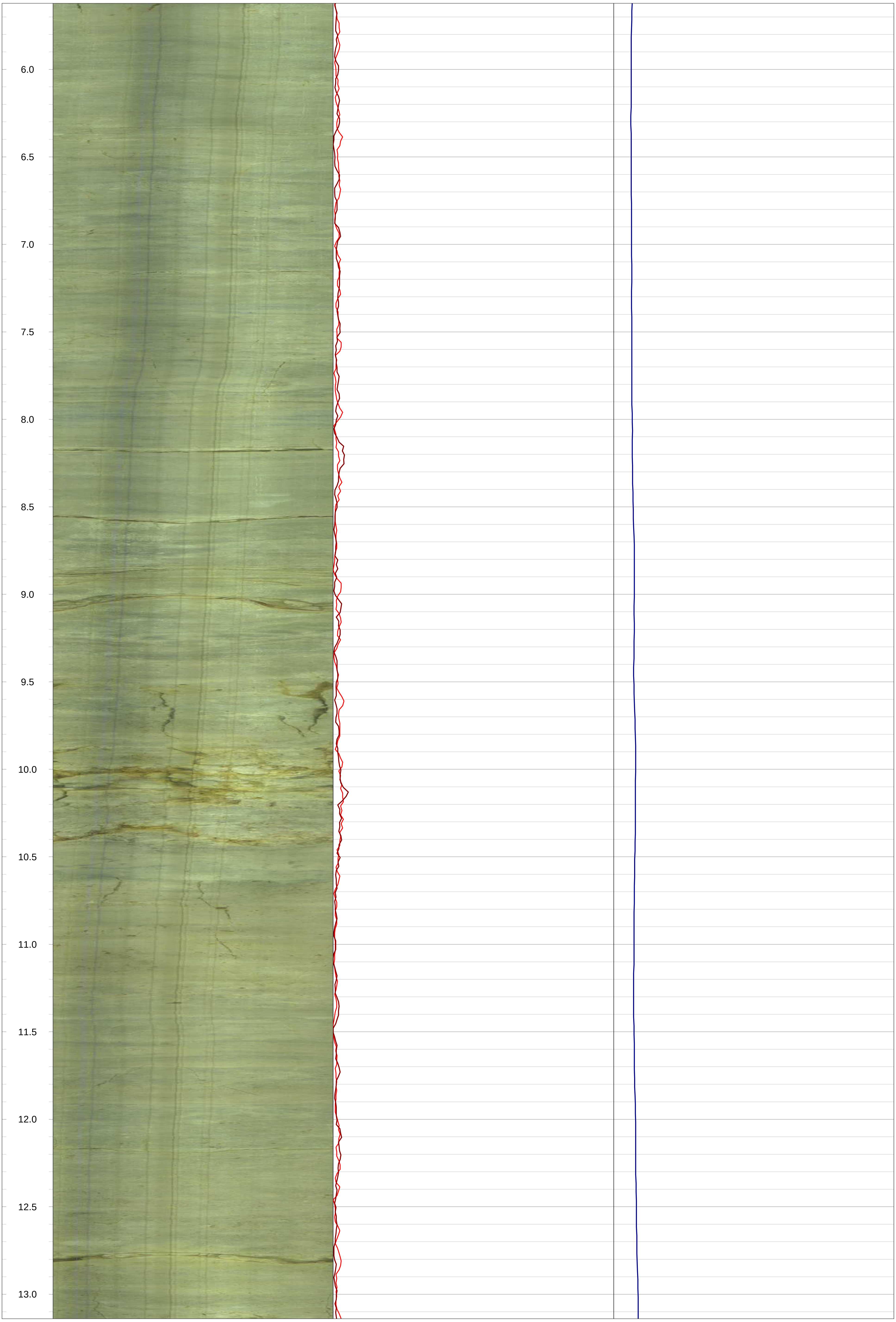
Geophysical Record of Borehole: BH20-09 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	3.33 m bgs	**Location:**	Caledon, Ontario
Easting:	578186.33 m	**Drilled Depth:**	16.77 m bgs	**Water Level:**	4.95 m bgs	**Log Date:**	Mar-10-2020
Northing:	4852803.00 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	402.26 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.52 m ags	**Logged By:**	CM

Notes:

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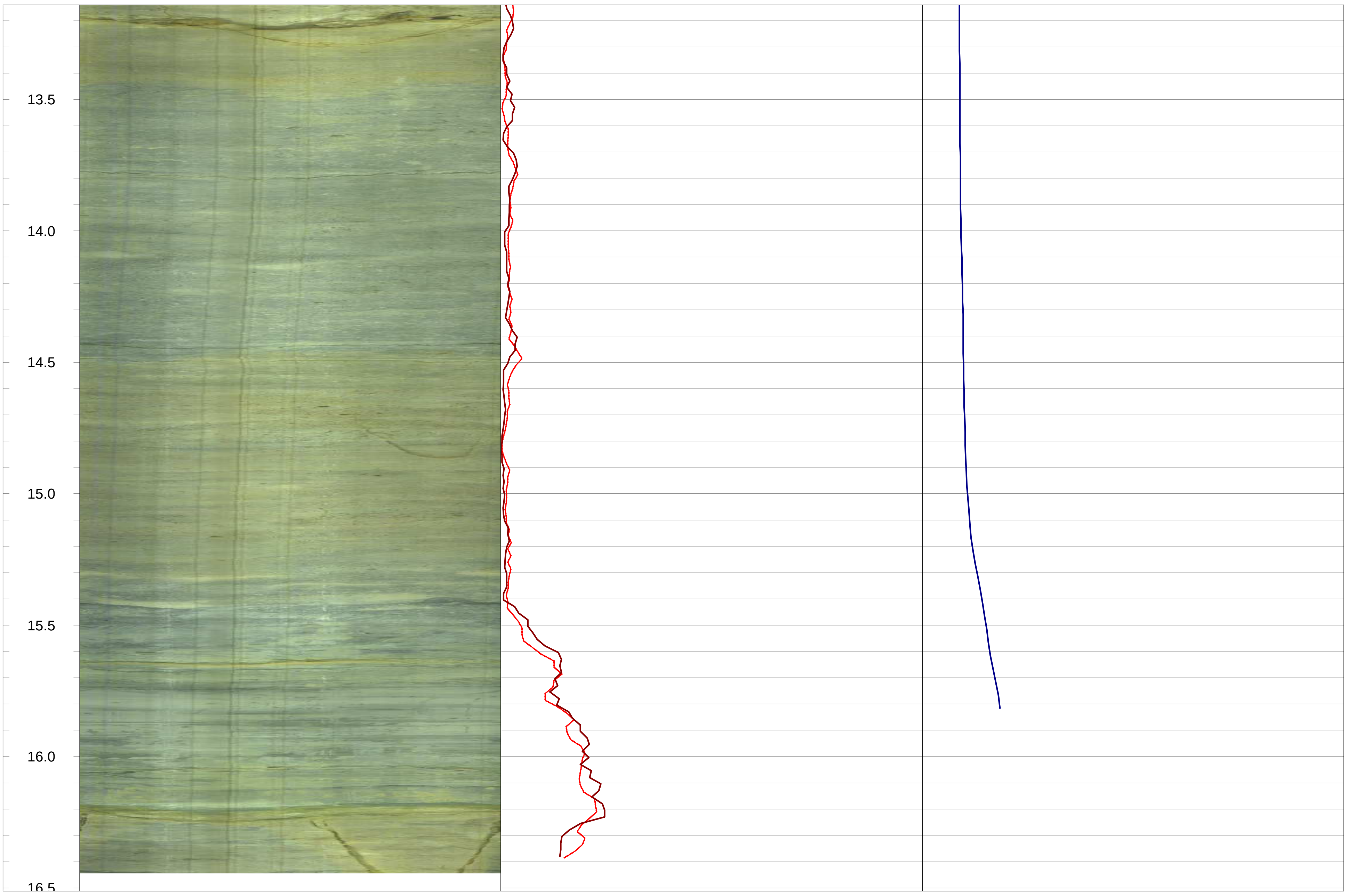
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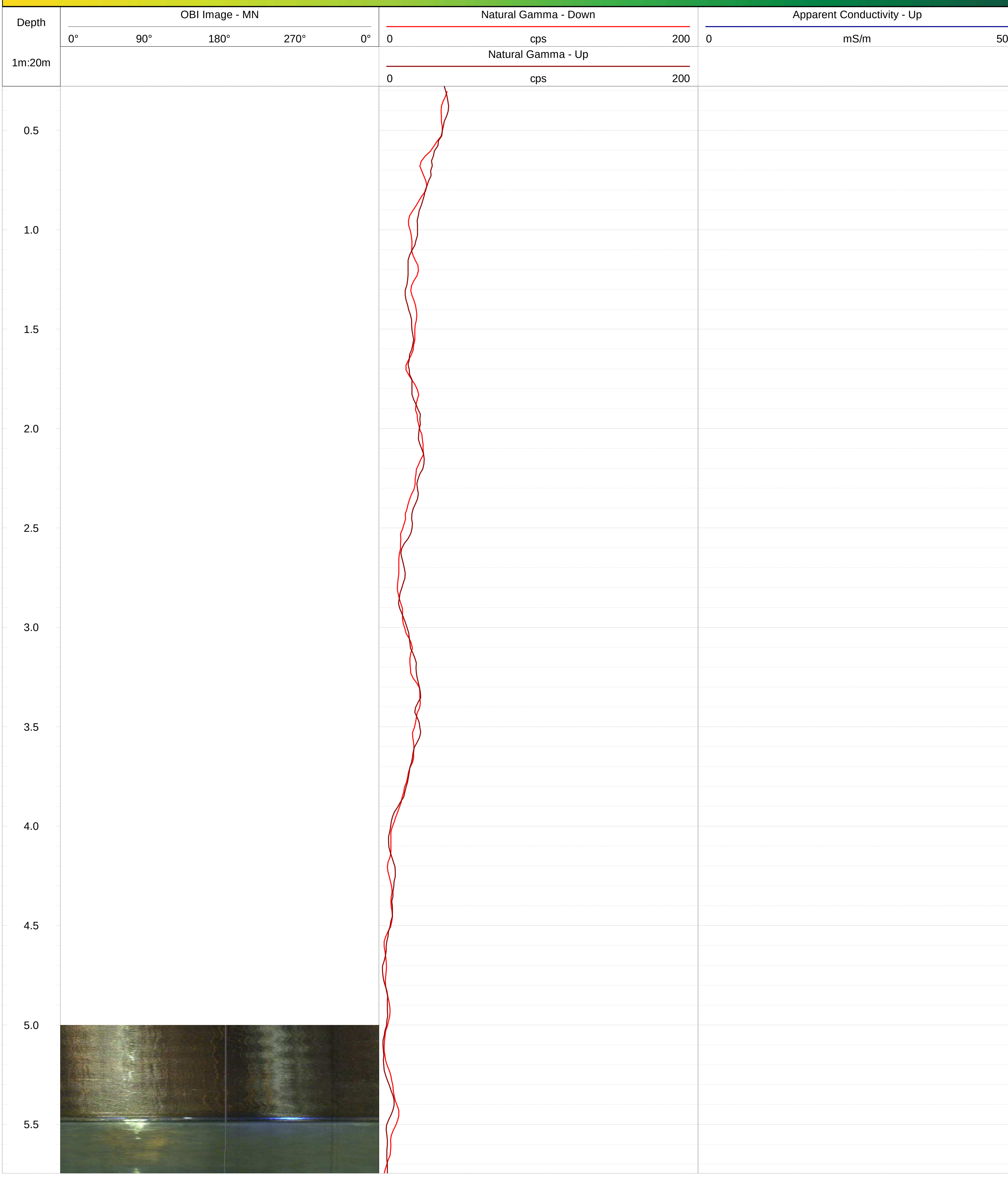
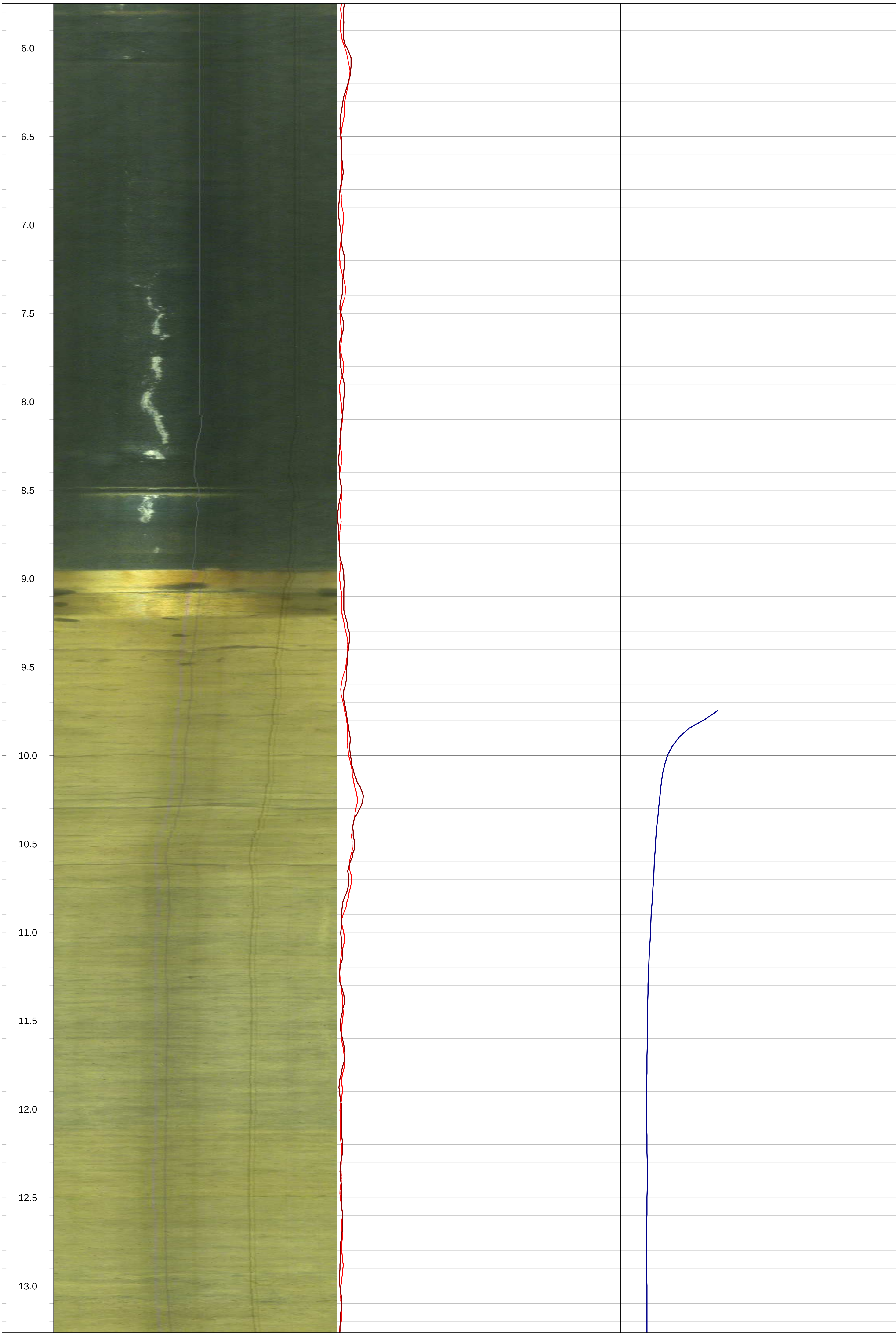
Geophysical Record of Borehole: BH20-10 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	8.94 m bgs	**Location:**	Caledon, Ontario
Easting:	577940.09 m	**Drilled Depth:**	19.55 m bgs	**Water Level:**	5.29 m bgs	**Log Date:**	Mar-25-2020
Northing:	4853952.34 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	411.07 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.40 m ags	**Logged By:**	PG

Notes:

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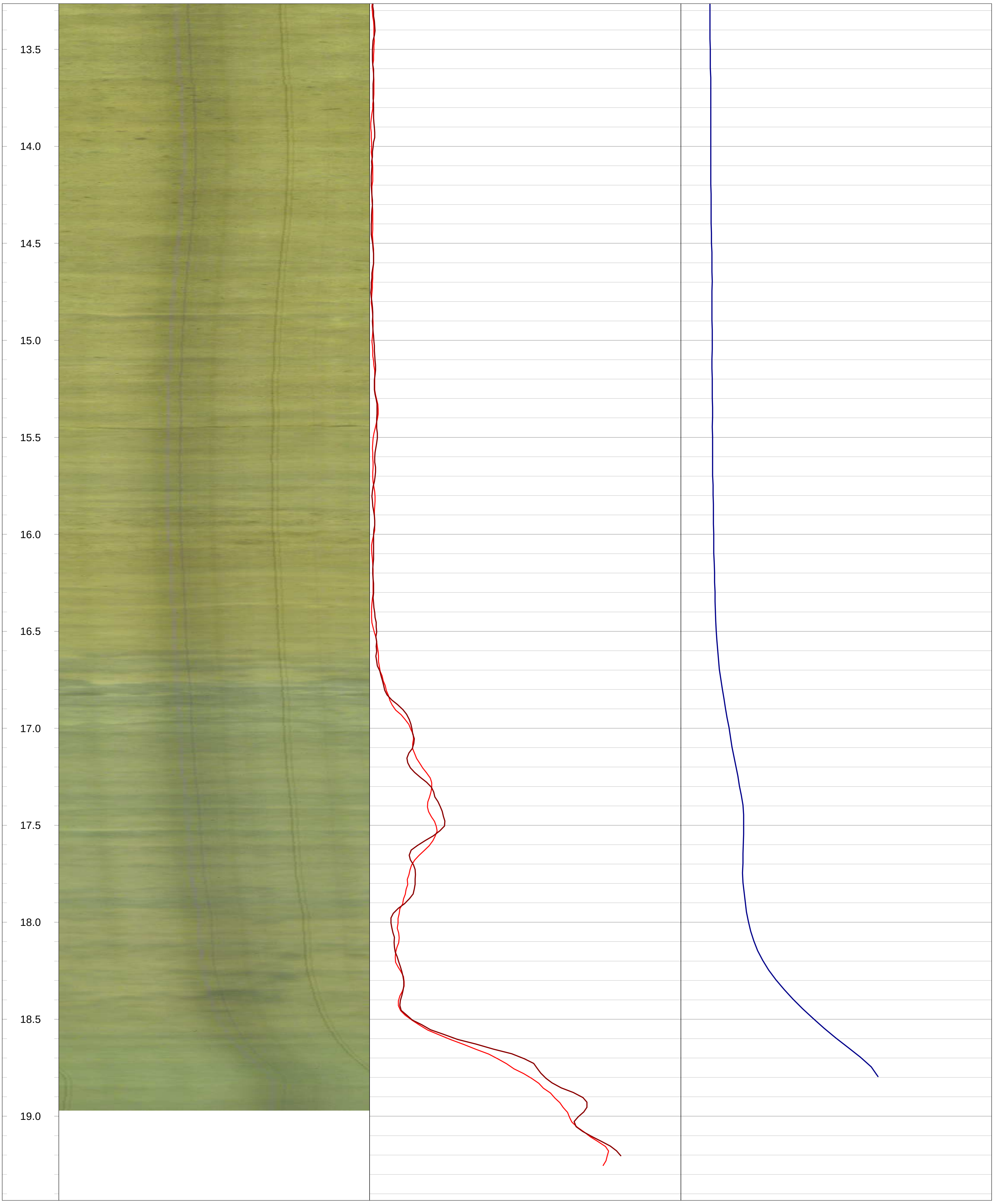
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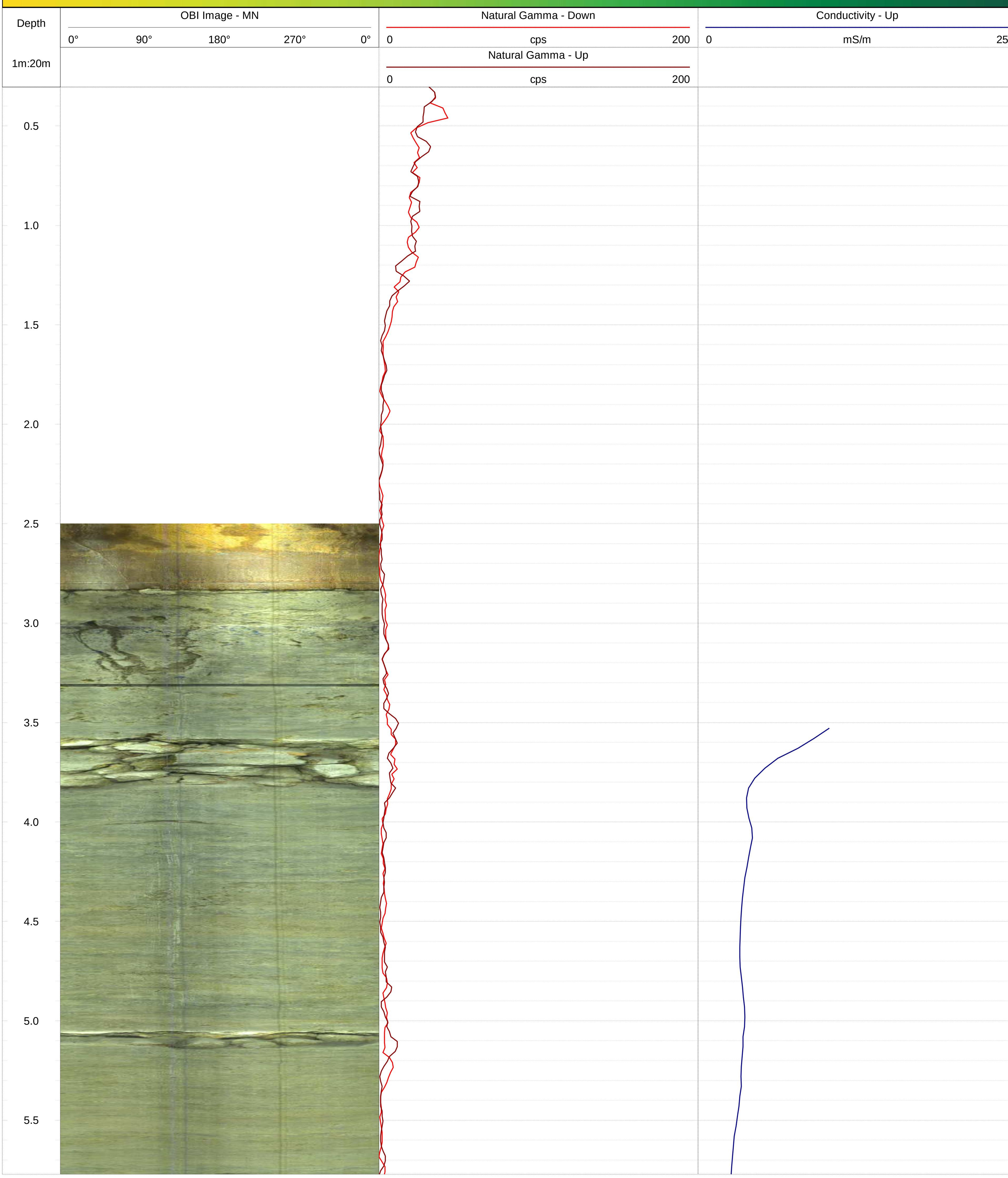
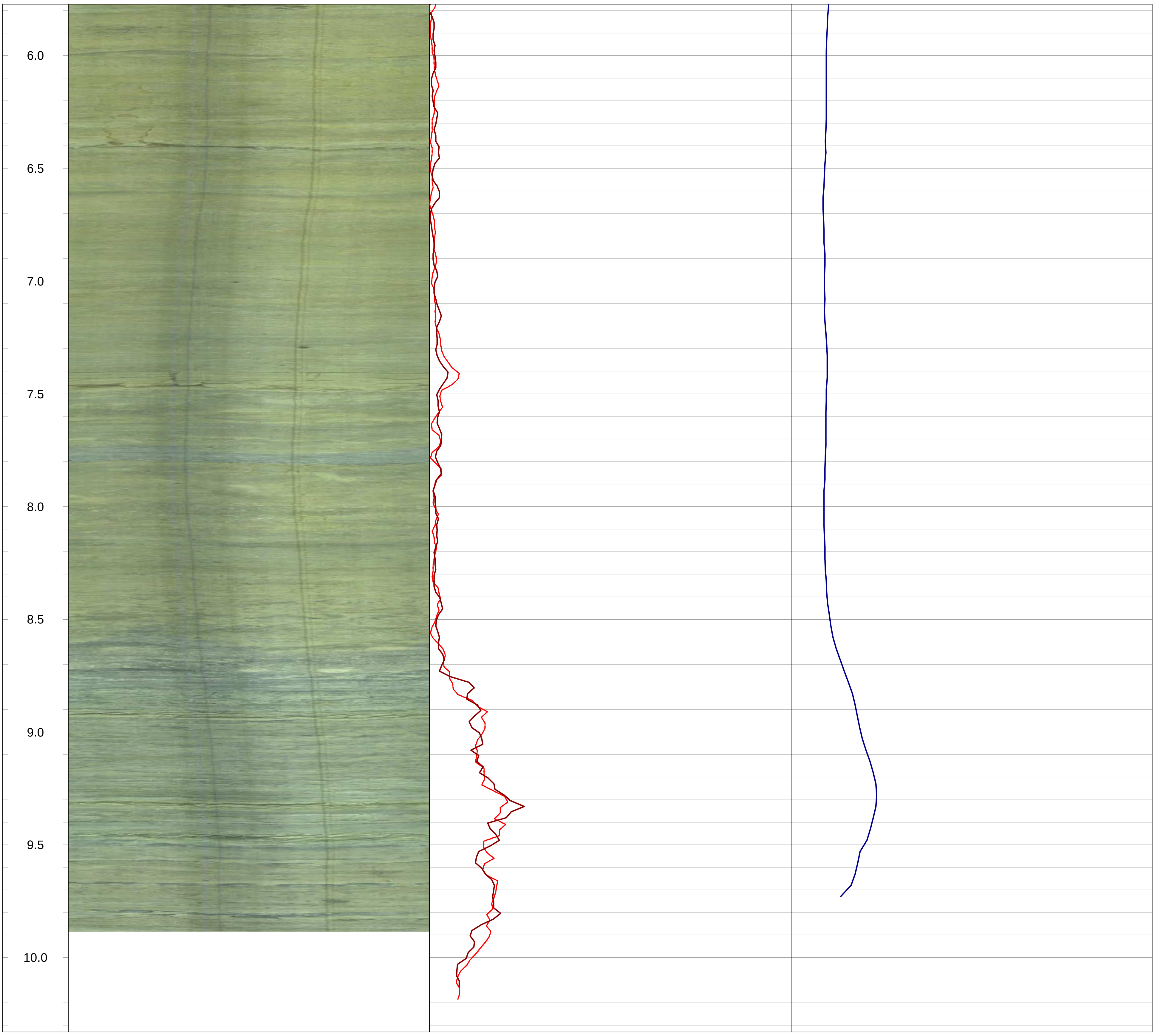
Geophysical Record of Borehole: BH20-11 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	2.83 m bgs	**Location:**	Caledon, Ontario
Easting:	578065.10 m	**Drilled Depth:**	10.20 m bgs	**Water Level:**	3.33 m bgs	**Log Date:**	Mar-26-2020
Northing:	4854240.45 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	402.10 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.36 m ags	**Logged By:**	PG

Notes: OBI image opaque > 9.95 m

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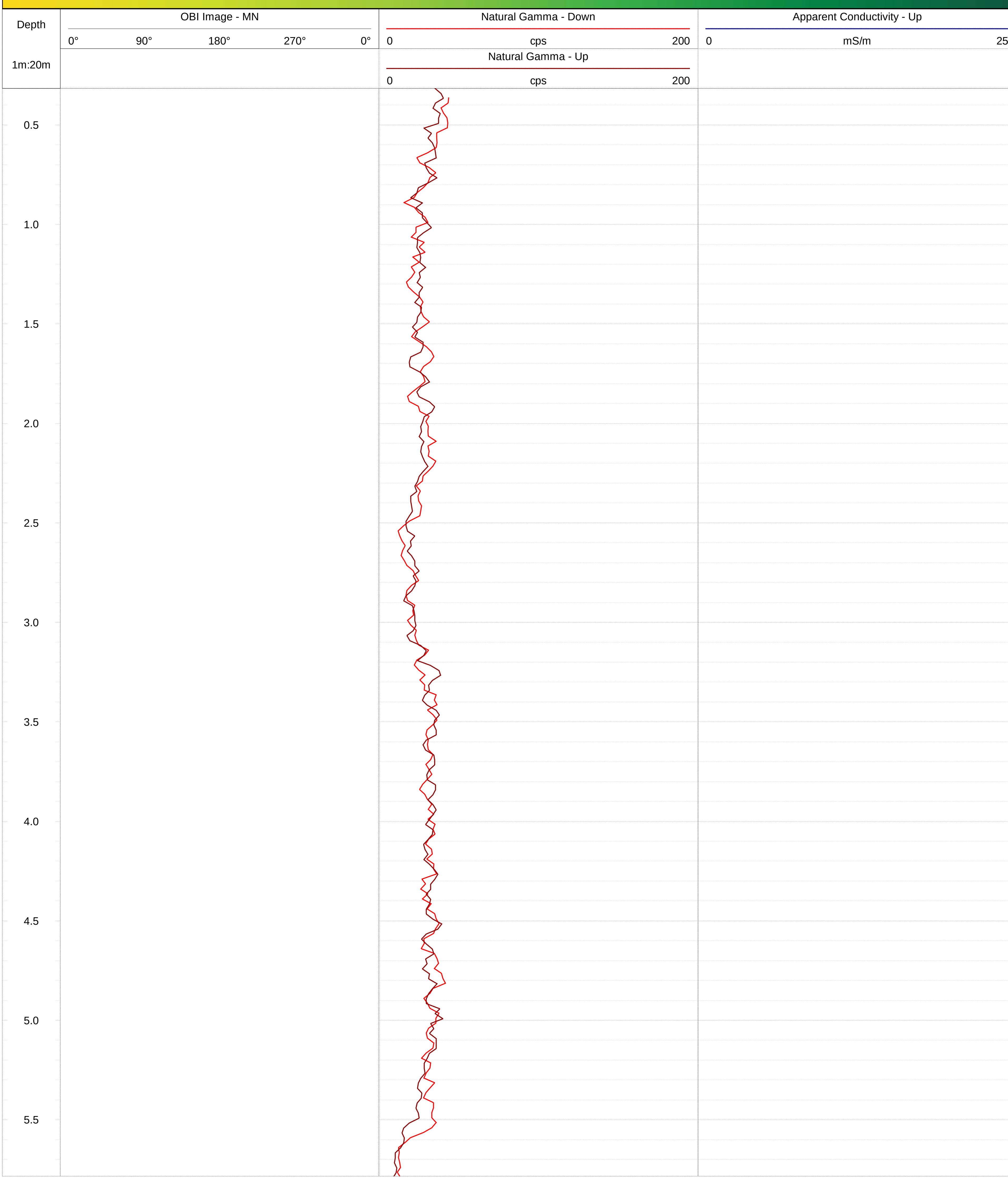
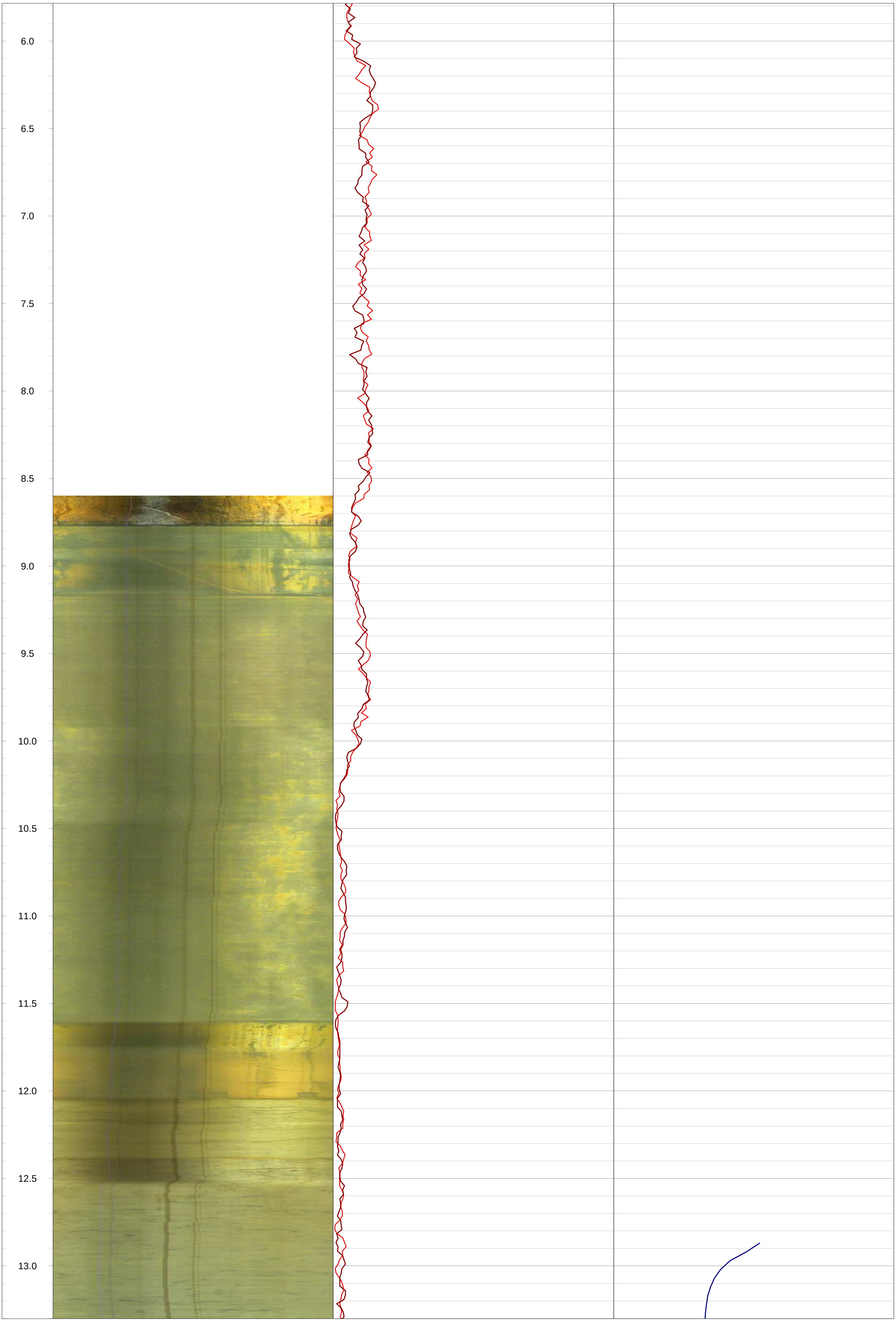
Geophysical Record of Borehole: BH20-12 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	12.04m bgs	**Location:**	Caledon, Ontario
Easting:	577780.56 m	**Drilled Depth:**	21.76 m bgs	**Water Level:**	8.77 m bgs	**Log Date:**	Mar-25-2020
Northing:	4854244.92 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	415.22 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.35 m ags	**Logged By:**	PG

Notes:

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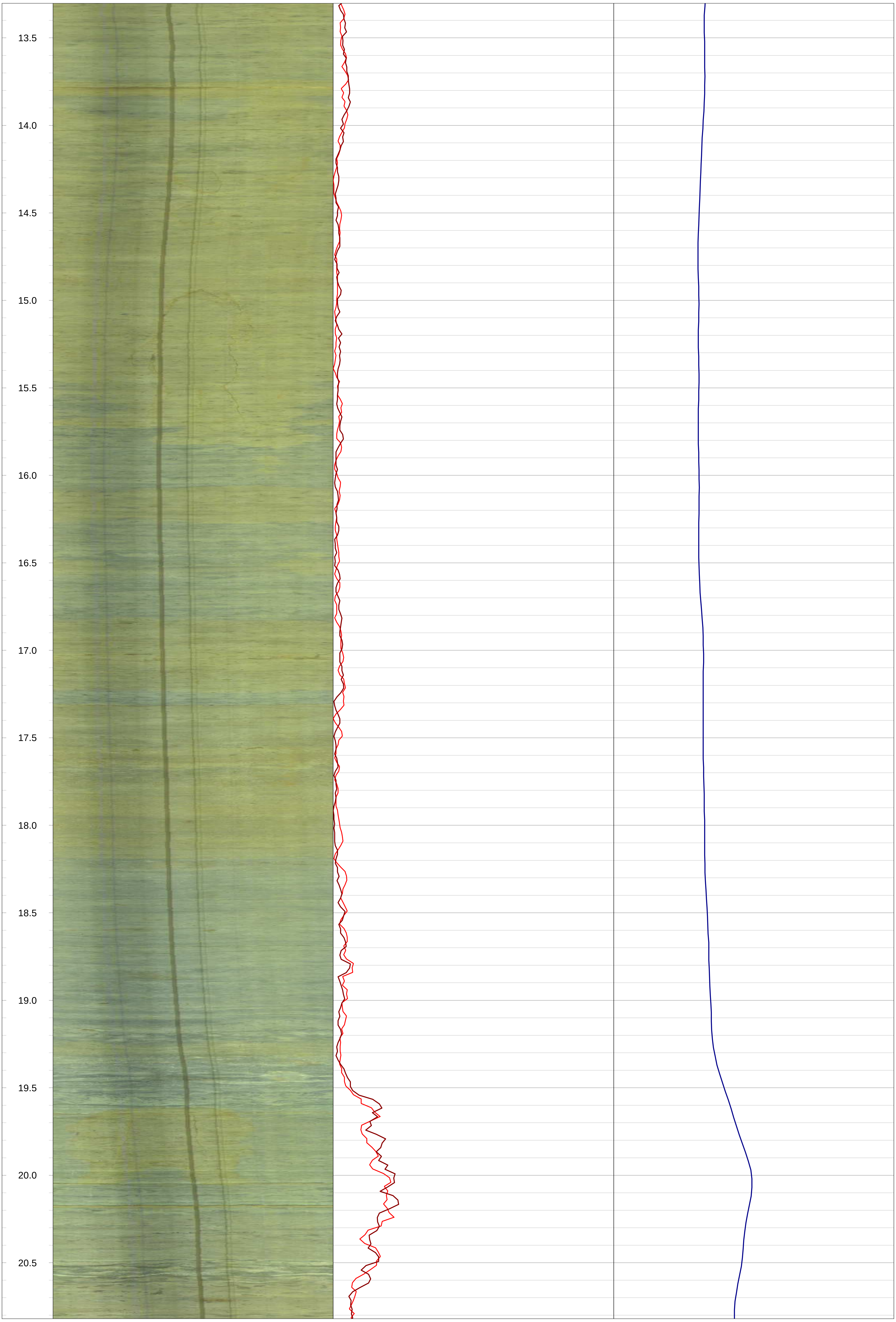
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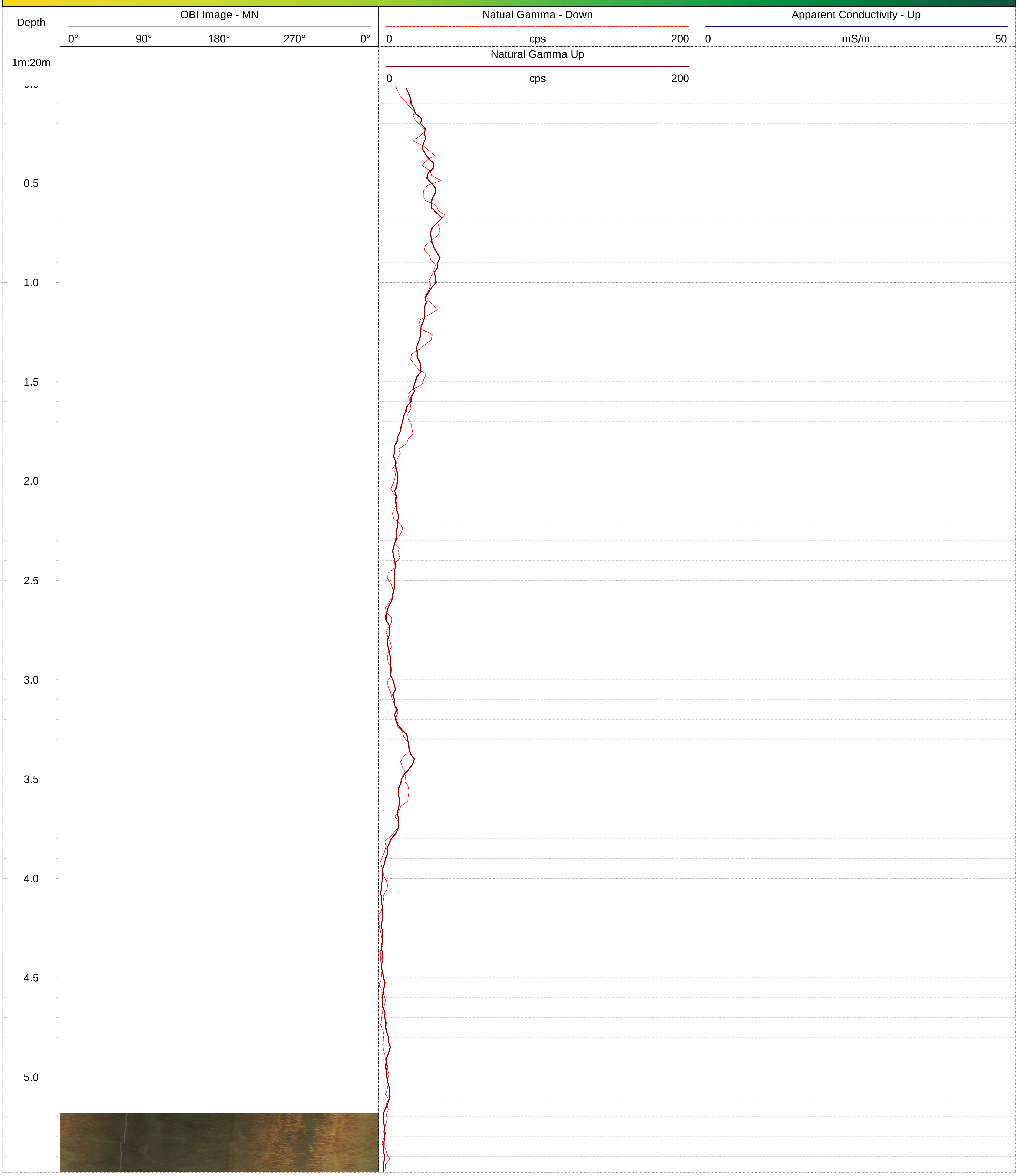
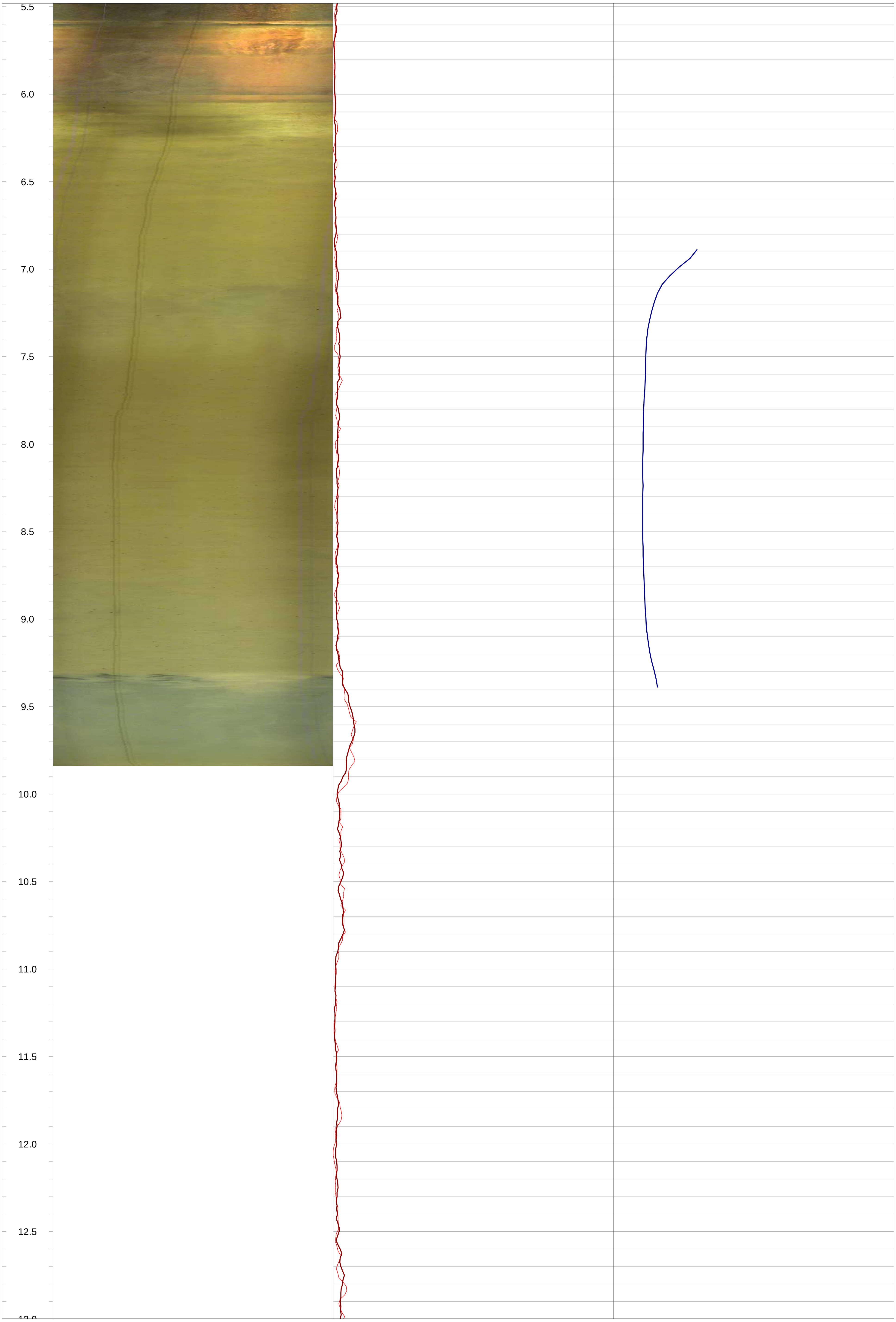
Geophysical Record of Borehole: BH20-13 (CAL)

Log Title:	Geophysical Log
Project Number:	19129150
Client:	St. Marys Cement Inc. (Canada)
Date:	October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	5.99 m bgs	**Location:**	Caledon, Ontario
Easting:	577209.70 m	**Drilled Depth:**	22.80 m bgs	**Water Level:**	3.48 m bgs	**Log Date:**	Apr-14,20-2020
Northing:	4854103.25 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	412.94 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.46 m ags	**Logged By:**	PG

Notes: Blockage at 9.84 m. Gamma survey was completed with drill casing in place due to poor hole condtions.

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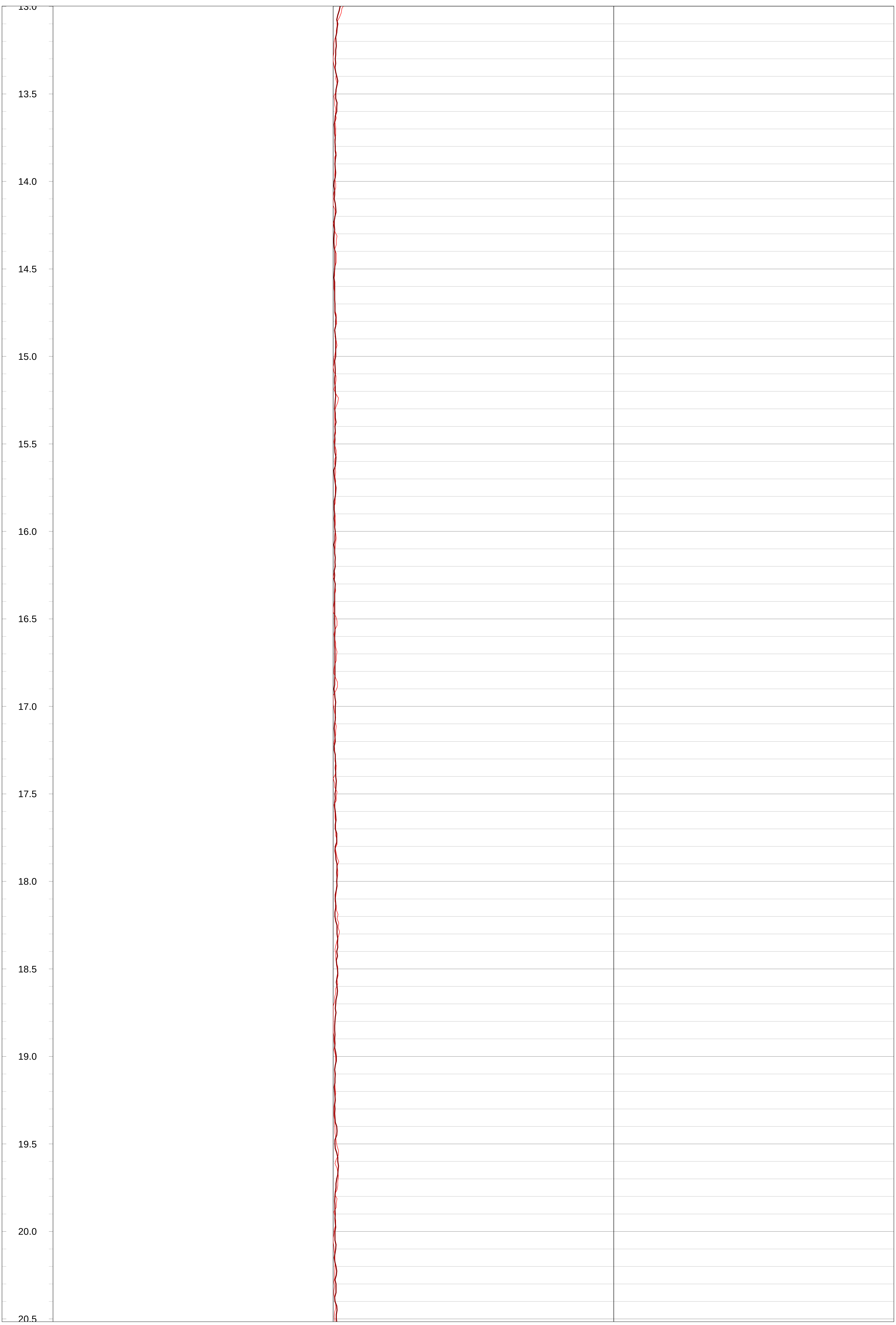
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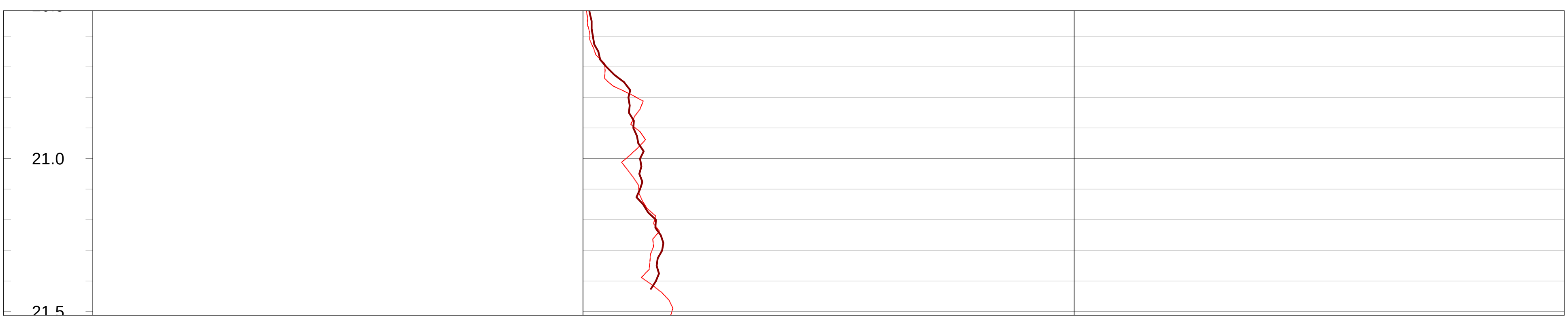
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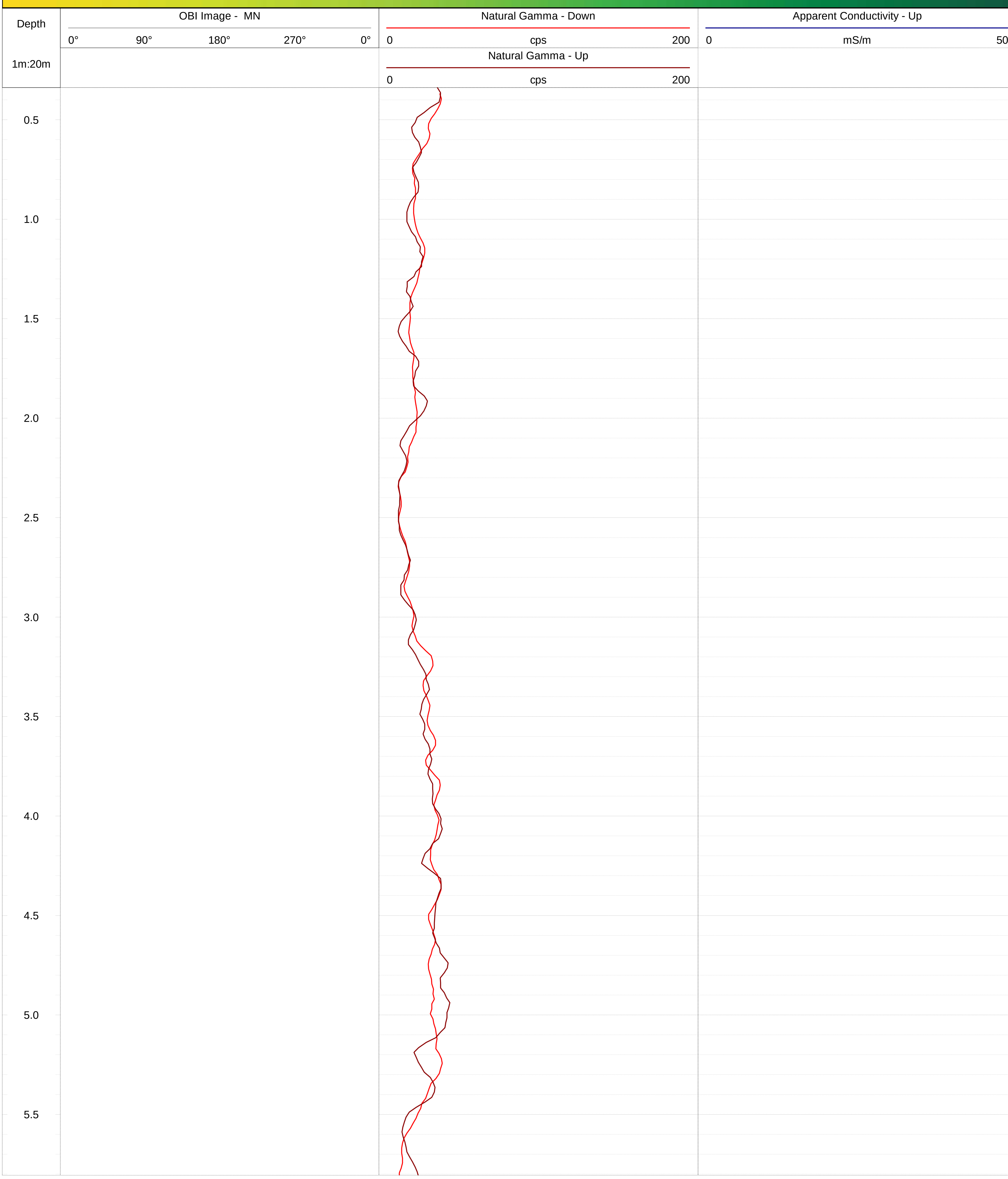
GOLDER
MEMBER OF WSP

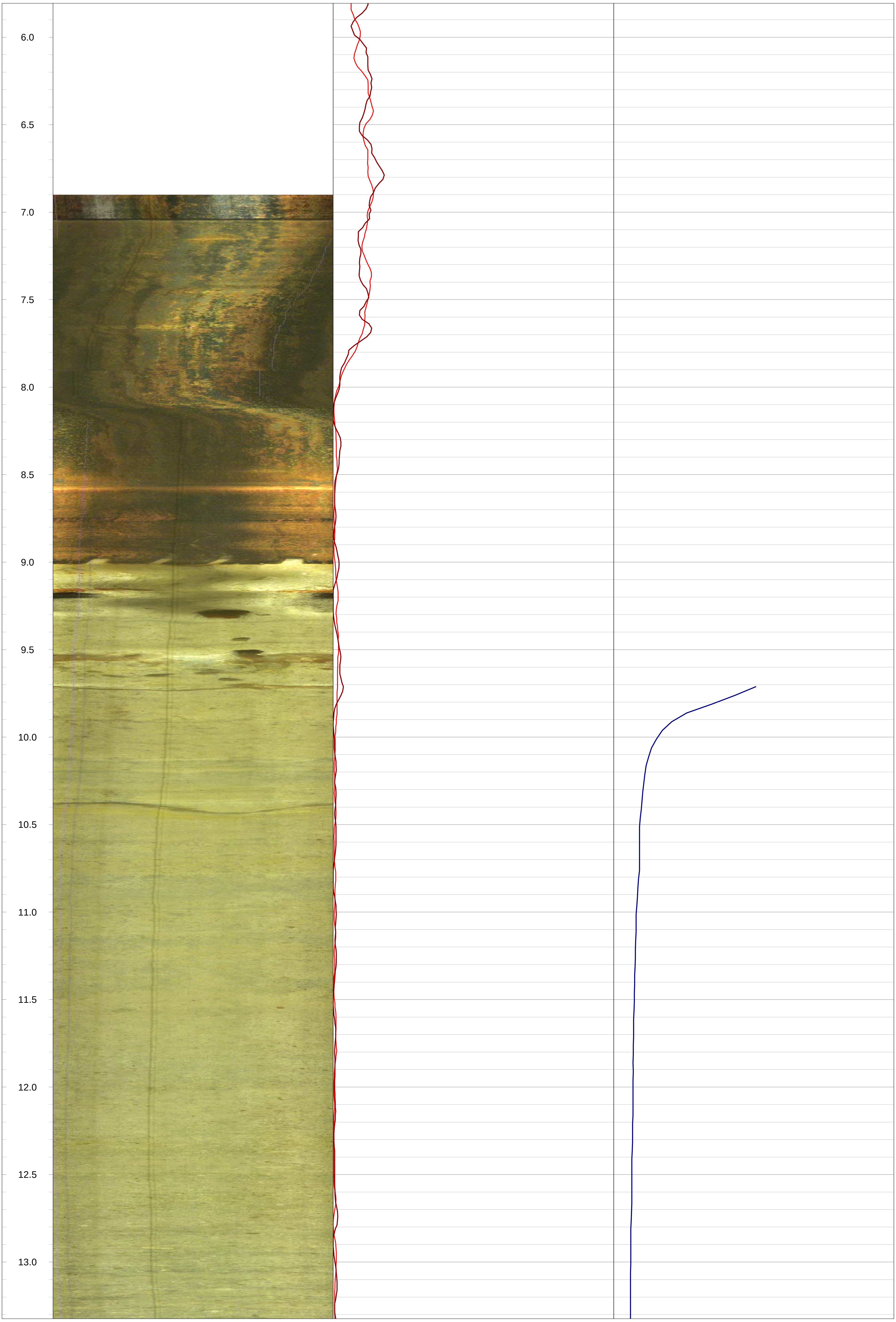
Geophysical Record of Borehole: BH20-14 (CAL)

Log Title: Geophysical Log
Project Number: 19129150
Client: St. Marys Cement Inc. (Canada)
Date: October 2021

Datum:	NAD83, UTM Zone 17N	**Depth Reference:**	"0" at Ground	**Casing Depth:**	8.99 m bgs	**Location:**	Caledon, Ontario
Easting:	577288.55 m	**Drilled Depth:**	31.46 m bgs	**Water Level:**	6.79 m bgs	**Log Date:**	Apr-14-2020
Northing:	4853881.70 m	**Borehole Diameter:**	HQ	**Borehole Inclination:**	0 degs		
Elevation:	417.27 m asl	**Casing Diameter:**	152 mm	**Casing Stickup:**	0.46 m ags	**Logged By:**	PG

Notes:

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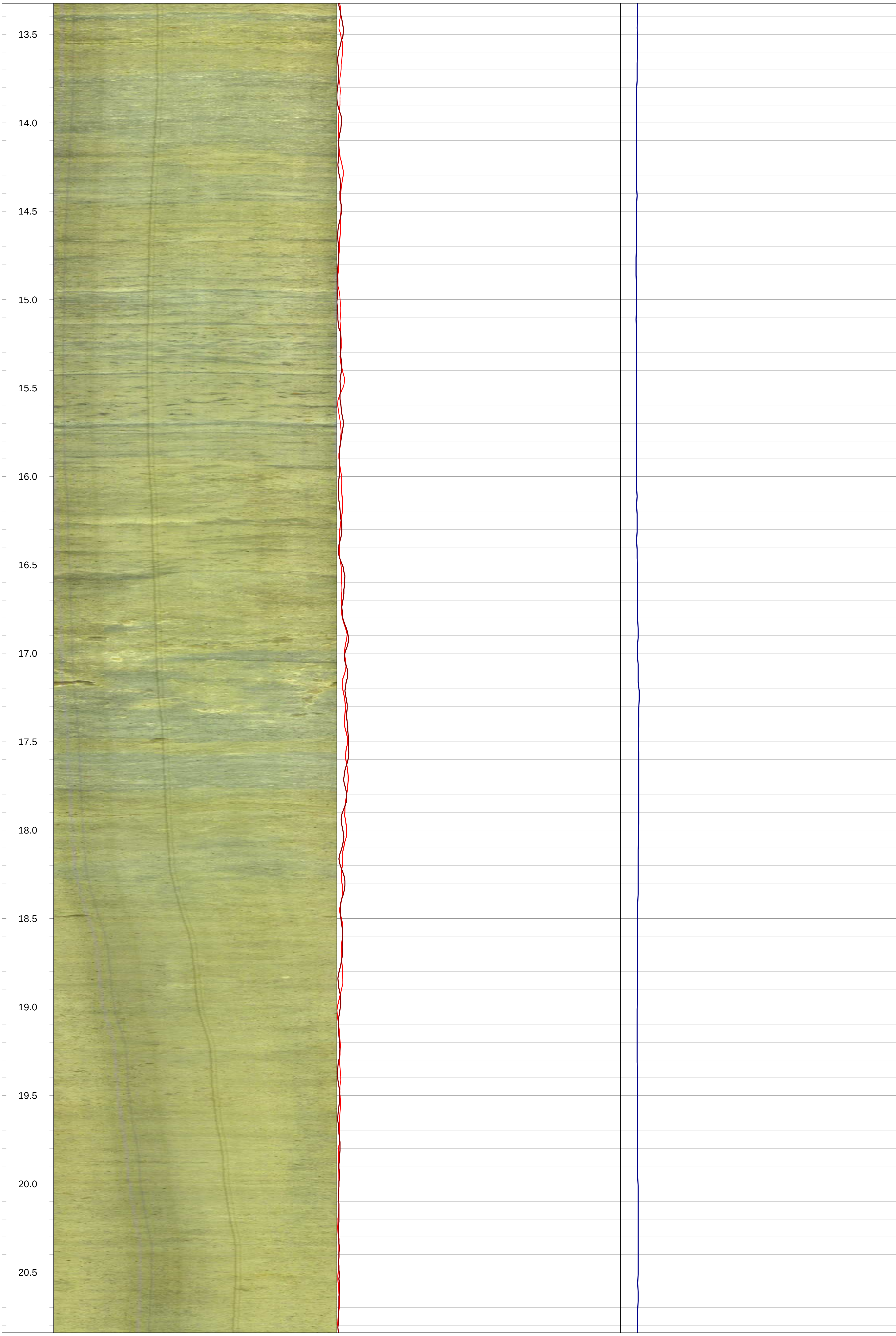
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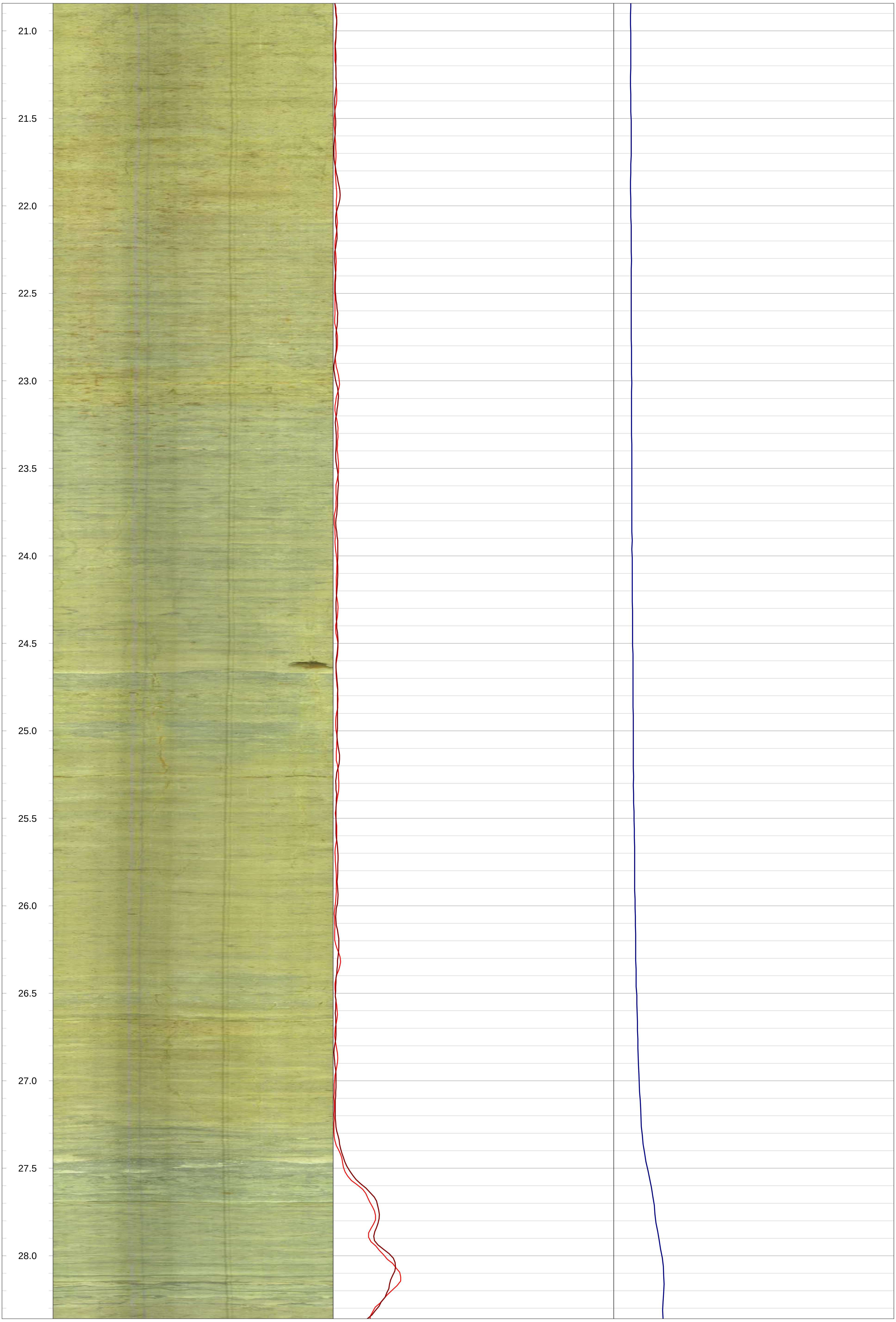
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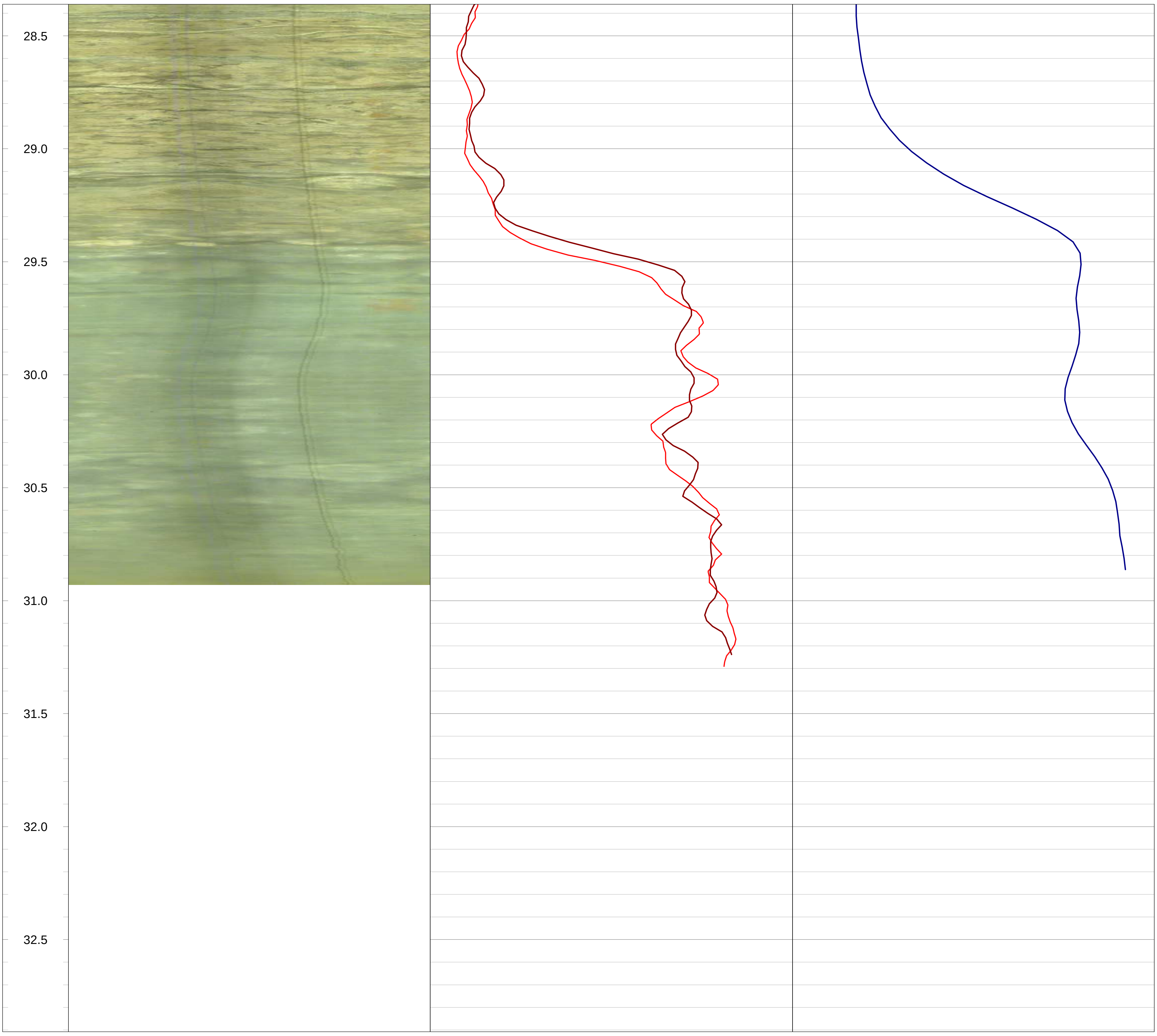
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